

# **Motorola's 30 to 1 ROI for Quality Training: Details from the Classic Study of 1984**

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# Atta Boy!!!!

**“Another critical goal for this year’s efforts ... will be to provide two more major program evaluations similar to the 1984 study which showed a 30 to 1 return on training investment in quality improvement training ... This independent evaluation proves the success of the Total Quality Improvement program.”**

**Quoted from *Opportunities*, Motorola corporate newsletter, January 1985**

**Cited in *Harvard Business Review* (1987), *Motorola U: When Training Becomes an Education*, by William Wiggernhorn, President of Motorola University**

# Executive Summary

Motorola introduced its second corporate-wide training effort in 1982, called Total Quality Improvement (TQI), the first one to be focused on engineers, line supervisors and engineering management throughout the organization. The objective of the training was to introduce and apply the quality methods to improve overall line operations and more specifically to increase quality, however measured, in each plant 10-fold in the next five years. Each plant management could design its own program from a menu of training options and internally allocate resources to support the effort.

All training curricula and materials were developed by external vendors and subject matter experts. That development along with licenses for videos and other materials cost Motorola's Training and Education Center more than \$1.4 million dollars. Eighteen months after program launch, less than 15% of total target audience had attended any training course, and only sketchy evidence of application of the skills and tools were known.

Thus, an external, independent investigation was launched in 1984 with two objectives:

- Determine the effectiveness and the ROI documented to date
- Discover evidence to help break the "Not Invented Here" syndrome that was apparently crippling more comprehensive implementation of the training.

Results of the investigation produced the following short and long term outcomes:

- Return on Investment for the sample of plants studied documented a 28 to 1 return (Motorola officials rounded it up to 30 to 1)
- Enough real case examples and results broke the NIH syndrome of Motorola engineers and managers
- Training staff could now prove the value of training to senior management and the Board of Directors; two years later, Motorola University was formed
- Motorola won the prestigious Malcolm Baldrige Award in 1988, and used the results of this investigation in their documentation.

## Performance Problem / Opportunity

Motorola's corporate performance in the early 1980's might be regarded as acceptable, but troubles were on the horizon. Many foreign companies, especially the Japanese, were manufacturing electronic products with far fewer defects with less cost than Motorola. Japanese companies were measuring manufacturing output errors in parts per million, while Motorola and many other American manufacturers were measuring in parts per thousand and sometimes parts per hundred. Eventually, this quality difference would impact profits at Motorola.

Motorola had attempted to direct a needed change in quality processes through their decentralized conglomeration of manufacturing operations and divisions, but change acceptance was low, and the "not invented here" syndrome was rampant. Only in 1981, did Motorola establish a corporate training unit, since prior to that date all training was assigned to field operations leaving each plant to provide what it desired. The establishment of a corporate training function was not viewed as welcome news by field operations. It needed to prove itself. See the data in the Training Completion chart to see how slow implementation was.

The first major business problem for the training unit was the design and implementation of a corporate-wide training program to reduce quality errors in manufacturing. This was a daunting task in the early 80's, before the "quality movement" really took off. This fact, the resistance to change at the plant level, lack of confidence in "corporate mandates", and no real standards for training were all factors in obtaining line support for quality training. What the effort had going for it was strong commitment on the part of its executives and senior managers.

Thus, the challenge for designing the evaluation for the Total Quality Improvement program was not only to determine the worth of the program as applied in the field, but to document "best practices" within the company to influence change in resistant sites as well as to assist the corporate training unit in selling its value to the corporation.

## **Description of the Training Program**

The Total Quality Improvement (TQI) program was presented to plant managers as a list of options or a menu to select training courses. The following is the main menu of options:

- Quality for Upper Management – an 8-hour course designed for senior managers to provide an overview of TQI and their role in the process. The course used videos based on the principles of the Juran Institute.
- Quality Improvement – a 32-hour course over 16 weeks for engineers and technicians covering problem-solving and introductory use of statistics. Based again on Juran principles and taught in a cross-functional team environment. Teams were also a new concept to the corporation.
- Advanced Diagnostics Tools – a 16-hour course for engineers covering basic statistics and analysis procedures. Based upon principles of two subject matter experts and taught in a standard classroom setting with no team emphasis.
- Planned Experimentation – a 16-hour course for engineers covering design and analysis of statistical experiments. Based upon principles of two subject matter experts and taught in a standard classroom setting with no team emphasis.

Each plant was free to select and design its own training and implementation plan; the Corporate Training office supplied the basic materials including instructor guides and videotapes. This meant that plant management was required to determine the necessary resources for implementation including costs of instructors, supplementary materials, technical and other support. No standards for implementation or an exemplary guide were prepared for field use.

