

THE FIRST
VALUE ANALYSIS SEMINAR

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FIRST VALUE ANALYSIS SEMINAR

**VALUE
ANALYSIS
TRAINING PROGRAM**

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VALUE ANALYSIS TECHNIQUES, METHODS, AND INFORMATION
AS PREPARED FROM THE PROCEEDINGS OF
THE VALUE ANALYSIS SEMINAR
of
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in
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VALUE ANALYSIS UNIT
MATERIALS SERVICES DEPARTMENT
MANUFACTURING SERVICES DIVISION

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FIRST DAY, 6 OCTOBER, 1952 - MORNING.10:00 A.M. - Welcome - L. D. Miles

I'd like to welcome all 58 of you from 39 departments. I think it's wonderful to have you all here. We are expecting each of you to at least double your value to the General Electric Co. and possibly to yourself during the next 30 days. We expect you, without exception, to be able to earn \$10 to \$25 for every dollar which it takes to support you and your office. I was delighted when I saw the list of men who were coming. We have a group of experienced men here. Some of you are beginners - fine! But look! We have Claude Watt who has headed the Value Analysis Program of Canadian G. E. and who has done such a fine job in using value analysis to motivate the overall cost reduction program that I heard Mr. Corkery, Vice President of Canadian G. E. say that in three years of value analysis they just completed a cost reduction of 5 million dollars this year which was doubled last year and 10 times the year before. Fellows, that's the way value analysis pays when fellows take the ball and run with it.

Then we have Mark Taylor from Lynn, from our Meter Operations. Mark has done an outstanding job. He's taken costs out of products such as watthour meters. We have Alf Spicer from Peterboro. Alf is an experienced engineer. He knows value improvement; he knows how to get it done. You'll meet all of these fellows.

We have Bob Strobe from the Meter Department in Lynn - Value Analyst - experienced in eliminating unnecessary costs. We have Milton Rome from Schenectady - engineer in the Purchasing Department doing this type of work - experienced. We have Stevens from Locke, Inc.; an engineer who even 10 years ago was a leader in this type of thinking. He brought into Locke designs and suppliers who gave them fabricated caps when every one said you could use nothing but cast or forged caps for porcelain insulators.

We have Kane, an experienced engineer doing this type of work. We have Sitterly who comes from Lockland. Sitterly is a Supervisor of Methods and Planning; has operated a group and done an outstanding job of it.

Now, fellows, please don't feel left out if I don't mention your name. I'm calling a few of the fellows I know personally. And there are a number of engineers who have done an outstanding job in their own areas and are swell engineers and fellows personally. Here are some of them I know, and again, my apologies for not knowing all of you. I'll soon take care of that. Stanton from Refrigerators at Erie; Sullivan, chemical engineer; Purdy, Creative Engineering Program; Odom, from our Gas Turbine business - one of the Government areas of Lynn; Coughlin, another outstanding engineer; Hvamb who has had varied engineering experiences throughout a period of five years in this country; and Europe

Carlson, an outstanding young engineer from Erie; Heckman, whom many of you know, now in our Appliance Control Department out West. That's just a few. Look what we've got: If we don't hatch something out of this, I'll miss my guess.

We've been asked to send our program to many people so that they can come in and attend single days on which outstanding attractions occur. That forced me to think. I don't think that we have any one thing which is outstanding. I firmly believe - and now I'm starting to teach Value Analysis - that a good value analyst is a semi-specialist in nearly everything. He will be a specialist - a top specialist - in knowing how to get and use other specialists. That is his real stock in trade. He will be a top specialist in the use of determination, in the absence of fear, in carrying out his daily work, in the use of courage and confidence.

As we progress there will be no duplication in this program. Today will cover one phase, tomorrow another, the next day another. Therefore, if any one wishes to come later and is not now here, he will miss this part of the program.

You'll find the program that the committee has worked up for you is broken in pace. You will work at the tables. With three of you at a table you can bring your papers, your books, make your notes, etc.

Now, we will be doing real projects here. Excellent projects have been submitted by the various departments. We expect to accomplish real results. I would be surprised if the results accomplished don't eclipse by 10-to-1 the cost of this conference. But I have never made that statement to any one before, because we are selecting projects not for the ultimate dollars that could be saved but for their instructional value. You'll find that as you see the various projects.

The committee has gone to considerable length to try to do this thing right. Help us where we have overlooked things. For example, they said we couldn't have telephones; there are no lines; so Charlie Zimmers who is in charge of that area paid them \$250 to run some temporary lines out here.

We had a choice in organizing this show ourselves or having professionals do it. You know, G. E. has professionals in all areas. Some of my associates had recommended that we have professionals do it, but we chose to use amateurs and watch them grow. Not one man in this program has had this kind of experience but we've had a lot of fun putting it together. Things that are not quite right we will polish off.

Now, in charge of this program will be one man. I have nothing to do with it. If anything goes wrong, we'll find him. His name is Roy Fountain and I'm going to introduce him to you now.

In Washington State he was a leader; he was president of the Student Council and active in other important activities. He also worked his way through as a troubleshooter in steam and electrical and mechanical maintenance. It seems that about that time Uncle Sam took an interest in him and he was invited to join the Army.

Following his Army career he signed up for G. E. Test. Roy had been on a test at Erie and he decided to come to Schenectady for the first Test. Erie heard about it and told him they had a program that evening; to stop off and get on a later train. He took the bait; he stopped off; and he didn't get on the train until five years later. He has been in the Design Engineering Department at Erie on the design of control equipment for locomotives. About a year ago he was selected by his engineering management for three months of value analysis training. He brought the controller from the locomotive. He said, at first, he didn't know what to do. He said he didn't know how to go about to take out substantial cost. After he had worked for two months he said, "I'm going to have to have my stay extended; I can't bring anything to a close; everything is opened up." "No; can't do it. The end of another month will see you done." I was thrilled when he came at the end of another month with a wonderful job done, in spite of interchangeability requirements. Then he said, "You know, if I could do just what I want I'd like to start in right now again on that thing and I'd get out more than I have in the last 90 days."

I now turn this meeting for the next four weeks over to this man who will be in charge of the program, the people, the food, the lodgings, the weather, the entertainers - in other words, work, wine, women and warbling. They're all his job. Roy Fountain!

10:20 A.M., Oct. 6, 1952 - Roy Fountain

Thank you, Larry. I'd like to extend my welcome and the welcome of the committee to you people. We're glad to see you all here. I'm sure we're going to have a lot of fun. There's just one thing that I'm a little concerned about. Larry has been at this value analysis work for about four years. I have been at it about one year. Now, take a look at Larry, at the top of his head, and look at mine, and when I look out and see that some of you people have hair, I just don't know whether we can do the trick in 20 days, but we'll try.

I'd like, first of all, to introduce my committee that has helped and that has put this program together. I'm going to ask them to stand so that you will know them. The first one I'd like to call on is Doug Eagan. He's in charge of getting together all of the projects. Doug, come on over. Do you have anything to say?

Doug Eagan

Well, I just want to say that my small part on this program has been to line up some projects that we can work on during this course and also invite in a number of specialty suppliers who will give us some information on their special products or processes or materials, whatever the case may be. We have picked four jobs to start with and those projects will be given out this afternoon. The first will be some Monowatt parts which are fairly high production; some refrigerator parts which are also high production; the motor terminal board which is low production; and a heating element for an electric furnace which is also a low production job. This afternoon, we will have two specialty suppliers tell us about their special products: Gries Reproducer in New York who specialize in miniature zinc die castings, and Mohawk Manufacturing Company in Middletown, Connecticut, who specialize in small tapped stampings.

Roy Fountain

O.K., thanks, Doug. The next man I think most of you have gotten acquainted with already. He's my Manager of Personnel and Transportation - John Sullivan. If you're lost or want to know where to go, just ask John.

The next man has charge of all the physical arrangements here; the layout; securing all the physical things for this meeting, etc. - Charlie Zimmers.

The next man is the technician, one of the Creative Engineering Program boys - Roger Purdy.

Is Gil Odam or Harold Coughlin here? They'll be here tomorrow. They are a couple of boys we borrowed from the Aircraft Gas Turbine Division. They will also help us put on the program.

Another fellow I'd like to mention who isn't directly connected with the Value Analysis Unit here in Schenectady and who has helped arrange for your evening entertainment is Dick Griffin. I also want to call your attention to one other individual who has helped and will help immeasurably and that's the beautiful young lady sitting over there in the corner - Anne Mayell. Stand up, Ann, and let them all take a look.

Now, Larry gave me a very fine introduction and it now comes time to introduce Larry. This seemed a little funny to me, because if we had enough people in on this act it could go on all morning. Larry first went to Nebraska Wesleyan where he obtained a Major in Education and amazingly enough wound up as a principal of a high school. But apparently, being principal of a high school he didn't get a chance to have his fingers on all the money that he would really like to get a hold of. The next logical thing for Larry was to become teller in a bank.

But then, as you will find out, Larry has a great urge to get his fingers into scientific things, so he went to the University of Nebraska where he graduated with a Bachelor of Science Degree in Electrical Engineering. He came on Test with the General Electric Company in 1932 with the Vacuum Tube Engineering Department. He was transferred in 1938 to the Purchasing Department in Schenectady where he was a buying specialist on ball bearings, turbosupercharger components and B-29 materials. In 1944 - you see, he never stayed long in one place - he was given the title of Purchasing Agent and sent to the Locke Corporation in Baltimore, Maryland, and after four years there in 1948 he returned to the Schenectady Purchasing Department where he was given a special assignment in establishing orderly methods by which the Purchasing Department could eliminate unnecessary costs. And this, fortunately for the General Electric Company, was the start of Value Analysis. He took this thing which we now call Value Analysis right from its infancy and soon won the approval and the backing of Mr. Winne and the engineering management as well as the manufacturing management. The results were so startling that in 1949 he was awarded the Coffin Award for his outstanding achievement. Since that time he has been steadily developing men and methods to carry on value analysis work. I'm going to turn Larry over to you now. Larry?

10:30 A.M., Oct. 6, 1952 - "What is Purchasing Value Analysis?"
- L. D. Miles

We all come today with all accomplishment behind. Let no one think that today is victory or he is useless for the problems we have tomorrow. In other words, today is the starting point for every man here, and when we can make today the starting point for every man in a responsible position in our Company, then we'll go places. We're all proud of G.E. and proud of what we've got - very much so or we wouldn't be here - but the facts are that we haven't quite done average. Now, let's look at some cold, hard-bodied facts. Value analysis study is not going to be easy. You're going to have to overcome things in your plant that are tough; you're going to have personalities back home that you must learn to work with and you must get the work done. Why? Let's look at these facts given by Mr. Cordiner last week: The earnings of General Electric 1935 to 1951 compared with the average industrial were 8% less than the average. The dividends paid by General Electric 1935 to 1951 were 11% less than the average. The increase in stock value which is really the value at the market place of what you and I did through the period of 1935 to 1951 was only 37% of the average of industrial stocks. Fellows, that's our starting point. On the score of appreciation of investment compared with 14 leaders in the industrial stocks from 1926 to 1951, the average of the 14 leaders was much more than double that of General Electric Company.

Again, last year, Westinghouse increased both the percentage of business and margin as compared to General Electric Company.

In market after market we've found that we couldn't make a profit and decided to leave. All of these best efforts of yesterday just kept us in the race. Now, let's win it.

For four weeks we can now learn Purchasing Value Analysis. Remember: we are not trying to do a better job than some engineer or some purchasing agent or some methods man in the factory. We are trying to help him to do a better job than Westinghouse; than Sylvania; Square D, Cutler Hammer, all of whom beat us in the last 15 years. Now, what is the job before us? What is Purchasing Value Analysis? How are we in value improvement work going to do not twice but 5 to 10 times as well in the future? Here's the story.

Purchasing has long found unexpected dividends. For example, we couldn't get 10,000 studs because the upsetter at the supplier's factory was overworked. The sales engineer said, "If you can use studs with two nuts instead of bolts, we can ship them immediately." Examination showed they were to be used for cable reels to hold on the ends. Obviously, two nuts worked as well as a nut and a head, and the cost was 20% less! We were using spacers made by cutting off tubing on a job. Tubing was so scarce that we couldn't get it. A manufacturer said, "We'll roll that spacer from flat stock for you." He did, and it did the job just as well for a cost just one-third what the tube spacer cost. Hundreds of cases such as this came about by accident. About then Harry Erlicher, our former Vice President, now retired, in Charge of Purchasing, and his assistant, Bill Sredenschek decided to do something about it. They decided to start some research and find out how we could make it come about intentionally instead of accidentally. They spun the dial. I happened to be nearby and was the fortunate one to develop this philosophy. So, the work started. We took a very realistic base. Where will we start? We will look at what we are actually doing. We will look at what the actual costs are; the actual methods; the actual designs. That is the method that's used today. So there is no question about the base lines, no question about the facts, or about the accomplishments.

About that time the Sales Department heard of this activity. They brought a control device saying, "Can't something be done here? We used to sell 2-1/2 million of these; now we can barely sell a million. Competition has just closed us out at the box office. We've had full-time engineering and manufacturing committees on cost reduction and they say that every unnecessary penny has been taken out. Take a look at it." We were frightened, but had to start somewhere and did. As we looked at it, fellows, with the simple value analysis approach of what each part is, what it does, what it costs, what else would do the job, the costs just fell away like snowflakes in the winter storm. For example, a phosphor bronze clamp holding on the cover cost \$7000 a year. In life it would normally be taken off an average of six times. Built into phosphor bronze for which we were paying were the properties that would allow it to flex millions of times. Changing to spring brass or to plated spring steel would

do the same job equally well for \$3000, saving more than half. The next piece was a simple, molded plastic cover. It covered the control in a secluded place costing \$40,000 a year. What do we need? A flat piece of laminated plastic punched from sheet stock would cover it up equally well for a $1\frac{1}{2}\phi$ - \$15,000 against \$40,000 - \$25,000 of non-functioning cost. Part after part ran just like that.

Well, we were amazed; we didn't think the same could happen on other products, but it has. As time goes on we will study the reasons. Truly, those of us in Value Analysis feel that this is the field which can establish General Electric's leadership in these markets.

All right, what is Purchasing Value Analysis? Purchasing Value Analysis is a creative study of every item of cost in every part or material considering other possible materials, newer processes, abilities of specialized suppliers, and possibilities of engineering re-evaluation, focusing engineering, manufacturing and purchasing attention on one objective - the same performance for lower cost.

It is not a substitute for the present engineering and manufacturing cost reduction work. It improves the effectiveness and of the work being done and also fills a blind spot. After the best job we can do in design and manufacturing methods, usually from 15% to 25% of shop costs can still be removed by activities originated by purchasing value analysis. For an example, one of our factories used large quantities of a stainless steel pin. This pin was found to be purchased from one supplier. A letter to him telling him of our desire to get better value brought a two-page letter telling why a better price could not be given. Naturally, that's what a good sales manager would do. His job is to sell his merchandise for all the traffic will bear. Ours is to see that it doesn't bear more than a reasonable amount. In his letter he left a key. He said, "You see, unless the tolerances are substantially changed, we cannot do anything about it." So, getting in touch with the engineer on the product, a meeting was arranged with the vendor in the factory where this was used. The vendor brought his factory superintendent so we'd have all the facts. When we got there we found that the engineer had not yet learned how to work on a value analysis team. Immediately, with the buyer, the engineer, the vendor's men and ourselves there, the engineer said, "I don't know why we're having this meeting; this is a good price and we can't change any of the tolerances." Well, the meeting was over!

But it's possible to start even under such adverse conditions and step by step pull the meeting along and teach such a man to the very great profit of the Company. In this case we persisted for three hours and had to carry him step by step every time he had an opportunity to make a statement. He made plenty when he didn't have much opportunity. We studied every step the vendor

uses in making the product. We studied each tolerance. When we got through we asked the vendor to quote five ways: as it's now quoted, with one tolerance changed, another, another, and another. I'm not picking on the engineer, but we're going to talk realistically all through this course; we have to overcome obstacles in every area, and together we're going to learn how to do it. After we had asked the vendor for that, the engineer said, "It's no use; I can't use anything else." We repeated to the vendor that we would expect the five quotations, immediately writing a letter confirming it so there was no question in his mind. About three weeks later we got a quotation from him. Instead of putting three centerless grinding operation, he was able to start with a smaller material. He wound up with exactly the same part to exactly the same tolerance. There were four or five other steps where unnecessary costs were eliminated. Instead of \$3.65 per 1000, he requested for the identical part \$1.90. The saving was \$112,000 a year.

In another of our factories a few weeks ago I saw 20,000 of a product stacked in a high pile. We were still making some. Our competitors were selling them for less than our shop costs. Let's take a look at some of the parts. One of them, quantity 100,000 per year was a stud about 5 inches long and 1/4 inch in diameter with some milling on it and tapped or threaded on both ends. The stud cost 15-1/2¢ apiece. What does it do? A study of what it does, bringing in suppliers who would make it on a nail machine, and put a rolled spacer around it, brought the same performance for not 15-1/2¢ but for 2-1/2¢. They used four studs on a device, 400,000 a year - it means \$50,000 savings a year on the stud.

Fellows, as we run through these points we want you to realize that we feel this whole ball of wax is a winner. Each purchasing value analyst is taught to use a businessman's judgment. He must develop all of the facts which he would need if he were spending his own money. In fact, for our study here let's assume that we are spending our own money. Let's not tolerate anything in these devices that we look at that we wouldn't buy if it were our own money. Hereafter in talking with each one of you I'm going to take that viewpoint: that it's your own money you're spending. We'll have that as the basis of our work.

Value Analysis relates cost to function or the service or operation which is purchased by that cost. Specialists within and outside the company are assigned specific functional areas. Their engineering is put to work on our job instead of our competitor's. Their suggestions are provided with a dollar sign for our evaluation. For example, on one of our 700/year products, after the completion of a fine cost reduction study, a gasket was picked up; a gasket of 1/8 inch thick cork about a foot square. What was the cost? \$4.15. No! How could it be? It was; we were buying the gasket material. Somebody marked gaskets out with a scribe and, I guess, chewed them out with his teeth. The man took home a dollar every time he made one.

With that, overhead and all it made it \$4.15. Why, give a specialist supplier who does that type of thing a chance to quote on it, and without any tool cost he'll make it for you for 15¢ each.

One of our products has a standard 7/8" long oilite bearing in it. 1/32" is machined off the length. Well, the standard bearing itself costs 3½¢ but cutting the 1/32 off of the length brings it up to 10½¢. Looking at the product it's apparent that the device would work just as well if the bearing were 1/32 inch longer.

On the clothes dryer there is a wrap-around cover up over the entire dryer. It was joined using angle irons and bolts. How else would you do it? Well, we often see men in the packing room use strapping machines. They slap a strap around, crimp it and it's on. That would save \$37,000 a year. The suggestion went to the engineers. They had it a couple of weeks, and they said, "All right; you fellows don't know nothin'. We'll put that together with this new metal stitching technique; just sew it together with wire like you do with cloth." They put metal etching in and took out another \$5000.

Again, one of our products has a disc spacer, it is machined off a 2" diameter steel rod 1/4 inch thick. It cost \$1.25. Well, what's its function? It has to hold two discs apart and support them as a hub. Why not make it from flat stock? Well, the quantity is pretty small, about 2000. Then somebody started to think, somebody who knew. The Aluminum companies sell, as commodities on the market just as the farmers sell bushels of wheat, tons of small circular stampings that go to the impact extrusion houses. They come in bulk. Looking in their standard list it was found that one could be picked out of the catalog that would cost 4¢. It would require 1¢ for flattening, 8¢ for putting in the holes, doing the entire job for 13¢ instead of \$1.25.

Value Analysis is an engineering and a manufacturing tool that reaches into the limitless supply of technical information outside of the Company and puts the best brains of our best suppliers to work on our specific jobs.

For example, a timer casting when machined cost \$1.76. We used 1000 a year. A supplier of small-lot stampings saw it. He said, "I'd like to make that as a stamping." "Aw, you can't do it. The tool charge would eat you up." "Well, let me quote on it." He redesigned it, provided a drawing and instead of \$1.76 he offered the equivalent function for 25¢. How about the tool costs? Well, that's their stock in trade. The first year the tools would add 10¢ apiece; after that they're paid for. So even the first year it went from \$1.76 to 35¢ by allowing the supplier a chance to work on it.

A wonderful product is our clothes dryer. We can sell far more than we can make at the present time. Inside the dryer there is a perforated metal all the way around. A vendor made that metal. He put in the perforations, stopped his machine and

put some holes at the end which were used to mount the liner onto the drum. It cost something like 60¢ to put in the 10,000 perforating holes and 28¢ to put 6 fastening holes on the end. Well, the analyst looked at it and said, "That can't be right." He called the vendor in. The vendor said, "Why, of course; I'd rather just run it continuously; perforate it all the way along. Why don't you use the same holes to mount it with?" The rough ends were turned out, anyway, so they couldn't come in contact with anything, nor could they ever be seen. The suggestion went in, it was adopted. The steel was made a little thinner at the same time. It's the only case I know of where Value Analysis in the unit we'd been connected with ever suggested thinner steel, and the saving was \$35,000 a year.

Now, Value Analysis, as I have told you, is a study of specific items, item by item, and you'll only need to look for five things: What is it? What does it cost per year? What does it do? What else would do the job? What would that cost? Value Analysts are being taught to seriously question any cost that does not clearly buy a definite function.

Now, function is simply defined - and we've been able to make this stick so far - function must fall in one of two classes: either something that makes the product work better, or makes it sell better. Evaluate every cost by those two yardsticks. You'll be surprised how much they'll help you.

Value Analysis is not committee work; it is conducted by one man intensely following a project, discussing particular phases with others, one or two at the most at a time. Purchasing Value Analysis is an on-the-spot job of an operating department. The job of the central group, as you know, is to promote and assist this activity. In general, they try to analyze one product for each department to show that "It can happen here".

Value Analysts must work with specific facts. They require drawings, specifications, planning cards, all shop costs, etc. If you think that's easy it's because you haven't tried to get them. I know you all know better. In discussion with the responsible engineer Analysts they familiarize themselves in general with the basic operation and the problems of the product. After a similar study of manufacturing operations their intense program of seeking out, adapting, evaluating and applying follows. For example, a pawl pivot on one of our products was made from a piece of wire about 1/8 inch in diameter. Part of it was machined away leaving a larger head. The material cost \$1.71 per 1000 but by the time the work was done it cost \$19.00 per 1000. By going to a specialist who makes it on a nail machine he provides the identical part and it costs \$1.18, complete, ready to use, which compares with \$1.71 we were formerly paying for the raw material after which we brought its cost up to \$19.00 by more work. And a valve pin - incidentally, these are very current jobs; this one less than a month old - costing

\$59.00 per 1000. As the analyst studied it and after he'd gotten the engineering story and what it had to do, he was able to make some minor changes which it seemed would produce the same performance and still allow it to be made on production equipment. The cost, as suggested, went from \$59.00 per 1000 to \$1.00 per 1000. The saving in that case was \$40,000 a year on one small part.

A planned program for project evaluation has been developed. It has the following phases that you will be in contact with. The informative phase, the speculative phase, the analytical phase, the vendor-contact phase, the engineering restudy phase, and the preparation of possibility sheets. As other skills are developed, we believe that we can develop a valuability skill? Why not? That is an ability to quickly pick out because of experience with similar items those items of cost which do not represent value, and an ability to immediately start some actions in the direction that will promptly eliminate these unnecessary costs. Our Value Analysis program and our on-the-job value analysis work is all slanted in that direction.

For example, although General Electric is large, we must keep some of the small company benefits to offset some of our big company disadvantages.

Here is a button which in high production costs one of our departments \$2.55. It happens that this identical contact button was being used in another high production department and was being purchased, also, for 93¢. \$2.55 per 1000 in one department, 93¢ in the other for the identical button.

Such simple items as springs are interesting. Here is a spring used in quantities of 1400 a year costing 21¢ each. A man with value ability will look at that and say, "It just simply isn't worth it." And it isn't. It's worth 6¢, not 21¢, and it shouldn't take 6 hours but rather 6 minutes or 6 seconds to come up with the answer.

Now, here's a heavy one, fellows, and I'm afraid it'll be a rough one here. Surprisingly, the men who have worked long on a project are the least capable of eliminating large quantities of unnecessary cost by value analysis techniques. These men cannot go about the job with the enthusiasm which is necessary to accomplish the startline results that are usually possible. Accordingly, they are being assigned value analysis work in other but similar fields.

Fellows, beware when a man, whether it be you or some one else has been on a job too long, he becomes blocked with so many "don'ts" that he is useless in this game but he may be fine in some others, he would be fine on another product. To me that's just a creeping death that we've got to beware of and we've got to fight it every minute.

It's the top order of value analysis policy that value analysis engineers are not policemen. They do not follow up anybody. They will become specialists; they will develop possibilities beyond anything we've yet had. Put a dollar sign on them, turn them over to the person appointed by the manager, and walk away from them. Their job is to learn the facts, to generate and select good solutions to the problems, set them up clearly with a dollar sign attached, refer them to the person delegated by the manager, and get on to the next job.

Value Analysis is a full-time job. It must be intense and thorough. It requires serious thought, hard study, and immediate action. It is not a second troublesome and unwanted activity. We must never let it be so, else the management will think it has value analysis when it does not. It is basic that Purchasing Value Analysts make no savings claims. The suggestions which they develop materialize as savings in either the engineering, the manufacturing methods, or the purchasing areas. There must be no flag-waving; no claims of big dollar totals to alienate various functional groups. The only report issued is the item-by-item study sheet which shows the possibility on each individual item.

Fellows, we do not in any case add up the totals of these study sheets.

A short time ago, in a very interesting meeting we had with Mr. DuChemin who incidentally will be our closing-day speaker, Mr. DuChemin said, "About what do the savings possibilities on that total up to?" It was fun to tell him, "I don't know; we've never totaled it." You'll have to take a rugged policy or somebody who wants to justify something will push you into doing something that will alienate you from the people in the plant. I want to tell you right now. We here have not given such reports to Mr. DuChemin; we have not given them to our boss, Bill Bryant, our former boss, Bill Sredenschek, or anybody else. Such reports diminish the result that can be accomplished. So far we've taken our time just to produce results and not to get involved in these routines.

Purchasing Value Analysts must look some into engineering, some into manufacturing methods and a lot into the purchasing areas. In so doing, however, they always work through the engineers, through the buyers, through the manufacturing men - never around them. Always strengthening them in their own orbit.

Value analysis is really a wonderful job, and I'll tell you why. Purchasing value analysts have no decisions to make. Their job is to accumulate facts for management's decision. Accordingly, of course, they do not factor in make-it or buy-it decisions but they develop facts from which management decides wisely.

For example, in one of our factories we were using a conduit ear in quantities of 8 million per year. We were buying it for \$3.22 per 1000. The value analysis study showed that we could make it for \$2.00 per 1000 against the \$3.22 it cost to buy it. The facts very often show that we should make things we're buying, and often show that we should buy things that we are making. We develop the facts, management makes the decisions.

Another example; recently we built a new vacuum cleaner factory or moved to a different one and put in new facilities. They had been printing their own paper work - catalogs and tags; and sewing their own bags. They asked for an analysis of the value. It showed that they could not afford to spend the money and tie up the capital in a building. They decided against spending the money.

Fellows, there's no end to the cases that come up to the different phases. One of them is the Government work phase. Years ago we sometimes detected the feeling in some people, "Well, it's for the Government; so what?" I'm telling you that's gone, and thank heaven for it. Just look at your deductions each month! Now we are in a phase and may every value analyst feel that and know that any dollar that's paid for defense materials is his dollar! - We have a lot of fellows now starting Value Analysis work and some who have been in it for quite a while in the defense area. I invite you to look at them about a year from now. In Government work where quantities are normally smaller, business more unpredictable and the problems of making alterations more difficult, the percentage yield is usually greater. We find that 50% to 75% of shop costs can often be eliminated without affecting in any way the performance.

Now, some of our projects that we'll use in our conference here, will be non-restricted defense projects. You'll get a chance to sharpen your teeth a little on that type as well as the high and low value commercial products.

To accomplish this 15% to 25% of shop cost reduction which is our object, the value analysis program includes the following:

Effective training for the men in each business.

Proper set-up for their successful work.

A continuous supply of qualified trained value analysis ^{men} ~~work~~.

Means for bringing the best men to the greatest opportunity throughout the Company.

To that program we dedicate ourselves. To achieve this 15% to 25% reduction brings to us two requirements: first, the trained value analysis specialist in the purchasing orbits in the various businesses. To accomplish this you are here as the first major step. Secondly, value analysis trained buyers on all jobs. To achieve this a course of 13 studies for buyers on how to get better value has been organized and for your interest, although

it will not apply to you, is now being started.

We conclude with the thought with all of the industries in the entire country at our disposal, the job of purchasing value analysis is to get today's and tomorrow's materials, ideas, methods, and processes into use today.

1:10 P.M. - Introduction - Roy Fountain

We have some very distinguished guests with us. The first fellow I even hesitate to introduce, because I know if he gets on his feet I'm just a little afraid of what he might say. You might guess that I'm talking about this fellow Claude Watt from Canada, I think, to heckle us. Claude, do you have anything to say in your defense?

Mr. Chairman, gentlemen, on behalf of the Canadian General Electric fellows, I want you, Larry, Mr. Bryant, and all of you to appreciate the invitation you have extended to us to come down here and be with you in this course. It certainly is a great chance for our fellows to get caught up on some of the value analysis work that is being done here in the States.

I particularly would like you to watch out and help Alf Spicer who is from our Peterboro Plant. Alf has been at this value analysis work for about three months.

We've been at value analysis work up in Canada for over a year now, and have had some wonderful things happen. We can see far enough in the future with this value analysis work that there will no longer be any jobs in General Electric or Canadian General Electric Plant if value analysis goes as far as we think it will go. As far as it's gone in Canada it's got every indication of wiping all our jobs out.

We found that Mr. Cordiner would have two buttons: a big button would automatically run the G-E and a little red button would run the CGE. So being value analysis fellows, being trained under Larry's techniques to broaden our thinking and to see what was going on in these specialty suppliers, we found that if we all lost our jobs, what would we do? We would go, like a lot of other fellows have done, to War Assets and see what business they could set us up into. We found in Canada that the only thing that was left was everything but the lands. They had sold the wire around the piece of property; they had sold the posts that held the wire. The only thing in Canada for us to work value analysis on was post holes. Two weeks from now, when you get into this course, this idea is going to hit you. What'll we do? We're going to have no jobs left. We decided that we'd better make a survey to see what we could do with post holes. We found that there is quite a market. Do you realize that there are hundreds of thousands of American

wholesale companies in the United States that have been selling supposedly holes for years and they never had a source of supply? Now, that was our source of supply for raw materials. Now, I could go on all afternoon, I am sure, telling you about the Bell Telephone and the Hydro-electric Power Commission that was stringing wires throughout the United States for years and they've never had to pay for those holes. Now, I assure you I could go on all afternoon - but I want you to know that after you do a good value analysis job and you've eliminated yourselves and your buddies that you love and you've worked with, there is still something else. Thanks a lot.

We have another guest with us today; a true backer of value analysis. He was born and raised in Norway; had all of his education there, and came to this country to build airplanes. At about the time that he saw the airplane was here to stay he turned his efforts to other fields, and fortunately for the General Electric Company they hired him and he has been busy since disseminating technical information to the various engineering departments, laboratories, etc. He is the man who tries to keep each and every one of us from discovering and rediscovering the wheel once a week. I am talking of a man who is on Mr. Winne's staff. Mr. Winne, of course, is Vice President in charge of Engineering. He's the manager of General Technical Services Section of the Engineering Services Division. John Horn.
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I had to promise Larry that I wasn't going to say anything this noon because he was short of time. I'm going to come back and talk to you at some other time. But I do like to say this that I envy you because in my estimation value analysis is the gold mine of today. Thank you.
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We have with us also today the manager of Manufacturing Training Program for the General Electric Company. He has charge of locating, selecting and training people for manufacturing positions. He also has charge of coordination of Apprentice Training: Mr. T. C. Houston.
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I'm not going to make a speech, fellows, because I know that with the kind of program that you have ahead for the next month it's going to be pretty much like the old saying that the mind can absorb no more than seat can endure. In fact, it sort of reminded me a little bit of the old Scotch minister who used to notice this chap who always sat in the same pew in the church on Sunday morning. He decided he'd speak to this chap after the service one day. He went up to him and said (with a Scotch dialect), "My good man, I see you're a very regular attendant at the church. I hope you're enjoying my sermons." The man replied, "Well, minister, it's no just like that. You see, I've got seven kids in our house and we've got such of a fuss of a Sunday morning that I love to come here to the church and sit and think about nothing."

I'm reasonably sure from looking over the agenda for these sessions that you're not going to be sitting here and thinking about nothing. But I do want to say that from our standpoint of Manufacturing Training we consider this approach to value analysis is a very essential and necessary part of our overall activities. I can also say that the men we are starting out this year on our new Manufacturing Rotational Program are all going to have a good understanding of value analysis regardless of what area of manufacturing they may land in upon the completion of their program. It's going to be extremely interesting to watch the progress and the success of your sessions. I wish you the very best of good fortune all the way. I'm sure you're going to gain a good deal of benefit from it.

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At this time I'd like to turn the meeting over to Larry Miles to introduce our speaker.

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Thank you, Roy. Gentlemen, I'm pleased to introduce your speaker. I'd like to comment that a number of years ago, out in the State of Ohio was born a child not quite as hairless but perhaps as noisy as the Roy Fountain. He proceeded to Carnegie-Tech and from Carnegie-Tech came to General Electric in 1931. He took the A, B and C courses, for gosh sake, and still lived. After he got through these advanced courses and super-advanced courses in engineering, he apparently wanted to get a little nearer the actual use of all of this knowledge, because next we find him in manufacturing. During the late 30's we find him organizing manufacturing training and conducting manufacturing training courses. I have it on good authority, although he hasn't authorized me to say this, that he even took a turn as an accountant. Then, while I was down working at Locke, Inc. about six or seven years ago, I came back to Schenectady and found Bill Purchasing Agent of the Schenectady Works. At that time it was the purchasing job. The thing that first came to my attention about him was a comment in a group of his employees one evening; this comment was, "You know, there's a great deal of uncertainty in Schenectady Works Purchasing. Every one thinks the jobs are going out into the Motor Department, into the Tube Department. This department will kind of wither up; however, since Bill has been here he has given every one confidence" because he has come out and he has talked to all of us. We know he knows our problem. We know he knows us. The morale in the group is just of a different order than it was before he came." Next, we find this man elevated to the position of assistant production manager of the Large Apparatus Division; perhaps it was the entire Apparatus Division at that time. In other words, almost the top production job of General Electric Company. From that time on, as he has always done, he saw the light more and more clearly. He turned into the purchasing channel. He came in to head up our steel-buying group during the war and right after the war when steel was so terrifically difficult to get. He then became manager of all of the buying activities of central purchasing. When Mr. Sredenschek went into the Sales Department, he became the manager of the Materials

Department of the Manufacturing Divisions. Thus, we have here in this leader a man who is an engineer, has had the A, B and C courses, has had accounting and auditing experience, has had purchasing experience, has had production experience. In introducing him I'd like to say to you to be sure that while you're here you get to know him. His subject today will be: "The Importance of Value Analysis". Bill Bryant!

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Thank you, Larry, for those most ^{undeserved} ~~undesired~~ kind words. *Page 2*

It's really a pleasure, fellows, to be out here today and see this group assembled. When we first talked about this program, which was actually before I inherited this job, I know that there were some reservations about tackling a program of this kind. Mr. DuChemin, whom you probably all know, is our Vice President in Charge of Manufacturing. He felt so strongly about this program that he said we were going to do it and were going to do it right. Larry took on that responsibility at that time. With the help of Roy, Doug Eagan, Charlie Zimmer, John Sullivan, etc., has come up with this program which we all hope will be most constructive. We're sure it will be. I think we have just about the right size crowd. I think it's large enough. We originally talked about 100, but I'm glad we don't have any more than 58. I want to take this opportunity of welcoming you here, and while I'm not going to make any great speech, there are a few words that I would like to say at this time.

First, Mr. DuChemin wanted me to express his regrets that he is not here today. He has promised us that he will be here on October 31st, unless some edict of Mr. Cordiner will prevent him from being here. We have that to look forward to.

Secondly, Art Vinson, who is Mr. DuChemin's assistant, was also forced out of town. He has promised to be here at a luncheon some day later this week and will say a few words for us.

Going on from there, however, I suppose we all know that we're here for a very special purpose. That purpose, of course, is to study the techniques and methods of value analysis. Now, I'm not going to attempt to discuss this subject of value analysis, because that will come up at a later date. If I did, I'd be doing a job similar to the one that happened to this explorer - maybe you've heard it - that was going into the deepest parts of Africa. As part of his gear they put in a little bottle of gin and a little bottle of vermouth. He said, "What's all that for?" They said, "Well, that's to make yourself a martini." He said, "you know I don't drink; why did you put that in for?" They said, "Never mind; when you get out in the deepest parts of Africa, you don't know where you are and you're lost, you take this bottle of gin and this bottle of vermouth and start mixing yourself a martini. In no time there'll be a hundred people there trying to tell you how to do it." If I tried to tell you, I'd be just one more of the hundred trying to tell you about value analysis which you'll get better and straighter.

from the people who are going to tell you later on.

I do want, however, to talk a little bit about the importance of value analysis as far as we're concerned. The decentralization program in the Company started a few years back. The particular purpose of this decentralization was to look individually, we might say figuratively, at each tree in the woods. The idea was that some were healthy and some were sick. The management of the Company wanted some one to look after each and every individual tree. The Company was broken down into elements where somebody could look after the individual trees. A General Manager of the various departments of the Company was appointed for that purpose. He was given responsibility and authority to look after the sick trees, the well trees and to make the well trees better and the sick trees well. Along with that, of course, goes his accountability to the management to do a good job in that respect. In that respect, every member of every department shares a portion of that responsibility with your manager to see that that job is done. As value analysis people it's our job to work with the managers, to be sure that they have the tools and equipment and the know-how to do a value analysis program to make some of these sick trees well.

