

# Continuous improvement project selection and execution

Daniel Bumblauskas, Ph.D. and Bradley Meyer, Ph.D.

University of Northern Iowa and Drake University

Email of corresponding author: [daniel.bumblauskas@uni.edu](mailto:daniel.bumblauskas@uni.edu)

## Abstract

Continuous improvement (CI) projects follow unique selection, deployment, and tracking processes. CI projects often are classified as business improvement initiatives (BPIs), lean / six sigma projects, etc. A survey and interview script were developed and data on CI projects have been collected from numerous companies across various industry segments.

**Keywords:** continuous improvement, lean, six sigma, project management

## Introduction

The purpose of this paper is to provide a framework for evaluating and tracking continuous improvement projects using a custom survey instrument, or interview script, and to describe a pilot test of the survey. Organizations pursue continuous improvement (CI) projects in a wide variety of ways and using different labels for the perspectives and tools. Common names include business improvement initiatives (BPIs), six sigma projects, lean events, 5S activities, etc. Project documentation tools include A3's, lean blueprints, and six sigma project charters. We sought to explore project traits at a level that transcends the specific CI approach. After discussions with a number of organizations involved in CI, we developed a survey instrument to learn:

- a) why CI projects are undertaken,
- b) how often projects are prompted by degradation in the process,
- c) what are typical shortcomings of processes that prompt an improvement initiative,
- d) what actual changes are made when a process is improved and
- e) what levels of improvement are realized from CI projects in terms of efficiency, quality, safety, customization and delivery time.

We tested the survey using data from a small number of companies. Due to proprietary interests stemming from the use of such a small sample, we are unable to report the companies in this paper. As we expand the research to a larger set of companies, we will be able to report those who participated in the study.

## Background

This project began with an interest in process degradation. Anecdotal evidence suggested that many process improvements are undertaken to ‘fix’ a process that has gone bad. For example, to rebalance a production line after a string of product design changes, or to bring order back to a process where several key components (equipment, tools, software) had been replaced without a redesign of the process as a whole. Meyer has argued projects that correct degradation should more correctly be termed process *maintenance*, and projects that innovate are more worthy of the title of process *improvement* (Meyer, 2006). In continued research, we hope to explore the hypothesis that less mature companies use CI projects as more of a temporary fix or “band-aid,” as process degradation increases, and/or as the organization grows and experiences pain outside its relevant range of operations. The concept of relevant range theory considers the changes which an individual or organization must under-go when operating outside of normal operating conditions (Bumblauskas, et al., 2014). Conversely, or as a potential corollary, more mature companies may have more projects focused on innovation. Drawing from these ideas, we expanded our scope to projects identified apart from degradation, such as cases where CI was undertaken to improve competitiveness or to innovate.

A second motivation and research interest is in project identification and selection in an organization. For example, one of the authors has used a simple categorization in six sigma-consulting project selection as described as

1. identified by necessity, i.e., blatantly obvious projects (e.g., customer / employee complaints)
2. identified by brainstorming (e.g., which work centers are problem areas?)
3. identified by a structured approach (e.g., collect data to prioritize, such as defects in six sigma or require departments to perform CI regularly in a set of areas, such as quality, efficiency, and safety.)

Some of the taxonomy for process degradation leading to project selection was previously developed (Kumar & Chaturvedi, 2009; Meyer, 2006). When a process degrades and incident or failure events occur, the application of a recurrent event data analysis for maintenance can determine the likelihood or mean cumulative function for the subject entity (Bumblauskas, et al., 2012). Data collected from on-going processes is censored data since the organizations are still running the process or CI project on an on-going basis. Censored data are data that are incomplete since the time horizon is still ongoing and require specialized techniques for analysis. (Efron, 1967; Hong, et al., 2009; Turnbull, 1976).

Brannon and Koubek discuss “knowledge degradation,” leading to the need for data collection, validation, and computation (Brannon & Koubek, 2001) and “degradation modeling,” (Peng, et al., 2011) which can be applied to the generation of CI project selection. Manufacturing and industrial facility CI is a well-documented area (Kumar & Chaturvedi, 2009; Maillart & Pollock, 2002; McKone, et al., 2001; Upton & Bowon, 1998; Warwood & Knowles, 2004); whereas service industry CI has not been documented nearly as much in previous work (our data collection strategy includes representation from the retail and service sectors). Six sigma project “benefits and obstacles,” have been documented (Kwak & Anbari, 2004) as have their effect on “corporate performance (Shafer & Moeller, 2012).”

## **Methodology**

Before gathering data, we spoke to several companies about their CI practices and particularly about documenting project performance. Our concern was whether we could answer our questions of interest from an external review of existing documents or whether it would be necessary to perform interviews, or to have individuals with more intimate project knowledge fill out a survey. We were not surprised to find that project documentation varies widely. Some companies seem to keep no centralized records. One company had a large spreadsheet that contained a project title, the name of the project lead, start and completion dates, a summary sentence on the project and little else. Other companies maintain report-outs, such as PowerPoint slides created for project presentations to management. These report-outs vary in their level of detail. Finally, we found some companies that require the creation of an A3 for every project.

