Title: Quality in Research

Course:
Year: 1993
Author(s): S. Bennett

Report No: P93039

Abstract: This paper discussed many issues, such as: what is quality research, the pros and cons of implementing quality in R&D, implementing quality in research, possible other areas of application, and suggested improvements and trends.

QUALITY IN RESEARCH

Sheila Bennett

EMP9339

Sheila Bennett
EMGT 610
06/04/93

QUALITY IN RESEARCH

INTRODUCTION

> *"As it has since World War II the U.S. continues to dominate every other nation in the annual research and development (R&D) spending race. U.S. companies plowed $70 billion last year into their technological future. However, once again overseas rivals outpaced the U.S. in spending growth. The worldwide slump and increasing global competition are having other effects on R&D spending. Everywhere, the goal is to pick the right projects - and accomplish more with less."*(1)

In the past, the U.S. had dominated the world in R&D investments. In 1960, the company slogan for 3M was "Research is the Key to Tomorrow". (2) 3M is an example of an American corporation that has historically prided itself in quality research. The healthy state of the economy that the U.S. had enjoyed after World War II, allowed firms to *invest liberally* in R&D. But the world is changing. International competition is increasing. And the recent trend has been for American corporations to invest less in R&D. Research may be the key of tomorrow's success, but with less money the quality research of the past is not the quality research of the future. The linear organizational approach of technology transfer of R&D products is giving way to an integrated efficient approach where R&D plays a part in defining the corporate mission, satisfying customer requirements and enhancing profits.

WHAT IS QUALITY RESEARCH?

Applying quality research in the planning, research design, and implementation stages of R&D certainly has it's advantages. But if not applied successfully, there can be some negative results. But before the advantages and disadvantages can be explored, quality research must be defined.

What is quality research?

George Roberts of Babcock Wilcox Research and Development Division states it this way: *"Quality R&D projects accomplish the defined objective of the research in a manner which is correct and reproducible and efficient in budget and schedule."* (3)

But there is more. Research quality is striking a balance between control and creativity. To design and implement research, within the minimum time period, that benefits the corporation's mission while meeting customer requirements is control. Yet successful

1 *R&D Statistics*, Business Week/Quality 1991, pg 169.

R&D must begin by fostering a creative environment that stimulates ideas. Roger Miller of the University of Quebec Montreal attempts to address this need for balance by defining quality research this way: *"To select and perform R&D projects that will maximize R&D investment returns and to create an R&D working environment that is open and flexible to discussion and debate and to enhance creativity and improved decision making."* (4)

When the balance exists, implementing research quality results in distinct advantages that competitive organizations are seeking: satisfied customers, complete, accessible and transferable information, reduced cycle time from conception to finished product and a satisfying work environment. (4)

When an imbalance exists, the disadvantages become possible. A serious drawback is when too much emphasis is placed on reducing cycle time. This can result in a reduction of quality caused by "rushing". This perceived time crunch could also constrain creativity and innovation. Also, R&D is characterized as non-recurring, therefore statistical methodologies originating from manufacturing experiences are not readily applicable, making a consistent measurement of "quality" a challenge. (5)

THE PROS AND CONS OF IMPLEMENTING QUALITY IN R&D

The primary **advantage** of implementing quality R&D is enhanced corporate competitiveness. Integrating R&D into the overall corporate mission and long term goals is essential for efficient coordination of organizational efforts. Through proper planning the customer needs are identified and the research is designed and implemented with scientific rigor and conformity to the customer specifications. The R&D product is used by the internal or external customer in support of the corporate mission.

Identifying and satisfying customer requirements is critical, but money is not made unless markets are penetrated and secured. Competitive organizations that respond sooner to the customer needs with a quality products are at an advantage. Quality research when applied successfully, can reduce cycle time from conception to finished product.

But perhaps the greatest challenge for any quality R&D manger is to create a stimulating work environment that fosters ideas. An environment that encourages debates, addresses issues and confronts controversy provides the spice for stimulation.

The primary **disadvantage** of implementing quality research is that quality costs money and time. A reduction in time and money works against quality. An increased demand on speed and efficiency may causes low concern for quality. This is why the *balance* is essential for success to be reality.

Another disadvantage is that doing more with less may constrain creativity and innovation. Research activities are characterized by a high level of uncertainty. Unfruitful avenues are

often explored. To consider these efforts as unproductive and to label them as costs to be avoided would be inappropriate since R&D by nature cannot be constrained to fruitful avenues only. Also, tying research too closely to business units and focusing it tightly on product development may constrain innovation. As a rule, about 1 in 20 product ideas from basic research to get to market. (5)

In a nonreoccuring environment, quality is most difficult to measure when statistical analysis methodologies can not be used. Good work is an subjective assessment - "good" or "bad" is defined in the context of current business requirements in terms of data accuracy, timeliness or significance of the information conveyed. Also, measurements of customer satisfaction levels are fundamentally subjective.