We may reach the point where some of the unhealthy trees may have to be destroyed. I use the word "trees", of course, in connection with our lines of apparatus. In the woods there are probably just a few big giant oak trees which will or may represent our turbine business, or our locomotive business, or our power transformer business or things of that kind. There are also probably a lot of smaller trees in the woods; maybe birch saplings, or small pines, or something like that, which may represent the small physical size-large quantity production items as our appliances, electronics, fractional horsepower motors, etc. In that connection each tree must be well. We are no longer going to go along with the policy of supporting a bunch of weak product lines in the Company. A product line is going to stand on its own two feet. It's going to earn its own profits. If it cannot do that, it's going to be destroyed.

Now, it's a very easy thing to say we're going to destroy a product line. It's not as simple a thing as that; there are responsibilities in connection with doing that. One is that there are people, employees in the General Electric Company, just like you and I, just as much as individuals as you and I are, who are dependent upon the production of that line and the sales of that line for their bread and butter, for their clothing and shelter. If those things were taken away from them we would cause, to a certain degree, unemployment among our own employees. Surely, maybe somebody else would pick that up, but after all, we're looking out for the interests of the General Electric Company and its employees. That is our collective job.

Secondly, there are ways of correcting this particular condition. The Company is continuously looking for increased outlets

for its materials; for new markets. Why should we be going out developing new markets when we've got some good markets right in our own hands that are not healthy, and all we have to do is make them well and expand. We're not looking to get rid of the products in the General Electric Company. All the management is trying to do is to look toward making every product a healthy one and to be able to stand on its own two feet as far as profits are concerned. Our job here is to help with these things. Where we have a do-or-die proposition with our products, we have probably at that point earned our, all of us collectively in the value analysis and purchasing functions, etc., greatest reputations because there have been actual cases where problems of this kind have brought the line out of the red into the black and the line is going along on a much more healthy basis.

Fortunately, however, not all of our product lines are in the red. Most of them are in the black. But are they well enough in the black? That's another question. The fact that they're in the black today is not sufficient proof that they're going to be in the black five or ten years from now. Continuous improvement, not only in the technology of the job but in the costs of the job, must be made if we're going to maintain a position at the head of the parade. We must continually go along with the problem of trying to improve our cost position on these so-called healthy lines. There is some reason for concern, even in these healthy lines. Larry Miles told me that he mentioned this morning a couple of points that I would like to repeat again. One is that the Company's profits per dollar of sales is only about half what it was in the pre-war years, 1939 and 1940. There's one main extenuating circumstance in that connection. That is the high tax burden that is placed upon us. It is placed upon all companies, as a matter of fact. As far as we're concerned, that is only an obstacle; that is not an excuse. We've got to find some ways of overcoming that. Part of our problem, perhaps, has been that the cost of industrial products, generally, has doubled since the 1939-40 period, whereas General Electric sales prices have gone up only in the neighborhood of 45%. That's not exactly an accurate figure, but it's in that order of magnitude. We, in the manufacturing activity, do not have any responsibility over the fact that the prices have not gone up enough. That's right. I'm not sure, completely, that our sales people do, either, because we are limited in the prices we can get for our product by what competition is offering. It only points up the fact, however, that if we have a fixed ceiling on our selling price - and I don't mean the OPS ceiling; I mean a ceiling by competition - then our jobs are to do something about the cost so that the spread is better. One of the best ways we have of doing that is this value analysis approach to our job. Larry sometimes staggers me with the figures that there's hardly a product in the Company that 15% to 25% of its manufacturing cost can be taken out through good value analysis. It goes to show what a tremendous problem there is ahead in the

value analysis program for the General Electric Company.

As individuals we're not going to do this thing alone. It takes everybody in a department to do it. It takes the engineers, the factory superintendent, the salesmen, the accountants, and every one to do this value analysis job. Your job specifically is to think up new ideas and coordinate these functions.

I know that you have been selected by your management because they felt you were capable and qualified to do this job. We respect that opinion. You are here because your management wants you to be here. I want to make that very clear. There was no pressure in any way put on any one to have any individual or any department represented here. Sure, we tried to do a selling job. Selling and pressure is something entirely different. The manager is responsible for the operations of his department. There isn't anything we can do or say that would cause him to do this if he didn't feel it was right. You are here with the blessing of your management.

That brings us to what I might make as my final point, and that is: What about you and me individually? How do we make out on this value analysis program? You folks are almost literally getting in on the ground floor of value analysis. While it's true Larry has been working on this program for five years now, it nevertheless is also true that most of the early years were in laying a foundation, in developing the techniques, in selling the ideas. Larry, Bill Sredenschek and all have done a splendid job in that respect. I don't believe there's a manager in the General Electric Company who is not familiar with value analysis. It's true that they do not know enough of all that value analysis can do for them. We are trying to see every manager in the Company, if we can, to point out to him what the opportunities in value analysis are. We will do that just as quickly as we can. Nevertheless, you are getting in relatively on the ground floor of the proposition. What usually happens when you're in on the ground floor or in the early stages of any development? Either you ride along with the inherent growth of the business or the business goes broke. I'm sure value analysis activity is not going to go broke. It is built on too firm a foundation. The facts have proven its worth to too great a degree. It's going to grow. It's going to be looked to in the future as one of the saviours, shall we say, of our profit and loss statements. When we are in an activity of that kind which is going to contribute so heavily to the profits of the General Electric Company. Individually we can't help but benefit by the overall program. There's nobody as much interested in the profits of your own department as your own manager. When he knows what value analysis, through your efforts, has been able to contribute that will be a great feather in your cap.

It is also true that, basically speaking, value analysis people will not be in value analysis all of their lives. As a matter of fact - and I think Larry will also agree with me on

this statement - maybe we don't want value analysis people to be in value analysis for all of their lives for a couple of reasons. First, everybody has some new and original ideas. Maybe we run out of our own ideas after a while. We need somebody to come in with new and different and better ones. Secondly, and even more important, we want the kind of people in value analysis that are too big for value analysis jobs after a couple of years, so that there will be a demand for them somewhere else. That's the kind of people we want, and we want them so that we will not be able to hold them in value analysis. There will be demand for your services in other fields, in bigger jobs where you will benefit yourselves to a great degree through the reputation you have built for yourselves in value analysis and your product. Opportunities for both your department and the General Electric Company will be immeasurable. Thank you.

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On the Techniques of Value Analysis, and the first talk on these techniques Larry Miles will cover the topic: "Learn the Basic Engineering"

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If you have the job of removing unnecessary costs and if you are challenged by the opportunity, you're already one-third of the way. If you have the well-known qualifications of temperament, experience and training of a value analyst, I'll say you're two-thirds of the way. When you have been broadened by the hundreds of contacts with special skills, special materials, which this conference will provide, you should certainly be AA winners.

The purpose of this study is to help you become able to use a businessman's judgment on every element of cost. Remember, it is your money. That's our philosophy here. Let's hypnotize ourselves. Would you spend it this way? Let's see: Step No. 1 -- Learn the basic engineering and manufacturing. If you know nothing of the product, then it's an even race. If you know something about it, you know a bunch of don'ts which put you back of the starting line already. You'll have to compensate for this disadvantage with great care or you'll miss the greatest of the opportunity.

To learn the basic engineering, how shall we do it? Arrange for a full engineering discussion. Don't do it piece-meal. Have two or three sessions of several hours each which are completely undisturbed. From the engineers learn why each piece was designed as it is. What are the problems connected with each one? What is being considered? What has been considered? What would they like to do but for various reasons are unable to do? What is started that they would like to have you follow through? What has been turned down by others for reasons they believe insufficient that you might help on? And dozens of other similar questions - the answers to which come spontaneously when the engineers know that you are on their team and hungry for basic information.

There are two purposes to this part of the program: First, to learn about the project so you can decide if you want to spend your money that way. Secondly, to get onto the engineer's team.

Make no suggestions. That's killer No. 1. If you see a few points that are kind of minor that you think you could improve, make a suggestion and your job is half done. That will close them up; you will be picking. Only ask questions, but don't ask why questionable materials and processes were used.

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There are two ways of asking a question. Never ask a question that will cause a man to take a position on insufficient information that you may want him to reverse later. For that reason never ask "Why do you make this steel that thick?" Say, "What were the circumstances that made it seem desirable to use .032 steel?" He will say, "We had the problem of rigidity and it seemed to require steel that thick." You're through; don't ask another question. Now, you know that you can provide rigidity with thinner steel by putting ribs in it, but don't suggest it. If you do, you dry up the source of facts. Go right on to the next question. "What were the circumstances that made it seem desirable to use stainless steel instead of plated steel for this nut?" "Well, we had an application over on the Coast where we tried plated steel and it didn't work." Good. Don't press it any farther. Now you know his top reasons for having it there. When you get back you evaluate as to whether you want to pay ten times as much for every nut that goes into the equipment because one nut over on the Coast supposedly went sour. Maybe it didn't go sour; maybe it was abused. I hope I have made that point clear. Don't ever put any engineer on the spot.

What I say about engineers will fit with buyers and manufacturing people just the same. It just happens that we're talking about the engineering phase of it now. In other words, you will not ask why they use something. You'll ask what the circumstances were that made it seem desirable. They tell you the circumstances. They are not in it. You don't have to affront them when you later come back and say, "We've been working on a way to accomplish these circumstances and still save half the costs." They say, "Gee, that's fine; that's just what we'd like to do." And they're not on the wrong side of the fence to start. Here are some examples.

One control device which was studied was brought under conditions that we were losing the market on it. What will be our first step? In this case, the engineers were so very busy that the phone was ringing and jingling all the time. So, we invited them to lunch. You'd be surprised how much a free lunch will get in the man's time. Two of them came. Two value analysts had lunch with them, went back to the

value analysts' office and discussed the small project all afternoon. What are the details of this part? Why was it designed this way? What were the reasons that caused it to be? What were the problems? What's the experience in the field? What are you thinking of changing? What would you like to have help on? What a wonderful job they did! At the close of that meeting the value analysts knew all the basic factors. In fact the engineers toward the end of it said, "But you're wasting too much time on us." If we knew what to do about it we'd do it. You ought to ask somebody besides us for ideas." That's a wonderful attitude. Now you're on the team. Now you've got a place you can do a job.

On this particular product was a piece of copper tubing. One end was large and the other small. There was a \$50,000 braze - \$50,000 a year to hold the two together. We asked the engineers, "What really is the function of that? Why do you have to have this thing as it is or what caused you to design it that way?" They say, "Well, we wanted a big operating end and a small assembly end." Then you can see the whole picture. They don't care what's in the middle; small end, big end. Fine. No more suggestions. Now, when you get away, "How else can I do that?" Well, let's start with the big tube and let's take it right on back down here and let's swage it down to a small end instead of starting with two sizes and brazing them together. By doing it that way instead of \$50,000 to braze the two together, it cost \$5000 to make the one end small. It worked beautifully; the engineers liked it, everybody liked it, because you haven't crossed anybody up. You've taken them on the team and you've helped them.

Another example is a governor for a locomotive up at Erie. The management there set up a meeting in which we could discuss for a day the problems of the governor with the engineer, and the next day the problems of manufacturing. Later after the analyst had worked on the project for about six weeks, the engineers came down to Schenectady and put in two days, undisturbed, providing more information. Now, in those two days they were not asked, "Can't we do this?" That's a horrible approach. Then here's the engineer, all of a sudden, without the benefit of any ideas you have, any suggestions, any new materials, any dollar signs, any original work by vendors, you're asking "Can't you do it?" You just ask him more background questions. What was the thinking back of this? You'll become closer and closer to the real problem.

Another thing we bump into when you talk with them is Underwriters. For example, in one plant we can't do this because Underwriters won't allow it. To the analyst it looked to be good judgment. It looked to be safe. However, that's the end of it, at this stage of the game. That is the reason. If it's costing \$50,000 a year more, that is the reason. If the engineer

gives you that reason, that's it. Maybe there're some smaller ones, but it's the big one we want first.

On a similar device in another competing unit of General Electric we found the exact thing being done. Well, the first comment there was, and very correctly so, because they're doing it - "Well, how can you get away with Underwriters with a thing like that?" "Well, we have tentative approval", they said. "It's our job to teach and lead Underwriters, not to set them up as tin gods to tell us what to do. We showed them that it was the right way to do it. We have gotten tentative approval and we've taken some orders and we've got some samples in the field." But at this stage of the game all you want to do is get the engineers' top reasons and then don't pick at them. Just tuck it away where you'll use it to influence your judgment.

The same thing on the use of phosphor bronze. Phosphor bronze costs 20¢ a pound more than spring brass. Its conductivity is half of spring brass, so you have to have twice as much of it. You wind up paying two to three times as much for phosphor bronze as you do for spring brass. "Why? Well, in one of our areas we always use phosphor bronze for that type of part." Why? Don't ask them why, not in so many words - "...we find out that the conditions were because of fatigue." All right. Now you know.

In another area making the same type of product and doing an equally fine job they would not allow a piece of phosphor bronze in the product. Both in G.E. The other place was spring brass. When I saw it, my first comment was, "Why, spring brass won't stand that temperature and that milling operation, will it?" They said, "It certainly will, but we wouldn't use phosphor bronze because that stuff creeps. We form and make our contact arms, make our switches, make our devices - they get through test and for three years that phosphor bronze is creeping and causes us trouble in the field." When you find the top engineering thinking that has caused the pattern of their usage in that area, then you're ready to think on the basis of facts. How do you want to spend your money? Now you know what the facts are; you know the reason why they're there.

In other words, to promote a businessman's judgment, we must always learn to feel that it's our money. We have to have enough facts so we can first decide whether it's a good idea. That's half of it; the other half for today is "Learn the basic manufacturing" --

In manufacturing, go out to the production line. See what's being done. All that's being done is not written on a piece of paper, as you all well know. Here are some of the questions: What is done in the plant? How do the parts go together? Where is there difficulty? What jobs do the people working on them object to and find troublesome and full of losses? What are the quality problems in each of the sub-assemblies? What are

the causes of a reject of a product? What do the factory people think would help? What have they suggested that has not been followed out? What is being delayed that some think we might help? You'll be surprised how many things will come forth if you give the people close to the job a real chance to tell you. Again, this is a listening session; no suggestions; you're just learning.

What's the tooling, the jigging, the automation of each part? Sub-assembly for sub-assembly? Assembly for assembly? What are the manufacturing parts? In one factory, for example, we noticed this: a yellow compound was being smeared onto a piece of metal about the size of a saucer and baked on. It cost \$2.00. It became a brake. It is used as a brake on one of our products. We use about 50,000 a year. The fellow who isn't close to the job looks at it. "A brake? Where do they use brakes? Where do they do lots of this? Why, in the automotive industry. So, we put it up to a company that provides this type of thing to the automotive industry and they said, "For 18¢ we'll sell you the disc that is used by the Cadillac with this compound on both sides and is all ready to go." "Well, wait a minute. How much power will it handle?" Ten of them will handle 150 horsepower on the Cadillac clutch; 15 horsepower per disc. We can buy it right off the shelf for 18¢ but we're making it for \$2.00. There's the kind of thinking that seeing what they're actually doing will bring to somebody.

In another factory, looking at the manufacturing we see a final operation on a control device. A girl with a screwdriver in reverse pushes down over each blade. She bends the blade enough so that the device will finally go through test and all the lights will come red and green as they should. Gee, it just makes you sick when you see that because you know that six months later that phosphor bronze will have reset and the thing will be back in the service shop. You see that when you go through manufacturing and study it.

In another plant we see them welding copper to copper. Now, before I saw that I knew doggone well you couldn't weld copper to copper. But unfortunately, they assigned a young engineer over there on that job. He didn't know it was not an accepted practice. He went at it and worked it out. Now you see tens of thousands of beautiful welds, copper to copper coming out. If anybody wants to know any more about it, ask Trumbull. There's where it's done.

Another place they'll tell you you can't weld zinc plated parts. Gosh, I went through one factory where they're welding thousands of them every day, and doing a good job. You see those when you get around. That's the bite that you get in looking at the manufacturing.

Again, one of our timers has connections soldered onto the blade. Seeing them assemble it you notice that they solder a

little short connection about two inches. On the end of the connection is one of these contacts that you can open up and take apart. Well, a vendor will bring a slip contact with the same positive action that you can put right out in the control and completely eliminate the soldering and the part in there. Take all the costs out. You wouldn't pick that up by looking at a drawing, probably, but learning the manufacturing, things just jump right out at you.

Walking through one of our plants we see them cutting copper tubing in lengths about two inches long. Here's a nice machine. It's going pretty fast. A fellow cuts one off every now and then; he slides it over and cuts another one. He's making out all right if he's got a good piece rate. It costs 4¢ apiece for them. It has 1-1/4¢ worth of copper and it costs 4¢ apiece, but gosh, that's a specialty business. Let's get somebody who's a giant in that industry to quote on it. A little supplier with probably 50 employees does nothing else. He buys his copper in carload lots; 1-1/2 inch diameter. He draws it right here. He cuts it off right here - no boxing, no shipping, no less carload freight, no less carload extras. What's his quotation? Let's get the figures. We were paying 1-1/4¢ for the tubing; we were cutting it off and burring it. It became 4¢. He supplies it, cut so cleanly that it doesn't need burring, in the box, ready to use for 3/4¢.

I don't want to make it sound easy. You have become accustomed to the deviation pattern that's followed in design and manufacturing. I don't know what the eccentricities are. We hope that you're being here and seeing how others are doing things and having an opportunity to learn other deviation patterns will allow you to go back to your plants and kind of lift yourselves by the bootstraps. I think you can do it.

We'll bring this to a close with one thought: Let's learn to take the initiative with these things. I know some of you work with strong personalities back in the plant. They bring things to you. They tell you what you can do. They tell you what you can't. The job of value analysis is to take the initiative on value. Now, let's quit being the catchers all the time in your plant. Let's get to be the pitchers. See these things and pitch these things out yourselves. I don't blame anybody in a plant when they're used to thinking that John Jones or Lee Stevens or any one else is the catcher, always on the receiving end. If all of a sudden he starts to pitch, they're going to be surprised. They'll be less surprised when you pitch the second time. After you get back start in pitching. Broaden yourself. Make it your job to generate these ideas and keep pitching them at the others.

End 3
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In our program today, is Carl Chase representing Gries Re-producers in New York, who will talk on miniature zinc die castings and molded parts.

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I want to start off quick by clearing up one thing about our corporate name. It's a hangover. We don't reproduce anything. We haven't in a good many years. We used to make sound reproducers about 25 years ago. Our company developed a process for making very small die castings and very small plastic injection molded parts. We operate equipment that was entirely built and entirely developed by ourselves. It operates fully automatically. It operates on single cavity only at extremely high speeds. The average plastic molding machine and the average die casting machine, conventional machines, run around 10 cycles a minute when they're doing very, very well. The normal cycle is 2 or 3 cycles a minute. Our machines run all the way up to 240 cycles a minute. In addition to which they are fully automatic. They rim automatically. Everything that you see in this little envelope that came with the surprise package comes out of the machine just the way you see it. This has a great advantage in small parts in that you have a lot more leeway on design. More leeway on design means the following things: (a) You can work in things, design features, cam surfaces, fasteners, all kinds of things like that into the original part, the original design of the part, without having to worry about providing these things in a secondary operation; (b) you can make parts by one single casting operation which you might normally have to fabricate or build up; (c) you can make parts in one operation that very often require secondary machining or assembly. And, of course, what is very important on high volume parts, there is no such thing as scrap parts. Each part that is in this envelope is complete in itself. All the scrap that may result from flash and sprues, and things like that is melted down and goes right back into the parts. Generally speaking, the volume on the diecast or molded part by our method has to be fairly substantial. It is not usually economical to make less than 100,000 pieces of anything at a time, although on pilot runs for a trial for the future we certainly do go along to give something to fool around with, if necessary, to prove the design or test the market, or something like that. Generally speaking, mass production is very important to this sort of operation. Supposing we take this part here - two pieces fastened together. One is a nylon part and one is a diecasting. When you take the diecasting apart from the nylon part, you'll see at one end it has a bastard thread; a thread that's had the side shaved away. At the other end it's got a part of a knurl and a tapped hole. All the way through you see it getting thicker and thinner at various sections. All those things are functional. This particular part was originally made on a screw machine. In small volume it was a darn good thing on the screw machine, because you could set up relatively cheaply, your tool expense was relatively low, and when you needed 5000, 10,000, 15,000 parts, you made them. On the other hand, this part is one that is used in very large volume. It's a part that's made for the control of the automatic blankets down in Ashboro, N. C. They run on the order of something like 100,000 pieces a month. You can very well see that all these machining operations for the thread, for the knurl, cutting away metal, making shoulders, and capping which

we still have, incidentally, can be a very, very expensive business. The original tools for this particular piece cost about \$1700. However, in figuring tools against unit price they got their cost back the first quarter million, which is appreciable when you figure an item runs 100,000 a month. There was a great deal of difference in unit price. We can make a part like this for about a penny - just the way you see it there, just as easily, once the dies are made, as any other diecasting of simpler or more complex shape. With the diecasting you have the terrific advantage of being able to vary your shape, just like in this part, and, of course, it's small. That is something I neglected to mention before. We make small parts only. The biggest part we would possibly make would weigh about a half an ounce. In this way we are completely different from any conventional diecasters you may have come in contact with. We're not in competition with them, because where they leave off, that's where we start in. We generally want to get at the design when they're being worked on so that a part can take full advantage of the method, just like it was done on this part. True, it was originally laid out for a screw machine part, but once it was changed to a diecasting there were a lot of changes. The mating part, a little nut, has a molded-in thread. The two together control the amount of heat that goes into your blanket. The spacing of the thermostat is controlled by the distance that nut is threaded up on the screw. That's molded of nylon for two reasons: one reason, which was very important, is that nylon is an insulator. The part was made of metal before and another insulator had to be provided in order to keep it from arcing over. The other reason was that it's relatively easy for us, anyway, to mold this thing with a thread. Between these two parts we feel that we did a pretty good job in helping the people in the Design Department at originally Bridgeport, now Ashboro, with the problem that they wanted solved. They came to us as a specialty vendor for a specific item which happened to be right down our alley. In addition to many, many specialties which we consider normal -- this we consider an easy deal. Both of these things are relatively easy.

We go into a lot of other specialties. For instance, we have a method we call intercasting where we can cast movable elements. You see the little scissor on the card and the piece of chain. Both of those pieces come from the machine just as you see them, except for plating. There should be a card in your envelope. You notice the scissors are movable. There's no rivet, no joint, nothing. This is just the way it's made. If you'll try to cut the card with it, you'll see that it cuts. Now, obviously this is a novelty. But the principle is one example of how our company tries to drive ahead and tries to find new ideas and new things in which to try to find applications for our very varied methods.

Another application which we have developed is known as insert casting and insert molding. There's a little brush in

there with 18 strands of wire on a metal ferrule. There's a little red cap with a brass insert. Both of these parts come from the machine just as you see them. The red piece is the insulator and the contact for a small hearing-aid battery. The plastic is molded right around the brass cap which gives a leak-proof joint and costs far lower than making caps and insulating them into molded pieces by hand. There, again, volume is rather important because of the relatively high initial tooling cost. This little brush with the 18 strands of wire is another example of a similar technique. The technique of insert molding. This is the reading brush on the IBM punch card system. They read the holes in the punch cards electrically with these brushes that pass through the holes through a contact plate which goes underneath as the card goes by. IBM had had a method of making brushes. They had had several methods of making brushes. One was to take wires, cut them off, bunch them in groups, put spacers in, solder them, put them in a little metal ferrule and stamp the ferrule closed. That was a fine way of doing it. As far as we were concerned, it was a heck of a way of doing it. They had another method. They went to diecasting. They realized, they said, that by casting them into place they could save a lot of money. They went to another diecaster. They rigged up a great big crane that fed strands of wire into a diecasting machine. Then you had to close the diecasting dies, make a shot, open the whole business out, clean them out by hand, clean off the flash. You had a terrific amount of hand labor. We take 18 reels of wire, we string them up next to one of our diecasting machines, and we run them right through the casting die. It goes faster than I can talk about it. Those things come out just as fast as that and just as accurate and uniform as that which is the advantage of the single cavity method. In a multicavity die you'd have the devil's own time trying to line everything up, trying to make it match. In the single cavity die you don't have that problem. You have a lot more leeway, a lot more room, and you can do a lot more with your pencil before the things get out into the shop for actual manufacture. In line with that, it is very, very often necessary to redesign a piece for diecasting. Whether you're making a big diecasting or a little diecasting, that's true. Generally you have to redesign a piece. When you have a screw machine piece and you want to make it as a diecasting, generally you have to make allowances. A good example of that point was the cup hook. This happens to be one of the standard fasteners that we make. We make about 10 or 15 different types of standard fasteners. Your ordinary cup hook is made into wire form, bent, thread-rolled. Next make a stamp flange, force the flange onto the cup hook. When you put the cup hook into the wall or into the shelf, you take up on it the wire bends and the flange strips off. I am sure that many of you have had that experience. Our designers went to work and said that with a diecasting we could do better. If you take a good look at it, at the very point where the old-style cup hook always bent we made it bigger. You see, we're not grounded, so to speak, by a piece of #20- wire. We don't have to have the same uniform

thickness all the way through. We don't have to worry about how much spread we can get out of a piece of 20-gauge wire. If you look at the tip at the end where the cup enters, it comes out in a nice round point, thinned out. Then it thickens right down to the base of the flange where your stress comes in. The flange will never come off. It can't - this is all one piece.

Another piece worthy of mention in this redesign is this umbrella-shaped affair with the threads on the side. This happens to be the lamp housing used in a military type aircraft panel. The hole inside holds a little bulb and the lump on the end is anchorage when it's enclosed in some kind of plastic. I don't know all the details of the application. It's one of these things that aren't mentioned in detail how. You'll notice there's a hole right down the middle. You've got a big diameter. You've got four lugs on the top. You've got threads on the outside. You've got cross-milling operation to get your windows. That piece cost approximately 10 times more as a screw machine part than we could furnish it. We'd furnish it for about something like .8 cents, just as you see it there. You can very well imagine what a screw machine part of that nature would cost.* The tool charge on a thing like this I think was around \$1150. *(Question in background.)

.....What tolerances can we hold?

A. Tolerances vary. It depends on where they fall. Within certain portions of the dies we can hold what we consider pretty good close tolerances, on the order of 1/1000ths. On other portions it may be necessary to go to plus or minus 2, plus or minus 3, depending on the requirements of the job and depending on the location of the tolerance, itself. There are certain angles to this problem which would have to be ironed out in each particular case. We have a reference book which includes what we call a "Design Engineer's Check List". It gives you a great deal of information about tolerances, about design points, checking thicknesses, parting lines, knurls, gears, and what-have-you.

.....In what quantities will you sell standard items?

We'd sell them one, providing it's within our minimum ordering limitation which is about \$5.00, or something like that. That holds true, by the way, about acorn nuts. We make a die-cast acorn nut which is cheaper than the brass turned nut. The main reason being that we don't have to throw half of it away. When you make a brass turned acorn nut, you start out with 7-16 bar stock and machine away your head. You drill a nice big hole in it. You're throwing away more metal than you're using. In a diecasting we come out with this complete except for the tapped hole, and we don't have to throw half of it away.

.....What materials do you work with?

We cast zinc alloy only. We mold all the commercial thermoplastics which includes nylon. We're working on a development on that now, and of course, it includes the acetates and the styrenes and the ethylenes, and that gender. We do not do compression molding nor do we do transfer molding.

.....How do you plate your parts?

We barrel-tumble to get a nice smooth surface and then we barrel-plate.

.....What about threading?

The internal threads on diecastings, for the most part, are tapped in a secondary operation. While that nylon part is threaded internally in the molding machine, generally speaking the threading or the unscrewing of the core that was cast in internal threads slows the casting machine down to such an extent - and don't forget, the casting machine is a high cost machine - that it is much cheaper to take the pieces in bulk after they come off the casting machine, hopperize them and tap them in a secondary operation. There is practically no labor involved and the high cost casting machine is then free to make more money for the company than it would if we cast internal threads.

.....

Mark Taylor who knows us and has known us for a good many years, asked me to go into the reasons for the alloys that we use. At the moment, there are two popular commercial zinc alloys. That's ASTM 903 and 905; also known as Zamec #3, Zamec #5, Fed. Spec. QQZ363 Type 3, 5, and so on. It's still the two alloys that we're talking about. Generally speaking, we use #5 as having the best all-around qualities for a mechanical part. No. 3 is more ductile and very often where a riveting operation is necessary we do recommend #3, but most of the time we recommend #5.

Now, why do we stick to one metal? Why don't we go into things like lead and tin, etc.? The reason for it is this: the diecasting will go bad in a very short period of time. Unless your alloys are controlled and every reputable diecaster does control his alloys, impurities will break down the casting in aging. That is why we, and most diecasters, restrict ourselves to a limited group of metals. The fellows who do both zinc and aluminum castings usually keep the departments miles apart in order to avoid contamination.

.....Is the sample tubular rivet a standard item?

That tubular rivet is a standard item.

.....What is its cost?

Offhand, about 80¢ a thousand. Generally, about 10% cheaper

than the steel rivet, generally about 30% to 40% cheaper than a brass rivet with this advantage: The steel rivet has to be plated in order to keep it from getting rusty. The zinc alloy rivet does not have to be plated. It is nice and ductile. It will never get rusty.

.....

We have, by the way, representatives at the principal industrial centers who are pretty well versed in life, as it were. Any really serious problems, give me a call. We'll arrange a meeting somehow; either you stop in and see us, or we'll stop in and see you. We'll manage it somehow to sit down on any questions that might arise on any particular part. I'd like you to take these parts with you. There's a lot more in them once you start looking at them than the eye meets. For instance, there are two things I wanted to point out. That is the terrific amount of detail that we can get on these small castings. This round part here. That happens to be the counter for a 35 mm. camera. You notice the lettering on the face of it. That is cast, not engraved. And on this part here the type is also cast. A good example of a good diecasting is this part here. If any of you have boys or were boys at one time - and I think most of us were, you will recognize this as the coupler from the Lionel train. A part like this would be absolutely foolish to try to make any other way than by casting. Lionel, who run a tremendous diecasting department themselves, come to us for small parts like this. That's our business.

.....

Our die life runs pretty good. We use specialized steel. As a matter of policy, we will continue to repair and replace dies as long as the part stays alive. In other words, if we quote you on a die, \$1000 just for the sake of argument, to make 50,000 or 100,000 pieces a week, we'll keep the die in shape as long as you have requirements.

.....

Mr. Taylor brought up a very interesting point which goes into the details of diecasting, of designing the diecastings themselves. I felt, Mark, that the scope of this meeting wasn't long enough, a half an hour wasn't enough to go into that. In the bulletin under - on page 7, "Knurls and Serrations", gives you a reason for the way we sometimes design gears with a web on the edge to get away from having to trim through the teeth. Wherever a gear isn't in full contact over its entire face, we try to put a web on the edge of one of the faces in order to avoid that.

.....

There's a little sector in here, part gear, part sector, which shows that principle pretty well. On one side you see a gear sector. You notice that the teeth are free. Those teeth had to be trimmed through. We do it right on the casting machine.

It's not as easy as the teeth of the other half which are backed up by a solid plate. This doesn't require any trimming or cleaning operation because the whole business is inside of a die cavity. On something like this it's easier to maintain tolerances than on dimensions that involve trimming.

What can be done, what can you, Mr. Chase, do to break the AN feeling down against zinc diecasting?

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The AN feeling against zinc diecasting and a certain amount of prejudice against zinc diecasting in some industries goes back to the time when we didn't have good alloys. Remember, I said something before about controlling alloys. Prior to about 1920 it can be safely said that all zinc diecastings were poor, because before that time the New Jersey Zinc Company had not developed the so-called 99.99 pure zinc which now is available. We ourselves, as a diecasting company, the American Diecasting Institute, as well as the New Jersey Zinc Company, are always looking for opportunities to prove our point with the AN people. You can't convince them on principle; it's impossible. We found that out. The only way to convince them is application by application. When an application comes up you have to try to beat down all the objections. If you have an application that might lend itself to a zinc diecasting and we can show a sizable cost reduction over another method of manufacture, that would be the way to go about it again, as it's been gone at before. The only way we'll ever get anywhere with the AN people is by continued pressure. The only way we can accomplish anything is by dollar-and-cents pressure. Even though they are a Government Agency, dollars and cents does mean something.

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Next on our program today we have John Boden, representing Mohawk Manufacturing Company which specializes in small tapped stampings.

Thank you, Doug. My name is John Boden. There is a great similarity, perhaps, in what the last gentlemen, Carl Chase, had to say about his company and his products, and our company and the parts we make and how we make them. Now, in order that every one has an idea of what a threaded stamping is, if you'll open the yellow folder you will find in there an envelope containing some parts. All these parts, you'll note, have threaded holes in them. I am going to assume that all of you are familiar enough with the metal-working industry to know what a stamping is and what a threaded hole is. You'll note that all of these parts have small threaded holes, and that they're all threaded internally. Now, that differentiates between the last gentleman's products and ours. We specialize in internal threading and particularly small internal threading. We do not make any standard parts; all our parts are made to customer specifications; to your design. We do not make up any standards whatsoever.

For years people have made threaded stampings. The only difference between these stampings and those that have been made for years and are now made by many people is but one thing: we make them in one operation. They're made on a machine and threaded completely automatic in one operation. Perhaps we'd better see what the normal procedure is and then you can see the advantages of a single operation.

A part has to be first stamped on a conventional machine, either a force slide or a power press. Next they are generally tumbled and cleaned so that they can be handled. They're put into another machine, usually by hand. In this second machine, which is known as a standard tapper, of which there are many styles and types, the speed of operation is governed entirely by the speed of the operator. Generally speaking, a hand operation to tap a small part is somewhere between 1500 and 3000 pieces per hour by hand. But now, you've got to make the part, burr it, clean it, and then move it to another machine where it's tapped. That's three operations. In our method we start with a coil of material, run it through our machinery, and catch the finished parts on the other side, all made in one operation.

Before going into the dollars and cents savings, I would like to point out some of the advantages that are gained by our particular method. When parts are handled and put into secondary operations, there is usually a great deal of trouble in maintaining the tapped holes of the body which, in many cases, is a very important consideration, particularly if two parts have to be matched together and are held by a screw thread. If the threaded hole is not square, naturally the parts won't come together square. By our method, we can insure that the threading will come out absolutely dead square within a quarter degree in most cases which is good enough for most types of work. The greatest advantage we have with our equipment is that the threaded hole can be maintained to any class fit that you desire. In other words, if you specify a Class 2 fit, we can maintain a Class 2 fit, not only just for a few pieces over a run, but over an entire run. We have set up, for example, the Sommersworth terminal. It's a little right angle piece with little ears on it. That was specified to be a Class 3 fit. We were so proud of the job that we did no maintaining it that we set up to see just how many threads we could get from a one tap in our machine. We set it up and run off better than half a million parts with one commercial tap and got all Class 3 fits. Now that, in itself, I think will show you the fine precision that we can maintain for tapping. To my knowledge, an ordinary commercial tapping machine could not even approach that precision.

Here's a little part that we call the "bed bug". It's a little $3/8$ inch steel part that's all cut up and bent and has some little projections on it. It has a 8-32 NC2 thread in it. The cost to fabricate in the shop as originally, cost \$3.03. Our price to produce this part with the threads complete as you

see it was \$1.98, a saving of \$1.05 per 1000 parts produced. The surprising thing about this particular part is our tooling costs. The machinery that we use is our own machinery. It's machinery that we've developed ourselves. Our tooling costs in most cases do not exceed the tooling cost that would be involved if you or any one else were just to make this part without the tapped holes. By our method the tapping does not cost any more for the tooling. In this case the tooling charge was only \$350.

The usage on this particular part was great enough that the yearly savings as we calculated were \$6,300. With a tooling investment of only \$350 you can see that the tooling is only a minor part of our process.

The second part is a terminal that's a U-shape with a threaded hole on one end with a 10-32 Class 2 hole in it. We found that the cost of that part was better than \$14.00/M. Our cost, including the entire part, as you see it, clean and ready for use was \$8.15, or a saving in this particular case of \$6.16 per 1000. The record shows that they saved \$8,392/yr. The tooling costs on that part were \$440. It bears out exactly the same relationship as for the other part.

A tiny rectangular shaped part with an extruded and tapped hole in it was originally a screw machine part. It was made out of a shaped stock, run through a screw machine, cleaned, and tapped in a separate operation. It was so small that in order to select the correct size for the entrance of the tap it had to be picked up with tweezers. You can see the advantages of changing the operation - changing the design - and in one operation getting a workable part from a piece of sheet metal without any handling. When it was fabricated in their own shop, the cost was \$40.60 per 1000. That cost was due entirely to the fussy handling. It just could not be handled rapidly.

.....Is tapping done before or after stamping?

It depends entirely on the piece itself whether it's tapped before or after the forming. There are many pieces where the tapping can't take place until the forming is completed because of distortion. In this particular part our price was \$3.73 or a saving of \$36.87 per 1000. It showed that in the yearly savings for that particular company over the number of pieces they used was something like \$44,000 a year for one little part. By and large I want to point out that the size is most important. If the stamping itself is too large or too bulky to handle, there is no advantage in most cases in doing it automatically. We have found that when the blank itself is over 2-1/2 or 3 inches in width or length, the automatic tapping is so slowed down by the other process that it's much easier and cheaper to do it by conventional methods. I think you'll understand that. Our method was designed principally to take care of the electrical component parts where many small parts are designed

to fit a particular need in an overall picture.

.....

.....How about blind tapped holes?

Generally speaking, by our method in a tapped part made of sheet metal, we do not run into a blind hole problem.

.....

Could we make parts with a blind hole? I would say "No", offhand. We have some difficulty, of course, in getting rid of the excess material generated by the tap itself; that is, the chip itself.

.....

The question is: What kind of lot sizes?

We have, on a very simple part, run off production of 100,000 parts and make it come out to show a saving. The part itself must be simple, in order to do that. On certain parts, we can tap two holes. We have done more than that. However, the production of that part is up in the millions. Additional tooling and experimental work was necessary in order to get this set up. It justified itself. 100,000 parts is just about the minimum for a simple piece.

How many holes can be tapped in one piece?

We have done successfully three, but the production must be up in the millions in order to justify that.

.....

