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Nonstatistical Skills That Can Help Statisticians Be More Effective

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Nonstatistical Skills That Can Help Statisticians Be More Effective

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ABSTRACT

The new economic era we live in has resulted in a variety of new work situations for statisticians. Many are asked to be a member of a team that involves several different functions of the organization. Statisticians are also asked to work with groups in nontechnical areas. These groups tend to have less experience with data-based problem solving methods but, nonetheless, are working on problems critical to the success of the organization. Many statisticians have the opportunity to work with mid- and upper-level managers. All of these opportunities require new skills in addition to our statistical skills. Some of the more widely used skills and methods that can help statisticians become more effective are discussed. It is also shown how these new skills have much in common with statistical thinking.

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The new economic era we live in has resulted in a variety of new work situations for statisticians. Many are asked to be a member of a team that involves several different functions of the organization. Statisticians are also asked to work with groups in nontechnical areas. These groups tend to have less experience with data-based problem solving methods but, nonetheless, are working on problems critical to the success of the organization. Many statisticians have the opportunity to work with mid-and upper-level managers. All of these opportunities require new skills in addition to our statistical skills. Some of the more widely used skills and methods that can help statisticians become more effective are discussed. It is also shown how these new skills have much in common with statistical thinking.

1. TODAY'S REALITIES

Today's rapidly changing world is creating new opportunities, challenges and demands on each of us. Global competition is forcing changes in all aspects of our society including business, government, education and health care. Customers are demanding more. They want, and deserve, better products faster and at less cost, delivered with more care. We have to change how we manage all aspects of our organizations if we are to meet these challenges successfully.

This need to change is expanding the use of statistical thinking and the role of statisticians. The expanding role brings with it the need to develop new skills to take advantage of the opportunities. In particular, statisticians will need to develop a variety of nonstatistical skills. Hoerl et al. (1993) identified five key "Nonstatistical Survival Skills":

- Understanding Total Quality Management philosophy,
- Developing knowledge of the economic and technical aspects of the business,
- Organizational development skills,
- Consulting skills, including communication, and
- Teaching skills.

Each of these skills is essential. This article identifies other nonstatistical skills that can help statisticians be more effective in today's environment. The skills identified fit well with statistical tools and methods and statistical practice in general. The use of these skills is, of course, optional. It should be recognized, however, that failure to become proficient with these skills can greatly reduce the impact of statisticians. Stated bluntly, those who fail to broaden their skill base run the risk of significantly reducing their value to their employers.

This article begins by identifying the new trends that are affecting statisticians and the increased demands associated with the trends. Next, key skills that statisticians can use to deal with these demands are examined. The article concludes with a discussion of the links between nonstatistical skills and statistical thinking.

2. TRENDS AFFECTING STATISTICIANS

A major change affecting statisticians is the need for organizations to improve their performance. This change has placed enormous emphasis on the need to use data effectively throughout an organization, and has led to numerous changes in the worklife of statisticians. Some trends associated with this change include the following (see also Table 1):

- The statistician's role is expanding from one-on-one consulting with an individual client to working with the whole organization. Thus a new dimension "The Organization" has been added to the work of a statistician (Snee, 1991). The statistician must be able to assess the organization's readiness to adopt new practices, and be able to provide guidance on what kinds of training and education will help increase this readiness.

- Teams are being used with increasing frequency, many of which are tackling ever-larger and more complex problems. Expert statistical guidance is essential to solving such problems. Furthermore, many teams are cross-functional in nature, and often the members of teams have never worked together before. As a result, statisticians find that many teams have complex organizational and interpersonal issues that must be worked through if the team is to accomplish its goals. Working together effectively is a skill that must be developed.

- As improvement efforts and teams become more commonplace, statisticians are moving outside of their traditional areas of expertise such as research, development and manufacturing. They now find themselves working with all business functions. The people they encounter in the nontraditional areas typically have less technical savvy and training. The language and concepts of measurement, data, plotting, math, etc., are by and large unfamiliar to these new audiences.

- Statisticians are also finding themselves working with more managers at all levels in the organization. The statisticians thus get involved in strategic and managerial issues in addition to improving operations, which until recently has been the main use of statistical thinking and methods.

- The work of the quality improvement teams and managers is to improve the organization to help make things better. As a result statisticians find themselves working with *ideas* on how to improve (soft data) as opposed to hard data. As a member of a team, it is the statistician's responsibility to help the team analyze the collection of ideas to identify the key needs of the organization and what changes should be made.