IMPLEMENTING QUALITY IN RESEARCH

There are diverse methods of implementing R&D in the work place during planning, research design, implementation, technology transfer and evaluation, but all require strategic thinking and efficient processes in project management. The choice of which quality management practices to use is influenced by the context in which R&D is being performed and the firm's position in relation to its suppliers and competitors.

The Planning Stage

Quality planning means integrating R&D into the overall corporate activities, goals and objectives so that R&D may influence the corporation's direction and product development efforts. Effective planning requires interaction with the market place. Each product possibility must pass the test of commercial possibilities. Using a list of what is expected and working toward meeting those expectations is an efficient way to plan.

In the planning stage understanding customer requirements and identifying specific goals that reflect those requirements is the basis of the research design. For example, the key to Alcoa (the world's largest aluminum producer) success was a fundamental change in how it does R&D planning. Using interdisciplinary team of experts from R&D, manufacturing, sales and marketing it custom-tailored its product and processes to make the sale to Boeing when it was planning the 777. Alco had awaken to the reality that R&D can no longer be done in a vacuum, but rather must be planned to respond to internal and external clients. (5)

Most problems are caused by inadequate planning and lack of understanding customer requirements. Problems can be minimized by first listening to the customer. Simple communication problems can be cleared up that relate to existing performance specifications or processes that have been communicated unclearly in the past. Secondly, engage in discussion with the customer face-to-face. This enhances communication and

leads to the third step, development of a partnership with the supplier where both sides recognize the benefits of open and clear communication. (6)

The planning process is part of an ongoing effort for improvement. The Plan, Do, Act, Check (PDAC) cycle is used for planning, execution, verification, and correction. Therefore, the planning phase is a dynamic process that supports improvement of the final product.

Flow charts are an excellent tool to graphically display the control sequence of events for a particular process. Objectives, inputs and outputs to the process are identified to establish the requirements of the process. Flow charts are useful in coordinating multifunction or multidivision communication when integrating processes or adding new processes to established new ones. It is a flexible tool to support changes resulting from implementing the PDAC cycle. Flow charts can model a process as it is or as it could be. (7)

Research Design

The research design begins with development of the project objective and research questions by an interdisciplinary team. In addition a survey of clients can be performed. IBM annually conducts and outlook based partly on interviews with top customers to determine what the market will want 5 to 10 years ahead. (8) Using bottom up participation of technicians and scientist who perform experiments but do not necessarily design research programs is helpful to get input about the commmercial viability of the proposed research project.

An effective research design tool is the Taguchi's philosophy which involves the entire manufacturing function from design through manufacture. Taguchi describes quality in terms of the loss generated by that product to society. The customer's loss due to a product performance variation is often approximately proportional to the square of the deviation of the performance characteristics from its target value. Thus a quality measure quickly degrades with large deviation from the target. The Taguchi methods attempt to design products that are robust to variation in the manufacturing process. (9)

As part of the research design data definitions need to be defined, levels of accuracy, timeliness, methods to maintain database integrity and other data characteristics.

The Pareto analysis is based on the 80-20 rule, which states that few of the causes often account for most of the effect. The Pareto chart makes clear which vital few problems (causes) should be addressed first. Pareto's principle should use data that reflects total costs or total time expended. (8)

Implementation

During the implementation phase correction action teams and interfunctional assessment teams are an effective tool when applying the PDAC cycle.

Correction Action Teams are used to solve problems that slow innovation and development.
The correction action team's primary action is in reaction to a situation. The members are internal to company and the focus is single-task and short term. Although many variations of the team type exist it requires communication, conflict resolution and increased cohesion and commitment among group members. (7)

Interfunctional assessment teams perform a function by function review of the work processes currently being performed. Unnecessary or inefficient processes are identified and improved or eliminated in order to enhance efficiency. Each functional unit collects ideas for improvement in a way that makes sense for that unit. Development of interfunctional relations and teamwork are aimed at stimulating debates and controversies so that issues can be resolved leads to better products. This is required because the transfer of technology process involves an entanglement of complex and sometime confusing decisions. Quality movement acknowledges the iterative and conflicting character of the technology transfer process. (9)

Performance Indicators

Quality can be measured by bench marking competitors on the basis of costs of projects for new product, project lead time, compliance with specifications, patents, R&D tax credits, publications, citations, patents, awards, participation in conferences.

Measure of performance can be assessed by seeking answers to the following questions: (5)

Is the quality of the technical results perceived to be better?
Are lab employees measurably happier working at the facility?
Are clients internal and external measurably more satisfied with new product developments?
Has average product development time fallen?
Has the percentage of products delivered on deadline increased?
Has the percentage of projects completed within budget risen?
Have more patents been issued?
Are new products more reliable and easier to manufacture?