## **Description of the Evaluation Design**

The evaluation design consisted of detailed investigations of five Motorola plant sites in four different regions of the United States (Chicago, Phoenix, South Florida, and New York) representing four separate divisions of the company. Site visits lasted approximately 4 to 5 days and techniques for data collection included individual interviews, group interviews, document reviews, and observations. When an application of the quality tools and methods yielded a significant monetary value, that result was confirmed by at least two other sources – that employee’s senior manger and a co-worker.

The design addressed three purposes:

- Determine financial impact of the training on the organization
- Determine changes in employee behavior to implement training
- Develop a “site implementation model” that could be shared as best practices throughout the corporation

The tools for data collection were developed using the following five evaluation issues as a framework:

1. Why did the site participate in TQI?
2. How was TQI implemented at each site?
3. What skills and competencies were learned during TQI courses?
4. Was TQI used on the job and how was it used?
5. What was the impact (financial and behavioral) of TQI at each site?

Results of the site investigations and an overall summary were constructed with the following subsections:

- TQI activities by site
- Implementation Process and Model
- Impact of TQI
- Recommendations for the Corporate Training organization

## Illustrative Performance Results

Location: Phoenix, EMO

Work Area: Crystal Growing

Engineer in Charge: ND

Problem Studied: Oxygen level was too varied in crystal production.

Test Objective: Determine process causing this result. Two of the many variables tested were cup rotation and cup lift.

Source of Knowledge / Learning / Tools: Obtained from taking the training course called Planned Experimentation (PE). Learned and practiced basic techniques on smaller projects with one of his classmates.

Techniques Used: Full factorial matrix experimental design

Results Measured:

1. Specific test results with variables not reported due to sensitive proprietary information except that cup lift had a significant greater effect
2. Estimated baseline measure of loss was over \$70,000 per month in 1983 and average yield was 50%
3. Installing changes found from the experimental design results improved the yield by 4% and since process was sustained for the past eight months, the cost savings was estimated at \$800,000 on a yearly basis.

Verification: Given the size of this organizational impact, two additional sources were contacted to verify the claims. Both individuals confirmed the findings, and documented notes from ND (in his handwriting) showed that he had performed this study.

Organizational Impact: This was the first major study using statistical techniques taught in the PE course. The process used helped to win over skeptics in the plant. The study was used as an example in future deliveries of the PE course in all Phoenix plants (in addition to EMO).

## Illustrative Performance Results

Location: Linear Products (Mesa, AZ)

Work Area: Every major process in the plant

Engineer in Charge: Lead Reporter was ML; but 20 engineers had various responsibilities in conducting tests.

Problem Studied: Haze reject level in final product was too high; median reject line is 7% and this is 50% to 60% above final inspection rates required from 12,00 foot candle light.

Test Objective: Discover which process (or set of processes) that are responsible for hazing; examine non-random pattern in results.

Sequence under test: 1) Crystal Growth; 2) Saw; 3) Lapping; 4) Chem Thin; 5) Polish; 6) Heat Treatment; 7) Back Oxide; 8) Clean; 9) EPI.

Source of Knowledge / Learning / Tools: Obtained from taking the training in Adv. Diagnostic Tools and Planned Experimentation. Learned and practiced basic techniques in two process sequences.

Techniques Used: Created 12 lots with 75 products each and ran each in random sequence design through each process; 3 months were required to complete each experimental run.

Results Measured: One coating on product increased yield by 25% over standard process (statistically significant); other major results inconclusive.

Verification: Test reports observed by evaluation team; 22 engineers and senior plant management present during meeting.

Organizational Impact: From observations and discussions with engineers, the commitment to learning how to apply the techniques and change their production process while changing behavior was nothing short of astounding. Documented as #1 best practice implementation among all sites observed. Financial impact was a modest \$150,000 at the point of site visit.

## Lessons Learned

The following lists some results found through the evaluation and subsequent activities undertaken by the Motorola management and training organization. They are meant to illustrate lessons learned, evidence of behavior change, and financial impact. See the Financial Impact chart to see what was found at each of the five sites.

“It could be \$0.5 million, \$10 million, or \$100 million; it could have saved the company”. Plant manager

“This is not a meeting; this is not a training session; this is the way we do business”. Team Facilitator introducing first session on TQI

“We thought initially that this was stuff we as engineers just had to learn – let alone apply it. Then we had a big breakthrough by reducing scrap to 10% of former levels. Now everyone wants to learn about – my line people are really excited”. Senior Engineer and line supervisor

Strong and constant on-going support from plant management was necessary to begin and maintain momentum from the training.