The question is: Must the holes be the same size? No, we have tapped two different sizes. We do not go over 1/4 inch, in brass. We do not go as large as 1/4 inch in steel; 10/32 has been our limit for tapping in steel.

.....

The question was: Why did we change from copper to brass on the range timer terminal? As I recall, that originally was made by G.E. out of brass. They found that they could make an effective saving by using copper wire. The price differential between brass and copper was such that by changing to copper wire there was a saving. However, when we came along to do it by our method, completely automatic, we found that the tapping of the copper slowed up the process enough that we could make it from brass cheaper than we could from copper. You can tap much faster, as you know, in brass than you can in copper because it's much freer cutting.

.....

The T nut is a standard part with another manufacturer who makes it, I believe, by stamping the part and then threading it in a separate operation, I believe that it costs somewhere around \$7.00/M and some odd cents. I'm not sure of the figures, but I believe there is a substantial saving. I show it here at \$6.35

but I know that it was bought from a third vendor who is doing it by the same method but undercut the first vendor just to get the business. We took it away from them at \$4.95/M.

.....

The question is: Do we handle stainless steel? I was afraid somebody would ask that question. We have. However, we would much prefer to stay away from stainless steel. In a straight chrome stainless we have had good luck. I have a part made of stainless that we tapped with a 10/32 hole and have been successful. However, in that same part they changed to a nickel bearing steel and, boy, did we have headaches!

.....

The question is: Is there any limitation on the distance between the tapped holes? There is a limitation, depending upon the shape of the part and how we would handle the part. If it could be done in two progressive stations, we then could bring those up on very, very close centers. We could make those threads come right together, as a matter of fact. However, if the shape of the part is such that this can't be done, we have brought our centers down to about 3/8 inch apart which is a lot closer than can be done by running two tappers together. I've never seen anything done that close on conventional tapping.

.....

The question is: Are our tools and equipment confidential? The answer is "Yes". We don't allow anybody to look at the equipment. Although you buy these tools, we reserve the right to retain the tools. We will not let those out of our factory.

.....

Mr. Miles: I wanted to make one comment about the way this business has fit into some of our products. We have found where the volume is less than about 2 to 3 million but more than 100,000 that Mohawk Stamping Company comes in and very often their costs will be 1/2 to 1/4 of what our costs would be, so if you can hit 100,000 be sure and look them up.

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Start of 2nd Day - L. D. Miles - Introduction and Review
V.A. Tech. - Get the Detailed Facts

Value Analysis is a system of "Do's", not a system of "Don't's". You were asking about "Can you have contact with the vendors direct?" With engineers direct? And the answer is always "Yes". We always have to push Value Analysis and help them. They have to push others. We don't want anybody to set any roadblocks in the way of value analysts. There are plenty of roadblocks in the way of everybody else.

Yesterday we probably should have brought forth a major thought, but we didn't. Let's do it now. The environment that we will work in is an environment of people, manufacturing men, purchasing men, engineers, who are doing in many cases the best they can; who have certain limitations and certain abilities; who in no case are supermen. None of these people are doing their jobs perfectly. We all know that. No human being is that good. Still, we're as good as the average; probably no better than the average. By helping each other we can perform better than the average. Our job is to recognize that in today's competitive market no one is good enough to make the outstanding success we need. One of our biggest problems is to get every one in our Company to recognize that. Therefore, every one will search for help and be eager for help. Our job, then, is to recognize that in any department there are men with abilities scaling from 'way up, down to average. There are men who are selfless; who don't think of themselves at all. They are wonderful to work with. They just want to do a job for G.E. and to our competitors. There are others whose prerogatives are on their sleeves all the time. Let's expect that. Our job in that environment is to learn to get them to call for help and to learn how to help them. Working together we can do a good enough job, but no man alone is good enough in any line to do any job good enough in General Electric.

Go right up to Mr. Cordiner. He realized he couldn't be president of this Company. Therefore, he delegated a segment of his authority to each of four men. He delegated it down; they didn't bring any up. There are four Mr. Cordiners in the Executive Vice President positions. He said, "I can't possibly do the president's job." Let the rest of us help keep that philosophy throughout the Company.

Yesterday we saw that it was our move; that yesterday's techniques and methods kept us in the race but they certainly didn't produce any winning teams. Today with the specialists we have, with the know-how we have, with the help we have, we can win. That's our job. We believe we have here one of the main tools that will help us to win in the market place. That's really the scoresheet.

I'm going to review the major points of Value Analysis. First, value analysis is not a substitute for any work now being done. It is an addition and it will help the work now being done. Second, we know we can get 15% to 25% more on the average out of shop cost without affecting performance. Each purchasing value analyst is taught to use a businessman's judgment. Fellows, you've become businessmen. Get out from under whatever thumbs there are around you that made you feel you had to do things that didn't make sense to you. Next, value analysis relates cost to function. What do we get for the money we pay? We spend what the company saves. We're handing out their money every time we make a planning card, every time we place an order, every time we design a thread on a screw. What do we really get in function for that money we hand out? Third, value analysis is an engineering and a manufacturing tool that uses not only 1/10 of the know-how that's in our Company, but 9/10 that exists in the thousands of other suppliers throughout the country and brings that into work on our product. Fourth, value analysis has this simple study; that is, what is it? What does it cost per year? What does it do? What else would do the job? What would that cost? To clarify the thinking, value analysis accepts only the costs that bring clear and definite function. What is function? Something that makes the product work better or sell better. Value analysis is not committee work. It is conducted by one man intensely following his project and discussing various phases of it with others who have creative imagination and creative ideas that will help. Value analysis is an on-the-job Purchasing Department job. Value Analysts must work with all the facts. A planned program for project study has been prepared, tested and will be made available. We all feel that we can develop a valuability in fellows like yourselves so that nine times out of ten you will look at a thing and you'll say, "It just simply isn't right."

We have found that a man is under a decided handicap if he has worked on a project for a length of time. It's far better if he will get off a ways from it and work on an area that uses the same techniques but where the same "don't's" do not apply. We have proof of that repeatedly. The top job of value analysts is to learn the facts, generate good solutions, set them up with a dollar sign, and then refer them to the person delegated by the Manager. He can then walk away from them and go right on with the next job, always working at his top skill. However, he will not try to push people around without authority and make himself disagreeable by alienating those who will help on his next project.

Value analysis is a full-time job. It must be thorough and intense as it requires serious, hard thought, immediate action. It is basic that value analysts make no savings claims for there has not been one place on the Company where they have tried to make savings claims where we have had good results. There have been no places where they have adopted the system of no savings claims where they did not get good results.

Purchasing Value Analysts must look some into engineering, some into Manufacturing, some into Purchasing. How else could you decide whether to spend your money the way it's being spent on a particular part?

Value Analysts make no decisions and first of all, they must let others know that they don't make any decisions so the engineer or the buyer, the manufacturing or methods man is never edgy. He knows "he is a prosecuting attorney developing information for me; he's never going to take the prerogative of trying to make a decision for me."

In Government work we have found the percentages to run very much higher - 50% to 75% - we believe can be removed without cutting down safety factor or function. We have a program set up for not only training value analysis specialists but for training buyers to assist in our Purchasing Departments.

To assist in getting off to a good start today on your project we will preview the value analysis job planned. You've got these projects; you look at them; and if you have had any time to study them - and I think probably you haven't; you've been getting information - you will very soon get to the panic stage. On every project that we have, we look at it first; it takes an hour or two or three, sometimes a day or two or three, depending on the size, to find out what the facts are. Then comes the time to generate some useful idea, or think of some specialist who may help, and get him on the job. You'll look at it and the wheels go round and round and panic sets in. Well, this is the one that won't cttack.

I don't know of a job that we've ever had that didn't go through that stage. You'll find that you do on these. We all go through it. To help get through that stage which you'll be running through about today and tomorrow, we will review this general plan. Some of these things you've done; some we're going to study in detail later. Here's the "quickie" on it:

First, the information phase - secure all pertinent facts; actual samples if parts are practicable; costs, quantities, vendors, drawings, specifications and planning cards. Review the manufacturing methods; discuss it thoroughly with the engineer; ask questions; listen; develop with him a thorough understanding of the problem.

Next, discuss and determine the amount of effort which should reasonably be expended on each item. Sometimes five minutes spent on a screw or a washer or a bolt will save \$500. Spend the five minutes, but don't spend five days. Evaluate your own time in this phase.

Next, is the speculating phase. This is where you are about now and this is the phase that's really wonderful fun. This one

really separates the men from the boys. Some fellows do not have an imagination. The fellows who do not cannot enjoy these speculative phases. Even if you do about two-thirds of the people with an imagination have been stepped on, so they're ashamed of it. They apologetically suggest ideas. Some of the finest ideas I have heard have been suggested as apologies by men with wonderful imagination and ability who have been submerged and stepped on. In the speculative phase, no negative thought is allowed. Every one is encouraged to bring forth any idea, no matter how remote and make a note of it. No matter how silly, how foolish it may seem, a certain percentage of those silly ideas cause somebody else to think in a channel he has not thought in before and he brings forth an idea that's wonderful. We'll give you lots of examples that are just shocking where that has resulted.

We've been invited to sit in on discussions with a number of cost reduction committees. I have never found a committee where we could get them to stop thinking negatives when the slightest new seed of an idea was sown. They won't leave it time to grow and develop in that group before swatting it down. That is the second stage. We generate every possible solution to the problem, consult others who may help, systematically explore various materials, machine processes, rearrangement of parts, etc., encourage free use of the imagination, record every suggestion, no matter how remote it seems and establish two-man teams for the creation of additional ideas on jobs that are large enough. During this session no negative thoughts are allowed. That's in line with streamlining our thinking, focusing every one's actions and thoughts in the same direction at the same time.

The next thing is the analytical phase. Here we evaluate each idea carefully, sift out those that are definitely impractical, usually eight out of ten you'll strike right out. This is the time to do it. They have had a chance to grow. If they haven't taken root, we don't have the capability of making them successful in the crowd. Investigate all promising ideas for practicality and savings possibilities. Select the most promising ones, set up a program to pursue each of them vigorously.

We call this next phase the Vendor Contact Phase. It could be broadened a little to Vendor and Specialist Contact Phase. Through the responsible buyers search for the best applicable suppliers and find the best specialists on the subject. Give good suppliers enough facts to enable them to make good suggestions. In other words, untie their hands, show them what has to be done. What we need is to let them come forth with the suggestion. This phase, when properly carried out, will strengthen the buyer in his position and will add to his facilities. That is still essentially right.

Then we need engineering restudy and preparation of the summary sheets.

When you start your projects if you feel lost and panic, then you're a normal case. That's what always happens. Perhaps we should analyze a few projects to show how formidable they appeared at first and how easily they were solved.

The main subject is this - your job is value analysis. It isn't some one else's job. If some one else tells you what you don't need, I'd suspect him, because how could anybody else possibly know what you need. If you accept that you're just accepting a shackle. This job of value analysis is a hard, tough job. You have to make things come forth where they haven't come from before. You can't do it with one hand tied behind you or with one eye blindfolded. You must have all the facts. If it means going and making an issue and going to top management to get it, GO. We've had plenty of such cases and top management wants results.

What do we need to start a job? Annual production and ordering quantities, copies of all the drawings, showing each material, the assembly drawing, wiring diagram, test and adjustment specs, supplementary specs, if any, and need a breakdown of all costs right up to shop costs. Shop cost is the thing the salesman is slapped with and what he must sell in the marketplace in competition. That's the cost we're going to get ahold of. We're going to try to give the salesman an even break. In costs we need the material, labor, I.M.E. If other than basic raw materials are used, the name of the vendor and the price; a memorandum concerning any special accounting, that is, labor accounting, adjusted or unadjusted; variances, when you have obtained all the facts you study that so you are familiar with it, too, so you can talk the accountant's language. If you can't, you'll have the cards shuffled around and you'll never catch up with him.

A breakdown of assembly and sub-assembly show costs, copy of the planning cards or general description of the types of process, and then actual samples of the individual parts and assemblies, where practical. In the case of our big products like big motors, it's a case of going down and seeing them and working with the smaller parts and then going out on the floor to do the rest.

That sounds simple, doesn't it? Just a case of going and getting it. It just simply isn't so. Let me tell you a few experiences. Here's what happens. In one case after the management had asked for programs, they became enthusiastic in value analysis. They wanted one of their products tried. They said, "We'll have all the data available and over on a certain date." Well, we got a trainee ready to do the job. There was the data. The costs were labor and material; nothing in it about I.M.E. Well, we called over and they said. "The only costs we give out are labor and material". Gee, it struck me interestingly. If you fellows have a way of making things for just labor and material, you're just what we're looking for. Well, they didn't give anything out but labor and material. O.K. You go and get your supervisor to tell the manager that. If

he decides to send over the shop cost information we have a man available to do the job. If he doesn't, we have plenty of other jobs for him to work on. It came over, but it had to go clear to the manager to break it down. I'll bet every poor guy in the plant who's been trying to get that kind of information to do his job up to then has been batted down and has just been given part of the facts.

In another case on a control device, the accountant said, "There is no use for us to give you costs, anyway, because costs are really just averages, different overheads apply, really, from part to part. We just average them out to make accounting simpler. Costs don't really mean anything, anyway. They'd just mislead you if we gave them to you". Well, the only thing in my reaction to that was that there was one thing I'm sure about and that was that there was a lot of "I.M.E. that goes to pay accountants. That was the way I reacted to that, if costs don't mean anything. Well, we got the costs there, too.

There are a lot of shadow-boxers around in our Company yet, and they haven't come up against reality. Now, I want them to come up against reality with you guys; I don't want you to accept nonsense from them. You've got to have the facts to do your job.

Well, this was an interesting case. One of the creative engineering trainees had 90 days value analysis training and he showed up as a Purchasing Agent in one of our plants about a year and a half later. He called and said "Say I wish you'd take this product and do an analysis on it. Out here they don't understand what value analysis thinking is." Well, that's swell, so we put it on the schedule for three weeks ahead, got a new man to do the job, sent him down to learn the manufacturing and the engineering. He called up at the end of his second day and said, "Say, I'm in trouble." "What's that?" "Well, I'm ready to come and they tell me I can't bring out any of these costs." "Well, that's interesting. Why not?" "Well, they say that they can give absolutely no costs to any one outside of the plant without a vice president's approval." "That's interesting. Maybe you or I ought to get acquainted with the vice president. The Purchasing Agent said, "I think it's time I got acquainted with him. I want to take a toss at it."" He did, and the next day he called me back and said, "I got approval, all right. They're letting the fellow go with the costs." He worked on for about a couple weeks and got to where he needed more facts, more information, a lot more manufacturing information. He went back again - I happened to be on vacation the second time. They hunted me up somewhere and it was this young lad. He said, "I came in here and studied methods and planning and manufacturing costs; I have it all written on the drawings; I'm in the middle of it. Now, as I start to leave the accountant tells me I can't take any of that out of the plant." I said, "Why not?" "Well," he said, "their regulation is that any manufacturing information that goes out has to have

a vice president's approval." "Well, all right, you get your Purchasing Agent on the phone" (He put him on) and I said, "Who's going to see the vice president this time?" "Well," he said, "I'll see him again." He did and I didn't hear anything more of him which meant that he got approval and brought it back and went to work on the job. He found parts in there where they could make functional parts for one-tenth the cost and do the same job exactly; others for half the cost; others for two-fifths the cost. That's the kind of a time you'll have to get the real facts so you can do it.

Most people have been brushed off by these paper boxes that enclose all of these areas.

Another case - and this is the one that didn't go through - one group wanted some work on control devices; they wanted quite a lot of work, so a schedule was set up. "We'll get a couple of men and put them on it a month from now." "What do you need?" We gave them a schedule of what we needed. A month from then it wasn't there. We had the men ready and the stuff wasn't there. "We have our desks empty and our boys are ready to work, where do we go from here?" "Well," he said, "you fellows want too much stuff. We think it would take a man 30 days to dig out all the stuff that you fellows want about those four or five products." "Sure it will." "And after you dig it out it's going to take two of our men 90 days to do something with it." They didn't have enough authority and action in that area so we took the men and put them to work on something else. Well, some of our areas they're cleaning up. Some have further to go. That one now has made progress. They're ready now for action but they weren't then.

Fellows, I'm telling you those things because you'll bump into them. Don't let them bat you down. You bat them down. I thought you might like a couple of specific examples.

For example, on a dispenser device, when we get the actual cost - and the actual parts - we look at a small spring about half the size of your thumb. It's costing 13-1/2¢; 35,000 to 45,000 per year. It falls on its face when you get the complete costs and the whole story from the factory. It isn't worth that much money. Working with Purchasing we find that instead of 13¢, it's worth 9/10 of 1¢. It's made as a tapered spring and can just as well be a straight spring and perform the same function.

Another thing came out that some vendors will sell a tapered spring for less than a straight and others a straight for less than a tapered.

Another was the case of a link. Here was linkage about 1/2 inch thick and about 4 inches long; too thick and too small to be punched out of solid steel. It was hogged out, costing 90¢. Seeing the cost, 90¢, for that little part - How can we do it?

we've got a lot of automation and it's still quite a lot of dollars, we're wondering whether to go out of the business. Maybe we have, I don't know. That's a lot like a lamp, isn't it? Automatic to the nth degree. We ought to have 35% to 40% of the plug fuse business and it ought to be a profitable line. On the renewable fuse, there's a cap that goes on the end that's made out of brass. The center is machined away and a thread is put on it. It costs 3-1/2¢. The fuse link, as you know, is zinc. Gries reproducers could cast and put the threads on that whole head part for the fuse. Bear in mind, it's stationary. It doesn't go anywhere, or move - and it would cost him 1-1/2¢, not 3-1/2¢, to provide it in zinc. However, it's customary to use it in brass and Underwriters have not approved it in zinc for the head. We've got a tiny little leafy flaky piece of zinc in the middle that is the heart of the thing, and still we pay over double for the end, in brass.

That's yesterday's thinking, in my book. I want all of you fellows to become free while we're among ourselves here; say any thing you want to. If you think it ought to be done, say it ought to be done. Maybe we'll be right. Maybe we'll be wrong. In our book with our own judgment it looks as though it's wrong, doesn't it? It surely does to me. Furthermore, the fuse link that goes in there is a thin piece of zinc about 4 inches long and 3/8 wide and very thin. In order to make necks there they weld on four little pieces of zinc; one on each side separated by about 1/4 inch. That conducts the heat away; gives it a little time lag. In other words, then, we have a zinc ribbon which has two thick places on it. Well, instead of this welding, as that was, why don't we get a zinc rolling mill to roll us longitudinally zinc that has two threads in it? We'll have the same thing. We went to a zinc company and they said, "No, we can't do that." "Well, why can't we do it?" "Well, it isn't practical. You can't handle zinc that way." We went to another place where they rolled zinc and they said, "Well, it looks pretty tough." "Let's look into it. Why can't we do it?" "Well, we'll make a couple of experiments and see." They made a couple of experiments and then they took exactly the different turn. They said, "You drop out of this picture and let us carry the ball. Let us have all the patent rights that are involved. We will get into this thing and we will make this thing. You can have what you want." It just took that much pushing to get them to go through this paper shell again to do something. They made up a bunch of samples and they can roll it like that. There, again, it's using your businessman's judgment. When we heard the first story, "We can't roll it," it just didn't make sense. You fellows use a lot of businessman's judgment. That's one of the keys to value analysis work. Every small business has men in there using a businessman's judgment. Too many times we flunk. We step on that judgment, inadvertently, on young fellows in our Company. We've got to jump out from under that.

You know the kind of a load a timer takes. Here was a case of timer gears being made of brass costing \$20.00 per 1000. This fellow who was here yesterday cast them for \$4.50 per 1000. Does

it make sense to you? Well, unless you see a roadblock that will stop it, it does make sense, so keep it going until you see a definite roadblock. Remove the roadblock, if you can, and then it's ready to go to the Manager.

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How do we get the costs from a vendor? 75% of the dollar volume of the product is made from the vendor. All material is sold for what the traffic will bear. That's the way General Electric sells. That's the way everybody else sells. All of us here who must form good businessmen's judgment, must have that as a basis. That being the case, it's the vendor's job to determine what the traffic will bear and charge that. That doesn't mean he's going to be a shylock. Traffic won't bear that much. That's a short-sighted policy. In getting costs from the vendors, two paths are often followed. The first, and the main one, is just simply one cost. The vendor will supply this component for \$15.00 and here it is. That's really all the costs that we have a right to ask a vendor to make known; that we have a right to expect a vendor to supply.

Now, there are some vendors who feel that they have so much confidence in certain areas of General Electric that they will in the long run command more business and a better profit if they provide you with much more costs. We have vendors who say, "Come in and we will give you the costs of every component that goes into this. We'll tell you how much is material. We'll tell you how much is labor." I should say that maybe 10% to 15% of the vendors I've come in contact with take that viewpoint. When they do that, fellows, they're giving us an added responsibility. We have to make sure that they don't suffer for having put their confidence in us. We can make sure.

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Of course, I'm primarily interested in helping the operating groups to get set up to operate and to roll, and that question applies - you mean to a staff operation at a distance? - Well, just as a matter of interest, the first projects that came were the ones that were in commercial difficulty, and the sales department said, "Well, we're sunk or sinking and we're catching at straws - can't you help?" And after the first job was done there were always too many of them offered. What we did then was to decide that we could take about one project for each department and schedule them in an orderly way, taking the ones from the managers who were most interested first and who would match our efforts. Then it's just been a case of choosing a project. There have always been more projects available than we have had time to do.

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Am I to believe that we of General Electric can ask and expect a supplier to give his shop cost to us? The answer is "No." Any supplier should give to you only the information which he feels will help him to sell more merchandise to G.E. at a better profit. 90% of the suppliers feel that all they ought to give us is just the selling price, and I agree with them. I don't want to know much more. It puts so much extra burden on us. There are vendors who work so closely on some of our specialized products that they say, "All we're trying to get is certain profit percentage, and you can come in and study our books and see where this money goes. See that it costs us half a dollar to take the burr off of this thing, and 35¢ to do something else. Anything you can help us take out in there will just bring the selling price down." That's the minority - when they want to take that viewpoint, that's fine, but that's the exception.

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Roy Fountain:

Unfortunately, I glanced at the program and saw that I was on it. I am to tell you about this rocker arm. This is a part that is used on a contactor and it pivots about this center portion where you see my finger, to transmit motion in this manner. This particular rocker arm was studied here in Schenectady. It's a casting, a malleable casting. I am told that it has to be malleable because cast iron broke. Malleable is the only thing that will do the job. So we studied this part - it cost \$3.90. After studying it and getting a better casting supplier, making some changes to the drawing or suggesting changes, the cost of this part dropped to \$3.25 from the \$3.90. Well, you might say that's interesting to save a few thousand dollars; a fair reduction in the cost. But Larry and I were discussing this part and we wondered why this monstrosity couldn't be made as a fabrication. It's a rather complicated gimmick, and has a lot of surfaces that are functional and have to be there. We talked to experts here in Schenectady, gave them the cost of the parts, and said, "Can this thing be fabricated?" I did this. I'm underlining "I" because I made a lot of mistakes. I'm telling you these mistakes only because I don't want to catch you making the same mistakes. We talked to an expert. He looked this thing over; we gave him the costs; and he said, "No. We can't do it. You'll never liquidate the tools." I put my papers in my bag and went back home. Did I ask him how much the tools would cost? No. Did I ask him how much the part would cost so that if I did know the cost of the tools I could tell whether I could liquidate them or not? No. It was rather discouraging. We knew some people in another G.E. Works that were experts in fabrication. I took the whole device down and let them look at it. They studied this part in particular for one whole day. The answer - didn't think it was practical. Did I ask them why it wasn't practical? I'm afraid not.

So I came back. I still wasn't satisfied. It seemed like we ought to be able to fabricate that part. I took it to the plant where this part is made. An excellent man there -- and this is no reflection on him or any one except myself -- looked at that and said, "No, we'd never liquidate the tools." Well, I'd heard that story before and it sounded pretty convincing, but I still didn't bother to ask him how much the tools would cost. On we went. It didn't seem like it was practical to make this part as a fabrication. It didn't seem like we could ever liquidate the tools. So I went back with my story. We had suggested reducing the cost of this part from \$3.90 to \$3.25, and I was naive enough to think that that was a pretty good job. We talked to the engineers. They said it looked like a pretty fine job. They couldn't see anything wrong with the suggestions, and they were adopted. But one of the engineers said, "Have you ever thought of fabricating that part?" Well, I said, "Sure." And he said, "What results did you get?" I said, "Well, one place told me it wasn't practical and one place told me we couldn't liquidate the tools." He said, "How much did the tools cost?" Boys, you should have seen my face! It wasn't until then that I realized I had forgotten to ask. Somebody had blocked me out. I told him I didn't know. He asked me if they had given me any other reasons why they thought that thing wasn't practical to fabricate. I thought for a while and said, "No, all they told me was that it wasn't practical." He said, "Do you think it can still be fabricated?" I said, "Sure." He said, "Would it help you any if you had a sketch made up?" I said, "Sure." He said, "O.K. I think that can be fabricated. We'll make up a sketch. Then you can go to work." I said, "Fair enough. There's nothing I'd like better." So they had a sketch made up, put a considerable amount of design effort into it, and here I was, all loaded with a sketch. I sent it out to one of my friends again who was an expert. They studied it and sent me back a very nice letter. It wasn't practical. About this time I began to wise up. I sent it out to vendors to see what they could do. In the plant in which this was made we had a tool estimate made. While the tool estimate was being made, just out of curiosity, we thought we'd try to find out if this thing could be made, and how much would it cost. This was about two months after we started thinking about whether it could be fabricated or not. It should have been one of the very first steps - to get the facts: how much would it cost if it can be fabricated. Once you've got that, you're ready to get an estimate to see how much the tools would cost.

Now, this isn't recommended value analysis procedure, but the person who figured out the cost of this part, to fabricate it, made a mistake, and it was on the low side. This part originally cost \$3.90. The estimate which was in error was 30¢. My gosh, you should have seen people get on the bandwagon! I never say so many people come to the front and say, "Boy! Fabrication! That's the thing!" Now, we had all kinds of help. But there were some skeptics. But \$3.90 down to 30¢? We had enough help.

Here's the part - it couldn't be done. Then somebody took a look at this part and said, "Gosh, we've made a mistake." Actually that part's going to cost about 90¢ instead of 30¢. So it costs 90¢ - it used to cost \$3.90. The engineers looked at that part and said, "It's a little flimsy-looking. It may not last as long as this big, husky casting. Put it on life test." They did. The fabrication outlasted the casting because moving in this manner all the time there's less inertia, so it lasted longer. Boy, oh, boy! Everybody thought this fabrication job was a slick deal. 90¢! Finally vendors' quotations came in. They range all the way from 90¢ down to 42¢. Here's a part that some day I feel sure will be in production, fabricating it. The price instead of being \$3.90 for this hunk of junk that always gave them trouble - they'll have this part that lasts longer, will cost somewhere between 42¢ and 90¢. What do I want you to learn out of this? Well, not that I'm dumb, but rather if you sit at these tables and one of you makes a suggestion, how about doing it this way and your buddy says, "Nope. We'll never liquidate the tools", you ask him how much it will cost. If you have an idea, don't let somebody tell you it can't be done, because I believe anything can be done. It's purely a question of how much it's worth to do it.

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Have you found out yet?

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Yes. The tools, depending upon who made them, whether it was our own Company or outside vendors, the tools ran anywhere from \$7500 to about \$12,000.

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Production is only about 5000 a year. No question on the \$7000 or \$8000 tools but that it could be liquidated in less than a year.

Volume is still the same. If somebody had gotten down and figured out just how much this thing would cost, and multiplied the savings resulting by the volume, they would have had the answer. But they didn't do it. I didn't do it.

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This morning, men, we have a real treat. Before we start working on our project and before we stop for coffee, we're going to have a man here who is manager of the Appearance Design for the General Electric Co. He is a graduate of the University of Virginia, having a Bachelor of Science Degree in Architecture. His job is to bring products of an industrial nature in line as far as appearance is concerned. This may interest a lot of you. His job includes

appearance design on such things as motors, generators, turbines, etc. I think, in short, he tries to make all of our G.E. products look like Powers models. I'm certainly happy to have this man here; I know he wants to help you with your problems. I know it because he got out of bed with a broken shoulder so he could come up here this morning and work with you. He's going to give you a little talk, and then as soon as you start working on your project he's going to try to help you and I know he will, on your project, especially where appearance is a big factor. I'd like to call at this time on Mr. C. F. Schaus.

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I think normally when we hear the words "appearance design" or "industrial design" we think of a lot of hocus-pocus, a question of fancy colored pictures and some glamorized models. Actually, we shouldn't have nearly as much of that concept in the Company today as we do, but it still exists and we run into it all the time. Appearance should be built into a product and not applied to it. Very often we think of appearance after a product has all been designed and the tools are ready. Then you come to an appearance design man and ask for a new color scheme, or "Can we add a few strips of chromium?" That is not the problem and that is not how we are working toward the solution of our appearance design work.

First, there are two classes of products in the Company, as you know: customer and producer goods. Basically, there are two different approaches. In the consumer line we are looking at products which the housewife sees on the counter and we're trying to attract her attention by visual appeal so that she will feel her toaster is outmoded in a couple of years and she's got to get a new one, whether it works or not. On our capital goods there is no real design cycle. Our turbines are still running after 25 or 30 years and there is no particular reason why we should try to accomplish obsolescence simply by changing the appearance for that reason. So that in consumer goods we have basically at the moment the packaging problem. I feel personally that the more fundamental approach, that of making the product fit the function, express the function - has been used in architecture for years. To fit the function of the product, to make the function of the product be expressed in the appearance is something we should shoot at in all our product lines, not alone our producer lines.

In the General Electric Co. there are about 130 people engaged full-time in appearance design work, and as you know, coming from some of the divisions that have appearance design groups, they vary greatly in size. Major Appliance has perhaps the largest group; Small Appliance, Telechron, Hotpoint, Fractional HP Motors, Meter & Instrument -- a good many of our divisions have their own appearance design people. In some cases they have their

own model shop, in other cases not. In Schenectady we have a very small central group which is set up to serve as a consultant group to any or all of the operating groups which ask for help. In order to accomplish and in order to get out a lot of work we draw, for instance, on the Cabinet Shop in Schenectady for a lot of our wood models. We feel free to draw on the Art Division, for pretty pictures, if they're necessary, so that I hope you fellows will all feel free to come to us with any of your problems if you have them.

One of the things that makes for fine appearance is a combination and a blending together of a number of technologies, each contributing something in the manipulation of visual design principles. It's not nebulous and it's not hocus-pocus, at all; it's just as fundamental as engineering or value analysis or anything else. Some of the principles of visual design are a little hard to define in terms of mathematical formulas, but it can be done. We are constantly working toward that, so that within the divisions there can be an awareness created of appearance and some basic principles to work with. These simplifications and improved appearance of a lot of our component products as well as the major units can be accomplished. If there are any major problems we are glad to answer them or try to blend the unit into a whole.

Again, in blending these technologies together we feel first that we've got to have a fitness to function, a fitness to material, a fitness to manufacturing techniques and processes; a fitness to environment where the product is going to be used; a fitness to economics which Mr. Miles was talking about this morning and which you are very much concerned with here; a fitness to the times and the marketing situation; and also fitness to these factors which control fine appearance. What we're looking for is quality in our product which involves blending together all these various factors.

I could go on and on and talk about this for a good long time. I think perhaps we could help most by working with you fellows on your particular problem and we'll do anything we can to help you. If there are any questions I'll be glad to answer them.

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Question was: How do you test consumer acceptance in terms of appearance? In the consumer lines, as you may know, they send out people to check with the housewife and try to evaluate what they want, what they have in terms of what should be produced. That is a important function, particularly in a consumer line. In a producer line there is no attempt to do that because appearance comes maybe fifth or sixth down the list. We've got price, shipment, service - all sorts of things that come before appearance, so that in trying to evaluate the importance or the effectiveness of good appearance we don't attempt to talk to the customers except incidentally on that.

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I think that we'll all agree that the public will buy something, as long as it's different. I think that's pretty well explained by the automobile field. In trying to design something which the customer is going to buy, that we're sure they're going to buy, we've got a problem. First if we give the something that's really fine in appearance, their taste may not be up to the level where they'll accept it. So, somehow or other we've got to get a finely balanced point in between what the customer wants, and what we think he ought to have, yet still retain our sales, so that if you say, for instance, that we cannot compete effectively with a square refrigerator box with our competitors, I wonder if that's what really is the basis of the argument, because actually a refrigerator has sort of reached the end of its rope as far as appearance design is concerned. I made that statement before and got jumped on. I'll still make it. I think that some of these items have gone as far as they can go. In other words, maybe we shouldn't even worry about the change in contour in a refrigerator or a range. We should be thinking about a unit kitchen which is much more flexible. Now I'm getting off the subject, but an entirely new concept instead of juggling the crown tops on refrigerators against the square ones.

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One thing I think is noticeable, Mr. Stanton, and that is that we went through a period when everything was streamlined. People still use the expression when they speak of styling or appearance design work. We all remember the radios that were going somewhere, and everything was going somewhere, soap dishes - regardless of what it is - and that still prevails in a lot of cases. Now, we're getting away from that, very noticeably, and I think that perhaps it's an expression of our whole philosophy of life. Everybody seems to prefer something which has more character, which is squarer in shape, instead of bulbous.

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I don't know of any formal program like that, but I'm sure it always occurs on a product because it's of paramount importance. In other words, how much can we afford to pay for appearance.

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Mr. Miles: Mr. Schaus, we're willing to pay for anything that's function, anything that gets us something. There are two things we recognize as contributing: one is things that make a thing work better and the second is things that make a thing sell better. You come definitely into our category of things that make it sell better.

Fellows, I have never heard the statement he made - and it's the best I've heard of its kind - he said that what we want to do is build our appearance into the thing, not tack it on. If that isn't good philosophy! Can I talk for one minute here? We looked at one of our products - it was the clothes dryer; a wonderful product - we had a call from the factory and they said "We just got in 400 of these nameplates and 285 of them are bad." "Well, what's wrong with them?" "Well, they're bent a little somewhere or scratched a little somewhere, or nicked a little somewhere." "Let's look at them." We have on the clothes dryer a big white front about 2-1/2 feet..... and then lo' and behold, here is a styrene nameplate that goes clear across the front! It's white paint part of the area, and it covers up white paint that we've bought and paid for behind it; it has to be made of thin material. I'm sure that can't be right; to buy that beautiful white paint job all across the front, and then get another big thing part of which is painted white, too, and is trouble and cost in every square inch, and strap it all across the front.

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I think there's a big question of how much you buy with that, how much more refrigerators you're going to sell, or dryers, or whatever it might be.

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All I can say is this that for the last seven or eight years we've worked as consultants with what we used to call the Apparatus Department, primarily in the producer goods line, and almost without exception in all that time every appearance recommendation that's been made involved a redesign of the product and our analysis of the problem. Coming into it sort of cold, we could see things that the engineers didn't see because they were so close to it, so it involved recommending a simplification or a rearrangement of parts in some cases. The net result was that a considerable cost reduction was effected, and we don't claim all the credit; it never works that way, because we're all a part of a team. But it's that question of getting in and looking at the problem and seeing if there isn't a way of simplifying. You don't have to add expense, that's all there is to it. One of the problems that you have, the drawer front on the new refrigerator; I think that's going to be a very interesting one to work on. The cost is fantastic.

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Mr. Miles:

Now many of you have had a chance to learn how easy it is to make mistakes and to use past bad habits in learning about the engineering. In all of our conversations this morning with the

engineers who understand what's being done, there should have been no question as to "Why did you do this? Why do you use this material? What do you think of some certain idea that comes to your mind?" "Have you tried thus and so?" If there has been any question along that line that's wonderful because you'll know that you have a lot to learn. That is old-fashioned, out-moded, yesterday's methods. There should have been no such questions. There should have been no questions such as "Do you think this would work?" You haven't even thought about the problem. Are you going to take the engineer's time asking him questions and even making suggestions in the form of a question before you've really come to grips? Well, yesterday we did and yesterday we barely stayed in the race; today we know better how to do it, and when we're through we won't do it and you'll see how much better it is.

Now, for today's subject - The Relationship of Purchasing Value Analysis to the Buyer". This is going to be something that's mighty important to you. You're going to have troubles, a lot of you, and the troubles are going to be with the buyer. Why? Because the buyer sees you playing ball on his baseball diamond, and he looks and he says, "Who is that guy, anyway? What's he up to? What's he got under his arm and where's he going with it? And where am I going to be when he goes over the goal line?" You're going to have a lot of problems; they won't be problems if you understand it and do it right. There's a right way to deal with the buyer, the same as there's a right way to deal with the manager, with the engineers and with the manufacturing methods men. Today it's our opportunity to think a little with you about the right way to deal with the buyers.

The buyers have a job to do, believe it or not, and it isn't just to take a drawing and send for three quotations and say, "Place it here" then get onto a hundred other drawings that he should have placed yesterday. That's a clerk's work; that's death. We still do it in some places, but we're putting in better and better buyers; we're training our buyers. They're going to be businessmen; they must be businessmen.

We said this morning that everything will be sold for what the traffic will bear. Here comes in the vice president of the company - General Electric usually rates him; probably a \$25,000-a-year man. He sits down on this side of the desk, here's the buyer on this side. Who are we going to have in that buyer's chair, a clerk? Who's going to get the best deal? Why, the Company can't afford to take the poor deals that a clerk gets across a table of barter and they're beginning to find it out. So, you're going to have excellent fellows to work with but we're going to have to train them. Let's train them right. You won't have to do all the training. Here are a few of the things that you'll want to teach the buyer.

THESE CHOICES ARE A SHARP REMINDER THAT
EVEN A RICH AND GREAT COUNTRY WITH A
PRODUCTIVE AND GENEROUS PEOPLE CAN LOSE
MOMENTUM AND BE FORCED TO FACE UP TO
UNPLEASANT RESOURCE CONSTRAINTS.

COMPETITIVE
REGAINING MOMENTUM, RESTORING OUR
COMPETITIVE EDGE, REVIVING OUR ABILITY TO
OUTPERFORM AND OUTSELL OUR COMPETITORS IN
THE WORLD MARKET SHOULD BE HIGH ON THE
LIST OF OUR NATIONAL PRIORITIES.