POSSIBLE OTHER AREAS OF APPLICATION

Quality data is the fundamental building block for quality information. Quality management techniques need to address how to obtain quality data so that every piece of that data is usable and of value from which conclusions can be drawn.

The data integrity is set by the standards of user requirements. Achieving high-quality data requires viewing data from the user perspective rather than from a purely scientific perspective. However, there are three general issues that relate to quality improvement. The first is appropriate data ownership. Ownership needs to be based on functional priorities determined by the research design to assure that the data definition is established by its most important use in the organization. The second is data accuracy-level requirements of specific data. These requirement can change throughout an R&D project based on shifting corporate objectives, new or revised regulatory requirements, or new management priorities. The key is to track the requirements and causes of change in the requirements during the life of the project. That is control! The third is proper management of procedural issues that influence how data are entered into and retrieved from the system that does not affect data accuracy, timeliness or function. Procedural problems can be solved through training and improved communications.(10)

SUGGESTED IMPROVEMENTS AND TRENDS

The role of senior management in leading a total quality effort is the single most important element of the system. It needs continual improvement. How to get the "worker bees" to be part of the quality policy, proving that total quality works and figuring out which parts are most important, is no small challenge. Senior management set the stage for values, customs and procedures. The role of the senior R&D executive is a true extension of the technology and business intellect of the organization. (8)

As part of the change in values, customs and procedures, senior management has to redefine research activities as a systemic interfunctional effort instead of a linear process of technology transfer. Decisions, observations and choices pertaining to research activities all impact on the engineering, manufacturing, distribution, marketing and experience of customers. (4)

The most effective way to implement this improvement is through training. The outcome of training is modified behavior. Each year about $210 billion is spent on corporate education and $230 billion is spent on education from kindergarten through the doctorate level. This demonstrates what the president of Harvard, Derek Bok meant when he said, "If you think education is expensive, try ignorance". (11) If spent properly training can return the investment many times.

CONCLUSION

"The times they are a changing."
Bob Dillion

In the past the U.S. weapons contractor, Sandia National Laboratories in Nevada developed high-technology nuclear weapons with no regard to how much it cost. This seemingly infinite nuclear weapon research budget, of the past, is being slashed by Congress to the amount of $1.2 billion. (12) The times have changed and for Sandia it is a new world order, where to survive it to accomplish more with less.

For any organization to achieve this it must define the R&D working environment by knowing its competitors, suppliers and customers. Corporate survival depends on identify customer needs and penetrating markets. The purpose of implementing quality research techniques is to minimized unfruitful efforts and invest in productive returns. R&D information can play an active part in defining the firm's mission and in establishing many of its corporate objectives.

Implementing research consists of planning, research design and implementation. Research quality is ensured through methodologies that seek to maintain scientific rigor and conformity to the specifications drawn up with the client. This approach shortens product cycle times by anticipating customer needs.

To meet the future challenge, senior management has to provide the leadership required to make a cultural change, implement quality techniques and create a stimulating environment. The executive role has to come first, for the organization to follow.

Bibliography

1. "R&D Statistics", BusinessWeek/Quality, 1991, pg 169.

2. Ronald Mitsch, "R&D at 3M: Continuing to Play a Big Role", Research Technology Management, Vol 35 No 5, Spt./Oct. 1992, pg 22-26.

3. George Roberts, "Managing Research Quality", Research Technology Managemetn, Vol 34 Iss 1, Jan/Feb 1991, p 28-34.

4. Roger Miller, "Practices to Enhance Quality Researach Management", Universtiy of Montreal, no date.

5. Naomi Freundlich and Michael Schroeder, "Getting Everybody into the Act", BusinessWeek/Quality, 1991, pg 149-152.

6. Robert Lovett, "Doing the Right Thing Right, all the Time", Research Technology Managemetn, Vol 34 Iss 1, Jan/Feb 1991, p 35-38.

7. Gitlow, Oppenheim, Tools and Methods for the Improvement of Quality, Boston, Ma, IRWIN, 1989.

8. John Carey, "Think Tanks Have Their Thinking Caps On", BusinessWeek/Quality, 1991, pg 163 -164.

9. Brocka & Brocka, Quality Management, Homewood, Illinois, IRWIN, 1992.

10. Barbara Maxwell, "Beyond Data Validity: Improving the Quality of HRIS Data", Personnel, April 1989, pg 48-58.

11. Eve Seward, "It All Began With a Customer's Request", Research Technology Managemetn, Vol 34 Iss 1, Jan/Feb 1991, p 28-34.

12. Eric Schine, "Weapons to Plowshares", BusinessWeek/Quality, 1991, pg 156.