Having to focus on the organization as a whole and all its separate departments, working with teams and managers who face complex nonstatistical issues, and dealing with ideas in addition to hard data require new skills. Informal problem-solving approaches used by many statisticians do not work well in this new environment. Statisticians should not lose sight of their traditional role as experts in the design of studies and the collection and analysis of data. Instead, they must integrate the new skills with their statistical skills and create new approaches to working. This will result in statisticians making greater contributions to the organization.

TABLE 1. TRENDS AFFECTING STATISTICIANS

From		To
One-on-one consulting	→	Working with teams
Being an expert	→	Member of cross-functional teams
We help others improve	→	We help others and improve our own organizations
Work with R&D and manufacturing	→	Work with all functions
Work with professional staff	→	Work with professional staff and management
We solve problems	→	We improve organizations
Work with data	→	Work with data and ideas

3. NONSTATISTICAL SKILLS FOR STATISTICIANS

Some fundamental nonstatistical skills that can help statisticians respond to the trends discussed in Section 2 and Table 1 are detailed in Table 2. This list is not complete but summarizes some of the broadly useful, effective methods. Each of these skills is discussed below. Further details on these methods and other useful tools and methods are contained in the books by Brassard (1989), Doyle & Straus (1982), GOAL/QPC (1994), GOAL/QPC and Joiner Associates (1995), and Scholtes (1988).

Table 2.
Nonstatistical Skills for Statisticians

- •Leading teams and dealing with group dynamics
- •Problem solving methods
- •Project planning and management
- •Finding structure in ideas
- •Education of diverse groups

3.1 LEADING TEAMS AND DEALING WITH GROUP DYNAMICS

Statisticians are often asked to advise improvement teams. In this role they work with the team and team leader on project planning, training, and coaching, and they intervene with the team's work when needed.

One skill essential to effective teamwork is the ability to run effective meetings. This includes defining a purpose, identifying desired outcomes and developing an agenda for every meeting. It is also important to recognize the three phases of a meeting: before, during and after. Each phase serves a different purpose, and each is necessary to achieve a well-designed and implemented meeting that produces the desired results without wasting participants' time. Well-designed and run meetings help the team work together more effectively.

Another set of skills revolves around effective decision making. Most often, it is best for the team to push for consensus — meaning that all team members will actively implement and support the decision even if they aren't all completely comfortable with it. Sometimes it's not possible, or perhaps even necessary, to reach consensus. In such cases voting may serve the purpose. Voting is especially useful in exploring issues and quickly finding out how different people feel about an issue. A useful strategy is to use voting to reduce the number of options the team faces and then use discussion and consensus to reach a final decision.

Facilitation is yet another useful skill. To facilitate means to make the work of the group easy. Facilitation is often thought of in the context of meetings, where it can mean anything from helping the team move efficiently through the agenda to helping resolve group conflicts.

3.2 PROBLEM SOLVING METHODS

Statisticians pride themselves on their ability to solve problems. Indeed problem solving is the focus of much statistical work. Statisticians can do two things to improve their effectiveness as problem solvers: spend more time on the implementation of solutions and provide clients (particularly teams) with methods for solving problems.

When working with an individual client, statisticians rarely think about the formal approach being used. Generally speaking, the client and statistician work together to identify the problem and the needed data. They may also collaborate on the collection, analysis, and interpretation of the data. This leads to solutions for the problem or identifies the need for more data to be collected. The implementation of the solution is generally left to the client, the person who brought the problem to the statistician.

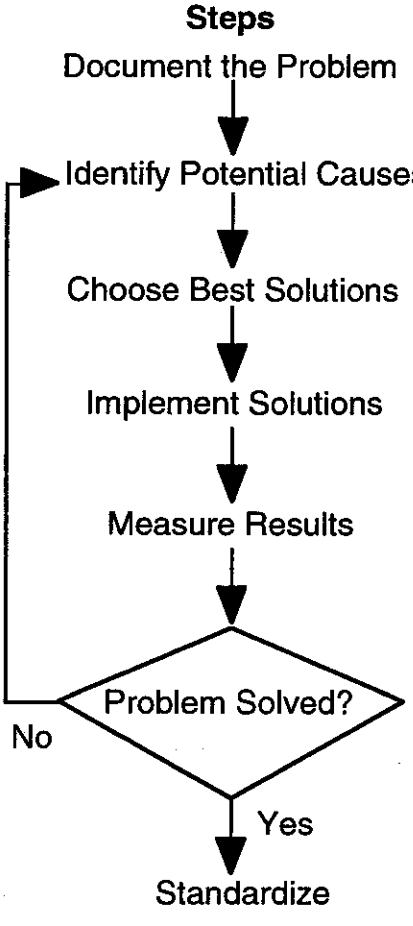
This informal approach has two key limitations. First, most of the attention goes to problem solution, much less to problem identification, and little if any to implementation. Second, this informal approach often does not work well with groups. Let's examine each of these issues in more depth.