REGAINING OUR PRODUCTIVITY MOMENTUM IS
ESSENTIAL IF WE ARE TO PROVIDE THE
NECESSARY FUNDS FOR NATIONAL DEFENSE AND,
AT THE SAME TIME, PAY FOR THE MANY
CIVILIZING AND SOCIALLY RESPONSIBLE
PROGRAMS AMERICANS HAVE LONG SUPPORTED AT
HOME AND ABROAD.

WITH THIS OBJECTIVE COMES NATIONAL
LEADERSHIP; WITHOUT IT, NATIONAL DECLINE.

First, are the available highly skilled specialists, the low-cost suppliers, really being used on that job? Second, have the engineers of the suppliers been given sufficient facts to they can come up with new and independent solutions that would produce equivalent performance? Have they been pressed for action? Our competitors are pressing them for action. The other day we went to one of our best suppliers and got an excellent deal. We found that that supplier makes for Westinghouse 50 parts for every part that they make for us, still for a part that was costing us \$28.00, they do the job for \$16.00 - saving \$12.00 apiece on it, and most of their facilities go to Westinghouse. We've got to press the best suppliers; nothing comes easy. Has the buyer taken advantage of the know-how of other purchasing units, using larger quantities of similar materials? Should some minor changes suggested by the supplier which afford lower cost material be considered further?

One of our big suppliers put out an engineer to call on us and others to tell us how to get performance at lower cost. He was on the job a while and he was gone, so the Company asked where he was. "Well, we took him off," the management said. "Why?" They said, "He didn't have any one to talk to. He came into the Purchasing Department and the Purchasing Department said, 'our stuff is all specified. We get orders to buy it and we buy it. What you're talking is engineering.'" So, he was pushed off onto the engineers. He went to talk to the engineers and the engineers had their day-to-day problems of making their items work, of fighting fires, all laid out ahead of them, and he wasn't popular at all. They said, "Why, we're through with that; we designed that; that's out of trouble. You can go ahead; if you want to talk to anybody about that go talk to the purchasing agents. We're through with it." Now, that happened not only in G.E. but in other companies to the extent that they took the man off; they said that people weren't set up right to get this unnecessary cost out; "we're not going to knock ourselves out; we'll sell them the stuff they order even if there is waste money in it." Now that's our whole area, it's wide open, and the vendors want to help us in it if we'll give them a chance.

Has the buyer found the basic source, that is, the manufacturer who may be in a position to extend the minimum prices? In this country many things are made to a large degree by a few suppliers but marketed through hundreds of others. For example, such simple things as copper bonnets used to close pipes in our air conditioning equipment. We were paying \$3.76 per 100 for them from a big supplier, but a little study of this showed that one other company makes most of them for the entire industry. He would sell to us for the same prices that he sells to the other fellow who was selling them to us, so instead of \$3.76 it cost \$2.14 - same thing; a third off of the cost and one less middleman.

Are parts obtained in the most economical lot size? It's a terrific problem and we won't go into that here; we'll handle that as such.

Fellows, we commit murder every day under the mislabeled guise of inventory control. Buying trifling quantities because we think somebody wants us to place a lot of orders which causes us at the end of the year to have a bigger inventory in dollars with lots fewer parts in it than we would have if we used sense. I'm telling you that the fellows at the top of our inventory control program want low inventory dollars, and they want sense used in every purchase, not blanket rules that run up parts costs and inventory costs.

But how will you work with your purchasing people? Here is the buyer; he wants to do a good job; he doesn't have time to get into everything, nor the ability to get into the technical things as far as he'd like to. What will he do? He can take several courses. He can encourage you to get right in touch with the supplier and if he does, God bless him! That's wonderful. But let's see what you do: supposing you work with the supplier, back and forth, and he has good ideas; you help him improve it, you write your specs and you get it all done. Now you come back and lay it on the desk and here's an order for \$10,000, \$5000, \$100,000 -- it's all set. All he has to do is just sign it and issue the order. Gee, that's terrible. You have really sold him down the river. Now he has two desperate choices, both of them bad. One is to say, "Nothing doing. I'm going to do a fine job on this." And that means that these ideas this vendor has worked out with you will have to be used with others and the vendor might suffer. The other is to say, "O.K., rubber-stamp it." in which case he might just as well be a \$40-dollar-a-week clerk as a purchasing agent; he's not helping in the slightest. And the reason for it is you. Let's don't do that. Somewhere between one and the other is the right answer and easy to find.

What are your choices? First of all, you, here, need to get a lot of vendors' help on these projects. Back home you need it; there's a whole new field to open up - you must open it up; the Company needs it. Put them on our jobs instead of Westinghouse jobs. That's these specialists and suppliers. But to get them you have to go out of the Company; have to work with the buyer or ignore him. Here are some things you could do: one is that you could ignore the buyer. You can look at a Thomas directory; you can call in Tinnerman, you can call in Shakeproof, you can call in anybody - No. 1: Ignore the buyer. No. 2: you can ask him to send the inquiries for you. No. 3: you can sell him a little on the job, tell him what you're doing and ask him for his help and his permission to allow you to draw the inquiries the way you want them and have them go out that way.

Now, the buyer may take any one of several reactions. He may say, "There'll be no vendor contact made by you, I've seen this thing before. Every contact will be made through here." He may say, "I don't have any time to do it but I'll get it out as soon as I can do it," and he may bog your program down. You'll

bump into these problems. What's the right answer? What's the fairest? It's working fine in a lot of places. This is the way it works.

Whenever you have a vendor's problem, go through the buyer who handles it; talk with him about it; tell him what it is; show him you're on his team; ask him to suggest a supplier or two, a specialist or two; then go further - tell him that you want to make a study and try to reach out further and help him to find another one or two, and we'll talk about how to do that in another two or three days. Then do it; get more suppliers. We don't care about just suppliers; get the right suppliers. He probably won't be doing business with them. We can't always have the best suppliers, any more than we can the best design, but the more we try, the more nearly we'll come to it.

Now, after you have those suggestions, he will usually welcome your drafting an inquiry, that's fine; if you're going to do that; but very often you will want to sell this to a specialist vendor, so you'll want to handle it on the phone - the first contact. Now, when you handle it on the phone, be sure you get the president of the company or the manager, or at least the sales manager so that you get top action of their best people, not neglected action by their clerks on what you want. Now, who's going to call them? There are two ways to do it: some buyers like to call on the first call. Fine business; I think that's a swell way to do it. They call, they tell the supplier that you're working on a certain job; the supplier knows what you're doing; he knows you're working with the buyer; you're not short-circuiting. He knows he'll never have any trouble in the future knowing who to deal with, you or the buyer, on the thing.

Other buyers say, "You go ahead and call him and lay the problem out to him." Fellows, if you do that there's one absolutely fundamental rule: Always, in your first sentence, say, "I am John Smith, so and so, I'm calling at the suggestion of so-and-so buyer; (name him) I'm working with him on this project;" and then go on with whatever you want. Now you're really going and you're doing it right and they'll like it and the buyers will want you to do more and more of it.

There's one more thing to do: you'll have a lot of contacts and develop a lot of give and take. Keep the buyer informed. Give him a phone call once a week, a little memo on something important, so he's on the team. Once in a while you'll come up to where you need more help, more ideas; you've hit a roadblock; go to him again and give him a 5-minute sketch on the thing so he knows what's going on; he has a chance to help. He'll learn to help and he'll help you a lot. The thing that happens here is you're building a buyer; you're not only doing your job, but he'll do a better job on every job he's doing. This thing will really work perfectly if we just pay a little attention to the position it puts a buyer in, then train the buyer.

I sum up with this: It's our job to teach the buyers. We told you yesterday that we have an overall training program and we hope to teach value analysis methods for buyers, to every buyer in General Electric Co. It's an excellent thing and that'll help you. You're going to have to teach them. Next, get his suggestions and then go on beyond his suggestions. If you stop right there you're just using the information that's in the plant, yesterday's knowledge, yesterday's know-how. So get on his team so he'll think, "I'd like to have Dick Heckman help me on this job. I think he can help me on this like he did on that other problem." Keep him advised. Not a lot of long-winded stuff; just a little something so he knows what's going on, then when you come with the thing all wrapped up, he'll know all about it. If he had any other ideas he'd give them to you as you go along; using his best judgment. He'd say, "That's right. I, myself, know that's the best deal for the Company; let's go ahead with it." When you do that you'll find out you have more and more and more freedom in what you do with suppliers. You'll always keep the buyer advised, and you'll find he's an awful lot of help to you.

I'll conclude this with a couple of thoughts and examples. Every good buyer knows that there's no end to better vendors and better prices, just as every good engineer knows that there's no end to better designs. For example, we were using 4,000,000 slides, little plastic slides. They were costing \$14.50 per 1000. Getting the right supplier for them, cut it to \$8.20 per 1000. You feel pretty good, but that isn't right because again getting the more right supplier for them which happened a few months later got it to \$6.30 per 1000. A filter, 700,000 filters, little button filters, were being used a year. The buyer thought he had the right supplier; he had the best we've ever had in that field. They cost \$34.00 per 1000, but with the aid of a value analyst a thorough probe was made and a supplier provided who does the job for \$7.00 per 1000 instead of \$34.00, and the identical part.

In one of our controls, a Telechron motor is used. That Telechron motor was analyzed; as a whole, when the control was analyzed. The Telechron salesman was asked what could be done to get the same performance for lower cost and said, "You mean to tell me you fellows want lower costs?" What a question! He said, "I'll tell you why I asked that. When you order these clocks you never order 5000 Telechron clocks on an order; you order 5000 coil assemblies on one order, 5000 roller assemblies on another, so you don't even get the clock price; your stuff is always built into that product on a parts price at 28¢ above the price of the clock." "Man, how long has this been going on?" "Always." "Well, what have you done about it? Why didn't you tell somebody about it?" He said, "I did. I told the buyer that if he'd order them on the same order and say ship them separately we could still do that and we'd save you the 28¢." "What did he say?" "He said he was a young fellow and he didn't feel that he had very much experience or backing from his management. He didn't feel he

could vary too widely from the instructions, so he said he went to the people who gave him the request for material and told them. They told him, "No, we've got to put this stuff through material list. If we start mixing it up we'll really get in a hopeless mess; we've got to put them through the way they come." So the buyer would write out the order for 5000 rotors, and he knew another one was coming. He would keep that order on his desk all week hoping the other one would come through and about half the time it did and he'd stick the other one on the same order. But when it didn't he said at the end of the week he felt that he would get in Dutch with his supervisor if he didn't clear out everything that had come to him so he'd mail it out. \$2800 extra on every \$10,000 order." That's the kind of thing we're looking for, fellows, and we're going to have to help teach them. Of course, when that comes to the attention of the proper people it's fixed just like that, but it goes on for years before that in every department.

Let's make sure the buyer knows that you're trying to get on his team and that you, under no circumstances, would allow him to be hurt or embarrassed by the new lower costs which are sure to be found if you work.

end 6

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Dr. Zavist works in the Works Laboratory and his job is to advise the factory on any resins, adhesives, plastics, material that they should use to perform any particular job with that type of material. If he can suggest the right material, he and his group will develop it. So I think you have the right man to solve all your adhesive problems. I'd like to turn you over at this time to Dr. A. L. Zavist.

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The first thing about adhesives is to consider them as a new type of material. We want to really change our viewpoint from the way most of us are interested in looking at it. We think of adhesives as things like library paste, glue, to just stick two things together. Well, they have a large use in that respect. However, most of us are interested in a new type of structural material. In other words, if you had to stick a hypodermic needle into or through the glass part. Now that's a tough job and really about the only way you can do it is with an adhesive. There are a couple of other tricky ways which don't fit into mass production. I want to suggest to you gentlemen to look at adhesives in this way. Most of the normal uses have been worked out for years and they run in millions of pounds, they also use very low-priced materials. I'm assuming that you're all familiar with those and we won't even discuss them, because most of the newer types cost a good deal more and would not be in a competitive position with that type of material.

One of the main features about adhesives in their applicability to diverse combinations. You can weld two pieces of like metals, or you can rivet metals. But if you have glass-to-metal, you're in trouble. You can't rivet glass; you're eliminated right away there. You can't weld glass. Now, unfortunately, adhesives don't do the most satisfactory job there, either, but they can do "a" job. I don't want to deprecate the adhesives because they will work in things like safety glass. However, from an engineering standpoint I deal a lot with aircraft applications and things like that where you have gas under pressure and it's a difficult thing to stick glass there.

Another thing where adhesives fit in is mass production. The way to fit it in is to choose the right adhesive. A lot of people get a bad impression of these materials because they choose the wrong material. They will send for some company and the company will describe uses for their product and they'll use it as such. Sometime they give you very good bonds, for instance, on aluminum-to-aluminum they will hold an airplane together but they won't hold a piece of rubber to a refrigerator door. You have to be very careful how you attack this problem.

There are plenty of people who know about the subject if you'll just check into it. You have engineers in your own plant and besides, since adhesives are such a specialized type of work, almost every plant has technically trained salesmen who can tell you very well about their product. Don't ever hesitate to ask them; they'll be glad to help you out and give you the answers you require. That's their business and they visit us all the time. A lot of people do not realize that. If you do have a problem you're interested in, be sure to check directly with the buyer, because he may have another product which will do it a lot better and a lot cheaper. It never hurts to check into it.

On adhesives there are also disadvantages, as I mentioned. First of all, mainly they have limited heat resistance. If you need high strength at higher temperatures, I would say above 250° C, in general you'd be better off with different types of material. However, there are inorganic types of resins which can do a job, although they are rather brittle, but if you have high stresses you should, in general, stick to welding or things of that type.

Another disadvantage is the bond is not instantaneous. You usually have to wait a certain amount of time before you can get the satisfactory bond. If you make huge quantities of a product, you probably end up with a backlog and that's definitely one limitation. As I said before, be sure that you pick the right adhesive for the job. One adhesive will work on one job, another one work on another job, and if you have the right one, you'll be in good shape. If you make errors, they may not show up until weeks or months later and get you in difficulty.

The principle which adhesives employs in bonding is that some time during the cycle you have to have tack. Tack is one thing sticking to another; no matter which type of adhesive you have, somewhere in the setting process you have to have tack to grab on one component to the other. There are several ways you can do this. One of the more common types is to use a solution of some material. You paint it on or brush it on and you get your tackiness after a certain proportion of the solvent evaporates and while it is tacky you can put your two components together and the remainder of the solvent will later go away. Obviously, this type of adhesive works best with porous materials, so the solvent can migrate into the pores of the wood, for example. In general solvent types with metal are not too satisfactory, especially rather wide sections where the solvent has difficulty migrating, the edges will tend to skim over and you won't get your ultimate strength.

Another way of getting tackiness is by using a material which is solid at room temperature, heating it up until it's liquid. Something like this would be asphalt or resin. You heat it up to fluid, as it cools it gets tacky, and as it cools further down to room temperature it gets hard. Something like this adapts itself to production -- when you don't need too high strength, you'd be surprised how easily these work in. We've replaced some riveting operations in small gadgets this way; all you need is a pot of some resin like that; put a dab on, stick your little component on. It cools in a few seconds. If you don't need much strength it's very handy.

However, if you require what we call the ultimate in strength or the highest practical strength these days, you should consider the chemical reactive types. These consist of two components; that's the usual way of making a polymer. You have one component which comprises the bulk of the material and another component which is either called the catalyst or the hardener or something like that. They are stored separately. When you want to use them you put them together and after a certain amount of time they will get hard and set up. They will give you very hard and strong resins. You have a wide variety of products available; some will set up at room temperature, and others require elevated temperatures. Generally, for the strongest bonds you need elevated temperatures. For some jobs this is very fine, in others it isn't. You have to choose the material to fit the job.

In the business of choosing the material to fit the job, you might keep a few things in mind. You have two pieces of metal that are dissimilar; (copper and aluminum) and you want to stick them together, but they have different coefficients of expansion. You can't match the coefficient of expansion of the resin to both of them, so the only way out of it is to choose a rather rubbery type of material. The point is with hard materials you would generally use soft rubbery types of resins or rubber, having the give that's required. Conversely, with softer materials you need hard resins.

As a typical example of this, if you want to stick wood together you'd take something like a phenolic resin which is very hard and gives a wonderful bond with wood. Put it between two pieces of metal, tap it and it's gone, cracks right off. They try to get around this a little bit by mixing combinations of the two. A lot of our more useful metal-bonding types have rubber with the phenolic in it. Perhaps you've noticed that they're switching away from rivets in brake linings, nowadays, and using adhesives there. They use a combination of rubber to give it flexibility plus the phenolic resin which sets up to give you a nice, hard bonding agent.

These bonds are extremely strong. I saw a picture of the brake lining and the brake shoe attached together with a Chevrolet hanging from it which will give you an idea of the sort of strength involved.

The problems run into, include beer bottle labels. You buy a bottle of beer and stick it in cold water. You want the label to stay on, otherwise you have a mixture of brands and everybody's unhappy. But conversely, the fellow who gets the bottle back wants to wash the label right off. They spent a good deal of time until they found one that would stay on in cold water and come off in hot water and fast, too.

Another useful type I might mention on the rubber types - is known as a solvent reactivation process. A rubber cement, is mainly some sort of rubber dissolved in solvent. You don't normally react the rubber any further when you use it.

There are certain of the synthetic rubbers nowadays that you can paint on and in a few minutes they dry entirely tack-free. In this manner you can paint a lot of your surfaces together, let them dry tack-free, and stack them away somewhere. If you choose the right kind they're what we call non-blocking; they won't tend to stick one to the other, until you're ready to use them. When you want to use them, all you do is spray them with some solvent and they get tacky again, you stick them together and put them right on the job.

This saves a good deal of production trouble and you can put them to very good use.

I'll go over the types of adhesives which are available. First of all, you want to consider what sort of bond you really need. If you're going to stick cardboard together, obviously you don't need an extremely high bond strength, so you're just throwing your money away if you use materials which are much stronger than the material you're bonding. You have to pay for strength as it increases, so for normal applications of bonding cardboard and packaging, we use natural types of glues, starch, waterglass. The next thing, as most people don't want to heat the

bond, to consider are the solvent types. Some of the names you may run into - Duco Cement is a good example, and we have a common Glyptal. These are merely solutions of thermoplastic resins. A thermoplastic resin is one which melts when you heat it, and each time you heat it up it melts again. A thermosetting resin, on the other hand, has all the components there; when you heat it once, it reacts, gets hard; when you cool it, you have the structure you want, but if you go to heat it again it won't melt any more. From then on it will char, if anything.

So the types we have are cellulosic types like Duco and Glyptal, and these types you would like to use with porous materials. I'll skim over most of these first types because in general around G.E. we have no difficulty employing them at the present time. They're all worked out and we'll forget about them.

Among the newer types are the epoxy resins. They've just been out a couple of years. Some of the names that they go by are Epon made by Schell, Araldite made by Seba Co., and Houghton Laboratories sell Hysol. They're essentially the same; some are a little bit better than others, but their chief advantage is they give rather high bond strengths to vary dissimilar materials. You can bond various metals to ceramic and glass and things of that type. In they're rather hard resins. As you will recall, the hard resins are good mainly for softer materials. It sounds as if I'd backed myself into a corner here, but we can use these hard resins with the hard materials, provided they have the right properties. Now, as I mentioned, phenolics would crack under this application. Epoxy resins have extremely good adhesion to materials, so even though they are hard, if you have metal of sufficient thickness so it doesn't bend very readily, you can use this hard resin and get good strength. The bond strengths run in the order of several thousand pounds per square inch and this type of resin is used widely in the aircraft industry to bond the various aluminum sheets. As you may realize, when you start hitting above the speed of sound, rivets are practically out, and the new British Comet that came across the Atlantic Ocean not long ago is almost entirely stuck together with adhesives. Now you can do the job; it's just a matter of doing it right away.

These epoxy resins are the kind which you can bond metal to glass, for instance, in the hypodermic needle. The spelling is E-P-O-X-Y. It's a chemical class, really. Most people call them Epons, made by Shell Chemical, or Araldite. Those are the two chief suppliers. All the other people buy from them at the present time; they're the only two that manufacture the basic material, as far as I know.

I've briefly given you an idea of what some of the types are. I'll go over again some things to consider if you ever come to ordering adhesives.

First of all, if you have a solvent system you want to consider the solids content. One product may be cheaper than the other but it actually has less resin in it. Second, you want to consider the viscosity. High viscosity is desirable if you have places where the thing may run out very easily. On the other hand, it may be very difficult to get in. If you have a coil of fine wire and want to get the stuff in there, you want low viscosity. The next thing is shelf life. Most adhesives last only a certain amount of time. Some of them last only a month or so; others last almost indefinitely. Depending on how rapidly you use your material, you should check on it; you don't want to have the problem of things going bad on you. Then you have to consider the method of application which is most applicable to the way you're doing it. If you make a lot of a certain product, you can build a gadget and make it an economical process even though it may be a shade more complicated, whereas if you only make one or two you have to look at it another way.

Another thing to consider is the temperature and time of cure. As I said, room temperature cures, in general, will not give as strong a bond as high temperatures. You want to consider vibration characteristics of the joints, particularly in aircraft applications we find hard resins give beautiful bonds, but actually you can't use them at all, because under vibration they go bad, and that's something to bear in the back of your mind. You may get extremely good data that looks wonderful but you have to consider the flexibility characteristics, too.

As far as possible, new uses, there are obviously a lot of them that come to mind. First of all, there are a lot of riveting applications. Very often the rivets are much stronger than are required. Things like nameplates - generally you can do a neater job with the proper type of adhesive, and they do a good job, too, if you choose the right types. The other types are the obvious types - gasketing - I was talking with some gentlemen here this morning. They were wondering about gaskets on refrigerator doors. A lot of these automobile companies now are getting away from using all sorts of clips and pins and string to attach rubber-like materials to metal. That's the old way of doing it and it's very expensive. With many adhesives now, all you have to do is paint them on and let them get tacky and stick this rubber-like material on and they give a very good bond. The labor in that other system - you know how the chrome trim is put on your car - is quite high. They have to drill holes in and put various pins in and mount them on and it's still not a very good job. I would think in the Refrigerator Works where you have cooling coils of dissimilar metals, you would have difficulty brazing the joints. You may be able to use an adhesive between the two which will hold up. A lot of the brazed joints, we've noticed, tend to crystallize or corrode and eventually go bad. I'm not saying the adhesives won't go bad, too, but adhesives have been employed in this type of work and they have given service over the years and they do save a good deal of

time and trouble. Fourthly, the time to consider them is when you're making a new product. When you have many dissimilar materials the usual tendency is to figure out mechanical ways of hooking them up together. You can get much smoother designs just by using the adhesives. If you - before you really get down deep into your designs - talk with the people who know something about them; ask them if you can stick these two, three or four things together, and you may be able to get a much smoother line at quite a cost saving, too.

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I'm not sure if I have all the details of the question, but the way I understand it the organic materials are essentially non-conductors, agreed, and is it possible to make them conductors, too?

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There are organic materials and there are inorganic materials. The organic materials, as far as you're concerned, are mainly the types, the old classification as they come from nature. They're mainly made from carbon; their main point to consider is that they are only good generally up to about 125° for a long period of time. The next type is a silicone type, for example, which is a combination of organic and inorganic. That type will be good up to about 200° C. for a long period of time or 250 or 300 for short periods. Then the next type is the inorganic type which is cement, or something like that. Cement is an adhesive, and that will be good in maybe 800° C. for short periods of time. Cement is not a good example because it will lose water, but there are other types like that.

On the matter of insulation, all organic types are insulators. Practically all inorganic types are insulators, too. You can make them conducting by putting in fillers. You can put in a powder conducting metal. The easiest way, though, is to use something like solder if you want a conductor. We don't always consider solder that way.

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There is a data folder on adhesives written by Mr. Doyle of the General Engineering Laboratory - I don't have the number. Sorry I can't give you the exact title.

You can always call me up at the Works here for information. Epoxy resin is in the data folder title, by General Engineering Lab. It came out last year and it covers the various types.

(Slides)

Mr. Miles: This afternoon it's a privilege to introduce to you a specialist supplier unique in the United States. This specialist supplier took a material which was considered relatively useless, though very high priced, and by utilizing the properties that made it useless built a tremendous business. On switch after switch they have made it possible for us to do a better job, many times for less than half the cost. You're going to see here the science of handling beryllium copper; a wonderful material, properly handled; absolutely no good, a bundle of trouble not properly handled. This supplier has hundreds of applications to show you. You'll see an exhibit out on the tables in the back so you may browse and get ideas after they've finished. What they'll tell you here is just the high spots which you can follow up and which should help some of you in getting performance for lower cost.

I would like to introduce the gentlemen and first I will introduce Mr. Lou Jacobi at the machine. He's the contact man who takes our problems and gets them before the group down in New Jersey and makes them come to reality.

Next, I would like to introduce Mr. J. D. Roberson, Vice Pres. of the Instrument Specialties Co. and he will tell his own story.

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We are indeed grateful for the opportunity of being here this afternoon. We are grateful for General Electric Co. allowing us this time. This is intended to be an educational program specifically regarding beryllium copper. We sincerely hope that what we have to tell you and what we will show you this afternoon will be helpful to you in your work and help improve General Electric Co.'s products.

The first part of the program, I want to tell you a few generalities and general specifications regarding beryllium copper. Tell you some of its desirable and undesirable characteristics and also show you and tell you how both may be used to an advantage.

The second part of the program I'm going to show you only a few things but it will be a typical cost reduction or cost saving application by using a more expensive spring material.

The third and fourth parts of the program will be entirely up to you. I want to allow a few minutes for a period of questions and answers and discussion period, after which there will be literature and samples on the rear table for distribution, and I want you fellows to help yourselves. If you don't get what you want, notify either Mr. Jacobi or myself and we'll see that you get it.

Perhaps many of you recall there were many fancy tales floating around about beryllium copper during its early discovery period. The tales were very similar to those that are floating around today regarding the use of titanium. Some of those stories were true and some were greatly exaggerated. It was first known as the "wonder metal", because apparently springs made from that metal would never tire so it was tagged the "metal that never tires". Its endurance strength was very high. It was capable of being hardened by heat treatment. So they thought at first that perhaps it was a re-discovery of the method that the ancient Egyptians used in hardening copper to make it as hard as steel. Well, they soon found out that something was wrong. They found out they could not fabricate the material by employing conventional methods, so it was necessary to set up special equipment and special techniques for handling beryllium copper. That is the reason that we are a company. We set up for it years ago and have never used any other alloy.

I'd like you to get acquainted with the three principal grades of beryllium copper. Berylco #25 is the most popular and by far the most widely used because you can do more with it. It has very high physical properties. Its metallurgical content is roughly 2% beryllium; actually, it's 1.80 to 2.05, but its nominal 2%, plus 1/2 of 1% cobalt. Berylco #165 is a second-grade alloy. It contains 1.60 to 1.80 beryllium and again, up to 1/2 of 1% cobalt. The physicals of this alloy are very low but the material itself costs almost as much as the #125. We don't use the #165 at all because of its low physical characteristics and because it does not conform to jig hardening. The third grade is known as Berylco #10. That is a special alloy used in high conductivity and high temperature applications. But it must be used under low stress conditions. I'd like you to remember that. If you want high conductivity and high temperature conditions, you must operate under a low stress, because its physicals are very far below those of #25. Some mills also produce what is known as a pre-tempered or a mill-hardened alloy. That is the #25 that has been tempered at the mill. Its physicals are much lower than the Berylco #25, consequently we don't use this at all because it does not fit in with our facilities.

Beryllium copper is not claimed to be the one and only spring material. While we love it, we certainly do not recommend that beryllium copper be used in all spring applications. So I don't want to leave the impression with you this afternoon that it is a cure-all for all spring problems. It isn't. Design engineers should consider it only when a combination of spring steel and copper are desirable. Copper is particularly desirable because it is non-magnetic, and beryllium copper has a very high endurance life, a very high hardness and a very high wear-resistance, so when you get a combination of those properties or characteristics that you need in a spring, then is the time that you want to think about using beryllium copper.

Some design engineers have a faculty of putting close tolerances on all dimensions if they design a spring. They think that all dimensions must be held accurately to make the spring perform correctly. That is very, very seldom true, because they can put the critical tolerances on one or two critical dimensions and the spring would be much cheaper to make and operate just as well. They also have a tendency to specify a Fresnel or Rockwell hardness, thinking that if maximum hardness is obtained then the spring will perform correctly. That, again, is very seldom true. You must reach a compromise between hardness and conformity that is usually done by proving your samples before freezing a design. It may also be proven by performance tests and after the performance has run successfully, you can write your specifications to suit the end use of the spring. You can also get a comparison of elastic properties by a very simple method; that's by bending the spring to a known radius of curvature, measuring the amount of permanent set. Now, let me emphasize again, that only gives you a comparison of elastic properties and has no relation whatever to the hardness. Hardness readings on thin sections are very inaccurate, regardless of the method used in making the test, and springs are usually made from thin-section metals. We use the 15N Rockwell Superficial for testing the hardened parts and we use a 30T scale for testing incoming raw material. So where you want maximum hardness and you want to measure it, we do recommend the 15N Superficial for thicknesses of .010 and above and by inserting an anvil of approximately the same hardness as the desired specimen, you can get a fairly accurate reading or certainly a comparative reading with the 15N scale on thicknesses under .010.

Now, the manner in which the ASTM specifications were originally drawn is perhaps responsible, or certainly contributes toward the success or failure of many who have tried to use beryllium copper and couldn't. They set up minimum rather than maximum figures so that the mills could produce it economically. Those specifications have not yet been improved to where we would like to see it. I'd like to make a simple comparison here that I think illustrates the point perfectly of keeping the correct amount of beryllium in solution and keeping it available for hardening - in other words, making it work for you - simply by comparing it to sweetening your coffee; you can put a small amount of sugar in your coffee and it will all go into solution, but it won't be sweet enough for your taste. You can put a small amount of beryllium in your solution or in your alloy; it will all go into solution but it will not develop maximum physicals. There you have a metal similar to the #165 alloy. Suppose you add more sugar in your coffee; it will all go into solution and then it becomes just sweet enough. You add more beryllium to your solution and it develops your maximum physicals and all of the beryllium becomes available for hardening. There's your #25 alloy. Suppose you add more sugar to your coffee. It has passed the saturation point, so it accumulates in the bottom of your cup but it adds nothing toward the taste or sweetness of the drink; in fact, it ruins it. By way

of comparison, you have added more beryllium than will go into solution and become available or useful in the hardening operation. That's why it is so necessary and so important to run a laboratory test on each roll of wire or strip before fabrication. That not only gives you or develops the correct time and temperature but also gives you the correct method for hardening. It is sometimes necessary to use two or more temperatures and two or more methods for hardening a beryllium copper part, depending entirely upon the specifications regarding the end use of the part. Beryllium copper work hardens very rapidly. Therefore, at the point of the more severe forming your internal stresses are very high. Fortunately, the hardening heat treatment takes place at the same temperature that serves to relieve these internal stresses. That results in a piece free of internal stresses and is, of course, much more stable under a load than a part gaining its hardness through cold work. The ability of beryllium copper to harden at this stress-relieving temperature gave us a new manufacturing process. We call it heat treat forming. That's where the part is held in or on a fixture during the hardening operation. You will see examples of that on the screen later.

In considering the costs of beryllium copper over other spring materials you're paying a penalty for using beryllium copper by paying more money for it so you must get all you can from it. It is necessary to take advantage of all the inherent desirable and undesirable characteristics. You can take advantage of the desirable characteristic, that is, the ability to harden at the stress-relieving temperature by heat treat forming. In other words, saving your forming tools. You can also take advantage of its low ductility. That gave us another manufacturing process of producing springs in strips. We call them "strip springs". That's where the springs are made individually on specially designed dies; they are joined together by a score line. They can be broken apart very easily either by the fingers or by automatic devices. That saves a great deal in secondary operations, such as inspection, plating, and, of course, most of all at the assembly bench. That is a point that will be demonstrated in a few minutes.

I'd like to emphasize that spring design is a specialized art and it is necessary that the design engineer be in close touch with the spring manufacturer if he is to get the best spring at the lowest cost. The designer knows what he wants; he knows the function and he knows the performance that he wants. The spring manufacturer knows the cheapest and the best method of tooling and producing that spring in the most economical way. The slides will show you a couple of illustrations where springs produced in the strip form will result in a lower cost in your assembled unit.

I'd like to briefly introduce the company. You'll notice we're located in Little Falls, N. J., and it is not to be confused with Little Falls, N. Y. We are a small company employing approximately 150 to 160 people in the office and in the manufacturing processes.

Here is a beryllium copper spring that is used in a refrigerator relay. I'm comparing it to this ordinary household pin simply to give you an idea of its size. The problem is to reduce the cost of that spring. You'll notice that the previous slide shows the spring made singly; it was necessary to pick them up one by one and put them in the heat-treat fixture in stacks of about a hundred springs each with spacers in between clamped down by this screw to result in an accurate contour of the spring. There are approximately 100 pieces in each one of those stacks.

Let's look at the redesign of that spring and make it by the strip method. You'll notice that the offset dimension here is .328 and is to be held to plus or minus 8. It looks like it's fairly simple to do, but when you consider the stock thickness is only .005, you run into difficulties in your punch press. So by simply providing radii here and a shoulder for the score line it is converted into a strip spring. You'll notice that the grain direction originally ran lengthwise of the spring. In changing it to a strip spring, the grain direction runs crosswise. I can tell you - and I have slides that demonstrate this point more thoroughly - it makes no difference whatever in which direction the grain runs in a beryllium copper spring. After heat treatment the grain is neutralized and there is no grain direction left.

After the spring has been redesigned into strip form it is produced on an automatic high speed die. This die costs approximately 10% more than a conventional die but that additional cost is amortized many times over in the succeeding operations by reducing their costs. These strip springs come out of the die by the yard, broken off or cut off into convenient lengths which in this case is about 50 springs per each length, and then they are taken to the heat-treating station and placed in this heat treating fixture. The stacks are only about 5 high here; that gives you a much better or closer control over the contour. This fixture holds approximately 1200 springs as against 300 for the old fixture. So there is a cost reduction there in the heat treating operation alone.

This is the finished spring after it comes out of the heat treat fixture. The score lines are very clearly shown here which permits the springs to be broken apart either by the fingers or by an automatic assembly device used in this case. When the strips are in the strip form, they are very easily put through a 100% inspection simply by sliding this go and no-go gage over the strips after they have been clamped on that surface plate. It's a very cheap operation and it's very fast. This gives a better view of the go and no-go gage. You'll notice that this gap is, of course, the thickness of the stock, which is .005 plus your plus or minus tolerance which is 16, so this gap is .021. It slides up and down over that strip and if there is one spring out of tolerance, an electrical contact is made and indicates it on a light.

Here are the springs, packaged, ready for shipment. These are stacked on pins so they can be held in position on a wooden form having approximately the same shape or the same contour as the springs. A cover is placed on them and taped in position and they are not damaged when the customer receives them. When the customer gets them he passes them through the usual inspection, of course, and from there they go to the automatic riveting machine where silver contact buttons are placed on one end of the springs. Here is one strip going through and here is one ready to go through. That operates at about 3500 piece per hour. From the riveting station it goes to the assembly bench. The strip is placed in an automatic dispenser with a weight on top of it to keep it pushed down. A girl simply pushes a foot button and a plunger comes out and picks off the spring at the assembly bench; one at a time and without any untangling to do.

Here is the assembly problem. The problem here is to assemble those loose pieces into this insulating panel, so you have to pick them up one at a time and place them one at a time into the holes. Here they are in position but, of course, it is very slow because each piece has had to be inserted in the hole and oriented to its correct position and then, of course, gaged afterwards to see that they are correct. Simply by redesigning that spring into strip form you can reduce the number of operations. These are cylinders, incidentally, and the little pushed-out conical sections there so that when they're pushed into the insulating panel there they are held in position simply by the spring action at this point. This selvage edge is wavy because it was necessary to do that to get the proper index between the two cylinders; also, this selvage edge is used to feed the material through the die. The score mark or score line is at this point. After the spring has been redesigned into strip form you pick them up, 10 at a time, push them into the holes with one operation; they are firmly set in place by the spring action of the section that has been pushed out, and they're ready for the selvage edge to be broken off. There they are, in position, and it is not necessary to do any hand adjustment or any further gaging. This is the point that I want to demonstrate, - in methods of reducing cost in spring assembly.

Beryllium copper is very stable because it has been hardened after forming, and during the hardening operation you have relieved the internal stresses. So there is very little creep. That's one of the reasons - and high conductivity is the other principal reason - that beryllium copper is used in so many places to advantage.

The pictures which you saw on the screen were rather misleading as to quantities. Those, of course, were very high activity pieces. They usually are ordered in quantities of 100,000 or more at a time. Strip springs begin to pay off at or on a quantity of about 30,000 per order. We have a short-run department that specializes in working with design engineers, development engineers and model shop men. In other words, we are equipped to make one spring or millions; it doesn't matter.

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Berylium copper accepts plating very readily; any kind of plating you want to put on it without danger of hydrogen embrittlement.

A great many times, it is plated to improve the appearance and also to increase the conductivity of the surface. Berylium copper is used extensively in high frequency applications so they do plate it there for conductivity purposes.

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We happen to use an instrument that we used to make - that's the electronic micrometer - and it has a berylium copper point on it; that's hard and non-magnetic, and has a high conductivity, of course.

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It follows the curve very closely. I would say the percentage would be - pretty hard to express it percentagewise - but 5%. We have a series of slides showing heat treating as applied to berylium copper wire.

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We use projection welding on some springs.

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We fabricate springs only, but we do make our own tools to make them, and most of the springs that we do make are necessarily small because the designers are tending towards miniaturization now. You can get a berylium copper spring in a much smaller space than you can a spring made of any other alloy. It has a higher strength, higher physicals, and does a better job even though it is smaller.

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The tooling costs to make the springs that you saw on the screen? The first one, the flat one; the refrigerator relay? My recollection on that is that the tools were approximately \$1000 to \$1200 including a number of heat treating fixtures to produce as many as 30,000, 40,000 or 50,000 springs a week. The heat treating fixtures themselves are made from cold-rolled steel and are very cheap to make; nothing in the world but a simple machining job to do with a few holes threaded; that's all there is to it.