Sites not yet involved in TQI training used the evaluation documentation to develop TQI implementation strategies.

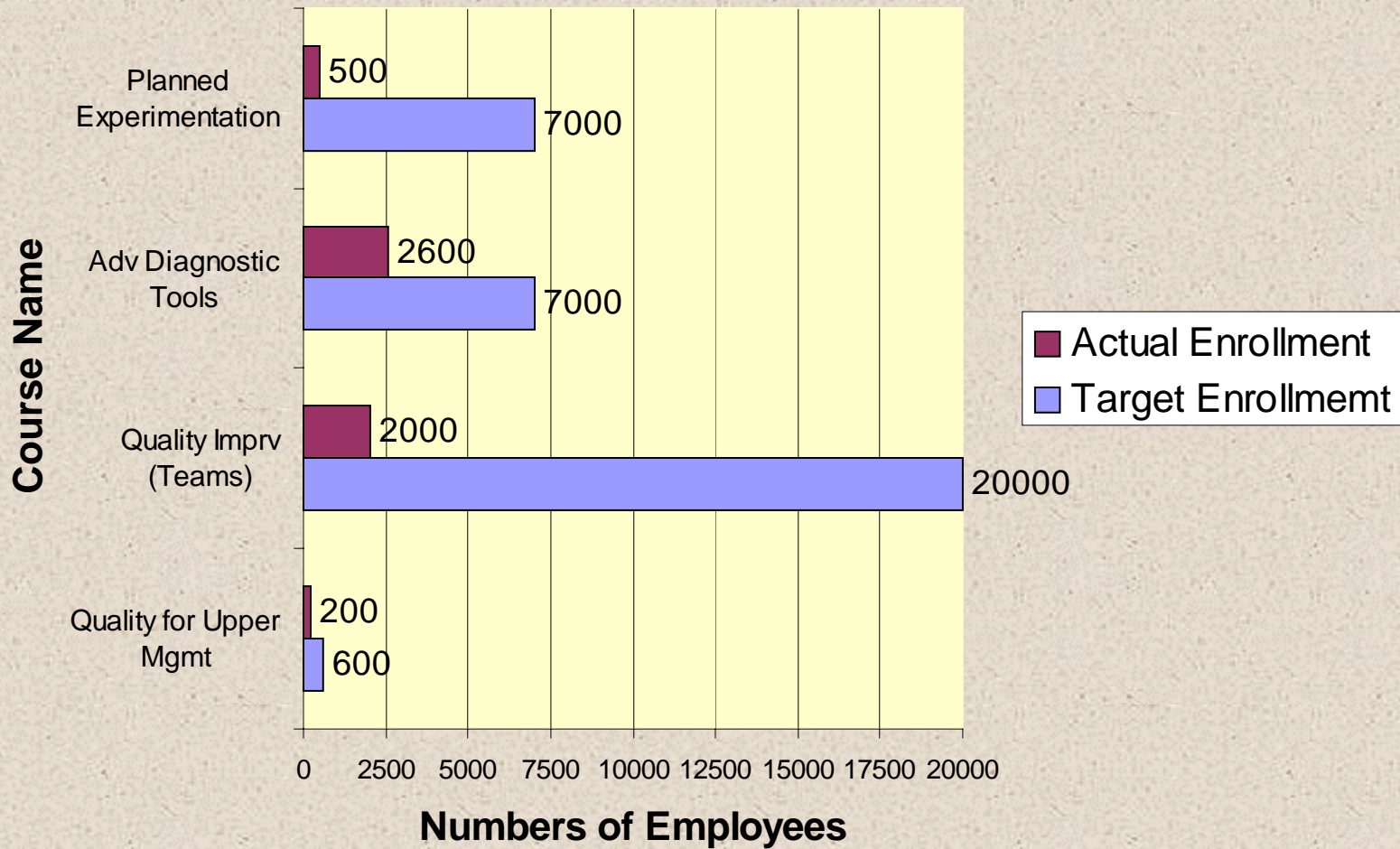
Illustrative examples of results were used in subsequent releases of training materials to show how training could be applied and results that could be obtained.

Success stories of individuals and teams were used for marketing the training in corporate newsletters, videos, and personal kudos.

Trainers and facilitators in a number of plant locations were “loaned” to other sites to help “jump start” new training efforts.

# Training Completion -- 12 Months After Launch

## Evidence of Limited Implementation



# Financial Impact for Five Sites

## Dollars Documented