Problem solving has three main phases: problem identification, problem solving and solution implementation. Following the Plan-Do-Check-Act (PDCA) cycle, solution implementation also includes checking the effectiveness of the solution and adopting the solution as standard practice when it is deemed effective. Successful implementation is essential to the project's success and must be part of the problem solving process.

In many cases, however, the client comes to a statistician looking only for help developing a solution. This can lead to solving the wrong problem if it was not properly identified in the first place. It also may result in too little attention being paid to the implementation of the solution by statisticians. We often hear the comment that "we did some good statistical work but it was not used." Statisticians must pay more attention to the implementation phase if their work is to be effective and have impact.

The second limitation of the informal approach to problem solving used by statisticians is that it doesn't work well with groups. Teams function best when their thinking is aligned in a common direction. Using a common problem solving methodology helps achieve this alignment. Everyone can see what needs to be done and where the team is in the problem solving process.

Figure 1: Problem Solving



Sample Tools

- Checksheet
- Pareto Chart
- Control Chart
- Run Chart
- "Is/Is Not" Analysis

- 5 "Why's"
- Cause-and-Effect Diagram
- Interrelationship Diagraph
- Scatter Plot
- Experimental Design
- Stratification

- Brainstorming
- Multi-voting
- Affinity Diagram

- Checksheet
- Pareto Chart
- Control Chart
- Run Chart

- Flowchart
- Procedures
- Training

The PDCA cycle is a more formal approach to problem solving and is useful in those situations where the solution or end result is known but considerable planning and work must be done to implement the solution. The PDCA cycle gives the team a process to guide their work. It also makes the important check and act steps an integral part of the work. Becoming skilled in PDCA can help a statistician understand and predict what a team should be doing and when in order to achieve its purpose.

There are many other structured problem solving processes to choose from. A key requirement is that the process include all aspects of the PDCA cycle. The main point is that it's important to use a problem solving process. It is less critical which particular process the team uses. One useful process is shown in Figure 1. Other effective processes are discussed in the publications by Joiner (1994), Gaudard, Coates, and Freeman (1991), and the Xerox Corporation (1993).

Another key mindset that enhances problem solving is that of focusing on the problem solving *process* and bringing in the tools as they are needed. This approach is contrary to the more common approach of selecting a tool (e.g., time plots, frequency plots, scatter plots, etc.) then trying to figure out how to use it. This latter approach generally leaves people confused as to what tool to use under which circumstances.

Integrating the tools into the problem-solving process creates clarity around the need for and use of

the tools. Figure 1 shows some of the key tools used in the different steps of the problem solving process.

Two other skills that are generally useful in problem solving are brainstorming and flowcharting. Brainstorming is used to generate ideas about what actions to take or issues to consider, such as thinking up possible solutions to a problem (Figure 1). The process enables the group to utilize its creative energies and gets everyone involved.

Though brainstorming is generally used in working with groups, it is also useful in individual work. Writing down all your ideas on a subject without critical review until the list is complete is an effective way to identify and organize one's thoughts on a particular issue.

Flowcharting a process creates a useful picture of what happens, in sequence (see Figure 2). Creating a picture of the process is an important step in problem solving because it helps people visualize the process steps and identify trouble spots The flowchart also helps the team understand the context for the work to be done and what role they play in the process. Flowcharting is particularly effective in non-manufacturing situations in which it is difficult to see the process in operation. Flowcharting is also, of course, key to understanding and controlling manufacturing processes.

One team commented, "Working with the flowchart as a focal point made it easier to make changes in the process. We were not questioning each other's purpose or job; we were all looking at a common process and trying to figure out how to make it better. Flowcharting helped to de-personalize and de-departmentalize the process."