That particular die was amortized in the first three months it was used. The total cost was between \$1000 and \$1200. And

incidentally when that spring was retooled to be made into strip the cost was reduced about 25%.

Mr. Miles: Do I understand you to say that you have an experimental department and that these people could submit a problem to you and get your expert analysis, and if it looks like a practical application you would make up a sample? And not have to buy a die to get the sample made?

Yes, very glad to do it. Would not have to buy a die.

There's engineering, the idea in a tangible form.

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Beryllium copper is misused in a great many instances. That was one of the principal reasons that it was cut, you might say, during its early discovery because it had a tendency to distort during heat treatment and the quality of the beryllium is such and still is such that it cannot be accurately formed because of your variations in your springback. So in those cases you'd have to use fixtures to gain the accuracy to form and the uniformity that you want in your spring. They were first used to prevent distortion; now we use them to a great extent in heat treat forming.

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Throughout this month training program we're going to have talks by four different divisions of our Chemical Dept. namely, Chemical Materials, Silicone Products, Molded Plastics and Laminated Plastics. On today's program we're going to have a talk on "Insulating Materials" by Frank McAuliffe and "Cutting Costs with G. E. Phenolics" by Mr. Chase who are both from our Chemical Division, Chemical Materials Section.

Frank McAuliffe is going to start this off by talking about Insulating Materials.

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Many of you, I am sure, have read or listened to the Silicone Story. Our story is not as formal as the Silicone Story but it pre-dates it by at least 50 years. General Electric Co. has been manufacturing electrical insulating varnishes for more than 50 years. Many of the products incorporated in G.E. apparatus today are the result of the cooperative efforts of the various engineering and laboratory personnel throughout the Company with our own Chemical group. The admirable record of the extremely low record of

electrical failures in G.E. equipment over the years has been due, in a great measure, to the high quality insulating varnishes that were used in the manufacture of this equipment.

Research and development facilities available to you and to us were almost unlimited. There are 1500 chemically trained people in the General Electric Co.; Research, General Engineering Lab., in the various Works Laboratories, in the Chemical Division. Where else could our customer departments better obtain this variety of talent, products, with cooperation often involving secrecy, than from within its own Company.

Typical of the results of this great organization are such firsts as Formax, a major contribution to the electrical industry. Your TriClad motor was made possible by that. Alkyd Resins, Glyptal - we were the first to apply them as electrical insulation; thermo-setting varnishes; oil-modified phenolics -- we were also the first to manufacture this type of varnish; Permafil, a polyester - again first to successfully apply this material as an electrical insulation. Silicone - micamat - and R108, an intermediate for obtaining outstanding chemical resistant coating. Let me highlight the better known products by number: the granddaddy of them all: 1201; there's no equal; protects equipment from arcing, moisture, oils, acids, alkali, dust, salt air. Resistance to sea water; four coats of an oil-modified phenolic compared to one coat of a phenolic plus one coat of 1201 - \$600 to over \$6500. Motor operating life from salt spray; one, two or three dips of an oil-modified varnish versus one dip of phenolic and one dip of 1201 - over four times the days to failure. Heat aging - three and a half times the life at 135-C.; 2-1/2 at 160; and half again as long as 200-C. Look at the wet dielectric strength after 1600 hours at 135; almost 7 times as great.

Most of you within and outside of the Company are familiar with the properties of 1201. Keeping these properties in mind we were very recently very happy to announce a new red Glyptal: 8001, having equal or better properties than 1201 and at a lower price. Solids and viscosity are the same; the drying time is longer at room temperature but when baked is the same; when cured, it's more flexible; dielectric is better by 20%; bonding strength is 10% better; heat flexibility, arc resistance, resistance to oil, salt water and acid are equal. It does not settle in the drums or other contain as badly as 1201 and it is glossy. To top it all off, it is 50¢ a gallon less than 1201. It uses a different thinner; the same as 1500 which we manufacture, and you pay 67¢ a gallon. It is no longer needed. A straight VM&P nap at 26¢ a gallon will do the job. There's a place for the oil-modified type phenolic varnish, and we have developed a material that has all the properties of most clear baking type varnishes. We have enough confidence in it to recommend that it replace all other clear baking varnishes now in use. Our new 9700 all-purpose varnish, this was developed several years ago but the lack of an assured source of raw material delayed its exploitation until a

few months ago. It has gained wide acceptance throughout the Company; it permits a substantial cost saving at Lynn and Schenectady. It's low in cost, has excellent properties; petroleum thinner, low baking temperature, versatile, and it, of course, is available. We no longer are dependent upon suppliers of intermediate resins; we are closer to the raw material source. Our modern closed kettle process which is the same as used in the manufacture of our Glyptal permits excellent quality control which is reflected in the uniformity of this product. 9700 cures in deep sections; has high bonding strength, long heat aging, excellent chemical and moisture resistance; produces a tough film; has good tank life; meets all Navy requirements.

Applications for this cost-cutting team - 9700 and 1201 - includes such things as field coils, motor frames, commutator ends, collector rings, magnetic separator coils, motor end windings, motor brush rigging, machine windings and frames.

Time will not permit our reviewing all the chemical materials that are important. Our main objective is to present the insulation story. We do, however, offer a reasonably complete line of finishing materials, for a variety of applications. Our ability to formulate and manufacture motor and other industrial finishes has been well demonstrated over the years. We want your business. We believe we have and will continue to have products and services that will permit you to continue your leadership with resulting benefits to all. Our general manager, Bob Gitzen ..., called my attention to the fact that word had come to him from several different directions that the Chemical Division does not want internal business. Let me assure you that we do want internal business. It's almost legendary that it's harder to do business with your own people than with outsiders, not only within the General Electric Co. but with most large companies. I have discussed this with a number of my contemporaries in other companies and they have the same problems.

We don't want to be hard to do business with; we don't intentionally change some of the ground rules, just to irritate our customers. Our efforts are to standardize on large volume material; suggest that standard items be substituted for special products; or request larger ordering quantities, less frequency, in an attempt to provide lower cost materials and permit us to give better service. We are your partners; we want you to be our customers. We have a dual responsibility to grow profitably with you for the good of the whole Company and to give service to you so that we'll both make a profit. We sincerely hope that you will continue to look to us in all matters pertaining to electrical insulation and finishing materials. Remember, when you think of insulation "You can put your confidence in General Electric" insulating material.

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Mr. Chase, Sales Development Supervisor for our Pittsfield operation, will carry on.

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You've heard Mr. McAuliffe tell you a little bit about G.E. insulating materials. Now I'd like to take just a few minutes to tell you about some of G.E.'s phenolic products. These two have a rather long faithful history, and today I'd like to spotlight several applications for you which I am sure can cut some costs.

First of all, to define what we're talking about when we say "G.E. phenolic materials", we refer to that class of raw materials which consists of phenolic resins such as this one here which may also be solid powered resins, and molding compounds which you're all familiar with, of course. It isn't always apparent where these materials may be applied. We're all familiar with the common applications, both in the electrical industry and in other fields. Today I'd like to tell you about two applications with which you may be familiar and which you may be seeking some more information on.

The first one consists of G.E. rubber phenolic molding compounds and I have a few examples up here of some molded items, that are familiar to you in the electrical industry. These materials which were developed exclusively by G.E. give you some advantages that aren't found in conventional molding materials. First of all, they have a tremendous amount of shock resistance which isn't found in the ordinary run of molding compounds. Now, you couldn't do that (sound of a blow), for instance, to an ordinary phenolic molding compound; it would shatter into a thousand pieces. So you get that plus factor of shock resistance. Secondly, because these materials have special properties you can mold them in very thin sections without danger of cracking; you can see this piece here which is some sort of a faucet attachment, consists primarily of the insert and a very thin shell of plastic which has been molded around it. Here's another example of what is primarily an insert with a small part molded around it. And here are several others, again, showing thin cross sections which may be molded without danger of cracking. Here is another part, for instance, where practically that entire center section consists of an insert and the material, of course, being molded around it during the molding operation.

In the resin area there is a very interesting application which I am sure many of you are familiar with and which is gaining in importance practically every day, and that is the relatively new development known as shell molding, a process recently developed in this country stemming from work done originally in Germany but now being done by perhaps 100 foundries out of the 5000 that exist in the United States today and more are working with this operation as times goes on. In this particular type of thing as contrasted with the conventional type of molding which you all know about, thin shells are made of the item to be molded. These shells are bonded in this case with G.E. phenolic resin; a special resin having special properties as far as flow and cure are concerned. We have

here, the end or side, of a motor. In this particular case a fine sand is mixed or blended together with a small percentage of phenolic resin and then upon a hot patter plate, is formed into the shape that is desired. Upon curing this a very short time in an oven, a thin, hard shell results. You can get castings out of this which save you a lot of cost, particularly with respect to finishing of the metal, do away with having to drill holes because smaller holes can be used in this type of an operation than can be cored, in conventional molding. On the other hand, there are overall savings of metal. There is one part which a foundry is casting which originally took 15 lbs of metal and required a great deal of money for finishing purposes to wind up with the finished casting that weighed some 3-1/2 lbs. Using this particular method of molding that amount of metal used was reduced to about 4-1/2 lbs. so that there was a very slight amount that had to be machined. Here, for example, is a piece of a shell casting that has not been touched in any way, either so far as finishing is concerned or any other operation. You'll note the relative smoothness of the surface and also the smooth hole that was molded in. Here is another example of a piece cast by shell molding. This again has not been touched in any way; as removed from the mold with the exception that the riser has been knocked off here. In this particular case you do away with a milling operation here and a milling operation there. Note the fine detail of these numbers which have been molded in. To give you an idea of the intricacy of molding which is permitted in this type of phenolic resins in this kind of operation, here is an example of a multiple mold containing four units. This is come sort of an axle plate. You'll notice the clear, sharp definition that's permitted. Also, these small projections here which, of course, wind up as a hole in the mold do away with a drilling operation, and in many cases pieces can be used "as is".

Those are merely two examples of how G.E. phenolics can help you cut costs. There are many others, of course. We have a complete line ranging from conventional materials through these types of products that we have been looking at today, plus other resins used for purposes of flame resistance, chemical resistance, shock resistance. This rubber phenolic material, for instance, is available now as a varnish. It can be used in impregnating applications, laminating applications, where a high degree of resilience and shock is needed.

That very briefly will give you a bird's eye view of the type of material that we have in the phenolics area. I want to stress again that these are the raw materials. They're not the finished items, so that the applications are not always apparent and that is where you gentlemen can bring your talents to bear in finding applications for these versatile products. You can do that in two ways, of course: one is working through your Design Engineering and Manufacturing groups, and the other way is by specifying G.E. phenolics in the end products which you purchase from outside vendors.

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Philosophy is something that takes a long time to discuss. You can discuss it for long lengths of time over a long period of years. Let me tell you just a little bit about the background of Dayton Rogers. Dayton Rogers himself had the philosophy of making tools to produce die-cut stampings at low cost, not only for the tool, but for the piece part. Back in the days when he was a professor at the University of Minnesota, he started with the idea - and after leaving the university he started building tools by hand to make a short quantity of parts for Minneapolis-Honeywell Co. The business has grown to quite a big thing and they are doing it nationally, now. This philosophy carried him not only from short-run stampings but also to short-run molded parts, plastic molded parts, and I'd like to point out also that today he is still very busily engaged in our shop daily in the experimental field of other short-run materials, one of which is no secret to any one who might have visited our plant - the next one that we hope to hit with is short-run die-castings. I don't want to go any further into that at the moment because I'm limited as to time. I want to try to cover short-run stampings and plastics and at the end of each of the groups of talks in which Mr. Asem will talk on the stampings and I will give a little talk on the plastics, we'd like you to come forward and give forth with all of the questions which you might have on it.

Coming back to the philosophy of our approach to short-run stampings and plastics, there is one thought that I would like to leave with you which is a part of our service in which we have a limitation, too, that is when you think of stampings and of plastic parts, low quantities I'm thinking of stampings which you would buy less than 5000 parts at a time and of molded plastic parts generally less than 10,000 parts; anything from one piece to 500 on stampings any place from one piece to 10,000 molded parts per order.

When you think of those parts I'd like you to think of us as a service company in an attempt to provide you with the lowest possible tool cost along with the lowest possible unit cost. Now, to get that we have to place certain limitations on what we do. One of the things that we must do is to limit our responsibility from a natural consulting engineering standpoint. When it comes to the choice of the metal to be made for your part assembly, we would rather not be called upon to make the recommendation as to the material to be used in the part. We'll make it to your drawing, make it of the material you specify, and make them in those quantities of which I spoke. The same thing holds true of plastics. We do not want to be called upon for the engineering application of the choice of material. That is a field all of its own in which a number of companies such as DuPont, Bakelite, Eastman, etc., are spending lots and lots of dollars for and development of, and, at the cost of these parts to you we cannot afford to get into that kind of engineering and offer you that kind of engineering service. That's another phase of the metal-

working industry, it's another phase of the plastic industry. That I'd like you to keep real earnestly in front of you as you approach any part. We want to work with you in the conversion of one part from a casting to a stamping, or from a combination of a stamping and plastic, or from any application of a part that possibly can be made as a stamping or plastic molded part, but we've got to depend upon your application people telling us what materials should be used. We try to perform a service of building low cost tools so that we can provide you short quantities at a relatively low cost per unit.

Mr. Asom:

First we wish to thank you for the opportunity of placing our story before you. I know that I, for one, have walked miles and spent hours and I only see a few faces among the group that I have contacted. This is a rare opportunity to place our story before you.

On the stampings of Dayton Rogers are tags, and I believe they are famous for leaving these little tags around with the sample parts - and on the tag will be listed the price for the first 100 pieces. It's a service that will give you a part that is representative of a production part. Now to production people that is very advantageous over a tool room sample, because tool room samples vary a little bit here and a little bit there, and you do not know for sure whether it is practical as a production part. When we give you a sample it is representative as to what you will receive. If your quantity exceeds 5000 pieces per run you have the opportunity to change you parts at a very minimum die cost. Actually, 100 pieces per month will cost far less than half a dozen pieces produced in your own tool room.

The maximum piece that Dayton Rogers to date can form is approximately blanks 22" x 22". Your thickness is up to 3/8" thick.

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That's in steel; now you're going into your non-ferrous, 3/8" is stainless, and by the way, on that the maximum depth that we can draw is the 3-5/8 deep on a draw. I'm not sure as to what the gage limit on that would be but I would say somewhere around 1/16" on that deep draw.

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On the material - on any items like that they'll be very glad to send back recommendations as to their limitations. If you're in doubt, mail us a print, if there's some question, as to our capability.

We can blank up to 300 lbs. pressure which will give you a pretty good size piece. Actually, the Dayton Rogers are geared to handle 500 to 600 jobs a week which is a lot of little pieces going through daily.

Your die life varies with the part, depending on the shape of the part, anywhere from 9000 pieces up to 20,000 pieces.

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Plastics is new with us. It's new - we've been in it about two and a half years. It's new - every day it's new. We started out with just one machine, a small injection molding machine; now altogether we've got about 12 machines, injection molding, and we've got about 15 compression molding machines. We can mold any commercial plastic material that is on the market today. We can mold it to any tolerances that that material will hold under molding practices, taking into consideration shrinkage, etc. Our technique is again in building the molds.

Each of our people who become molders, each of our people who become press operators serve an apprenticeship through the die shop, strange as it may seem, or the mold shop, and in that fashion they get to know what is required to make a part so that when they get out on a machine, either a molding press or punch press, they do know what is needed to make a part and make it to tolerance.

As to the plastic parts, we are now molding a part as large as - and a good item at the moment to keep in mind - as large as the cubic area of your telephone which most of you have on your desks. In fact, we are now molding a complete telephone unit for a New York State firm. It started out with short quantities and as it's going on it looks like it's going to run into large quantities. The molded parts, again, are from any materials - can hold any type of tolerances, and we ask that you advise us the material of your choice and a drawing; we can quote on it, we can make it. Insert molding - we do lots of it. Metal inserts, either screw machine parts or stampings. We do not make our own screw machine parts. If it's an assembly on which you have a supplier on screw machine parts, we would prefer that you supply us the screw machine parts. If you do not have a vendor, we'll have the screw machine parts made and supply you the complete assembled part.

Assemblies such as the one we were looking at a short while ago with electrical wiring, or for electrical wiring devices, wherein wires are molded in various shapes and forms - we're doing that. We're trying - coming back again to our philosophy - we're trying to provide a service that is before the long run production work; a service for development; and a service to various units that are low production rate per year. Many

companies are using us today for their finished parts. We have plastic and stamping parts going into all types of office machines, typewriters, milling machines, adding machines, etc. A lot of parts going into General Electric Co. parts, as you know.

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Originally, we thought that our quantities that were purchased per order or per release of 10,000 pieces would be the maximum that we would want to take, and our only limiting factor now as to the quantity that is advisable is from the standpoint of tying up our equipment, because the molds that we are building we are finding last a long time. We have parts that are coming off the molds in quantities of 200,000 pieces and the molds are still good, yet we have other molds which have deteriorated due to close tolerances, etc., after about 20,000 pieces. So it's a rather flexible thing and as to plastics, we would like to keep our capacity for a lot of people, for a lot of small quantity work while we have a limited capacity for it. As time goes on and perhaps we have more machine capacity, then we'll probably welcome longer runs of molded parts. But currently, we'd like to keep the quantity per release at 10,000 or less pieces.

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Are the dies of our plastic parts of a low-cost variety? Yes they are, comparatively. If you're going to build a complicated mold, our mold cost on some of these parts which you might view here - you might notice a mold cost of \$700. Well, \$700 is a comparatively low mold cost for that part compared to what a permanent molder might charge you. Generally, our mold costs will range from 5 to 25% of the cost of a permanent mold, depending upon what it is. That's a rather broad statement but it's one that I'm forced to make in a general way.

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Is our policy the same on plastic dies as it is with stampings relative to maintenance of the dies? We do maintain the dies for their life and when they're worn out we do on our stamping as well as on our plastics ask for some assistance in building of new dies. Many times it is not necessary to build a complete unit because only certain parts of it need to be replaced. Coming back to a question earlier as to the removal of dies or molds from our plant, one of the secrets - and we speak of it as a secret and yet it is no secret - of our philosophy of service - is the use of a multiple of tools over a long period of time. We have racks and racks and racks of dies stored and they have been in our place for years, and through the use of some part of a die, cataloging all of these we are able to produce parts and quote prices on new dies for jobs that are considerably lower than any other type of permanent die operation.

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It would be conceivable that we would have a die made up for a part similar to yours or exactly as yours, but not too probable. If it's a commonly used part, perhaps in one of your units that another competitor of yours were making or something of that kind, then it is possible. As to removal of these dies, again, we have on occasion been requested to return the dies, and when the party gets the dies he opens up the box and looks at it, invariably we get a wire or a phone call or a letter saying, "Something went wrong in your shipping room and we got a box of scrap." As you look at them, sometimes they look like scrap. That's a point where I hope nobody gets up and says "Your parts look like scrap", because we do have a lot of nice parts and later we'd like to have you take a look at them and you can see some pretty good quality in them.

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Thanks a lot, Ken and Homer of Dayton Rogers. You fellows will have an opportunity after our next speaker to come up and see the approximate costs of these parts that they brought along and talk to them a little more about it.

Next on the program today we have Bill Kinser from Armstrong Cork who's going to show us some adhesive applications.

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Bill Kinser:

This subject of adhesives is somewhat new as far as its application in industry. I have attempted to outline a more or less general approach to this subject and I'm going to ask you to bear with me until I get through with this and then we'll give you a chance to ask questions.

Though adhesives have been used in one form or another for many years, it has only been recently that industry has in general begun to capitalize on product design possibilities which adhesives offer.

A few years ago, for example, the use of adhesives to attach friction clutch facings was unheard of. But today your automatic transmissions and your automobile owe much of their compactness, their small size and their reliable operation to adhesives. Several of the large automotive manufacturers have adopted adhesives for the attachment of brake linings to the brake shoe. Similarly, sandwich construction - not ham sandwiches - are opening up fresh design possibilities in the aircraft industry. These sandwiches provide light but rigid structures with smooth exterior surfaces that permit weight reductions of as much as 25 to 40% which is a

very important factor in the aircraft industry. Modern adhesives have also made practical the disposable cellulose sponge mop, the California process shoe, the bus type doors, and a host of other products. New jobs are being developed for adhesives almost every day. In fact, the accomplishments in the last ten years suggest that no idea should be dismissed as unorthodox or impossible until it has been thoroughly reviewed by experts in the field. Incidentally, I'm not an expert. The chances are pretty good that no matter how difficult the application and adhesive can be developed for the job.

The very next question that comes into anybody's mind is "What is the right adhesive for any job?" That's my purpose here today. The right adhesive for any given job is one that provides an adequate bond at the lowest possible cost. This may seem perfectly obvious to you men, but it's a natural tendency for many users to choose the strongest adhesive that they can find, regardless of the actual need of the application. This tendency to over-buy creates unrealistic adhesive specifications. It is needless, for example, to specify water resistance if the application doesn't come in contact with water; neither is it necessary to adhere a piece of felt to steel with a high strength adhesive with a low strength, lower cost adhesive would delaminate itself. Strength alone, moreover, is an unreliable gage of an adhesive thickness for a given job. Shear, tensile or peel test can measure strength but they cannot, however, demonstrate an adhesive's ability to withstand static loads over a long period of time. The strongest adhesive, according to these tests, may fail in service under a relatively low static load. It may be equally unrealistic to build to rigid specifications around characteristics of a familiar adhesive just because it's giving satisfactory service. You may be paying a premium for unnecessary characteristics or barring yourself from new, more suitable and more economical adhesives for that particular application.

From the standpoint of the design engineer the first question is, "Well, how do I choose the right adhesive for my job?" What has already been said makes it clear that no one factor controls the choice of such an adhesive. Instead, there are a number of important considerations that must be taken into account. Based on our experience, some of the factors that should be considered are: (1) the material to be bonded; (2) the service conditions; (3) method of application; (4) assembly requirements, and (5) any special requirements for the application. We believe it might be worthwhile to discuss briefly some of these factors in the selection of an adhesive.

Under "material to be bonded" we might say that there's virtually no limit as to the variety or types of adhesives that can be used to bond most materials satisfactorily. There are, of course, those exceptions like Teflon, certain types of silicones, polyethylene and a few other materials of a similar nature. However, for

the most part, materials to be bonded are not themselves quite as critical as the surface preparation and the design of the mating parts. Materials to be bonded in almost every case must be cleaned. In the past some materials have gained the reputation of being difficult to bond whereas improper cleaning before you tried to bond them was the source of the difficulty. Molded rubber parts, for example, may have a mold release agent on the surface and if the bond of this film to the rubber is good and strong, O.K.; you can get a good bond to that with an adhesive. But it's usually that film is weak so it's necessary to clean the parts thoroughly before you attempt to bond them.

In most cases it's necessary to do a real job of surface preparation or proper designing before adhesive applications. Some of the things that give you trouble are oil on metal, improper degreasing, dust on wooden parts, attempting to bond to a painted surface, surface oxidation on the metal - all those things offer poor bonding surfaces and should be removed before you attempt to use an adhesive. To realize maximum efficiency from adhesives, the parts should be designed for adhesive bonding. For example, a metal label applied to a curved surface of a fire extinguisher would be preformed to the curve of the fire extinguisher and the back of the label ought to be smooth so that it presents the entire surface for bonding and maximum strength.

The second factor I mentioned was "service conditions. This includes such things as temperature, load and strength requirements, resistance to liquids, resistance to weathering and other special factors. Now, adhesives may be classed conveniently as either thermoplastics or thermosetting, although very few do not, for all practical purposes, fall into either category. Thermoplastic materials generally are those types which will soften repeatedly when subjected to heat and in many cases, in fact most cases, become brittle at low temperatures. Thermosetting materials, on the other hand, are those which generally do not soften when they're exposed to elevated temperatures and thermosetting materials vary in that some can be set rather quickly with heat and others set slowly at room temperature. If service conditions range above 225 or 250° F., in most cases the thermosetting adhesives would be desirable or necessary. However, if service temperatures range from normal to perhaps a maximum of 250° F., in most cases the thermoplastic adhesive will do the job. It should be noted that while some thermoplastic adhesives maintain a good bond at temperatures as high as 200 or 250, they may fail very quickly if stresses are placed on the bond at that temperature. An example of that - Doug was talking to me about nameplate on an industrial heating application over there where the temperature of the part gets up around 700°. Well, the thermoplastic adhesive would be no good; as a matter of fact, most thermosetting adhesives would be of very limited strength at that temperature, but might possibly work because there actually is no stress placed on the nameplate even at that temperature.

Thermal characteristics of the material to be bonded have to be taken into consideration, because occasionally you run into a combination of materials which might have different thermal expansion characteristics, and in a case like that you would select a material that would remain somewhat elastic in the cured or finished state. High temperatures affect the deteriorating action of water, solvents and oil and other liquids, so that some adhesives which may resist a particular liquid satisfactorily at normal temperatures might fail if they were exposed to the same liquid at an elevated temperature. And here is a very important point when you are evaluating for purposes of selection the effects of temperature: Consider only the temperature at the glue line - at the line where the adhesive is placed. It's not important, for example, that some parts of a clutch mechanism reach temperatures as high as 1000° because we've found by actual measurement that at the glue line the temperature never goes much above 500 and that affects our selection of an adhesive very considerably. Strength requirements should be considered both in relation to the materials being bonded and the load encountered in service. Obviously, no bond can be stronger than the weakest member of the assembly. For example, if you bond a piece of rubber to a piece of painted steel, the bond is only as good as the bond of the paint to the steel; you can't expect it to do any better than that. The ideal bond is one that has enough strength to perform satisfactorily in service. As a measure of strength it is sometimes desirable to achieve failure under test of at least one of the materials being bonded. This may be true where you're bonding a material like textolite - this table top here - to plywood. You want that to rip the plywood when you pull it apart. But, for example, when you're making a metal-to-metal bond it would be rather difficult to do that with an adhesive that would actually be stronger than the metal itself, although still one which would perform satisfactorily. Loads vary in type and it's important that the type of service load be determined. Will the adhesive be subjected to heavy sudden shear loads or static loads or impact or shock or internal stresses? If an adhesive has to withstand a high load intermittently, as for example, on a brake shoe where you have the brake lining bonded to the metal brake shoe with an adhesive, if it has to withstand high shock and high temperatures, you have to have a material that's going to stand that sort of service characteristics: high shear strength and elevated temperatures.

In many applications a constant or prolonged stress or force is exerted. Such a static load may fatigue and adhesive and cause bond failure after a period of time. This failure may occur at loads which are substantially less than those required to fail the adhesive in your normal shear or peel strength tests. A good example of this is an application of desk-top linoleum to radius edge steel desks. After the application of linoleum to this radius edge, the desk top has a natural tendency to lift up and go back into a straight line if held back down here by a metal edging, and after some time in some cases weeks or months, this steady pull has

a tendency to lift that linoleum away from the seal. We actually found a case of that in one of our steel desk manufacturers where we were using a reclaim rubber cement which had a very high peel strength. We thought that was important, but after two or three weeks in their stock room they began to get blisters back of this radius and an examination of that application indicated that what was needed was a high fatigue resistance adhesive. We made the substitution and have been going along for two and a half years now without a single problem in that regard. It just goes to show how necessary it is to really analyze the type of stress or force that is exerted in the actual application.

Another point on your service conditions is resistance to liquids. The term "waterproof" is often misused. Actually, very few adhesives are really waterproof - that is, able to withstand water immersion for an unlimited time without any change, and even if it were waterproof adhesive, the adhesive itself in most cases couldn't make the assembly waterproof. Metal parts may rust or wood parts deteriorate in which event the bond would fail. The degree of water resistance required depends both on the assembly and the external conditions and should be based on the actual application. Resistance to weathering is sometimes a factor in the selection of an adhesive, and when you have that problem you might run into such things as resistance to water, heat, cold, ultra-violet light, or if it's outdoor service, ice formation, salt water spray, heavy acid concentrations in the atmosphere - all of those factors have to be taken into consideration.

The third factor for the consideration of selection is the "method of application". From my talk with a few of you boys here earlier, that's a very important point. It's important to choose the right method of applying an adhesive, just as important as it is to select the right adhesive, because improper applications are often the cause of unsatisfactory performance. Streamlined manufacturing with parts handled by a mechanical conveyor obviously is the most desirable setup, where you can apply the adhesive in the first stage, the adhesive film can be prepared for bonding in the second stage, and you apply pressure and, if necessary, heat at a third stage. The two methods of adhesive application most suitable to straight-line production are spraying and roller-coating. Spraying is ideal for coating uneven or irregular surfaces. It's fast, speeds up drying, and it makes possible a uniform film of adhesives in the thickness needed. Spraying can be automatically controlled. Roller-coating flat surfaces gives maximum coverage, deposits the film evenly on the bonding surface, and it's really fast. Several other methods of adhesive application are the doctor blades where you have to control the film thickness; dipping which is practical where a uniform thick film is necessary and is particularly suited for hot melt adhesives. Flow guns are used with heavy bodied adhesives and sealing compounds and brushing and troweling can be used where production is intermittent and where

it's not practical to establish a regular production line. Full consideration must be given to the product to be bonded. The normal production flow, time limits and many other factors determine the proper application. It's not just a one-man operation; you have to consider the whole application and assembly line technique in order to fit an adhesive to an existing product.

The fourth item was "assembly requirements". The method you select for applying the adhesive will be determined to a large extent by assembly requirements of the adhesive used. Those assembly requirements include time, heat and pressure. They vary not only with the adhesive used but also with the material to be bonded. Two time factors are involved: one is open time which is described as that period of time which can or perhaps must elapse between the actual coating of the parts and the joining. Some adhesives permit no open time at all and others must be kept open at intervals ranging anywhere from 5 minutes to as much as 24 hours. Curing time or aging time is that period which must elapse before the adhesive bond attains its full strength. Here, again, the interval may be measured in terms of seconds or actually weeks. Heat is required in varying degrees in many adhesive applications. Whether one or both surfaces are coated, forced drying of an adhesive film by heated air speeds drying, makes the drying independent of weather conditions, and prevents water condensation on the adhesive film. Some of these newer adhesives have very rapidly evaporating solvents and the actual rate of evaporation is such that it drops the temperature below the dew point, and if you have a condition like that it is almost essential to use forced drying in order to avoid condensation. Under some conditions, it's possible to dry the adhesive film completely and later reactivate it either with heat or solvent. That, incidentally, if it can be applied, gives you the strongest bond at the immediate moment; there's no build-up of strength.

The fifth factor in the consideration of the selection of adhesives was "special requirements". For most industrial applications these are not always important, but I mention them because they are there in some cases. Such things as the color of the adhesive; some people don't like a black color in a stickum, so you have to have one that's brown or green. Staining properties - not so much a problem unless you're using an adhesive in connection with fabrics or vinyl materials and you don't want migrating stains. Toxicity - you safety engineers are always interested in that. A lot of other similar specific or special requirements that may come into the picture.

Now, all of our remarks up to this point have had to do primarily with the various factors in the selection of an adhesive. I could talk to you at some length about the various types of adhesives, but rather than take the time for that I'd like to refer to

a few examples of industrial applications of adhesives that have resulted in product improvement and economy and actual improvement in customer service.

One of the very recent developments which is growing by leaps and bounds is the use of the neoprene resin adhesive for laminating high or low pressure laminates to plywood or to metal. The lack of a suitable adhesive for this purpose has been a very definite limiting factor in the sale and use of high pressure decorative laminates. General Electric textolite with which most of you are familiar, I am sure, is an outstanding example of this type of product. Until the development of a suitable adhesive for laminating to wood, it was common practice to use a casein phenolic adhesive which had to be prepared just before it was used. This was mixed with water, and this mixing operation was subject to variation due to the errors on the part of individual operators. It also had a very definite limited time for working life. The use of water in the adhesive and an unhappy facility of raising the grain of the plywood and that showed through the textolite, so they had to go to the use of mahogany top ply on their plywood in order to avoid the grain showing through, and then after they did stick the two things together they had to put it in a press and clamp it and leave it sit for 12 or 24 hours until the thing dried and set up. They wound up with a rigid bond there so that if somebody set a hot teakettle on the textolite top table and it was really hot, the textolite would oil-can or pop loose and it was loose from then on; there was no more sticking it down. Now, with the development of a suitable synthetic rubber resin adhesive incorporating high strength and high fatigue resistance, it has become possible to decoratively laminate the plywood in a matter of 2 or 3 minutes, and that's not wishful thinking; it's being done. Actually, this is being done in a number of nationally known furniture manufacturers, and the assembled panels are sent directly from the laminating operation to the saws and routers. Gertrude Bros. out on the West Coast and Kenni Bros. in St. Louis have set up now where they're laminating as many as 1500 4 x 8 panels a day and they go right from the laminating operation to the saws.

No really suitable adhesive was available for combining the high pressure laminate steel until the development of one of these synthetic rubber resin adhesives. Now, most of the nationally known manufacturers including General Electric have approved the material which does a thoroughly satisfactory job. The same general type of adhesive has been used in the application of metal nameplates to other metal surfaces.

Another one of the more outstanding applications of adhesives for industry is the use on bonding brake lining. I have a couple of samples up here and you boys might want to come up and look at some of these things. These shoes, incidentally, are of two different sizes so it isn't necessary to increase the

width when you go to bonding. Here's the rivet bonded brake shoe with 12 ribs, 12 countersunk holes in the brake lining, 12 holes in your brake shoe and 12 rivets to be headed. And here's a shoe of comparable size with your adhesive bond. Here's an actual passenger car brake shoe adhesive bonded from a Chevrolet that took 11,000 lbs. to push a section of that brake lining off the shoe, which gives you some idea of the strength and serviceability. You know that when you had a brake lining riveted on you had to be very careful that you didn't run your linings down to the point where your rivets were exposed before your drum because you got into a very expensive repair job and that situation just doesn't happen any more. In addition to that where you have spot fastening and you've got a brake shoe wet your shoe bulges between your points of fastening and you just operate on high spots and you don't have the braking action that you normally get with full contact.

The same general type of application is being used in frictional material and clutch facing, in your hydromatic drives or torque converters in automobiles. I don't think either one of these are automobile clutches - I don't want to mislead you - but this is the general type of thing that's used in your torque converters in your automobiles where the frictional surface is bonded to the metal with a thermosetting adhesive.

The very homely O-Cedar mop is possible only because of the development of an adhesive for the attachment of this back-up plate to your cellulose sponge in a manner that will not be affected by your detergents and hot water. That's a very simple, homely application that you can remember very readily.

A rather novel idea in the field of adhesives is an abrasive deck coating that was developed for your Syracuse Works in connection with radar tower design as a non-skid flooring on steel. It's actually an adhesive but it's loaded with an abrasive material. And here is an application in the printing industry; a photo-engravers' zinc engraving plate adhesive bonded to a magnesium die casting, dissimilar metals which under normal circumstances would set up an electrolytic action and raise the devil with almost anything - that's being used commercially in substantial volume.

Metal-to-metal bonds with thermosetting adhesives - this aluminum here; in the aircraft industry they're getting bonds 2000 to 3000 lbs. in shear, 5000 to 6000 in tensile. It won't break the metal but it does hold them together.

I don't think I mentioned in going through here other than in my lead-off the sandwich construction for the aircraft industry. I'd like you fellows to come up and take a look at this. This is a typical honeycomb section. Thin aluminum foil, spot bonded and then expanded into a honeycomb affair with an aluminum skin; the skin is put on here with a thermosetting adhesive so that you can

achieve equal strength with weight reductions of 25% to 40%. I mentioned to some of the boys here earlier a rather interesting parallel development where Union Bag & Paper Co. up in Hudson Falls are making a draft paper honeycomb core structure which they're selling to an outfit in Philadelphia and they're making expendable pellets out of kraft paper; pellets about 3 inches thick, have four legs made out of this honeycomb structure - they're so light you can pick them up with one hand, hold them with one finger, and yet they'll hold up to 3000 or 4000 lbs.

I'd just like to close with - by repeating what I said at the very beginning of my talk here, that new jobs are being developed every day. In fact, the accomplishments over the last ten years have suggested that no ideas should be dismissed as unorthodox or impossible. Chances are pretty good, no matter how difficult the problem that an adhesive can be developed to solve it, and if we Armstrong can be of any help to you, we certainly would be glad to do it.

Morning, 3rd day, 10/9/52

Now, the philosophy of project work is this: no one man can be good enough to do as good a job as we need nowadays. Fellows, if you don't believe that, you're not quite ready to start, because it's true - there isn't an engineer who's good enough. We don't have one in the Company. There isn't a buyer who's good enough to do the kind of a job we need to do in this competitive world. There isn't a manufacturing man - and most of them know it; they see newcomers sprout out with processes that put them so badly in the shade that we find them to be, generally speaking, further advanced on the scale of open-mindedness than we buyers or engineers, and I'm both, so I can catch both tomatoes.

Then, with that philosophy that no one man is good enough -- our study on these projects takes the form of putting three men to work on a project because more than three is too many, so when you study your projects, no one man is supposed to sit and think alone on anything. He exhausts his thinking and then goes around in circles, but two fellows will jab each other a little if they have good minds and they'll get into new good territory that neither one could reach. May I suggest that as you work on your tables you move them so that one fellow can get either on the end or on this side so you have a nice working nucleus of three people rather than three of you stretched out alone which isn't good. Move them anywhere you need to in order to accomplish that. That's always the way we work on this.

Then, we suggest that you only meet a few minutes at a time in the groups of 15 or 20. That's just a little coordination meeting; it will not generate any good ideas.

The plan in this work was to have the tables in this row study one project; each table a unit in itself, so we have five parallel operations. Then, after a couple days of study you'll find that one group has generated some good ideas, the other hasn't, although you have good sharp fellows at all tables. In other words, this unit of three men works the project just as though there was no one else. Then you get together in these little cliquey meetings and review it. Now, that means we should have six or five sets of everything and each of you will work like you were the only table working on that project. I know at the end you have only one sample so you can't quite do that. I also know you have to deviate from a plan now and then to be practical, but you will know if you're doing anything different that you're deviating from the planned course and let's get back onto the planned course very quickly. So work intensely on your projects, with three minds at a time; when we're through with it we'll stop it sharply and get onto another one. You're bound to hit some that click good and some that don't click good. That's part of the experience; that's the way it'll be when you're working on a job.

Now, there's one thought you must remember and that is after you're through looking at the project you put your intense study of three minds on one thing for maybe an hour, maybe 2 hours, on a little area there and you're done with it. When you're done with it still somebody else will come along two or three or four

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years ago and do something that's so effective and so simple that it makes you feel foolish. I've already had a chance to see that happen on job after job that our fellows have looked through. So when you're through you don't have the job done; the only thing is at any one time and at any one place, any one, two or three fellows can only think of so many things. Another year you'd go on just as much farther or somebody else would. There's still plenty there when you're through, but you can't work on one job too long.

Now, let's get on with the subject. Just how do we go about it to accomplish results where they have not been accomplished before, to bring in something new, get it effective, and get it into operation? The first step of it is the use of the creative approach, creative thinking. Fellows, you'll learn a lot more about that; Roy has the Creative Engineering Program, part of Mr. Winne's operation, here later, to conduct a session or two or three with you. But generally speaking creative thinking is the ability to make something grow where it hasn't grown before. Don't look at Roy and me because it has grown before there. But many people are not creative; now let's be realistic. I don't suppose all of you fellows are creative and I know a lot of you are. Fine, find out just as quickly as you can if you are creative. I think that probably most of you are; I can hope that all of you are. If you are not creative, this will fall flat; you can't do it; neither can anybody else. If a man isn't creative he can't understand what we're going to be talking about. He can't understand it, so his defense is ridicule; he will ridicule you, but nothing of this type - you might say nothing great of any type was ever done without a lot of creative ability. Fellows, let's harness that; let's think a little bit about that creative ability. Now shall we use it? For the moment, now, we're all a bunch of fellows engaged on a problem and we're ready to attack that problem with the creative approach. Well, what shall the problem be. I don't care; it could be anything. I'll pick this watch up. Maybe the problem in this watch is a nuisance, it's apt to drop on the floor; it doesn't keep good time; it costs money; it needs repairs; somebody may steal it. Isn't there a better way to know what time it is than to have to have a chunk of this stuff around all the time? I just picked this up. I could just pick up a paper clip or anything else and just look at it the same way. Well, what does a watch do? Now let's start a creative session. How could we get along without the watch? Well, I could have a clock on the wall, I could have the thing strapped onto my wrist, I could have the time painted on the back of my hand - I'm getting into the ridiculous to show you how ridiculous it could be; that suggestion is no good, but if somebody makes them like that - and they make them just that ridiculous - you don't smile, because he's doing the best he can and you'll be surprised how that'll shock somebody to think in a new line. How else could I know what the time is? Well, you could have it built into the desk. I could have a gong that announced it. I think if we sat we

could think of a hundred ways we could do it. We could if we were creative. Not many of them would be very good, but we're not ready to analyze yet. Now, if we've had any thoughts about that's no good, we're wasting our energy, we're supposed to concentrate every ounce of attention on thinking about some way that that could be done. That's what a creative session is.

Now, the way a creative sessions works out, of course, on a part - we look at a part; you've been looking at them here; and you see what the part does and the question is, how else can you do that job? We're going to have a talk about that more tomorrow, so I'll just brush through it. So you start thinking about how else can you do it. One fellow says, this way, this way, this way. Now, if you don't have trained fellows there one of them will take a swipe at you. He'll say, "Aw, that's silly." You'll say something else, he'll say "Aw, we tried that; that's no good." Stop the session. Get rid of him. He stops it. You can't break through when you've got that kind of a character in the group. In a creative session there must be no analysis; absolutely no analysis. Maybe the silliest, most foolish idea is the one that's going to break through with the same performance for one-tenth of the cost. Dr. Whitney, most of you know, the father of our laboratory; a wonderful, wonderful fellow, says that you can't usually accomplish big improvements with people who know very much about the job, because they start in negative thinking and analyzing and they will never give themselves a chance to take enough rope to get into new ground. That's what we're doing here, we're plowing new ground in the creative sessions. We'll have some actual experience, some trial runs so you'll know what we're getting into.

Now, if you think any thoughts during a creative session other than how can we do that job some other way - if that's what the session is on - you are dissipating energy and dissipating possibilities. Don't think any of them. Somebody suggests something ridiculous to you, you'll think a little about how to make it practical. You won't say that that's no good, wood wouldn't work. You'll say that if you take that wood and treat it with plastic then it would have more rigidity. Now, you've taken his suggestion that wasn't any good and in a positive way you've made it more practical. The next fellow might say, "Let's treat it with a fiberglas reinforced plastic." Now, you've got your wood which was no good, the idea of the plastic of better plastics. Pretty soon you're in new areas which give you the performance at half the cost and it all stated with a silly suggestion, "Make it out of wood instead of stainless steel." Don't mind silly suggestions. Be big enough to know that there isn't any silly suggestion in a creative session.

Now, I don't want you to be shocked when you first start to do it. You'll be disappointed because your bosses, probably, and others of stature of your boss, will look at you with ridicule and here are some of the things that they'll say when you try to get others in the meeting, and these I quote from places I have

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been. One fellow the other day says, "I'm too realistic to do this sort of thing." (I want to keep this in the realm of realism.) He's no good; he can't create. I knew he couldn't create in the first place; we were just trying to see if we couldn't get him to. But that's what he said, that he was too practical. He can't understand you at all. It's like a man who doesn't have any eye not seeing; he doesn't know what people see who see; he doesn't know how to create. Now, for heaven's sake realize that difference: people who can't create don't understand you at all. They won't know what you're talking about or what you're thinking about. They'll just think you're plumb crazy.

Another thing is, this man's too realistic; let's be practical. That often comes up. They're both killers. Another thought, "I'm not enough of a stargazer and a dreamer to take part in this." "The idea, suggesting the thing be made out of wood, or make it out of glass or make it out of some silly thing." That's right; they'll say that; they'll mean it; they don't know any better. But they're wrong and we'll prove it time and time again and the Creative Engineering Department will prove it. Another thing they say is, "Let's not waste this time." I think that gives you the tone of the whole thing. You can know you're doing something that isn't often done. It's a new technique, relatively new; the Creative Engineering Program - some of our top engineering, our top management have been doing it but they haven't formalized it very well until the Creative Program came along under Mr. Winne's group a few years ago.

Let's take an example. I'll make an exception this time and name the product - usually we don't name the product because we want to be able to send copies of this out without ever any one person thinking that his past is going to embarrass him -- but in this case this is the oil burner control, the flame detector. It has a quartz member about 6 inches long and 1/4 inch in diameter; a rod that extends into the firepot. Its job is to cut off the flame, cut off the oil if the flame stops, or cut it off if the flame doesn't come on. It works swell. Here it is, 6 inches long, a rod of quartz. It costs 32¢. Now that's a very competitive field so in analyzing that part, here it is; let's have a session on it, let's decide what we can do. A top technique - we'll soon get to it, as you know - is to get specialists there. Where'll we get the specialists? Well, in this case quartz comes from the G.E. Lamp Department in Cleveland, about 90% of it in this country. So we have two of them, the chief engineer and the sales manager, and we started looking at it; here's what we have to do; here's what it is. Here's what it costs. How can we do that job for less cost? We sat in that meeting - we had in addition to them the engineer of the product and one or two value analysts. We were in there three hours. During that time: what could do it? Well, we could give you a smaller diameter, 1/8 inch. Maybe we can make it out of stainless steel that has high expansion; maybe we can make it of a ceramic

that has high expansion; maybe we ought to use a bimetal to do the job. But most of our time we concentrated on how to do it with quartz. We threw out the idea of a smaller diameter. After the creative we came to an analytical session; then we threw it out because it would make it more fragile; that would be quality deterioration. Finally, at the end of three hours, the engineer from Cleveland said, "Well, instead of a 1/4 inch rod, why don't you use a 1/4 inch quartz tube?" Well, we looked at it and the little hole inside of a 1/4 inch quartz tube is not much over 1/16 inch in diameter and you couldn't save much quartz and you have all the trouble of handling the mandrel and having warpage and all. So, one of the fellows spoke up - and it was probably me - "Well, for heaven's sake, we would expect it to cost a lot more for 1/4 inch quartz tube than a rod." "Well," he said, "that's because you don't know the quartz business." "Fine. What would it cost for the tube?" "Instead of 32¢ it would cost 21¢." Took 30% out of the cost; there was only a 3-lb. load on it, tolerances were the same, material was the same, operation was the same, but it took three hours of battling and if we had stopped 5 minutes short of that we wouldn't have had the answer, and the answer is just that simple when you get it. Fitting on the top of that quartz was an assembly that took the mechanical motion that cost 17¢ for the time it was cemented onto the quartz rod. Now with the quartz tube they merely made one simple part like a nail with the head in the center and they stick that thing in the tube and the point sticks up into the relay and that costs 2¢ - went from 17¢ to 2¢. Beautiful and simple thing and all this was unlocked by just the simplest kind of a thought that we could have had any time.

There's one more step to it: it illustrates maybe a different study. In the same study then the question was, "Why not use glass?" Most of you know probably what I think - it is vicor glass? - the Corning Company reasoned that since quartz is all silica and glass is 90% or 95% silica, if they pulverized glass and then treat that powder progressively with chemicals and solvents that would dissolve out all the impurities they can't have anything left but powdered silica; push it back together, melt it up and we've got man-made quartz. By gosh, it really works, so they do it now and they make lots of things of it. Samples came in that way; we didn't they'd work; they'd be quality deteriorations. The engineers put them on test; about 7 or 8 months after this work was done they called up and they said, "Get us an up-to-date deal on that. There's no test we can make where that doesn't show up just exactly the same as quartz." "What does it cost?" From 32 it went to 21 and the glass was 16.

The next step occurred about six months later. They called up and they said, "We want to take the quartz off of the approved drawings so that you have to use vicor." "Wait a minute, wait a minute. If quartz does the job, let's leave it on there. We might want to use it some time and then we'll buy the most economical thing." "No," they said, "We've found that the glass comes to so

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much closer tolerances that we save a lot of money elsewhere by using it so we won't use quartz any more. We want it restricted to glass."

I think I've said enough about that. Use it on your project.

Quickly spike anybody who does the opposite here; learn to think together; three fellows thinking exactly the same thing at exactly the same time.

The second phase of our chat this morning is on the subject of "Blast, Don't pick", and fellows, I really mean it. Everybody has been picking so the picking is pretty well done. Don't pick; you don't have to pick. I don't think more than one person in a hundred is courageous enough to blast. So the blasting has not been done; the blasting is wide open. Opportunities to take out half the cost, a third of the cost, three-fourths of the cost - it's lots easier to do it than to take out 10% in many cases. You'll use different techniques and you'll get far better results. We want value analysts to be courageous enough to blast, not pick. I'm going to show you some examples of it.

For example, on one of our jobs they used a brass elbow in large quantities. This elbow had a fine constriction in it; it cost 11¢. Another vendor who was also a specialist in that line was invited in. Where the former one was made of two parts, this vendor was asked if he wasn't ingenious enough to design it in one, and perhaps come up with a better commercial proposition. He liked the project. The engineers came and studied it, took it back to Chicago and were gone three weeks on this and another part or two; came back and said they had it. They showed us a sketch made of one part. Fine. "What does it cost?" "11-1/2¢". We had started with 11¢ but of course, they didn't know that. "No, it's no good. No good." Well, we chatted a little, they got up, picked up their papers and started to walk out. One of the value analysts remembering this blast thing said, "NO, wait a minute. You now know everything that brass fitting has to do. You know all about it, and still you're walking away. You're just now in a position to do something about it, to make a contribution." "Well," he said, "we've done all we can." What would you do if your boss told you "You're fired unless you can sell that for one-third to one-half of what it is now - that is, one-third off, a half to two-thirds of what it is now. Well, he said, "I couldn't do it." Then he started to think. He said, "I couldn't do it unless I could make it straight. If instead of an elbow we made it straight, that would be beautiful. It would fall off of an automatic screw machine." Well, what would it cost?" Looked it up - 4-1/2¢. "All right. Let's go see where it is used. Go in and look where it's used and it's on the side of a liquid receiver; is 2-1/2 inches out to the nearest position that a motor could ever get and all that ever fastens onto it is a 1/8 inch copper capillary that goes to an instrument. The finest thing in the world to take a bend in. So by blasting that guy, really clubbing him, we made him take a piece of business

and took out about 60% of the cost and performing the same function. I don't think there's an engineer who wouldn't have put the elbow in there. I would have put it in if I were the designer; just natural, without thinking.

Now, there are a few examples that have come up recently from some of our products. Here was a timer; this goes back into the work that Mark was doing some time ago; when the range timer was analyzed here were little gears and pinions and a large flat gear and then a small gear - I don't know what you call them, pinion in the center -- little assemblies costing 32¢, but by using blasting techniques we're going to get it for a third; that's the kind of a goal we ought to set. The Greis Reproducer, who were here, make it and their cost is 6¢ instead of 32¢, as a diecasting. It's interesting, of course, after Mark and some of these engineers investigated that they put these things into effect and they do the job just the same as the others.

There was a case of a grommet on one of our products costing \$7.20 per 1000. By a little ingenuity and jigging they could use a piece of rubber tubing to do the same job for \$3.70 - half the cost.

A permanent magnet used in a relay, a bimetal device; permanent magnet costing 8¢ apiece; quantity 500,000 a year. "Let's cut the cost in half." "Oh, you can't do it. You have to buy that at G.E. and you know what permanent magnets cost." "Well, can't you get the detailed costs?" You find that another department has learned to buy the magnet unmagnetized, bring them over and magnetize them right on the line, eliminate face grinding, because this kind of an application didn't need it. By doing that here the cost goes from 8-1/10¢ apiece to 4-1/2¢ apiece - \$25,000 with the same performance. Let's blast on these things we look at. We don't want to refine them. Rivets: here are a bunch of rivets, solid rivets, being used; cost \$8.00. Eyelets put the job together just as well, cost \$1.20, that is, per 1000. Here's an interesting case. One of our products has a small stamping, it's about half the size of my hand. It is so designed that one end can just as well be opposite in shape of the other end. They did have a tool that made them with trim all the way around in the conventional manner. A blasting study of this showed that by making the tool just exactly the size and shape of the part we wanted, we could move the material twice as far as we wanted each time. The tool comes down and blanks one out; we get a good piece here and a good piece underneath it. We have no waste; we get two stampings with every operation of the press. The cost went from 11¢ apiece to 2¢ apiece for the identical part, and that was a big volume part, again.

Here is an example of a cover used on some of our apparatus equipment, and I want to read just one paragraph from the report. Incidentally, the suggested change is from \$4.19 each to \$1.75 each. Here's one paragraph: "A discussion with the Services Engineer has revealed the fact that the observation of the stabilizing rheostat is not necessary. Apparently, its observation will not aid the service man in diagnosing minor troubles. For major

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repair the cover is always removed, anyway. On this basis it is suggested that the windows showing the rheostat be taken out." Cost cut to less than half. We're looking at a gasket costing 23¢. By setting a target and then going after its purchase instead of for 23¢ for 2-4/10¢ of the proper supplier -- one-tenth the cost.

Fellows, as we go through all of these studies I'm going to have examples by the hundreds from our actual products. All of these will be available for your peruse if you wish to

We're looking here at a bottom flange which is about 6 inches in diameter and maybe 10 inches long. It goes on one of our products in quantities of 100,000 a year. It costs \$2.55. But by bringing in a diecasting specialist we find that weight which is not working can be taken off and it can be purchased for \$1.45 instead of \$2.55. There is labor on it so that the overall -- wait a minute; the \$2.55 is the cost with some labor. By the time we get the labor on the new one it's \$2.00. So there is actually a cost difference of about 55¢, \$46,900, and the same performance. In other words, the cost cut in half again. That's what we want in all these things.

Here's a rather simple one. One of our high product parts - 100,000 a year. It's very much like about a 8-penny nail but it has a head in the center and it's threaded on both ends. It's made as a screw machine part and it's a little tricky. By going to one of our best upsetters and giving him the problem, he makes one that does the job perfectly and instead of \$67.00 per 1000 it costs \$3.25 per 1000. Same performances exactly for 5-1/2%.

One more example, another stud about 3 inches long made from 1/4" hex stock, threaded on both ends, and a little cutting in the middle. 200,000 a year - this is all current work within the last year - \$82.00 per 1000. But the part I just spoke about which is used on the same job and a rolled spacer can be used together making an even simpler assembly so that the cost becomes instead of \$82.00 per 1000, \$8.00 per 1000. 10% of the cost; identical performance -- in this case \$14,000 saving a year.

*And 7
start 8*

I want to tell you about this interlock that I have here. This interlock is used in conjunction with a contactor so that a number of circuits are interlocked on a diesel electric locomotive. I have here only the finger block and the contact fingers, 7 of them, and this interlock you can see these fingers here; have a little cam surface on them at this point. This interlock is operating by mating cam locks that move back and forth in this fashion. This interlock originally cost \$6.92. So, it was one of the first things that I started to work on when I came up to Schenectady for training under Larry. I worked on it a while; he didn't tell me what to do. I worked on it in the same manner in which I was accustomed to doing ordinary cost reduction in Erie Works. This interlock, by the way, had been gone over by the Engineering Department, by the

methods people, the planning people - everybody. They said, "This is it. No more changes contemplated; we've got everything out of it." So, not knowing anything about interlocks I had this on my desk and worked on it for a week or so, and you know, I was convinced after that length of time, even though I didn't know anything about it, and still don't, I was convinced that, by gosh, the engineers made that thing and did a pretty good job. But I worked at it - I didn't want to let the engineers beat me, and I changed one of the screws, and I fiddled around here and there and saved a few pennies. About that time a fellow came around by the name of Larry Miles and he said, "How are you going?" Well, I wanted to make him at least think that I was working. I said, "Pretty good." He said, "What have you done?" So I told him, and he said, "No, no, no!" Well, that was a heck of a way to treat a guest, I thought. I was about ready to go home. So, I sat there getting angrier by the minute. He finally said, "What is this thing you're working on?" I thought that that was a stupid question. He knew that this confounded thing was an interlock, just as well as I did. I sat there for a while and then I said, "Why, an interlock, of course." He said, "oh, no, no, no!" Well, I was even more angry, and if I could have gotten a train I'd have probably gone home at that time. he said, "What is this thing, basically?" I thought, well, what is an interlock? Well, the only thing I could think of was that the darned thing was a switch. I told him it was a switch. He said, "Very good. And what does a switch do?" By heck, I was an electrical engineer but when I stopped to try to figure out what a switch did I had a hard job. I stumbled around and muttered in my beard and finally said, "Why it breaks volts and amps. What a stupid answer." He said, "How many volts and amperes?" Well, I had that information, so I told him. He said, "Now, if you didn't know anything about this job and you wanted to buy a switch and somebody said 'Go buy a switch to break so many volts and amps,' what would you do?" "Well," I said, "I'd go to the nearest hardware store, naturally." He said, "What would you buy?" I said, "Well, buy a wall switch." He said, "How much would it cost?" "35¢." "Well," he said, "you're going to buy quite a quantity of those things and you could probably get them for a quarter." "Yes," I said, "that's probably true." He said, "How many of those things do you need?" I said, "Seven", because I had seven contact fingers on here. He said, "Seven times a quarter is \$1.75. Now, you have to have something to operate these switch handles, you have to have a base to mount them on." He said, "You couldn't visualize making that operating handle and the base for less than a quarter, could you?" I said, "No." He said, "All right, there's your interlock - 7 wall switches, an operating handle and a base," and boys, this is where I had him, because I was an electrical engineer and I knew gosh darned good and well that that wouldn't work. So I said, "Yeah, that's fine, but it won't work." About that time he got up and he patted me on the back and he said, "That's great. You've got an interlock here - \$6.92." He said, "you've got your wall switches, \$1.75 for the switches, 25¢ for the mounting and the operating handle - \$2.00. \$6.92 versus \$2.00 but the \$2.00 one won't work," and he slapped

me on the back and got up and walked away. Well, I sat there for a while. Finally I said, "By golly, I'm not going to let that rascal run over me like that." And as I sat there I began to wonder what I could do. So I searched everywhere; I became an expert on switches overnight. I looked in every blooming catalog and everywhere else. Finally, I came up with a switch - the thing looked a little bit like this, at least it's got 7 contact fingers. A little bit of a bunch of stuff; pretty much a bunch of junk, and I looked at this for a while and said to myself, "Do I have courage enough to present this thing to the engineer and say that this is going to do the job that this thing did?" Well, I didn't have courage enough; I probably should have. But I sat there, I guess, for another two hours and finally it dawned on me, "By gosh, I wonder what the score is here. Here's something that I'm afraid won't work but I don't know that it won't work. I knew that Larry's wall switches wouldn't work; at least in my opinion I thought they wouldn't; but maybe I was wrong. But here was something I didn't know. I didn't know whether the thing would do the job or not but I was afraid it wouldn't. But this thing only cost \$2.80. I thought, "Gee, whiz. Why the difference?" Well, I looked at this and the obvious thing was that there was not much material on the base on this gadget. How about this other one? Quite a lot of material, and so I visioned a cam to operate these contact fingers and, heck, I wouldn't dare put a great big cam up here, as big as this finger block, would I, because it would look silly. So I visioned a little bit of a cam and I took a look at the other cam for this thing and it was a nice big thing that matched this thing perfectly; it looked beautiful. Why not take some material out of it? Well, I talked that over with the engineer and probably made another mistake - I know I did. I said, "Why don't we take some material out of here?" That was the wrong kind of question to ask. "Well," he said, "fortunately, it sounds like a good idea; I don't know why I didn't think of that myself." He said, "I can tell you one thing: if you take material out of there you'll never liquidate the die charge, because they'll have to change the die." "Well," I said, "let's find out." "Well, go ahead if you want to, but you're wasting your time." So I found out. Die charge was \$25.00 - could liquidate it in a week. So, we went on and worked on the contact fingers. Why could I work on it now when I couldn't before? Well, I've gotten started with some doggoned old wall switches that wouldn't work, or this thing that I didn't know whether it would work or not. I had a new approach. I don't care what you call it - you can call it a functional approach - because I started clear back with a switch: what does it have to do? Forget about this darned thing! Now, all this time I had in the back of my mind - and I think the real reason I couldn't get started was because I had this switch in front of me and I knew doggone good and well that I had cut the price of this interlock in half, or in order to overcome the objection of interchangeability -- on all this locomotive stuff they're sticklers; everything has to be interchangeable; every change you make. If you can cut the cost of a device in half, well, then somebody might

consider changing it and making a new form. But here I started out with this gimmick which certainly isn't interchangeable, and I keep looking at the two, first one and then the other -- a new line of thinking; that's all.

Well, when I finally wound up, this interlock which costs \$6.92 we had suggestions how to make it for \$4.65, and I also had another suggestion which was not interchangeable that I was pretty sure would work for \$3.65. Well, engineering department looked at that. Well, fine, but in one case in order to get a lower price on a molded part we had to go to a different vendor. Our present vendor wouldn't let us have the die to mold so we had to buy new molds \$2000. We could liquidate the tools, all right, but the way we wanted to change this thing in order to get the better price -- the other vendor wouldn't give us the better price even though we did change it -- the way we wanted to change this thing made this finger block not interchangeable with another application and the engineers said, "No, sir, by golly; we're going to hold that thing up. We're not going to spend the \$2000 because we want that finger block to be interchangeable with another block." This other job, incidentally, wasn't in production, either. They didn't know whether it ever would be or not.

Now, fortunately, we didn't have to follow this thing up. Somebody else kept heckling. "Here's some money that can be saved, why don't we get this tool order signed for \$2000?" The engineers kept objecting. Finally, pressure was brought to bear and the three engineers who objected sat down with their pencils - and this shows that it can be done - they had gone over this thing before. They started with the suggestion, and when they finished they have now an interlock which is going to cost about \$3.75 instead of my \$4.65 and the darned thing is still interchangeable.

Now: Why didn't they do that before? Why didn't I get onto this approach before? Well, Larry couldn't pull my hairs so he kicked my shins, patted me on the back, did everything else. I started out with a wall switch because he made me. I didn't do one doggone thing, actually. Larry says, "A switch, what does it do?" I'd like you to ask yourselves the same question on your parts. Don't look at this thing in front of you until you convince yourself, "By golly, this is the way to do it." I don't care if you have to go downtown and go to a hardware store or any place else. Try to find a different approach. What the Sam Hill do you have to do? I don't care where you look or what the rules of the game are when you're in this creative stage. What you're after is a different idea. If you sit here and look at this gimmick and study it and think only how can I change this, you're liable to be right back in the same rut that everybody else's in and maybe you'll wind up not making any money out of it, either. Go beyond the thing that you have in front of you. Ask yourself, "What does it do and what could I make to do the job or what could I buy to do the job?" And at this stage of the game we don't care whether you're going to use this thing or not; that's not important. Get all the ideas you can and when you've got them all, you've thought about them a

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couple of days, then decide what you're going to use. Today that's my story.

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L.D. Miles:

Fellows, we realize that we have been talking about principles and methods and techniques and individual parts, so we're going to take some quickies throughout the program and show you just how a whole product falls apart; with the blasting and creative approach.

This control is made in quantities of 2-1/2 million and it's made the best way we know how to make it. Engineers have designed it, have worked over every phase; the quality control people, purchasing people, manufacturing people, and this is it, but the box office closes out, as I told you the other day. We couldn't sell them - Philco, Norge, the others buy elsewhere; only Erie continued to use them for reasons that you bellows can suspect. It's a good control. -- I see I got a smile out of Burr on that. I suspect he's been over a barrel and had to use them, that's probably why. -- It's a doggone good control. Now, we're going to see some things that are going to look simple, but please, let's move back a few years when we didn't know any of these things. This was the top thinking of General Electric Company. Let's look at it. First, the phos-bronze wire which holds on the cover about which I told you briefly - \$7000 a year - and what does it do? It holds the cover in a static position for 25 years. Phos-bronze - that's 70¢ a pound. No! Never! It's capable of millions of flexings. Spring brass, a dozen other materials, for almost half the cost. Works out about \$3000 worth of either spring brass or some other material will do it. Half the cost and hold the cover on just as well. That's the first part. Second, here's a nice little plastic cover. G.E. makes it; costs - \$40,000 for a million of them - what's it worth? "Can't buy it for less than that; we've tried the market and evaluated it. \$40,000 worth of what? Well, it's \$40,000 worth of keeping the butter out of the control, that's what it amounts to. That's what we get for it. All right, now function is two things: something to make this work better or sell better. We could keep that butter out for less money but wouldn't cut down the sale of refrigerators? And there we can think pretty clearly, because a woman never sees anything but the front of it when she buys a refrigerator. So this, then, should be a functional cover in our judgment, and all of us are going to use our judgment freely on all these things.

All right, we're going to make a functional cover. Let's take a piece of flat laminated textolite and run it through a press; stamp the holes in it like this has to let the moisture run out. What does it cost? Not 4¢ apiece. Make it of the same odorless material and it costs 1-1/2¢ apiece. Goes from \$40,000 to \$15,000 a year. \$25,000 worth of cust out. No change in performance. On the outside case - 31¢ apiece -- \$310,000 a year; made in our own plant; several big machines used full-time on it. I'm going to tell you the story of that a little later on, but just the results now. That went from \$310,000 down to \$240,000. \$70,000 a year out on that.

I told you about this little tubing yeaterday; originally the tubing had a larger end which was brazed together, costing \$50,000. Then it went to a large tubing all the way with a swaged small end which cost \$5000 a year, instead of \$50,000, so \$45,000 then came out. Then the engineers, running a series of tests, found that they had improved the device and the gas in it so much recently that it actually performs just the same having a capillary all the way as having a big end on it on most of our models. So they went further to the capillary, taking out another \$5000. The result is where this did cost \$100,000 for the copper and the brazing, now it costs \$50,000 and that's the way you use it. Looking inside we have a spring here - I'll show you in detail some time, because I have a slide on this whole little assembly - spring costing \$11,000; that went to \$3000; this large spring cost \$26,000 a year; that went to \$9000; the phosphor bronze spring costing \$15,000 a year went to stainless steel at \$9000 and made a better product. Phosphor bronze creeps for about three years, so you'll notice that your wife will be turning her refrigerator just a little as time progresses to keep the same temperature. This will be static right from the start. Costs \$9000 instead of \$15,000. Contacts in there could be provided for just half the cost with the same amount of silver and of the same material. The bracket, instead of \$13.00 per 1000, \$2.63 per 1000, and there are a lot of other parts which I won't want to use to illustrate particular approaches so I won't tell you any more about it now. But that's the way an entire product will break down under a blasting attack instead of a picking attack.

One of our basic operating plans is never to make any figures on overall reductions, so I just want to take this opportunity to drive that point home. We have never added them up. Of course, value analysis is bound to be a staff operation, because there is a buyer, there is an engineer, there is a manufacturing man, so anything we do should never be put together in some big figures that will alienate and embarrass them. I don't know how much it would amount to.

Here's Bill Small of the Creative Engineering Program to give us a talk on the Creative Approach.

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First I'd like to talk about the word "creative". What does it mean? This is a highly controversial subject. There have been a lot of articles written on it. There have been a lot of discussions on the subject, and there have been some good, hot arguments on the subject. Some people believe that people are born with creativeness. Some people believe that it can be developed. There are some other people, such as Mr. C. F. Kettering, who is one of the outstanding inventors for General Motors - who says a creative guy is simply one who doesn't take his education too seriously. It runs the gamut. We all know, though, that creativeness applies to all walks of life. Musicians use it in writing new works of music. Artists use it in new paintings. Writers use it

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in creating new novels. Lawyers use it in establishing a case for their clients. Military men use it in outmaneuvering the enemy. Engineers use it in creating new devices. It doesn't apply to just one select group of people - it's used everywhere.

In the Creative Engineering Program we believe that to be successful in creative work the individual must possess a number of qualities. The first one is an active and an inquisitive mind. This means that you should observe all that goes on around you. For instance, valves that are on the steam radiators. Why do those things let the air out and not the steam? In fluorescent lamps the little fluorescent starter is an extremely interesting little device. How many of you know how that thing works? Things that you see every day that you just take for granted. All of us use the little boy's room here a number of times a day. Do you just walk in, pull down the zipper, hit the handle and walk off? Or have you wondered how that valve works? It's an extremely interesting device. How would you design it if some one were to ask you how to design such a thing? Take the automobile, for instance. How about the voltage regulator? That works over an extreme range yet maintains voltage within close limits. How about the gas gage? There are all different types of systems used in automobiles to indicate the level of the fuel. How about the little turn signal indicator? Why does it make the light flash? The automobile is just loaded with such devices that are extremely ingenious things and we can sure learn a lot if we just have enough inquisitiveness to look at the things we use every day and just take for granted.

Inquisitiveness, we believe, leads to creativeness, because if you've got enough curiosity to operate on the thing to find out how it works by the time you figure out how it works you're going to be asking questions. Why did they make it this way? Why didn't they do this, or why didn't they do something else? And as soon as you start making suggestions, then you're starting to be creative.

Second quality you should exhibit is a constructive discontent. All that means is that you should see a need for yourself. To take some more simple examples, how about the guy that came up with the baby bottle warmer that you could plug into the cigarette lighter in the car? That was an excellent idea and they sold a powerful lot of them. There are much simpler things than that. How about the curb finder? The guy that had the idea to wrap a few turns on a piece of wire and put it on a fender and put it on the right side so that it made a racket when you hit the curb. They sold a powerful lot of those things - it was just an idea that paid off.

How about the bug deflectors that you put on the hood of your automobile? I was sucker enough to buy one. Don't know if they work or not. Actually, the number of bugs that hit it at least don't hit the windshield.

To get a little closer to home, how about the fellow who came up with the idea for the Shelvador refrigerator? Using the door to store eggs and bottles, etc.? They have forced competition to follow suit.

Again, a little closer to home, we were pretty much on the ball with the butter conditioner. Everybody else is following suit. In other words, see a need for ourselves.

Also in this same category, you've all heard the expression that "Necessity is the mother of invention". I was listening to the radio the other night. They were explaining how some of the things were brought about in the early days in the middle west. For instance, the Indians with their bows and arrows had a lot more fire power than the settlers did. It didn't take the Indians long to find out after the white man had fired his one shot he was done so the Indians circled them until everybody had fired their one shot and then they moved in. A bright young fellow by the name of Colt decided to make a six-shooter to increase their own fire power. Also, about the same time, cattlemen and farmers were having a little feud. Back east where there was a lot of timber they could make rail fences to confine cattle but out in the prairie states where there was no timber they couldn't conceive any way to fence in the cattle. Some bright fellow came up with barbed wire. In that same period, cattlemen recognized that they needed water for their cattle. There was plenty of prairie grass, plenty of food, but they needed water. They didn't have any easy way to get water. There were no streams or lakes. They were not nearly so plentiful as they are back here. They decided to harness wind to make windmills because there was plenty of wind out there.

What it boils down to, then, is to recognize the need. Don't wait for necessity. If necessity does present itself, do something about it. This brings us into the next step: an inner drive to get a job done.

Once something is started, finish it. Because you run up against obstacles, this doesn't mean that it can't be solved. Stick with it and you will solve it. To quote Kettering again, he said "one of his most difficult things to do when he gets a new fellow is to teach a fellow to fail intelligently." When something fails, analyze it. Why did it fail? What's wrong with it? How else can I do it? Just because a thing fails, don't give up the ship. Try again. Kettering also says that another difficulty he has with young fellows, educated fellows in particular, is that they have a natural tendency when they get a problem to run for the textbook, turn to such and such a page and prove that it says right there on page 284 that it can't be done. Well, this is one of the things that we in C.E.P. try to discourage; leave the textbooks alone. It's a new problem, chances are. A different way is needed to do it. If it was written up in textbooks, the solution would be obvious.

The next quality that you need is a background of fundamental knowledge. Now, this, you get in college. You gain experience while on the job. It includes mathematics; the physical laws;

new or unusual devices. How does it work? Just common things that you see every day. You know the how of a particular device. You know the problems with it. You know the limitations of it. A lot of times things can be combined, different things can be combined forming a new device. New materials and processes. A lot of problems have existed for a long time because they didn't have a particular material that would answer the problem. Maybe this new material that comes out will answer the problem perfectly, and you can go back and revise the old system and do it an entirely different way.

The next thing is an approach to any problem. This is nothing more than deliberate and organized thinking. You might call it an organized approach; you might call it a logical approach. All people are different. All people think differently. They all do things differently. Therefore, we say that a fellow should develop his own approach practice his own approach. The important thing is that you develop one, and try one. You can observe the approaches of other people. Our fellows get a wealth of experience by taking a lot of rotating assignments, working with entirely different people every three months. They get a chance to try their own and to try other people's approaches. You can do the same thing.

So let us now take the other word, "approach". This is not the only approach. This is the one that is recommended and the one that is used in the Creative Engineering Program. Our first step is to define the problem. This sounds like - "shucks, we all know that. You don't have to tell us to define the problem." It's amazing the number of people who don't define their problems, really define it. Pay particular attention to the specifications that are written. Why are the specs written the way they are? Why is this particular spec written into the contract? Question each one and know the reason for it. Why is it a problem? What you might try to do some time, if you think you have the problem defined is try to explain it to somebody who knows nothing about the problem. It will become obvious how many questions he asks you that you can't answer.

To give you an example, we get a lot of problems from divisions to be used as homework problems in the Creative Engineering Program. Time after time we get problems from divisions and we thrash around in the office trying to decide among ourselves, what are these people talking about, what do they want? So we write letters back and forth and ask questions. We had one case one time where we got a problem. We had some questions. The letters that came back didn't look anything like the first ones, and we really got confused. We wrote some more letters. The more letter-writing we did, the more confused we got. Finally as a class problem we duplicated all of the correspondence that had taken place in this particular transaction and handed it out to the fellows and said, "This is the problem, fellows. Figure it out yourselves."

So don't think it's an over-statement - if a problem is well defined the answer sometimes becomes obvious. It no longer is a problem once you find out why the problem existed in the first place.

Our next step in our suggested approach is search for methods. This is probably the most important part of anybody's approach. It's the part that most of the people bypass completely. There are many techniques that will help you in this search for methods phase. One of the most popular ones and most successful ones that we have found in C.E.P. is based on a book written by Alex F. Osborn. The name of it is "Your Creative Power". I suggest that you get it and read it. It's interesting reading. Your wife will even take it away from you and read it. Again I repeat, the author is Alex F. Osborn - I believe Scribner is the publisher. In this particular book Osborn invents a technique. He calls it the "brainstorm session". That's just what it is. Osborn says that every man's mind is made up of two parts: the judicial part and the creative part. The judicial part is the one that judges, is the one that squelches the creative part of the mind. It's the one that says that it's impossible and that it's been done before, it can't be done; it's ridiculous. The creative mind is the one that let's you wander off into the far blue yonder; let's you build castles in the sky. It's the one that works while you're relaxing. Sometimes, you can imagine all sorts of things. Osborn says - and he uses the technique - that when he comes across a particular problem he shuts off his judicial mind and uses the creative mind. Osborn is an advertising man. When he needs a particular line or a particular gimmick he goes into his office, closes the doors, puts his feet up on the desk, takes a pad and paper and a pencil and writes down every single thing that comes to mind, with his judicial mind shut off.

Regardless of how ridiculous it is or fantastic it is, he writes it down. He comes across an idea or a particular idea flashes across his mind. "Ten men on a dead man's chest". Will he write this down just to get it off his mind? He says, "Some day I'm going to find a use for that line and it'll not bother me any more."

This brainstorm session technique is becoming more and more popular. More and more divisions in the Company are using it to great advantage. To give you an example, we received a problem from Transformers in Pittsfield. One of the tests their transformers have to undergo is a certain rainfall without flashing over. They have sprinklers up over the top of the transformers. They adjust some valves, etc., and then stick a cup under this rainfall to find out whether or not this is the proper rainfall. In other words, it takes some time to fill the cup up. It fills up in a certain length of time and this is the certain rainfall. Well, they have to adjust valves and fiddle around for a long time.