3.3 PROJECT PLANNING AND MANAGEMENT

When two people work together (e.g., statistician and client) informal planning is usually sufficient to guide the work. As more people are involved the projects generally get more complex, larger in scope, and require more time to complete. This results in the need to carefully plan the work of the group and to set up a system to monitor progress relative to the plan.

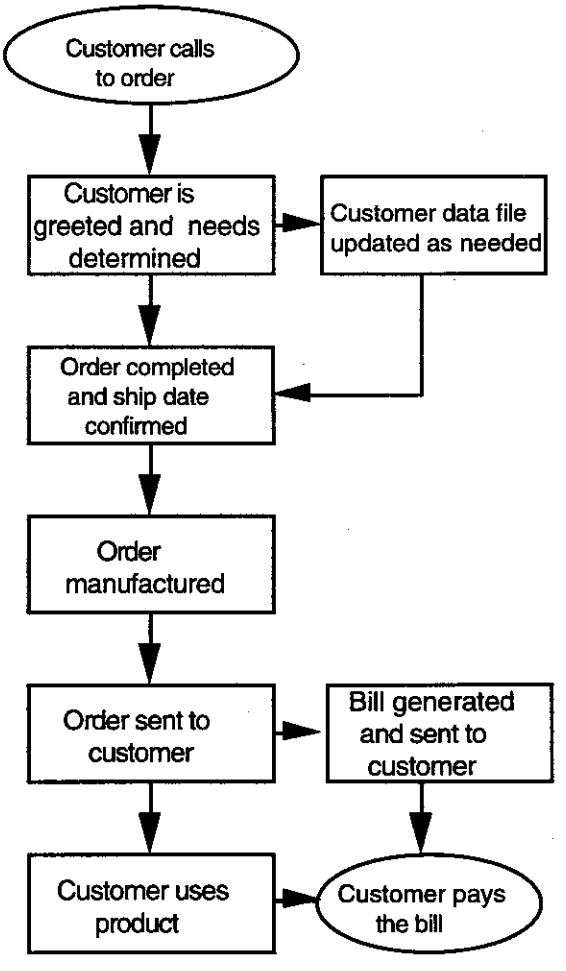
The project typically begins with some type of planning work. It is often pointed out that you should "plan the work and then work the plan." Paraphrasing John Wooden, renowned UCLA basketball coach, "Failing to plan is planning to fail."

Planning can be done in many ways, with the end result being a sequential list of blocks of work that need to be done to satisfy the goals and objectives of the project. One possible process is for the team to brainstorm the blocks of work that need to be done. This list is refined, put in sequential order, and start and completion times determined. The plan is periodically reviewed during the life of the project and revised as needed.

Three tools that are useful in creating the plan, visually displaying the plan to all interested parties, and monitoring the progress of the work versus the plan are the basic flowchart, deployment flowchart, and Gantt chart.

The basic flowchart displays the key blocks of work that the group needs to accomplish. Typically, the project plan is at a high level noting the 4 to 10 key blocks of work and the sequence in which they are to be done. An example of a plan to develop a sampling process is shown in Figure 3.

Figure 2 - Customer Order Process



The deployment flowchart visually displays these key blocks of work in two dimensions: sequence and responsible person or group. The result is a visual display of "who does what, when." The deployment flowchart of the project plan shown in Figure 3 is displayed in Figure 4.

The basic flowchart and/or the deployment flowchart are useful to get agreement on the work to be done and responsibilities and as a periodic check on progress. The Gantt chart is useful for monitoring progress. The Gantt chart is a two-dimensional display with the sequenced blocks of work running down the left hand side of the chart and the projected start and completion dates for each block of work running across the page (see Figure 5). The Gantt chart is typically reviewed at each team meeting and revised as needed.

3.4 FINDING STRUCTURE IN IDEAS

When selecting improvement projects, searching for solutions to problems, creating strategies, etc., by brainstorming or other methods, one ends up with a long list of ideas. This is particularly true in dealing with management issues where hard data are often not available, and a team's perception and views are used to chart direction and solve problems.

Ideas can be thought of as soft data. Just as a statistician can find structure in a body of hard data, one can find structure in a list of ideas. Given a list of n ideas, it is rare that all n ideas are independent. Typically, there are only a "vital few" key ideas in the list. The ideas are frequently interrelated with some ideas representing causes and others describing effects. Two tools that can help analyze a list of ideas for structure are the affinity diagram and the interrelationship digraph (Brassard 1989).