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The way it happened was this: we received the problem and a number of us were talking about the thing near the secretary's desk. We were having little unconscious brainstorm sessions, talking about it. The secretary popped up and said, "Well, why don't you count the drops?" Well, gee, the rest of us looked at each other and sort of snickered. You could imagine all sorts of things here. Lo and behold, one fellow popped up and said, "Well, now, that's not such a dumb idea. How about taking a piece of blotter paper and impregnating it with an electrolyte. When the blotter is wet it will conduct and measure resistance of it. Let's put a heater underneath it so that we can plug heat into it to dry out the blotter paper and then calibrate a meter depending on how much heat is put in to hold constant resistance, or some such arrangement. From that one suggestion we launched off onto a whole flock of new possibilities, ideas that could be used. Some were impractical, sure, but they were possibilities. So, just sometimes one innocent remark will spark in somebody else a whole new idea that takes you down a whole new train of thought, quite different.

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Well, this is one good technique, the brainstorm session. You can have a powerful lot of fun doing it. You can have bull sessions all the time. Put it to good use. Call people in, took, that know nothing about your particular problem. A fellow that doesn't know anything about your problem and isn't too closely connected with your work sometimes doesn't know what he can't do. He comes up with some ideas that may have possibilities. This happened, I understand, a while back in Pittsfield where they were hunting for a particular way to mount something. It was a bracket problem. They called some people in that knew nothing about brackets on transformers. As I understand it a draftsman suggested an idea that was obvious. "Why didn't we think of this a long time ago?" It was adopted.

Another good technique to use in this search for method phase is to keep a notebook with nothing but ideas in it. You're walking down the street and get an idea. Put it on a piece of paper and put it in your idea notebook later. Any place you may be, they will come to you in moments of relaxation. Eastman calls this "illumination". This is another philosophy on the subject of creativeness. He says that when a problem is well defined and you have it in mind you are unconsciously on the lookout for ideas. This is true. The example that Eastman gives is James Watt walking through a forest one Sunday afternoon when he suddenly got the idea of adding a condenser to the Newcomb steam engine. He had been working for years trying to improve the efficiency of the steam engine; couldn't find a way to reduce back pressure. While walking through the woods he got the idea for adding the condenser.

Another useful way to get ideas in this search for method phase is to turn to the back of a good physics book and look for all the laws and effects, the Curie effect, the Thomson effect, the Hall effect. These are all extremely fertile grounds for coming up with new ideas. There are a lot of laws and effects

in there that they haven't found a good use for, and they offer some extremely interesting possibilities. I know a number of people in the Company who are in development that when they get a problem that's what they do. They reach for a good physics book and start thumbing, looking through the laws and effects, to find "Is this a possibility?" In West Lynn Mr. Hanson, Meter & Instrument Division, has cards with every law and effect that he has ever heard about. I think there are over a hundred. He sits and takes the cards and starts thumbing through them. Are these possibilities? If a problem is extremely complicated, take it step by step, break it down into parts, and by so doing you can break it down into input and output. For instance, say you want to measure amplitude displacement. Measure it with a strain gage, you'll get an electrical signal; or a displacement gage, you'll get an electrical signal. Maybe you can use another means whereby you'll get a pressure, hydraulic pressure, air pressure, or vacuum. Maybe you'll get again, linear motion; maybe you'll operate a cam; maybe you'll operate a rack -- and so forth. Now, then, with all the electrical signals, you might get displacement, pressure, air or hydraulic. You have a whole new set of inputs for your next block and there, again, you can get a whole flock of outputs. In other words, what you're doing is multiplying all your possible ideas. Just squaring them, you can get many ideas - possible ways to do this. I understand this is done in refrigerators in Erie. They're talking about a particular problem. They'll write down all the ideas about one axis, all the ideas along another axis, and then they try to combine them. They prove to themselves that, if anybody later on ever comes up with an idea, they can prove to them they at least considered it.

If you're working on a particular problem and you find all your solutions are falling into a mechanical vein, say to yourself "Why don't we do this electrically, electromechanically, chemically? How about using permanent magnets? How about using glass? How about using rubber? How about using silicon putty?" There, again, you have launched off into brand new fields.

To give you an example that proves there are a lot of different ways to do things. In C.E.P. problems are given to the fellows as homework. They go home and work on this problem. They have nightmares over it. They dream about it, and they'll eventually settle on one solution that they think is the best way to do this. Now, the mechanical guy will come up with a mechanical solution, invariably. The electrical guy will come up with an electrical solution. The electronic bird, the one that's got tubes sticking out of his ears, will come up with an electronic solution. As far as they're concerned, this is the way to do it. In class we ask the fellows to give us a 5-minute quickie, to present the ideas of their reports. They put their ideas on the board. If there are 20 people in the class, there are 20 different solutions, which proves that there are more than one way to do a job.

In second year our homework is in group activity; three or four fellows work on one problem, collectively. Here a while back

we had a problem from A&OS. They wanted an indication of when a shaft was rotating or not - had to do with autopilots. If the shaft is turning, they want an indication. If it's not turning, they want to know it. Well, these three fellows happened to be working on this particular problem. One fellow said, "I'll do it an electrical way." Another said, "I'll do it an electro-mechanical way." One guy said, "I'll do it chemically." How in the world are you going to do this thing chemically?" He started to brainstorm the problem, to get an idea. Suddenly he hit upon the idea of using a mixture of oil and some conductive material. What he eventually came up with was a mixture of silicon oil and graphite. When it's stirred, when this mixture is agitated, electrical resistance is very high. When you stop stirring, the electrical resistance drops. Well, people are still trying to figure out how that works, but it works and it was a good solution.

In C.E.P. we say there are at least eight ways- now granted, this is a number we just pick out of the air because the first idea is easy, the second idea is a little more difficult; the third idea, well, you have to start thinking; the fourth idea, well, that gets tough, and from there on usually you really have to start thinking, and it's these first four ways that are the obvious ones that everybody else has thought of. Get those out of the way. It's the fifth, sixth, seventh and eighth, and so on, that really start paying off. You're really thinking now.

Depending on how much time you want to spend on it, you can find many more solutions. Mr. C. I. Hall, one of the outstanding inventors in the Company in Control, uses this technique. He had a little problem here a while back and his problem was to come up with an appliance timer. I talked to him about that and if I'm not mistaken he had over 70 ways to make an appliance timer. Now, maybe he can think of 70 ways in about the time it takes me to think of 7, but depending on how much time you want to spend on it you can find a number of ways to do it.

The important thing to remember in this search for methods phase is that you don't use judicial thinking. Here you're searching for ideas. You're not selecting, which brings us into the next phase.

Evaluation and selection of solutions. Here, the most important thing is that you look back and does it define the problem, does it answer the problem as you define it? Here is where you go through and use your judicial mind. This is where you factor in the time, the time element, to the degree of perfection that you want. The economics involved - are you building one or is it a mass produced item? Your experience helps you there; the experience of your colleagues helps you there. The consequences of faulty operation such as - does it mean that if it fails it kills somebody, or does it merely mean that some housewife is going to have to go without toast some morning? Here's where you make some simple calculations to determine whether or not you're within a

row of apple carts. You're checking magnitude here. For instance, in the idea that the fellow had for the chemical way of indicating rotation. I'm sure he didn't make up - go to a lathe and turn down a very precise little cup and all kinds of rubber diaphragms, etc.; I'm sure he used a glass beaker, dumped some stuff in it and started stirring with an iron rod, or something like that, to find out if the idea is possible. Look into some of the fantastic ideas that you have and prove whether they will or will not work.

The fourth is the solution. Here, again, you apply some feedback. Does it answer the problem? Oftentimes when you're detailing a particular design you're so wrapped up in the fasteners that you're going to use, whether it's going to be a punched part, a diecast part, a fabricated part - worrying all about the little details that you forget what the problem is. When you find yourself, "Does this answer the problem?" Step back off and take a look. "Is this really what we want?" This is where you make further calculations to get things down in fine shape. This is where you start making tests. If the tests indicate that it's possible, all right. But if tests indicate "Well, if it's a production item I'll not have the little difficulty I have here or here; I didn't quite make this right, etc." - maybe those little things are a clue that when it comes to production you're going to have some trouble. So consider them. One of the things that we tell our fellows is a big word of caution - anybody can come up with something that's extremely complicated; it can be extremely ingenious, but it's not practical. Usually it requires a lot more ingenuity to come up with a simple solution. It's usually the simple ones, the simpler the better, that cost less and are more trouble-free.

Well, all of this is a guide to establish your own approach. People are individuals. Observe techniques of other people. We have provided a spot here to put in your own part of the approach. All I can suggest is that you combine creative philosophy with an organized approach and you'll have a creative approach. Try it.
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The way we handle the problem is this: a particular division has a problem. They need ideas. All they have to do is write to us, give us a brief outline, a brief statement of what the problem is. We will look at it. We have a problem supervisor who does nothing but try to find good problems and decide on problems that we will use for class. Now, naturally, the problems that we can use in a calendar year are limited, but if the problem looks like it could be used for homework, we will ask the division for further information, more details. We try to get the engineer who has the problem to come in and present it to the class so that the fellows get the information as it should be. The fellows can ask questions. The fellows work on these problems as homework. They spend from 15 to 20 hours a week outside of Company time. Coming up with ideas, they write a report, submitting sketches, etc., and explain their solutions. We've got 30 first-year people so that's 30 ideas, 30 reports. These reports then are sent to the division

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who had the problem. They then get the benefit of all the ideas that are in the reports. The only hooker to it is this: to benefit the fellow who wrote the report we would like comments from the engineer as to the practicality of the idea. What's wrong with it. Will it really answer the problem? Why doesn't it? Etc. This fellow is getting a powerful lot of experience, submitting a solution and then finding out what's wrong with it so he'll not make mistakes in the future. That's all there is to it. The reports are then sent back to us, we grade them, and return them back to the members.

Now, in the second-year class we recently got a model shop. In this class instead of merely writing a report we divide the class up into groups of three, four, sometimes five men depending on the complexity of the problem. We assign a problem to a group. Regardless of the technique this gang uses, they can work on it individually or collectively. Within about a 7-week period, depending, again, on how complicated the problem is - it's their responsibility to come up with a model and a report that will demonstrate the solution that they have in mind. Here, the only charges are for parts that are actually used in the construction of the model. There is no engineer's time, no class time. Once in a while we ask the group leader to go out to the divisions to get further information and to discuss the various proposals before they actually start construction so the work is not wasted. In other words, the division should need it. Last year these projects were very successful.

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What is your address?

Creative Engineering Program, Room 231, Building 22,
Schenectady Works.

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It's a two-year program. Actually, it's three because we don't take fellows from Test until they've had about 9 months on Test. It differs from the Advanced Engineering Program in that respect. The Advanced Engineering Program gets fellows while they're still on Test.

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Want to hear what some of the second-year projects were last year? Types of problems? The projects that were used last year in second year - the earthshaking one was a machine which would automatically assemble these new tantalytic capacitors that they're now making in Hudson Falls. It's a tiny thing; it reduces the overall size of Pyranol capacitors tremendously because of the dielectric that you get by virtue of tantalytic oxide you get on the foil itself. Right now these capacitors are hand-assembled. They cost like the very dickens. As I understand it, the Armed Forces are the only ones so far that can afford them. They are applicable because they are extremely small size and will stand very wide temperature ranges, beautiful for aircraft application. Our problem was to take that part, crimp or slip

on a little paper washer on each end, crimp over the end of the wire, spin on a rubber grommet on each end, and slip this whole works into a little case. The fellows worked like troopers in the model shop. They came up with the machine - I'll grant, it's not a finished product. But the machine did work and it demonstrated that they could be assembled automatically. The machine was sent to Hudson Falls and they have been doing some experimenting with it up there.

To give you another example, we've got a problem from Mr. Murphy's group, Equipment Development Works, at the Race Track. Their problem was that in Owensboro the little miniature glass tubes were coming off the line at a high rate of speed. They had a whole flock of girls that did nothing but take tubes and plug them into sockets. They did this to age the tube and also to test it. They wanted a machine which would take the tubes at a random lot, plug it into a socket. One group worked on that and they came up with three separate and distinct ideas. They built three models and turned them over to the Equipment Development Works. They were tickled pink with all three of them and I'm almost certain one of them will be used as it was proposed.

Another project was one for Philadelphia. In one of their delay relays they have on the back side a little motor that's nothing but a coil. It has a shaped armature that goes through this coil. When the coil is energized this little armature pulls in; you get some rotation there which cocks the spring which then sets an escapement to work which gives you the time delay. As I understand it, a small company owns the patent on this little solenoid motor. Philadelphia wanted a way around this thing. They wanted a time delay device that didn't use this particular motor. Our fellows came up with a scheme of using two bellows, one on top of the other. In between the bellows they put a dividing plate and put a bypass valve on it such that if they filled it with alcohol - that when you cocked the bellows you compressed the bottom one, you expanded the top one, you forced the liquid into the top chamber easily and rapidly. But then, to come back down into the bottom bellows they had a metered hole. Depending on the weight which was on the bottom, which was fixed, they wound the coil as an integral part of the bottom of this little mechanism so that when the coil was energized it snapped up, pumped the liquid to the top and the liquid then moved down to the bottom of the bellows. Depending then on how far the bellows moved you'd get a time delay. They put switches on the sides, cut special threads so that a tenth of a turn or one turn gave them a tenth of a second delay, and that sort of thing. Philadelphia was very happy with it. It looks like it has some possibilities. They filled it with alcohol and the design was such that there was no friction in it. The accuracy that these fellows got when testing the particular device was well within the limits that Philadelphia had specified. Does that give you an idea of the second-year projects? Some of the first-year problems?

To give you an example, it's for components in River Works. At any rate, what they want is a throttling means to maintain a certain pressure drop, air drop, across an air-cooled generator. In other words, if you put an air-cooled generator on an airplane, say, a jet airplane, and you used air to cool the generator, if you just let air go sailing on through there at any old rate that happens to present itself, you're losing power. So they want to maintain a certain pressure drop across the generator so that the generator is cooled yet you don't waste energy. This was the first problem that these fellows used this year. I don't know what the outcome is on it yet.

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There are many, many papers on creativeness. A lot of the impressions vary widely. One we use later on in the program is a paper by, I think it's W. H. Easton; I'm not sure. The name of it is "Developing your Creative Power". It's a small paper, it's a reprint. In there he talks - he divides the mental processes up into creative processes; he doesn't call them judicial, but they are the work processes. Under the creative process, tools he calls them, are inspiration, illumination.

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One of our fellows last year as a six-weeks project came up with the idea for an ultrasonic vacuum cleaner; that is, head and nozzle that would clean a rug, a nozzle that would fit the canister or tank-type cleaner. The upright cleaner will clean a rug better than the vacuum-type cleaner because you get some vibration there; the particles are raised up out of the nap and the vacuum carries them away. They needed something to produce vibration at the rug with the canister-type cleaner. He had the idea of using ultrasonics to do this. He built a little dome-shaped affair and put a whistle in it. The vacuum runs the whistle at high enough frequency so that it's not an annoying noise. The shape of the thing was such that it transfers the point source energy to a line of energy that's supposed to meet right at the rug. His preliminary tests indicated that it did improve efficiency. He also has an idea that it might be applied toward coating aluminum wire. Whether or not this can be done, I don't know, but it looks like it has possibilities.

Morning, 4th Day, Oct. 9, 1952 - L. D. Miles

I thought you'd like to know of a little incident that took place a couple of years ago, performed by a young fellow in the Erie Refrigerator Department. This lad was not a full engineer. He'd had only two years training which, in my book, makes a doggone good engineer if he's got ingenuity and creative imagination and knows how to use them and picks experience the hard way. It seems they realized there that the stainless steel trays cost a terrific amount of money. The new hard anodized coatings came out, so the engineering department immediately thought of trying to apply aluminum. They assigned a small engineering group to study it. This group worked on the welding problems, worked with vendors, worked with G. E. technicians. After a considerable period of study, they came to the final meeting and said, "We simply have not been able to work out the problem of welding these shelves so that every shelf will be good." That's a little surprising, but since everything they knew how to do and everything any of us knew how to do had been tried, the engineering management then said "We have no choice but to discontinue the project." This young fellow was not one of the engineers on the team, but he was sitting in. After the decision was made he said, "Well, I don't know whether we ought to drop the thing altogether. Why don't we try to do it like an Indian would do it?" Nothing more was said; I guess he said, "Somebody ought to try to do it like an Indian would do it." A few days later the engineering manager called him in and said, "I heard your remark the other day." He said, "What did you mean?" "Well," he said, "I didn't mean anything special excepting that I know that if an Indian did it he wouldn't weld it because Indians didn't know how to weld. Probably they'd crimp it or something." "Well," he said, "you've got a job." So he worked on the thing. He got in touch with the best experts and suppliers of crimping and automatic machinery and all. It wasn't too long until he was back with a design that had the bugs worked out of it and laid it on the line. They had a meeting. They approved and accepted it. They put it into use. It saved the Company something like 2 million dollars a year. It gave the lad the Manager's Award for the job he did. Also he pulled the thing clear out of absolute death.

Today, we're going to get a lot nearer to the heart of value analysis. It's all I can do in any discussion to wait until we get to this part, because now we're going to be talking about real value analysis. We're down to this. A talk on functions - what it is that we really buy when we spend the Company's money. It's function. What is function? I've had a lot of folks ask me what it is. They say that's double talk. It doesn't have any meaning. Well, let's see if we can't find that out. What we want to find out is what function do we get for what we buy? The pencil, the paper, the piece of steel is just the medium by which we go from money to a function, to an operation. Then what is function?

Function is this. Function is the job or the service that's performed. The function is the holding of the bracket in place; the keeping of the two parts together; the turning of the refrigerator on when the temperature rises too high. We buy a pencil but what we really are buying is something to write. We pay 10¢ for something to write. The best value in electric lamps is the product that gives us the best ratio of cost to light. We don't care about the screw shells, the glass bulbs and all the things that go into it. They are just middlemen. We can dispense with them very nicely. In all value analysis thinking we're thinking basically, "What does it do? What does it really do? And what are we paying for that service?" We've seen switches where all of the working parts of a switch - contact, everything - will cost in the neighborhood of 6¢, and we've got a 12¢ shell on the thing. Now, does it make sense? It certainly doesn't in a market like the industrial market where the shell isn't the thing. The function is the thing. This morning we are going to be thinking function, function, function. What's the purpose of this stand? It's to stand here and hold the paper, give me something to lean on. How else can you do it? Dozens of ways. Now, if it costs \$100 for something to do this job it's wrong, because it's too simple a function to put so much money in. So this morning we're just going to be thinking about the expenditure of every dollar being the buying of function.

Fellows, as we go along you'll see that in our first talk we sort of dragged in by the coattails all the value analysis principles. Now, we're going back and make something of each one so we'll really drive it home. For example, here is a dust cover in one of our products. The dust cover is about the size of a half gallon pail if it were cut in half. The product is about 2 ft. square and has a lid all around it. The lid presses against the gasket. Now, that dust cover is costing \$10 and the dust cover is inside of the other cover. Why? How can any dust get in there? It was a strange thing. The fellows who were so close to the job had some ideas that caused them to keep it there. I couldn't get any dust inside of it. It doesn't have it on now. The thing that blew it off was the question, "What was the function?" I'll tell you more about that in another case where it also fits a little better.

On one of our products we saw a 36¢ shoulder screw being used. It was about 1/4 inch screw about an inch long with a pretty good sized head; 36¢. A standard screw cost 1/2¢. Why was it a shoulder screw? What was its function? Well, in addition to holding on a part, it acted a bit as a pivot. When they changed the adjustment on a gear, they loosened another screw and raised it up to a different point so this pivoted a little. 36¢ against 1/2¢. I wonder if we really get something for it. The interesting thing was that

when this product was studied, there were two screws - this special 36¢ screw and the 1/2¢ screw on the same device. Lo and behold, when we took it apart we found the 1/2¢ screw actually up in there and the 36¢ screw down in the 1/2¢ spot. That started the boys, stirred them up and gave them a considerable conviction. They finished their assignment and went to the factory where the product is made, had them go out in the factory, and had them bring in another product and set it down. The report was ready. That was quite a momen for all of us. We were hoping against hope we could hit another stroke of luck like that. Got the screwdriver, took it out, and we were in luck. We hit another 36¢ screw down below in the 1/2¢ spot and the 1/2¢ one up above. Of course, that did quite a lot of selling for it.

I want to back up just a minute to some of the reasons we do what we do. It ties right in here. Most of us, I think, in our operations are afraid of somebody. We're all here to grow a lot mentally. We find the boys have to shake off a lot of shackles to do the kind of a job that needs to be done to give us leadership. Why is it that we so long accept such cock-and-bull stories as we do about some things when the facts don't add up to us? Why do we do it? I want you to think now. Why do you do it? We see it in different places, we see it in our own organization. Some superintendent or some P.A. or some engineer or some production manager or some accountant look at us with a sneer if we get a little off away from the status quo, and by gosh, we give that fellow the authority of letting him order our thinking. Think of it: isn't there somebody back in your organization who, if you come forward with kind of a keen sharp idea that's so far ahead that it needs some thinking, looks at you, "Why, grow up!" And you're done for; you lose all of your self-esteem. I think there is in most cases. Let's bring these fellow out in the open where we can batter them down. We've got to, because they've got to get this nonsense out of them.

Another thing, we see the way that works is it causes fellows to build a shell around any situation that comes up and make kind of phoney reasons and phoney excuses and take phoney actions. We don't want any of that. Here we are with one premise: None of us can do a good job. None of us can do the perfect job; we all need help. "Yesterday we made mistakes, tomorrow we'll make them, but by gosh, we're going to learn how to make less of them. If we made a mistake, thanks a lot for showing us about them. We don't have to protect any mistakes we made yesterday and we have to teach others the same thing.

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I'm going to let you be the judge. You name it. Here are some of the sheets of work recently done by value analysts, suggestion sheets. What do you think about this? Here is a switch on the automatic dryer which when somebody opens the

door before the drying cycle is done, before the timer automatically turns it off, stops the drum from rotating and turns on a light. It costs us \$43,000 a year which is \$3500 a month. Is anybody getting value in stopping the rotation of that when somebody for some reason opens the door before the cycle is done and turning on a light in a shallow little thing where there's nothing in it but clothes, anyway? You be the judge.

Function is two things: something that will make it work better or make it sell better. You need one more piece of information: how about the sales? At the time this was being made we could sell five times as many dryers as we could make. Now we've doubled production, we could sell 2 or 3 times as many as we could make. What do you think about it?

Let's look at another one. You call this on the score of function. On our dryer we pay \$85,000 a year, \$7000 a month, for an ozone bulb. Why is it there? Dozens of people who have to cover up decisions they've made in the past and lack of decisions will tell you why it's there. It is easy to find out. But why is it there? The reason it was put there was because about a third of the housewives say, "Oh, I don't want my clothes to tumble in a dark old barrel; I want them out in the sun where the sun shines on them and the ozone purifies them and kills all of the germs and makes them come out smelling sweet." This isn't fiction. Three of my friends' wives have told me this, so I know why they feel that way. So we have it in. What is it? Does it make it work better? I have a Hotpoint and it has no ozone bulb in it, and borthor, the clothes are really sweet when they come out of there, just as nice as with sunshine. So from my angle it doesn't make it work better. The question is, "Is it worth \$7000 a month as a sales feature when you can sell twice as many as you can make?" You name it and think clearly on it.

Here is a screw machine part - costing \$11.00 per 1000. What's its function? That's a pretty decent price for that screw machine part. Well, its function is the function of a rivet and a shoulder. It's a shoulder rivet - holds things together and holds them apart. We'll go to a rivet manufacturer. Fine! Goes right into his line in fine shape and instead of \$11.00 it cost \$4.50.

Here is a screw, about an inch long, 1/8 diameter, with a large head. On top of the head of the screw is fastened a silver contact. It costs 9¢ for just the screw, made as a screw machine part. What's its function? To hold that silver contact up there. Why don't we take just a perfectly ordinary screw and leave the slot right in it which we can buy for not 9¢ apiece but less than 9/10 of 1¢. I don't know. Maybe we don't want the slot. Well, let's take them off the automatic screw machine before they have the slot

put in, and still get the same price - 9/10 of 1¢ instead of 1¢. What brought it out? Just the study of what is its function? What does that screw have to do?

Here's a piece of wire. It's a lead, about 9 inches long, and it's costing 24¢. What's its function? It has to conduct current, a little bit of current for 9 inches. Look at the way we conduct it on our other products. Here's another product that has a lead longer than that and a double lead and the whole double lead with the end strip at longer than this costs 9¢ where this single lead costs 24¢. You know it's nonsense. So, by using the same supplier, the same equipment, make the thing on the same machine but just have the double lead pulled apart in the machine; you get two leads for 9¢ or 4-1/2¢ instead of 24-1/2¢ for the same function. What we're really buying is function.

Here we come to a condenser costing 10¢ apiece. A condenser in 500,000 lots, costs \$50,000 a year. What does it do? Well, it goes on a thermostatic device to prevent chatter and radio noise when it opens up. An examination of the device finds there's also an Alnico magnet on it. As that device opens it snaps. There won't be any chattering on it. Do we get \$50,000 worth of good out of that condenser when we have the snap action that comes from an Alnico magnet on it? Along that line, it was questioned, the engineers restudied it, took it off and saved \$50,000 a year.

On our fluorescent ballasts - we make millions of them, as you know. Each uses a condenser. Across the condenser is a little resistor. The resistor costs 1¢. What function does it do? Well, it has to allow a little leakage there. How else can you get a little leakage in millions of cases? Lots of ways. A pencil line will give you leakage. A little piece of printed paper fastened there would give you leakage. That's along the thinking of printed circuits. So printing a little tab of paper, putting it inside the condenser shell gives you the same performance and just instead of 1¢ is 1/10 of 1¢ each.

Our products are just full of places where functional thinking will lead you to the same performance at 1/10th of the cost. Think of it here: what are we trying to do? We're trying to get leakage and why hang something on the outside? Let's build it right in.

Let's look further at that ballast transformer. We make 10 million of them a year. My apologies to you for talking to you about big quantities all the time. A lot of you fellows must be very unhappy and say, "Why, that's a lot of nonsense. We don't have that kind of quantities." What can we do about it? We'll get into your hair yet. But first will

you look sharp at the principles and methods that make these big quantities fall. There are laboratories and staffs full of men who have studied and combed and worked over these big quantities jobs. The fellows in that area say, "Why, value analysis is a cinch in the low production jobs where it hasn't paid to spend so much money already but out here we've combed everything; there's nothing left." That's what many have told me.

Let's look into some more; into some of these toughies and the ones that have been combed and there's nothing left. Here's the fluorescent ballast transformer. What is it? Essentially, it's a transformer and a condenser put in potting compound and then in a metal box. Let's look at it functionally. The amount of copper and iron we have to buy is established by temperature. If we could get the heat away a little faster, we can buy less. So we take the transformer and instead of making it to take the heat away, we insulate it and isolate it in potting compound. Then to make sure that the heat doesn't get away too fast - and you'll pardon my sarcasm; I don't mean to be critical, at all - we put on a metal case around it, which further insulates it. That isn't half the story. The other half is this. We pay about 70¢ to 75¢ each and in 5 million ballasts 75¢ each is a lot of money for condensers. The cost of making the condenser is absolutely increased by every degree rise in the operating temperature. If we could run them 25 degrees cooler we could take out barrels of money. What do we do with the condensers? We put the condenser right next to the transformer and place it all in the same potting compound so that the transformer acts as a heater and heats the whole business up. We also have to have enough potting compound to cover the condenser which is bad. It already has a zinc coating. It could extend in air. Then we have to have more metal to cover the whole business on top of that. Why, you look at that product about 10 years from now, you'll find that the transformer part is right out where the heat can get out. You'll find that the condenser sits right out in the air and as a result of being able to radiate its energy you'll find that - even if we don't make a big advance in improvement in transformers, it'll be only about two-thirds the size of what it is now and two-thirds the cost. That's where functional thinking will take us, even on well established products. It makes a difference of 1-1/2¢ on potting compound, alone.

Here's a roller bearing costing \$1.00. What is it used for? It's used for a cam follower. It's a needle bearing. There's very light load, functionally. A ball bearing makes an excellent cam follower in a clean place - costs 60¢. What's the function it has to do? Here is a metal channel, rolled section, about a foot long and made of rather thin metal. What's the function of it? To provide stiffening. Well, this channel has quite a lot of material on the feet portion. It's

the riser portion of the channel that gives stiffening. Cut away half of the foot portion of it and the cost goes from \$2.20 per 1000 to \$1.85 per 1000 and it gives the same stiffening.

Here's a double pulley. It goes on a 6 HP motor. It has to have two V-belts on it spaced about an inch apart. What do we need? Really two pulleys on the shaft would do, wouldn't they? Well, the way we're doing it we take a solid piece of steel about 3 inches long and hot out two V grooves. It costs 60¢. The metal between those pulleys is not functioning. By taking that metal out, by casting a double pulley, instead, it costs 22¢ instead of 60¢, saving \$22,000.

Here's a felt being used for oil wicking. It's white felt. It costs \$44.00 per 1000. Grey felt does the job for \$15.00. Wonder why they used white felt? Well, somebody in that area felt you had to use white felt to do the job. About six months ago, a couple of us were talking through one of the factories. Here was asbestopaper being used under a paint conveyor system to catch paint drippings. Asbestos? Sure, it's hard to get; terrifically expensive. It's sickening, to any one who knows how hard it was to get it. We hunted up the foreman, "How come you use asbestos paper?" "Well, we have to use it." "Why?" "Because of the fire hazard." "Why don't you use some other fire-resistant material?" "There isn't any. Safety code says we have to use this." "O.K. Thanks." We called on Barney Ugly, the buyer of that type of materials on the commodity basis to look at it. He calls in a couple of his paper specialists. Paper is a wonderful product. They can make anything with paper. They can make fire-resistant paper. They can make paper that will do almost anything excepting what steel will. They look the thing over and they provide a fire-resistant paper. They can't use it. Safety department won't approve. Come on over; let's show the safety department. They brought the stuff over. They went down and spent a half a day with the safety department and set up some tests; showed it worked just as well as asbestos, and it just took 24 hours to get that thing knocked clear out of the window. Now they use a fire-resistant paper. It meets the safety code, and it costs one-tenth of what the stuff cost a few days before.

On an oil burner - if you look at the oil burner control of about two years ago you see a fancy two-color nameplate. What does it cost? 11¢ by the time it's on there. Well, what does it do? Supposed to sell more oil burners. We asked the engineers and they said the commercial people say to put it on and the stylists want it there. Get to the commercial people and the stylists and they come right back with the answer, "12¢ is ridiculous. This thing is always used under a hood. Nobody ever sees it but the service man. Take it off, put on the Monogram and put the Monogram right in the mold and save the money.

Here's a bushing that is about 1 inch in diameter and about 2 inches long. It's costing 29¢. What's the function of it? The function of this bushing is on the end. It's really a spacer to accurately space two tapered roller bearings apart. That is accurate, because the clearance is fixed by the spacing. 29¢ for a little spacer like that. We don't care about the circumference of the spacer. It's the length that is important. Then, why instead of making it of a piece of tubing don't we make a rolled section and come up with the same tolerance on the length? A specialty supplier does it and the cost instead of 29¢ is 2-4/10¢; the same function with \$27,000 of unnecessary cost out.

Another small bushing is a type that we have every day is made by cutting a 1/4 inch of tubing off. This particular one - a supplier makes as a rolled spacer; the same geometry excepting there's a seam down one side which doesn't interfere in this light duty. Instead of \$16.00 per 1000, it's now \$4.60.

Finally, this clamp used to hold a small assembly against a vertical surface. The assembly was already supported on tubes. This clamp was put on with two rivets and used considerable material in making it. It cost \$7.00 per 100 - 7¢ apiece. By using the material differently we could provide the same length of mounting and using two rivets instead of 4. It only holds it against the sides, anyway. The cost suggestion brought it down to 3-8/10¢ instead of 7-4/10 - saving of \$45,000 a year. This is very current and I had telephone advices the other day that the engineers, when they got this, are going still further. They're going to practically throw it away and fix something up there to do the job.

We'll stop on this thought: what is the function that you're buying? As you look at these products don't let anybody put thoughts or words into your mind. That's why your management sent you here; they want you to use your minds. What is the function? There are bound to be parts in here in some of these things you look at that don't do the things that folks think they do. Let's clearly know what function we are actually getting with every element of cost.

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Mr. Linder^g said out in Louisville at his vendors' meeting. He said, "We need to break through with a new design that brings us clear to the top of customer acceptance. Then we only need functional things in it. Our competitors will keep creeping up with their design, and as they creep up we in effect lose our margin. Then, "he said, "we have to make little steps by adding sales features fast enough to keep this market." It's just a question of good evaluation, isn't it? Whether we ought to pay this kind of money for that sales feature at that time, and it's not our problem to evaluate it, our job is done

when we clearly set it up so the manager looks at it. Here's what I get and here's what I pay \$8000 for."

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That's all in the area of management decision, isn't it? Value analysis is clean. We don't have any decisions to make. We don't have anything to do that we can't have the facts for. Our job is to develop the facts. What does it cost? In this case we don't have to tell the management what it does. One little paragraph - it costs us \$7000 a month. Under these circumstances, is it good judgment? Now it comes right to the manager clearly. Half the time he didn't know it cost him \$7000 a month.

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John Sullivan - Value Analysis of Textolite

Purchasing Value Analysis. Where is it feasible and where isn't it feasible? This is the question which arises so often and I'm sure that you've heard it and I've heard it at least ten or fifteen different times, when people have said "It's just not applicable to my situation." They usually say, "Our production is low where we make single units", or some excuse. They say, "It is not applicable for this operation." This is not true. It's applicable to every operation if you break it down into its individual components. I think my first assignment in Value Analysis is a good example of one area in which many people thought that value analysis was not applicable. It was in our Plastics Division - the laminated plastics, decorative laminates, to be exact, like on that table top there. Here I have a decorative laminate; one piece. It doesn't look like it lends itself too well to value analysis. But when you break this down it lends itself just as well to value analysis as a washing machine does or a television set, or what-have-you.

I would like to show you how it does lend itself to value analysis. Unfortunately, I'm not like Roy; I can't point out that the thousands of dollars that I've saved, nor can I show you the mistakes I've made. But I'm probably at the point of making mistakes, right now, and don't know it.

All the figures that I quote are on the basis of 10,000,000 square feet, which is our next year's production of decorative laminates. We start with the sheet like this; this is the finished product.

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Just one word of encouragement: we did treble our production last year. This year they expect to double it again,

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so we are moving into the percentage figures slightly. This is generally the breakdown of the sheet. This is the separator. In other words, you have two textolite sheets back to back in the pressing operation. You have a diaphane separator which separates these. this is a smooth highly glossed sheet of paper and it's a one shot operation. You use it and you throw it away; you don't use it again. This separation costs us \$36,000 per year, just to separate the backs of the two sheets.

Now we come to the functioning surface. This is what you buy textolite for. This is what you see in textolite. This has all the properties for which you buy textolite instead of linoleum. You have the overlay sheet which is impregnated with melamine resin, melamine resins having all the good qualities which you generally associate with this product. This is 3-1/2 mils and you do not see this overlay sheet. It's transparent in the final product. It's a very expensive paper and has to be absolutely clean. It is isn't clean, if you have specks of dirt in it, they stand out. This means rejects and increases in your overhead. This sheet costs us \$250,000 a year; a very expensive sheet.

Next we have the print sheet, the sheet which you see. This is an expensive sheet, also. It's the sheet on which you print your design, whatever it may be. Incidentally, G. E. tries to maintain as far as possible exclusive designs in its products. This is 7 mils, and costs us \$490,000 per year. Here you have the functioning surface, essentially, for which you buy textolite. This costs us \$776,000, not including overhead, I.M.E., etc. Then you come to the support for this sheet. We have the two barrier sheets - and incidentally, the paper in the whole support is made up of 11 mils unbleached saturable kraft. It's about the cheapest grade of paper that you can buy and still have wet spray. In other words, you can still put it through a bath and impregnate it with resin without it breaking apart. You have two 11 mil sheets and a barrier sheet. This barrier sheet serves one main purpose: it is a barrier. For the most part your whole sheet is made up of thermosetting resins but they do have some thermoplastic resins and when a housewife lays a hot utensil or something down on the sheet, and unless you have something to prevent the thermoplastic resin from flowing, it will flow through a discolor your print sheet and ruin your sheet. The barrier sheet functions for this purpose. For this function, we pay \$247,000 a year.

Next we come to the filler sheet. The filler sheet gives you strength in all directions, and it gives you impact strength to back up your functioning surface. These are all 11 mil sheets, or 11-point sheets, as they refer to them in the paper industry. This costs us \$352,000 a year.

Next we have the warper sheet which is, again, 11 mil kraft, and it's impregnated with a fast-cure resin which offsets

the shrinkage and the warpage of the melamine resins. In other words, you'd have one warping in this direction and another warping in this direction, and the forces would tend to equalize. For this warper sheet we pay \$450,000 for a year.

Last, we have the sanding sheet which is impregnated with resin, and is sanded off in the final operation to give you the rough surface for bonding to your masonite or plywood surface. These totals add up to \$1,618,000 for the coated sheet; add your I.M.E. on of another \$1,145,000 and a manufacturing cost for this sheet of \$2,763,000 for 10,000,000 square feet or roughly 27.63¢ per sq. ft. of textolite.

Now let's break down the cost per sheet and see what we get for our money. We have the overlay sheet, a 3-1/2 mil sheet of expensive high grade, high quality paper, which we buy from the Hurlberg Paper Co., it's 65% rayon and 35% rag. This is an expensive sheet. It has to be clean and very transparent. We treat this with a bath of 50% melamine resin, a very expensive resin; dilute that with water and a small amount of isopropyl alcohol. Incidentally, this is one point where we're ahead of our competitors, who use ethyl alcohol which is much more expensive than isopropyl alcohol. The final sheet comes out with a resin content of 65 to 68% and incidentally, this sheet does not actually provide the surface; you have a smooth melamine surface and not the sheet itself, because if the sheet protrudes you have a dull surface effect, and this they do not want, in some sheets. In other sheets they actually try for this. This breaks the cost down to a paper cost of \$84,000, plastics \$130,000 and labor \$36,000, adding up to a total of \$250,000. This is for the overlay sheet. Then you come to the decorative sheet, the print sheet. It is a 7 mil sheet, 100% alpha fiber which is nothing more than ordinary paper, highly purified, where you've taken all your simple sugars and lignons out. This is pigmented with compounds such as titanium dioxide or zinc sulfide to give it opacity; because, when you look at this textolite sheet on the top you only want to see the print sheet; you don't want to see the barrier sheet below. If you do not put pigments in it will be transparent like the top sheet. This, again, they maintain terrific standards of cleanliness. They treat it with a bath, diluted down with urea. The urea lessens the good qualities of your sheets, but as long as this does not migrate up into the sheet, you can maintain the effect and keep melamine up here and urea here. The final sheet has a 45 to 47% resin content which is half urea and half melamine. The cost breakdown, - \$92,000; printing - \$131,000 -- you can see our printing costs are a large amount of the total -- the plastics \$212,000; and the labor \$55,000, adding up to a total of \$490,000 for the decorative sheet.

There you have your functioning surface. The total costs of the sheet are \$740,000, the diaphane separator which should not be in here because it is the lowest, \$36,000, and the assembly costs, AAE, IME, \$380,000, a total of \$1,156,000 buys

the functioning surface. What do we get on the functioning surface? We get temperature resistance - in other words, when the housewife lays a frying pan on the surface it does not bubble, it does not darken. You get abrasion resistance - when she rakes that frying pan across the surface it does not scratch. You get corrosion resistance - she can wash it with detergents and soap. You get stain resistance - when she spills something on it it doesn't discolor. You get high polish and smoothness; it's easily cleaned and it looks good. You get the design you want - and incidentally they have a variety of designs which you can pick from. And last, you have the impact strength which is partially connected with the functioning surface.

Now, what else do we need after you buy the functioning surface? You need support for this. You need something to give it strength while in shipping and handling. You need strength while mounting and you need strength at or in service; so when you drop something on it it doesn't crack it, or it doesn't split when your plywood gives and takes with the humidity in the air. You need a hard, smooth top, and this is connected directly with the core material you use. If you use a core material that is discontinuous, soft in one spot or thicker in another, this will be telescoped into your surface and you will see that in the final design. Lastly, you need a tough body - strong in all directions, as I've said before, so it won't split when your plywood gives and takes. Incidentally, they've had trouble with this. In a humid atmosphere the plywood would have a tendency to expand and it splits right down the center. This is one of the reasons you have to have support. For this support we now pay a total of \$1,607,000 which we can break down. The resin bath is a G. E. phenolic resin cut with a slight amount of isopropyl alcohol. You get a 31 to 33% resin content in your final sheet. You can break down the cost of the barrier sheet, paper \$60,000, plastic \$134,000, labor and losses \$53,000 - a total of \$247,000 for the barrier sheet. It costs us \$247,000 essentially, to prevent the thermoplastic resins from flowing through up into your print sheet and discoloring it.

Then you come to the four filler sheets, broken down as follows: Here they cut it with Vinsol, the cheaper thermoplastic resins. They cut the price here by using Vinsol in your phenolics. Final resin content is 30 to 33% about half and half Vinsol and phenolic. Break it down into paper costs again - plastics \$118,000, labor \$83,000, and Vinsol \$31,000. The filler sheets broken down cost us \$352,000.

You can do this same thing with the warper sheet, the sheet that prevents the warping of the final textolite sheet. It offsets the shrinkage tendency of the melamine. Here you use a fast-cure resin. Paper costs \$31,000, the plastic costs \$92,000, and the labor and losses \$31,000 adding up to a total of \$154,000. The sanding sheet in the same manner; you use the

same resin here as you use in the filler sheets, only leave out the Vinsol. You have a final resin content of 30 to 33%, and this is sanded off, in the final operation. The paper costs \$30,000, the plastics \$38,000 and the labor \$21,000. It would be nice if we could eliminate this operation entirely. Quite a saving right there.

Are we buying function? The sheets for which you buy textolite, the functioning sheets, cost us \$1,156,000 for 10,000,000 square feet, or 11-1/2¢ per sq. ft. The support which goes under that costs us \$1,607,000 or 16¢ per sq. ft. A cursory observation of this would indicate that we're paying too much for the support. This is just kind of a schematic diagram to show you how they impregnate these sheets and why you have to use paper that has wet strength. Newspaper would be the ideal. Just to use newspaper made out of ground wood and a low amount of sulfide, or sulfate pulp would be cheap. But it is too weak and does not have wet strength. It just tears in two when passed through the baths. The paper comes off the roll over here, passes through the bath, and is saturated - you have to have a saturating paper so it will take up sufficient quantities of resin to give you a lamination. It passes here through a doctor blade more or less to remove the excess resin, and goes to the dryers, where the alcohol and the water are evaporated off leaves a dry resin on your sheet.

So you come to your pressing operation. I drew this up so it would be easy to explain some of the approaches that we have taken to cut some of the costs out of this, and as I say, like Roy, I can't make any great claim to savings; we haven't made any savings yet. This is your pressing operation. You have two steam-heated rollers on the end. The sheets are double sheets with the backs in the center, and with a diaphane sheet separating them. The fronts face a stainless steel pan, 90 mils thick, very smooth which gives a smooth surface to the textolite sheet. You cannot have any discontinuities. Any scratching, etc. is telescoped into your final product. So you build up your stack in this manner and slip it right in the press. The distances between the two pans are fixed; in other words, they can't increase or decrease appreciably, on the presses that they have there. For instance, if you laminate on a masonite board, make it 1/4 inch or 1/2 inch thick, that means that you can just put that many less sheets in. If you make it 10 mils thick, you can put that many more. Of course, it isn't a direct function, because you have your 90 mil stainless steel sheets which go between the faces of these. You have to transfer your heat from the steam heated battens down completely through your sheets in order to get the curing.

Now, I hope that you have a picture of how you can take a sheet like textolite that on a first observation does not appear to break down and lend itself to value analysis study

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like, say, a washing machine or an ironer, or something like that. On further study it breaks down just as beautifully and lends itself to value analysis just as well.

Larry said a minute ago to blast first. Well, I picked first. like everybody else. So we'll pick and then we'll blast later.

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Going back into the history of textolite we found that originally they did not use this high-cost paper, this 65% rayon, 35% rag. They used an all alpha fiber, a cheaper sheet; just about half the price of the present one. But at that time they had stainless steel battens which were chrome-plated, and every time one of the operators scratched it or it got dented it was necessary for them to take that sheet, ship it to a steel company; have it de-chromed, and chrome plate it again, then send it back to the Coshocton plant. This was very expensive. They found that they could get just about the same results if they went to a stainless sheet - I think it's 304 stainless steel - and they put in their own buffing machines in their shop, and fixed up their own plates when they scratched them. They cut a terrific amount out of their costs in this manner. But at that same time they found with the stainless steel sheets which were not chrome plated, they got a fogging effect when they used the alpha sheet. Incidentally, about 50% of the industry still uses an alpha sheet. How they do it, we don't know; either they're using chrome plated pans, or they've licked the problem in some other manner. Nevertheless, they found they got fogging of the stainless steel pans; the melamine resin was picked up and deposited on the surface of these pans and it's not easy to get this stuff. They tried many different solvents with not too much success. Undoubtedly you can use an acid or a base but you have to neutralize these and this costs a lot of money and they like to use something like alcohol.

This morning we have a real treat for you. We have with us an expert, in the field of packaging. He's Paul Vogt, Co-ordinator of Packaging, Shipping and Handling for the Manufacturing Services Dept. of the whole General Electric Co. Not only is this man an expert in packaging in the General Electric Co., he's the expert in packaging throughout the United States. He is extremely well known in this field; he's the National Vice-Chairman of the Board of Directors of the Society of Industrial Packaging and Material Handling Engineers; he's also the chairman of the Packaging and Packing Division of the American Ordnance Association and chairman of the Packing Section,

Society for the Advancement of Management. I could read you off a list here that I think is as long as your arm. I know he has an interesting story for you - and if you will permit me to cut it down to saying just this: He is the packaging expert and I am sure that he can help you with your packaging problems. Mr. Vogt.

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Gentlemen, it certainly is a pleasure to attend one of your meetings on Value Analysis Trainings. Not too long ago I had the pleasure of talking to the local chapter of the Society for the Advancement of Industrial Packaging and Material Handling Engineers in Philadelphia. When I arrived there I went to the hotel and registered, and the first room they took me to was occupied, as usual. The second room the maids were working there, just cleaning it up. I found that I only had a few minutes in the room before I had to leave for the meeting, so I was working with my slides, and one of the maids came up to me and said, "What have you there?" I said, "I have some slides." She said, "Any pictures of Philadelphia?" I said, "No pictures of Philadelphia". "Where do you work?" she said, I said, "I work with General Electric Co." She said, "How long have you been with the General Electric Co.?" I said, "Thirty years." "Thirty years is a long, long time." "Yes, it is." She said, "They've got a plant here haven't they?" I said, "Yes, they've got a plant here out on Elmwood Ave." She said, "I wonder if I could get a job out there?" I said, "Well, the General Electric Co. is always looking for good people." She said, "Well, I believe I'll go out there and see if I can't get a job. You know, there's one thing about the General Electric Co. - it's a mighty-mighty fine company. The Western Electric Co. is, too, but I'll tell you something right now, the General Electric Company makes good Frigidaires."

General Electric, being as large as it is, having plants scattered from coast to coast, and manufacturing complete products weighing less than an ounce to many hundreds of tons, boxing, packing and shipping operations present numerous problems. In most cases our shipping superintendents are responsible for both receiving and shipping, so we feel there is a definite tie-in in manufacturing, in packaging and materials handling. Packaging, shipping and materials handling is now being coordinated in the Manufacturing Services Division. This also includes package research, the standardization of packaging and materials handling through the Packaging, Testing and Developmental Laboratory. The establishment of standard test procedures; designs and specifications; and to see that materials are packaged to reduce materials handling costs. In each department of General Electric there is a departmental coordinator responsible for this activity in his department. He is acquainted with all the latest developments in packaging, shipping and materials handling and places into use those ideas

that will improve his present operation. An organization such as this which provides a free exchange of information promotes the finest kind of teamwork.

Must has been accomplished by the various departments along this activity. Picture, if you will, a freight train 75 miles long which is nearly half the distance between Albany and New York, filled with packing material. Eight million dollars worth of lumber in wooden boxes; ten million dollars worth of corrugated and filler pieces; and two million dollars worth of paper products. This would represent General Electric's annual purchase of packing materials bought in one year at one central location for nearly 130 plants located in 88 cities in 22 states. This also gives you some idea of the huge task in securing materials and the expense involved to adequately protect the many products G. E. manufacturers from the hazards encountered in transportation.

It is now estimated that General Electric Co. will spend 30 million dollars in 1952 for packing and shipping materials. An additional 50 million dollars is spent for incoming transportation from suppliers and for shipping outgoing products to customers. Recent and proposed increased rates for rail, truck and parcel post carriers will raise General Electric's transportation costs \$3,500,000 annually. Expenditures of more than 80 million dollars in packaging, materials and transportation charges represents a fertile field for economy and a real challenge for cost reduction in our box, pack and ship operations. This can only be accomplished by aggressive action in the operating groups through the selection of the proper men to organize and stimulate this work. An adequate program of projects to be reviewed, the application of new and cheaper but equally satisfactory packing material, a thorough review of the packing charges which are hidden in the cost of the vendor's product. You're working on vendors' things, I know, today on your value analysis and there is one thing to remember, gentlemen: are we being charged for their packing? Are we being overcharged? Is the packing right?

The adoption of automatic packing, particularly on conveyerized assembly lines - I'd like to just stress one point here: there's not a place in General Electric Co. where we have automatic packaging. We are working on two or three projects at the present time, but believe it or not the millions of lamps that we build are not packaged automatically. Cooperation with engineers and commercial units for economical packaging when new designs are originated - there's another place where we fall down very, very badly. A lot of times, I know, the packaging engineers are notified that here's a new product. Then it reaches the Shipping Department or in the boxing or packing area. That should have been designed at the time the product is designed. That way, we may, by working together, certainly help the design engineer and point out his weaknesses, perhaps, in design where it's going to cost many pennies for extra packaging to protect that one little part of his design.

A reduction in the paper routine and clerical work through the mechanical preparation of shipping documents. This is now being done at one of our plants, the mechanical preparation of shipping documents. I happened to be down in our warehouse in Zanesville, Ohio last week and I never saw so much work being done with these IBM machines as I saw there; practically all of their work is being done with IBM machines, and that's one place where we certainly can save a lot of money.

It is hardly believable that 35 years ago we were packing meters by wrapping them in paper and floating them in straw, eight to a barrel; or fractional horsepower motors - six in a heavy dimension wooden box, also being floated. That is the way massive production was being packaged where customers purchased our products in large quantities. With the production as it is today, it is difficult to visualize the tremendous amount of space that would be required for the packing and storing of raw materials and finished products, should we not have improved our packing operations and methods. The improvements made in packaging development and research has done much to make this an important part of manufacturing and I am glad to say has kept pace with modern industry.

First, we must know what we are doing, when changes are made in packaging, and second we must have some way to evaluate the carrying qualities of various materials. Through the adoption of many new developments in packaging, we have come up with many worthwhile savings. For example, through the coordinated program we have increased our savings in the Apparatus Department. In 1946 the savings were \$193,000; in 1947, when we really got rolling, the savings went to \$770,000; in 1948 it was \$885,000; in 1949 it was increased to \$1,220,000, and in 1950 it was increased to 1-1/2 million. Then our first company-wide box, pack and ship program, which was last year, went over 4 million dollars, company-wide, and we estimate that this year it will go about 4-1/2 million - we have nearly 3 million dollars for the first 7 months of 1952.

I brought along with me some slides to give you some idea as to how we have made a lot of these changes. I'll be glad to show them to you now, and if there are any questions, gentlemen, during the showing of these slides, I'll be very glad to answer them.

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I thought this would be interesting to you just to show how paper is made. Here are the logs as they have been cut in the field. They are hauled into the plant and then they go through what is known as a washer, from the washer they go into a chipper, and then through this washer they also have a debarker - it takes all of the bark off, and from there it goes into the chipper. Then it goes into the screens - it's all screened out. From there it goes into a chip storage,

and a digester which you see here and then it comes down through here into what they call the cyclone and wash pan. From there it goes into the blending operation, and then into the screen again, washed and bleached, then through another washer, bleached pulp storage chest, as you see here; then it comes down into a beater, then over through the chest and around through the Jordan. This is called a save-all. There's where they take all the parts out of the wood such as rosin, sulphur and other things that come out of wood products. It's almost the same in the manufacturing of paper as it is with meat packers. The only thing that they have left any more is a squeal and that's just about all that's left in the making of paper. It comes through the screen and right here is a long Fordinier machine. I might say that that machine through here would be about 150 ft. long. It presses it and it goes through the dryer, and into the calender machine which calenders the paper. Then it goes into the reels, the trimmers, and then from the trimmer into the storage and into the box car. That gives you some idea as to how it's handled.

This will give you an idea as to how the fibers in corrugated paper look, highly magnified; you can see the big cord fibers. That is in a piece of what is known as Fordinier Kraft. I think the next job will show you - this is out of jute material. You see how fine these fibers are, and you see how coarse the others were. That is a new development - I saw new, it's come within the last 10 or 15 years - and that has helped us tremendously because we can get boxes that will go up as high as 500 lb. test and now we have a new one up to 600 lb. test where we can pack 140 lbs. in a corrugated box. Just recently I was in a plant down at Hartford City, Indiana where they have manufactured a double-wall board that tested 1190 lbs. That's stronger than you get even out of a piece of 3/16" veneer, so I don't know where they're going to go in the manufacturing of paper.

This is a picture of time switches which were formerly manufactured at our Somersworth, N. H. plant and are now being manufactured at our Morrison, Illinois plant. This shows the old method of packing; 24 packing pieces were used to pack 18 of these timers. You'll also notice that this is a creased piece and each one of the ends had to be stapled to hold the timer in place. This will give you a little better picture of it; it rests right here; and it rests right next to this mounting you see there and also over here.

This shows the old and the new method of packing. Here we use to pack these six timers - 7 pieces of this diecut and all of these with the new method of packing where we have just one die-cut pad, we have 5 timers to one packing piece. This will give you some idea as to just how that works. These small diecut holes here, fit into the mounting lugs here, and hold these things in position. You'll also notice this flat

piece across the top here is almost an inch wide. Here it is in the box and the box is slightly larger than the other one and in this box we pack 30, while in the other box we used to pack 18. Another thing, due to the width of this piece across here, we were able to eliminate all the interior packing with the exception of these three; no pads were needed through the center. This box here was squared up; when it was squared, we didn't need any pad at the top because the inner flaps met. This amounted to quite a large saving.

This is a picture of some cutouts, manufactured at our Pittsfield Plant. Here are six cutouts that were formerly packed using 6 or 8 packing pieces, all different. Now we use one packing piece to pack each one instead of the six, but it's again a case of standardization; we're packing all cutouts in the same manner.

This is a clock that's used in the clock-radio. The old method of packing is on your left, showing one piece here, another piece here that's almost a box - it has two flaps on the outside; you pay for this material right here but you don't get it because it is cut off; you also pay for this type of material here and you don't get it because it too is cut off. You pack one of them in one package each and here you have five of them in one using two packing pieces. Here is another case where we packed 5 of them to one packing piece. You'll also notice how that's designed; it comes up at the top and these long pieces come below and it's stapled on each side there so that the long stem that goes clear to the back of the radio is fully protected.

This is a sign-lighting transformer which is manufactured at Fort Wayne. This is the old method packing, as you see here they used six packing pieces; the new method of packing uses one packing piece.

This first operation you see here is to fold in these two pieces here; one at the back and one at the front; protecting these porcelain bushings you see here. The next is to fold these two pieces and tip the transformer. The next one is to throw these two pieces on this side; again, all in one packing case. There it is going into the container. You'll notice you have a uniform barrier around the entire surface of the end of the transformer. That type of packing, again, has made a tremendous saving at our Fort Wayne Works.

These are ballast transformers that are manufactured at our Danville, Illinois plant. This is the old method of packing using a large piece across the center, pushing the leads in here, and then using a small piece here. A new development on that is this one where we use two pieces exactly alike. Use one piece through the center, two pieces that will go around the edge and slide into the end of the box. That's another saving we made; instead of opening the box on the side, we open the box on the end. You can always save a lot of material by doing that. This has been submitted to the boys in Fort Wayne and I think it's going to be adopted.

This is a fairly new development. It is molded pulp and is used for meters. We started to use that a year or year and a half ago. This top and bottom is interchangeable; the inside of this pulp is very hollow; it gives the meter plenty of cushioning. This type of packing can very easily be used when we're talking about automatic packaging. We have a lot of projects going at the present time in molded pulp, and the reason for it is the fact that molded pulp is made out of newspaper trimmings and old newspapers. It has no life in it; when paper goes through the sulfide process it kills all the fibers, and that's exactly what happens here. So as a result the material itself is very, very cheap.

We are also working on a 4-meter mold at the present time, where the only thing you'll have to do is drop the four meters in one and then place the other on the top. We're even thinking of bagging them; putting them in a paper bag instead of a container.

This is another piece of molded pulp that is made just like a corner piece. The outside here is a little wider than the back, the reason for it is to protect these knobs. We have made several shipments to the west coast and back and that type of packing has proved satisfactory. However, we're not using it at the moment as we're working on another method which employs a honeycomb, but molded pulp definitely has its applications.

This is the old method of packing showing four pieces and a piece of wax paper to protect it. Here is our molded pulp packing and over here is what is known as a honeycomb packing. This is a very good way of shipping, and I think within the next two or three years, if not sooner, you'll hear a whale

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of a lot about this honeycomb material. I might say that we're making pallets and things like that from honeycomb material on an experimental basis, and so far they have proved very, very successful.

Here's the 4-meter molded pulp pack again. Even a little part is built in here to keep that meter from turning. If you'll recall, this meter must not turn in transit because of its floating disc, it must be kept in one position.

It takes 98% water to flow pulp of this type onto screen and these are all made on screens. Also your dies are not too expensive.

This is another piece that is made out of molded pulp that is a little heavier. I brought this along to show that you can build your molded pulp to fit the contour of your product and you can also build it so that it will fill the flats in between the inner flats. You see these small channels that we have in here. Turned over, this is the side that fits the top or on the bottom, and this part here fits between the inner flats, so it eliminates that one packing piece that would normally be used if this were not built in the molded pulp.

This is another piece of a back of a chair that I'd like to show you. You can see how thick this can be built in here. This is approximately an inch thick; and this in here is only about 1/4 inch. This is a piece that has been flowed onto brass screens. I predict that you'll hear more about molded pulp and honeycomb within the next 4 or 5 years than almost any other type of packing.

This is the old and new design for agitators which are manufactured at our Taunton, Massachusetts plant. The old method of packing you see over here was one per container; here we use a Christmas tree type of packing. These agitators are pushed through this form from four directions and when these things are placed in the container there is not one of them that's in a corner as every one of them is protected against a flat surface. This new method of packing 10 agitators to a carton instead of one saved 136 board feet of material. Today this has been improved; we've made three improvements on this by research. As Dr. Kittering says about research, "Research," he said, "is like an old dachshund; it sniffs with its nose for tomorrow and wags its tail today". That's exactly what we're doing in our research of packaging.

This is another piece of honeycomb, it shows you some of the ideas we have for the shipping of radios and television sets. This can be built so as to make a regular corner pad out of it. This one right here goes right through here; this is a long piece that is strapped to the bottom and this is another one. Right here would be a case for standardization; but the plant is not laid out to take that type of packing. But experimental work is being done right at the present time.

Here are some transformers which were manufactured at Pittsfield but are now being manufactured at our Hudson Falls plant. In this old method of packing we had a lot of wrap-arounds. A little job of standardization shows how we have built up pads that go all the way around. I think this picture itself tells you there has been a lot of money saved on packaging.

This is another case of where we changed from a wirebound box to a corrugated box. You'll note that the cleats around the center here hold this arrester up and protect the bottom section. The flaps are turned to the outside under here, and this heavy piece across here keeps it from moving back and forth and also protects it at the top.

This is a bucket wheel and shaft assembly which was manufactured at our Pittsfield Works. These buckets are all placed around this wheel separately and it's quite a tedious and expensive operation. So we must do everything we can to protect it and not take too many chances.

This was one of the methods of packing we had; before this was adopted they used a regular box that fit right over the top and this thing was held in position by another piece that had a hole through it, also they had to come clear down in here to be sure that the thing didn't rock. Then we started on a new design; and as you can see we cut out quite a little lumber out of it. Each one of these cleats here is of the same width but not quite of the same length. We just use this small piece up here to hold the shaft up above the wheels. Then we placed it in a corrugated container, instead of a wooden box, here you have these flaps that fold back; they're also folded back at the bottom with one base, that one flimsy base as compared to the other one; this one turns around and we again had to go down into this cavity here to hold the shaft in position. That was another place where we saved a lot in material, labor and, I might add, freight.

I might say that every pound of freight that we save, we save on an average of 2-1/4¢.

These are three steps in the packing of an insulator. This is the old method of packing in a regular dimension wooden crate; the new one is in a wirebound - you can see just how we've reduced the weight again and also the cost. Then it went into the corrugated box.

This is an old crate for a motor. I believe this was designed for the River Works. I don't know whether River Works has adopted this method of packing or not. I know our San Jose plant is using this with a great deal of success. Again, I think the picture gives you the story - we are reducing the weight and as a result, the freight, and another thing - this corrugated box costs much less, the motor is clean, and it's just as easy to handle.

D4a.

This is a small KVA transformer manufactured at Pittsfield. This gives you some idea as to how the old crate was made, using the regular dimensioned lumber. Then the new method of packing was in a wirebound crate. Notice how large this crate is here, and this bushing was placed right here in the center. They thought that the bushing should be left there so that it would not become damaged. Just to give you some idea how much that weight can be reduced, that's how it's being packed today.

This bushing here, now, is being placed in a corner; all the dimension diagonals are taken off, and by having this hanger lug in the corner it bolsters up the crate so it will not rock or weave in any way and it has proven to be very successful.

We wanted to see what could be done packing the same transformer in a corrugated container. We could save a whale of a lot of money, believe it or not, by doing that as far as material is concerned, but due to the fact that these transformers are stored on the outside, this method of packing cannot be adopted, but it did satisfy us that something could be done about it in the event that things ever changed.

This is a 100 KVA transformer, again manufactured at our Pittsfield Works. You'll notice the old type of dimensioned wood crate and the blocking that was a large block over on this side and then another one that goes along through the center. That is the new method; that is a wirebound box for a 100 KVA transformer. Due to the development of a new machine Package Research Laboratory in Rockaway, N. J., we were able to form, drive and pinch the staple through 2 inches of hardwood. That's what made this possible and I might say that this is the first crate as large as this that was ever built for a 100 KVA transformer. You'll notice another thing that we've done with this crate and that is to build in a pallet-like base so it can be handled by a fork truck - I think that weighs 1500 or 1800 lbs. I might tell you, too, that we've just crated a 100 HP motor in a wirebound box.

This is an old bushing box, which was made at our Pittsfield plant. The next picture will show you how large a wirebound box can be made. That is the same box, believe it or not; it doesn't look as long; but that's the same box made wirebound. The weight was reduced around 150 lbs. on that particular job.

This is a gear that's manufactured at our River Works. The old method of packing is on your left and the new method of packing is on your right. We just skidded this piece, placed another piece of veneer along the side and then blocked it down the top and crossed it over. That was our first - this was our first design. After we started to think this over a little bit, the River Works came up with something like this: by just adding this small piece, using the same base, same size, and a piece just to hold it down, they packed two gears to a pallet. These gears are shipped from River Works to the

American Locomotive here in Schenectady.

That is how the old method of packing looked in a boxcar and here is how the new method of packing looks in a boxcar. I think you'll all agree it's quite an improvement and quite a large savings in both material and freight. These are the loose parts that usually go along with a shipment of gears. You'll notice, too, that the gears are kept clean, that the inside journal is protected here, and as I say, it's been very, very successful.

This is a packing of six motors in an expendable pallet - also a River Works job. They packed six motors, they used three pieces across here; the motors are bolted down to the bottom pieces, and this is known as an inverted cover; they use another inverted cover on the top; and then they use a tube in the center. This shows you 18 motors being packaged. You can see the cube has been reduced materially and you can see that each one of them was packed in a wirebound box before. Ease in handling and everything else. Saved in material, labor and freight on that job. That's the only three places you can possibly save anything.

These are castings that were formerly packed by putting 8 castings on a piece of baling wire. I might say the damage was terrific between our Elmira Works and our Fort Wayne Works because they were thrown around so much. During this new method of packing here in a pallet we have what is known as four half-slotted cartons; this is one, two, two more at the back. This piece goes across the top and it prevents the corrugations from crushing. It also ties in the box in the front and also in the back. There's about 3000 lbs. of castings there and those things are packed and they're floated in a boxcar. This gives you some idea of the ease of handling. One man carries them in the boxcar.

I might say, too, that the Fort Wayne Works saved 48 manhours in unloading the castings by the adoption of the pallet which almost paid for the pallet.

This is a boxcar showing floating loads. This is a floating load; you'll notice this 2x10 in the front, a 2x10 in the back. It's loaded away from the back of the car approximately 36 inches. This is an 1-1/4 .035 strapping and allows each one of these to float back and forth in the car; they're not fastened down at all, and all this space in here was left open. This is one of the first cars.

These are stators that are manufactured at the Fort Wayne Works. The old method of packing was wrapping them in 3 and 4 and foil and separating them with a collar across here, and then placing them in a corrugated tube with the exception of the center ones, as you see along here. The new method of packing is in a bag, vapor and moistureproof bag, using a tube,

D6a.

packing them vertically. See, they're just giving this bag a confectioner's fold and just means the stacking of these things in the pallet. I think we'll all agree that this is a much neater and more efficient job. There's absolutely no dividers; all that you see there - I might say that is expendable. The other one was not expendable - I forget exactly what the saving was but it was tremendous on that particular job.

These are rotors packed in the same manner. I can say a load like that - you wouldn't think there was very much load on a pallet as high as that is, weighs 3600 lbs. in that particular pallet. It still goes along real well.

I might tell you, too, going back to the castings that you just saw that were shipped from Elmira, Fort Wayne is using over 60% of those expendable pallets for the shipping of their motors.

This will give you some idea as to the amount of foil paper - kraft-back foil with a polyvinyl butyrate coating on it to make it moistureproof; very expensive. That's the amount that was used for the packing of one pallet load of rotors where we only use one bag as compared to this amount of foil.

Again is this honeycomb that I talked to you about. You can get this in any height up to 4 inches with a facing sheet on both sides. You can get it 10 to 12 inches high without the facing sheet. The machine that they have is still in the experimental stage and that is the reason they can only go to 4 inches. This is the way it looks when it comes out of the machine, after it has been glued. I might mention that it's manufactured by strip-gluing kraft paper. Then when the strip is out, this is the way it looks. Here is a small piece - perhaps 1/2 inch; here's an inch, perhaps here's one 2 inches. These all have facing sheets on them. I might tell you that's so strong if you get on top of it you can jump on it, just by the amount of sizing that they put in the paper. We are using it now for a lot of our packing.

There's a honeycomb pallet. This pallet was used for the shipping of capacitors from our Fort Edward plant to our Danville, Illinois plant. These legs are 4 inches high, this is an inch, this piece of honeycomb. This pallet had right around 3000 lbs. on it. The old wooden pallet weighs around 30 to 32 lbs. and this pallet right here weighs 7-1/2 lbs.

There we are using honeycomb - there's the honeycomb pallet, and here's honeycomb on the inside to protect the little leads that are on the transformers - you can't see them, but they are on there, just the same - the ones down below are - we stack one of them like that, then the rest of them the other way, so one piece is approximately 1-1/2 inch thick which protects the leads of the one at the bottom and the one at the top.

That's the way the pallet looked when we got ready to ship it. Again saving a lot in material, a lot of boxing, a lot of gluing, a lot of tape, and a lot of waste.

I thought this may be interesting to you, especially the boys who are not around Erie. This is in our Erie Warehouse - the handling of refrigerators. We have these lugs here which handle four refrigerators. Gentlemen, these are all corrugated boxes, as perhaps a lot of you know, and you know how heavy a refrigerator is. They're holding up and they're holding up in good shape. I might say there's a new handling device that's just been developed which handles six of them, instead of four. That is the warehouse. There's five-high in the warehouse; I've seen them six-high in the warehouse. But you don't see any sagging of this corrugated down below. The reason for it is due to the fact that it's properly designed in the inside with interior packing pieces; they all have corner pieces that protect it and also give it strength. These - the top and bottom cap are interchangeable; they lock in with the small flange that is on this long tube and that's where you get your strength. You can pick it up right underneath there after the thing is strapped.

This is a warehouse over at our Pittsfield, Massachusetts plant which I think shows a good job of palletizing. These are on expendable pallets and you'll notice how nice they work on the racks; pick out any one of the pallets without disturbing the others, in the event you want it. It also permits you to pack more than one model in a rack.

This is a car that was specially built at our Erie Works for the transporting of motors from Erie to Alco. The motors formerly were skidded and placed in a boxcar. These are all built on here and they're permanent. This will give you some idea here how they look. This is the old skid over here; this is all we have here is the things are strapped on there because there's no place, really, to bolt them down. Gives you some idea there; there's 16 motors to a boxcar, flatcar.

This is one of our small instruments. I think I mentioned to you that we, General Electric Company manufactures products weighing less than an ounce to many hundreds of tons. This is a small exposure meter - polaroid exposure meter. It's a very, very small complete instrument and they're comparing it to the key that you have over here. I think that a lot of you, perhaps, have seen this picture. This is the picture where we stopped traffic in San Francisco to deliver this large turbine to the Pacific Gas and Electric Company. It took four trucks to pull it and two trucks to push it. It took a special truck to hold it. There were 24 wheels in the back of this truck.

I always liked that picture for one reason: it denotes teamwork. Without teamwork they couldn't get any place. They needed every one of those trucks to deliver that. That's the type of teamwork we have in General Electric, and that's what's made the General Electric Company what it is today. That's what has made our box, pack and ship program so successful, and I'm sure that it will make your value analysis program successful.

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Thanks very much.

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The more sizing you put in it, the more it will stand up; the stronger your honeycomb is. I would say that sizing on the outside is no good. You must stack it in the inside.

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That won't affect it at all. You mean the dampness? That won't even affect it. You know you can put any kind of sizing in paper that you want to; you can make paper as hard as this floor or you can make it as soft as a piece of cotton. It all depends on how it's manufactured and it also depends on how much sizing you have in the piece of paper. We can do anything with that type of paper. I'm sorry I don't have a sample of that; I did forget it, but when I left there were three or four fellows who wanted to talk to me and I had to get out here, so I didn't bring it in. But you can actually get on top of that and jump on it. It's not going to go down.

.....

It costs at the present time 25¢ a lb. A pallet 40 x 48 with 6 legs under it like that I think will cost you \$1.20, f.o.b. Hudson Falls, N. Y.

.....

We're limited by the freight classifications. The heaviest motor we could possibly pack would be 140 lbs. But when you start doing that the amount of paper it takes to really protect the motor is far more expensive than it would be, in a lot of cases, if you were to put it in a wirebound box.

.....

I do know, as I mentioned there, that we do have a 100 HP motor that is now in a wirebound box and has been shipped successfully.

.....

Well, there's a breaking point there; it depends upon what you do, whether or not you can get this cost down. We've been able to do it in lots of cases.

.....

We're using a lot of galvanized wire in wirebound boxes successfully.

.....

Wirebound boxes and galvanized wire has proven very successful even in Government shipping, where they're stored any place in the country and it has been approved by the Armed Services, so the chances are we're getting an inferior grade of wire. That's the story, probably.

.....

Wirebound boxes have been used for export, yes, if they're good galvanized wire, I would use it. There's different types of wirebound boxes and different types of closure. In an export job you'd want to get one that has what you call the twist closure so that they cannot be pilfered. That's one of the things we're bothered with on all of our export shipments, pilfering.

.....

I think the engineering department certainly should go along with you on anything that you want to do. Of course, there are a lot of things you've got to take into consideration, but the engineer certainly knows his product and he should follow that right along with you and he should at least go along with you on the idea. I'm thinking about other things; if you're just putting it on skids and again putting a band around it to keep it corrugated, do you have some means of stacking it?

.....

At Davenport, Toronto, you're going to have a new coordinator with the Canadian G.E., Joe Collins is going to take over. I've been at your Davenport plant a couple of times. I just don't know your problem offhand, but I can tell you one thing about the Canadian General Electric Company. You're getting by with a lot of things we can't get by with in the States. I don't know why; you have an inferior grade of paper; believe it or not, even though you're paper-makers in Canada, you don't have too much sulfate; you have a lot of jute paper in Canada.

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The honeycomb depends on how far you want to stretch. You can pull it out, the closer it is the more strength you're going to get out of it.

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It certainly has a lot of applications in manufacturing.

They're taking that material right now and experimenting with it with pieces of aluminum on both sides for airplane floors. I just saw a piece yesterday that had a piece of masobite on one side and a piece of nice plastic on the other; they expect to make little squares for ceilings and like that.

.....

Miles: Can these fellows consider you on their team? In other words, can they phone you from Canada or Podunk or Danville or anywhere at any time?

Vogt: I'd love it, Larry, any time that I can ever be of any assistance to them.

Miles: In other words, Paul, you know he's with you from now on.

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Vogt: Right. Anything that you have. My address is: Paul Vogt, Bldg. 36 - Manufacturing Services Division - Room 209. There's one thing you must remember, gentlemen: Packaging has nothing to do with the quality of your product. Packaging has a whale of a lot to do with the quality at which your product is delivered. We want to get everything out of it we possibly can.

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Pittsfield is using it, at the present time, West Lynn is using it on meters, and we're using some down in Control, at the moment.

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It can be purchased from the Union Bag and Paper Company, Hudson Falls, New York. Mark your letter for the attention of Mr. B. K. Clifford.

.....

There's a lot of BPI being used in the Company. These rotors and stators that you saw have 2 or 3 pieces of BPI in there and it worked out very good. We just got through making a test with BPI and one of those 48-day-cycle tests proved very good. We've used it in three different ways: We had a grade A bag - grade A bag is one that is lined on the inside with a neutral sheet of paper, then it has the kraft sheet on the outside. We put BPI in that and run it through the 48-day-cycle test. Then we've used the regular metal-foil bag and heat-sealed that and ran that through. Then we used what is known as a flip-cover can with a piece of paper on it and we did a punk job just to see what might happen with that job, because that was the only thing that would actually hold water. So we ran through the 48-day-cycle test and both of the bags came through in fine color; the parts were in excellent shape. In the cans, we had water and not a thing happened until that water started to evaporate. At that time it took off the gas, the paper pours out at the time when it has to really start to do the job. But there's a report coming out of my office within the next week; it's going to all packaging men stating exactly what we found out in these 48-day-cycle tests.

.....

We have here in Schenectady a small packaging and testing developmental laboratory. We are moving this laboratory into quarters about three times as large as the quarters we have today. We will have in this laboratory a vibration tester, a convoy tester, a drop, sample-making machine, a compression tester -- where we can simulate any kind of road test that you may want us to simulate. We are following the what is known as the ASTM Standards, which is the American Society for Testing Materials, and we have found them to be adequate. Today we are receiving many, many packages, redesigning them; we encourage all of you to send your packages into our testing laboratory. I might tell you that the testing laboratory is on Erie Boulevard,

D11a.

the new one will be over on Erie Boulevard. We'll be very glad to evaluate any product that you might want to ship us as far as testing is concerned, and evaluate the package as to carrying. In other words, we simulate the same action that they would get in boxcars-instead of making a 30-day road test we can do that in about 3 or 4 hours and it'll be over with; some won't take that long.

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You do at the present time use an expendable honeycomb pallet. I don't know whether Underwood or Wakefield would take care of that or not. I would suggest trying one of the honeycomb pallets. There are two box-making machines in General Electric Company. This box making machine is a very good thing where you have small quantities. You can build up to 2000 and save money. I hope to see more of them in General Electric.

Where we pay an average charge of \$10.00 for set-up charges, for the box-makers, this machine can be set up in a minute and a half, for any size box. I've seen it done many times. I think the Fort Wayne Works has it over at the West Lynn Works on printing. We have a very efficient printing operation at Fort Wayne.