The two tools are used in the following way. The affinity diagram is used to group or cluster ideas. The ideas are written on cards, one idea per card. Ideas that are similar in nature are clustered together. Each cluster is studied to identify the key theme of the cluster. This theme becomes the "header" for the cluster. It is not uncommon for a group of 20-30 ideas to be grouped into five or six clusters. The headers for the clusters identify the key themes or dimensions in the group of ideas. This structure is further studied for "cause and effect" using the interrelationship digraph.

The interrelationship digraph is constructed by placing the "headers" in a circle and using an arrow to show which headers are linked to and "cause" the other headers to happen. There may be no links between some headers. Each arrow can have only one head – two-headed arrows are not allowed.

After all the links have been identified, each header is labeled with the number of "In" arrows (effects) and "Out" arrows (causes). The headers with the largest number of "Out" arrows are the key causal ideas (also called drivers).

Figure 6 shows the interrelationship digraph for "reasons why statistical thinking is not used today" constructed by the Statistical Thinking Group at the 3M Company (Hare, Hoerl and Snee, 1995). The nine headers were obtained from an affinity diagram of a much longer list of reasons.

A study of the "In" arrows and "Out" arrows shows that there are two key causal factors: "Fear of technical tools and methods" and "people have competing priorities." Each of these headers has 0 "In" arrows and 5 "Out" arrows. This analysis indicates that these two issues must be addressed if people in the organization evaluated are to make greater use of statistical thinking.

After experiencing the use of the affinity diagram in the interrelationship digraph, one will not likely be comfortable in the future discussing a long list of ideas or items. There is almost always some structure to be found that will provide insight and simplify the interpretation.

Figure 3 - Flowchart of Sampling Process Design

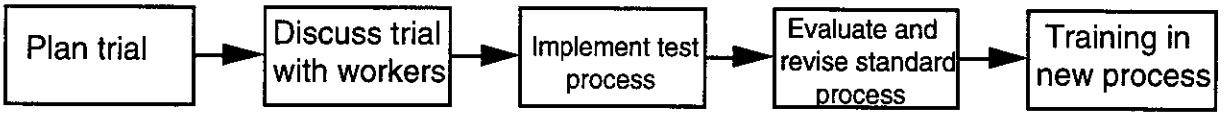


Figure 4: Deployment Flowchart of Sampling Process Design

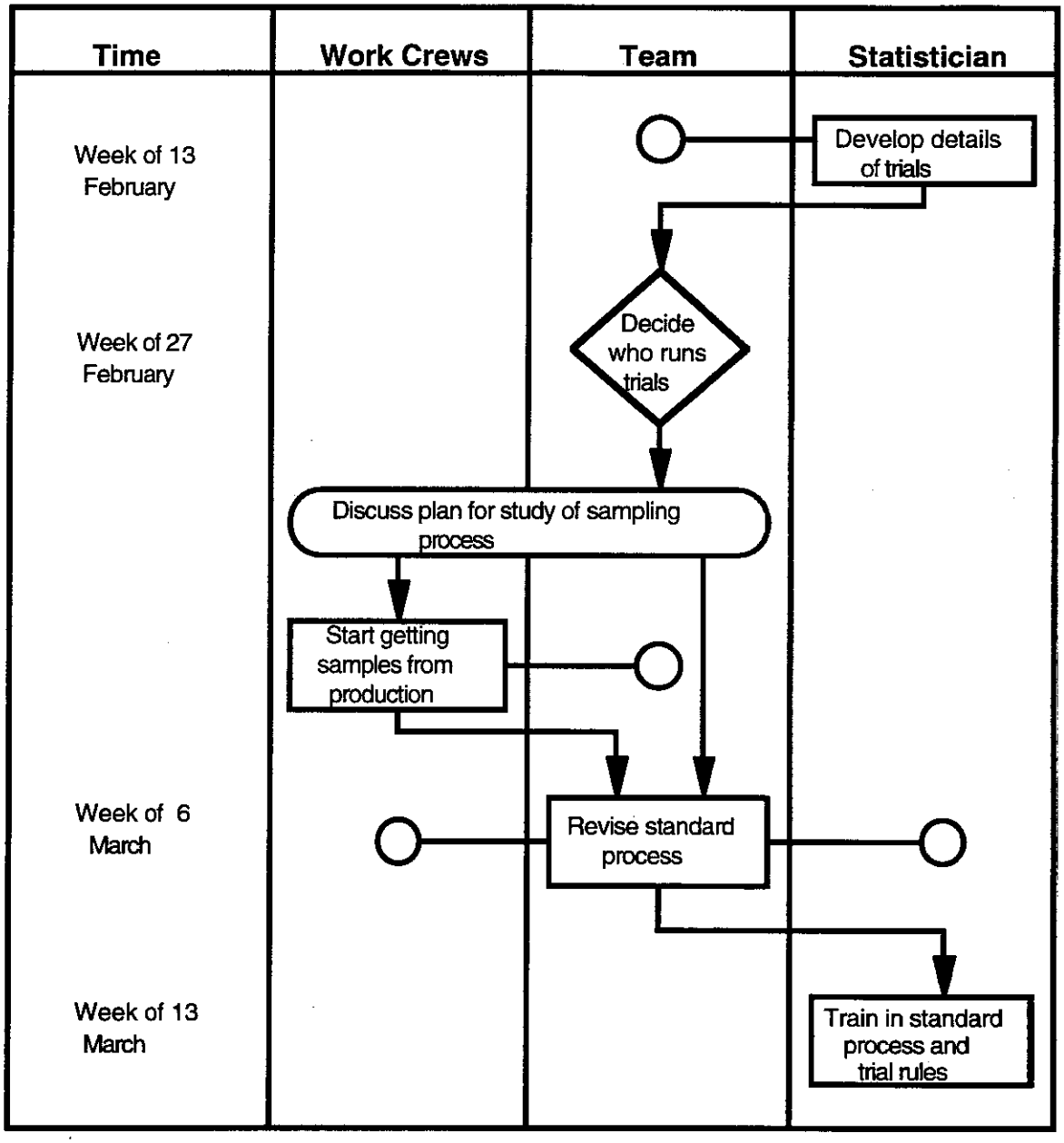


Figure 5 - Example of Gantt Chart

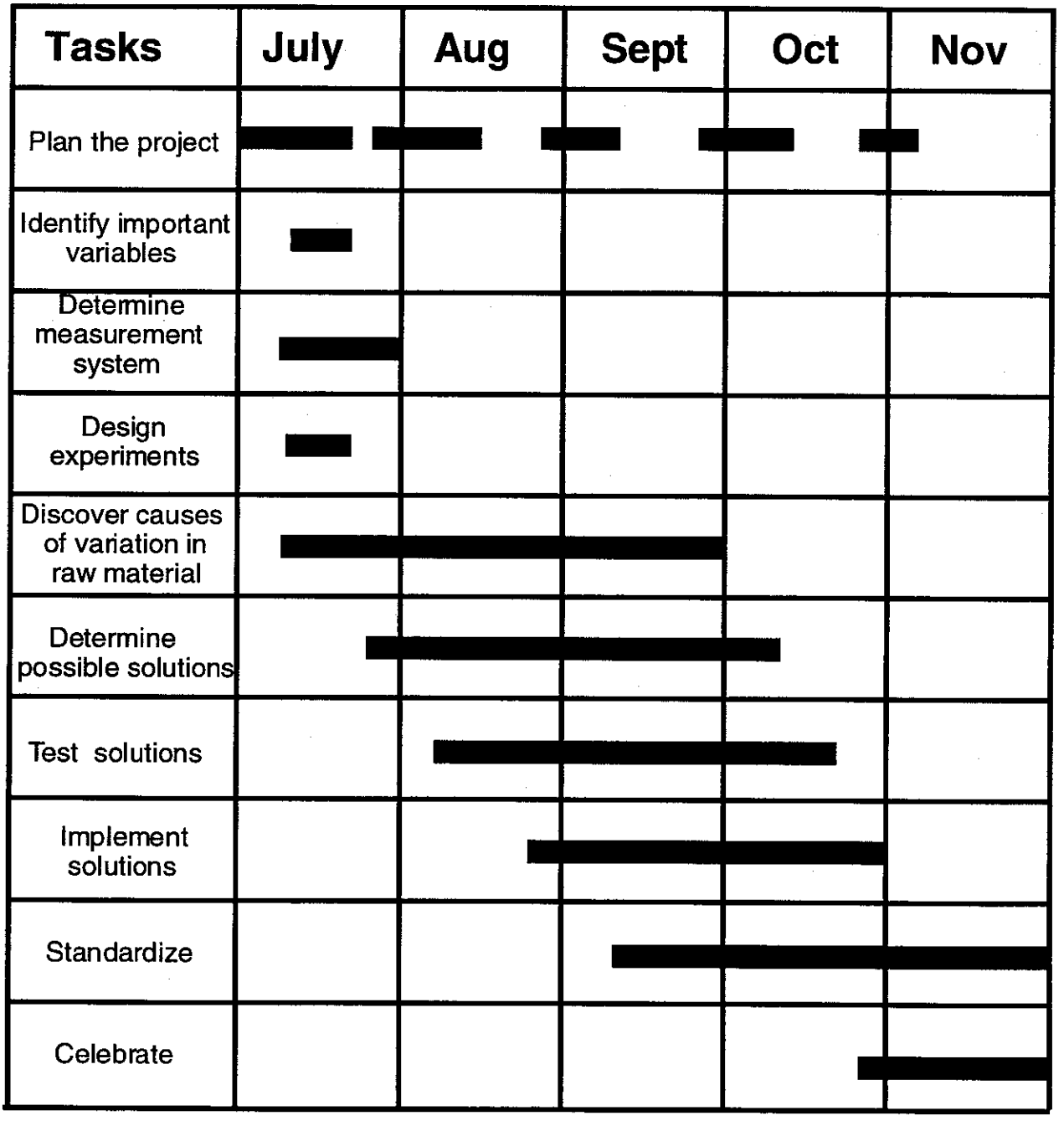
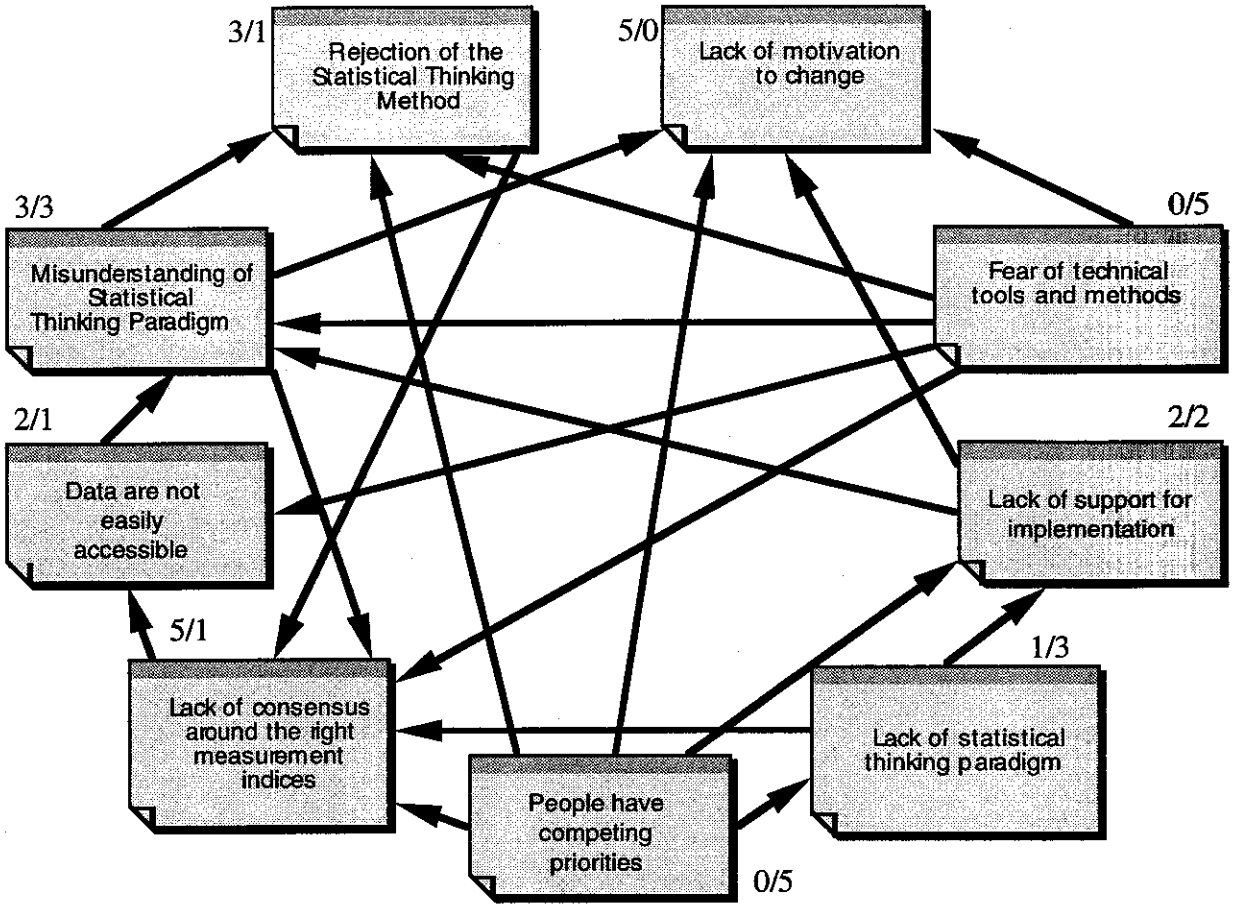


Figure 6 : Reasons Why Statistical Thinking is Not Used



3.5 EDUCATION OF DIVERSE GROUPS

Education and training is an important activity for statisticians. Indeed Hoerl et al. (1993) indicated that effective training skills are critical to the survival of statisticians. It should be recognized that the participants in educational and training events have diverse backgrounds, perhaps even more so than ever before as the use of statistical thinking expands. The participants have different experiences, different needs and different learning modes. Our educational and training approaches should take these differences into account.

Behavioral scientists and educational researchers have found that people take in and process information in different ways (Herrmann 1989, Markova 1991). People have different preferred learning styles. Many of these differences are related to how we use the left and right sides of our brains.

Herrmann (1989) identified four learning styles. Some people learn by their feelings, hence the learning experience must be personalized for them (nurses, teachers, sales persons). Some need facts to learn and enjoy analyzing, reading texts and studying theories (lawyers, engineers). A third group needs form of structure to learn (accountants, administrators). They enjoy details, learn by testing theories and appreciate guided practice. The last group is future orientated, thinks holistically and intuitively (CEOs, artist, entrepreneurs). They need opportunities to be creative and to transfer knowledge into their field of study.

Much more could be said on this subject. It suffices to say that statisticians will be more effective if they recognize that different people work and learn in different ways. Designing meetings, team endeavors, and educational and training events that take these differences into account will make the work more effective and increase its impact. Further

discussion of educational approaches that take different learning patterns into account can be found in Hoerl and Snee (1995) and Snee (1993).

4. LINKS TO STATISTICAL THINKING

At first glance many of the skills and tools discussed in this article may appear to be outside the field of statistics. Deeper analysis reveals however that many of these approaches have links to statistical thinking. Some examples are summarized in Table 3.

Table 3 - Links to Statistical Thinking

Method/Tool	Link
Affinity diagram	Cluster analysis
Meeting design	Process thinking Reduce variation Create alignment
Ideas	Soft data
Structure in Ideas	Modeling
Learning styles	Variation
Interrelationship digraph	Cause and effect modeling

The affinity diagram forms clusters of similar ideas, hence a link to cluster analysis. Constructing an interrelationship digraph is a form of cause-and-effect modeling. Designing a meeting with a purpose, outcome, and agenda, uses process thinking to reduce variation and create alignment (agreement) on needed actions. Ideas can be thought of as soft data. Searching for structure in ideas is a form of modeling. Finally, recognizing differences in learning styles is understanding variation and designing events that compensate for that variation. Many of these skills may be considered "low tech" but are nonetheless effective. In the end our goal is to be effective.

So we have come full circle. We started out discussing nonstatistical skills and found that the skills discussed are in fact linked to statistical thinking. The major difference being the absence of hard data. Much work is not centered around hard data. Statisticians will have to deal with this reality if they are to expand and increase their impact.

MY MESSAGE

My message is quite simple. In order to improve their performance, organizations are adopting new approaches to management and operations. These new approaches are expanding the use of statistical thinking. New skills are needed if statisticians are to take advantage of these opportunities. Statisticians must be able to deal with group dynamics, provide teams with problem solving methods, effectively plan and manage projects, analyze ideas as well as data, and effectively work with and educate groups that have diverse backgrounds and learning styles.

My message is much easier to state than it is to implement. Personal learning and change is required. Change is always difficult and painful. Someone once said that the only person who enjoys a change is a wet baby. Ignoring the opportunities presented by the new economic era we live in may result in even greater pain. We have to learn to work in a new way.

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