We were encouraged by those companies that maintain detailed project records and conducted a pilot test of the survey instrument using external review of project documentation. In total, we analyzed 36 projects, 56% from financial services/insurance companies and 44% from manufacturing companies. Because the sample was not scientifically determined, we cannot treat the results as representative, but they do provide some idea of the completeness of the survey options and suggest trends that will be further explored in future research.

## **Findings and Results**

Question one focuses on what prompted the CI project; see Figure 1. A given project could have more than one rationale. Profitability issues, including poor productivity, wasted time, and high process costs had the highest frequency of response. One option was that a management “quota” for projects drove the project, perhaps in a given category. We added this as an option because of conversations with members of process improvement teams who told us this was sometimes the case. However, since an external analyst completed the survey, rather than internal administration, there were no cases of this response. We did get a number of “other” responses, suggesting that we could add more options to the questions. Other responses included lack of training, need for standardization, and miscommunication.

Question two focuses on whether the process declined in performance in some way since initial installation. As shown in Figure 2, there was a nearly identical response rate across the three mutually exclusive possible answers suggesting that all three of these cases commonly occur. A little less than one third of our sample described processes where degradation was a factor. Question 3 and question 4 explore causes of degradation and only applied where performance decline had occurred, which amounted to 11 projects.

## What prompted this improvement project?

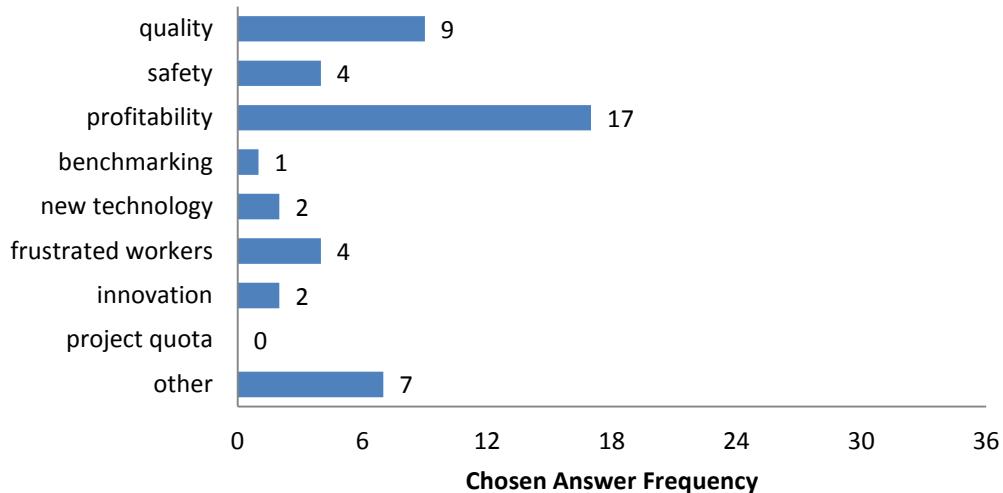


Figure 1. Question One Response Frequency.

## Had this process declined in performance?

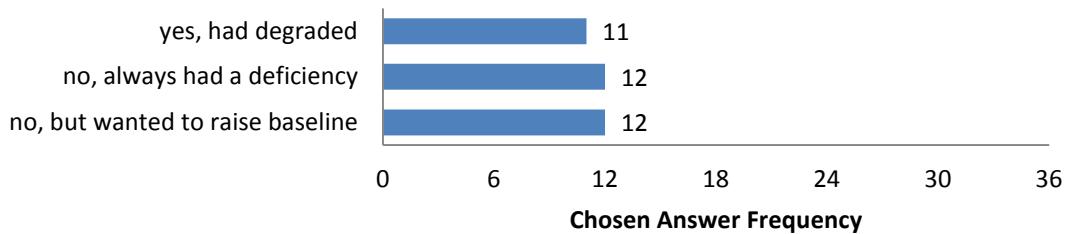


Figure 2. Question Two Responses

Question 3 asked for all causes of performance degradation and question 4 asked for the main cause. The similarity of the responses, as seen in Figures 3 and 4 suggest the need for only one question. However, the project documents, for which brevity is a virtue, often describe only the main cause of the performance decline. If the project lead were filling out the survey, the answers to question three may be more complete. Note that no project evidenced decline due to process modifications over time that introduced inefficiencies, abbreviated as "changeout of process components" in the figures.

## What are the causes of performance decline?

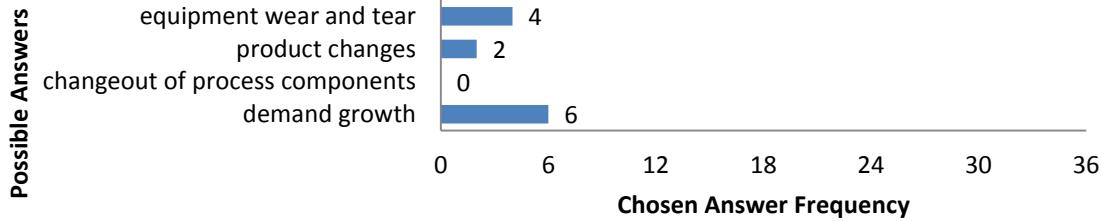


Figure 3. Question Three Responses

## What is the dominant cause of decline?

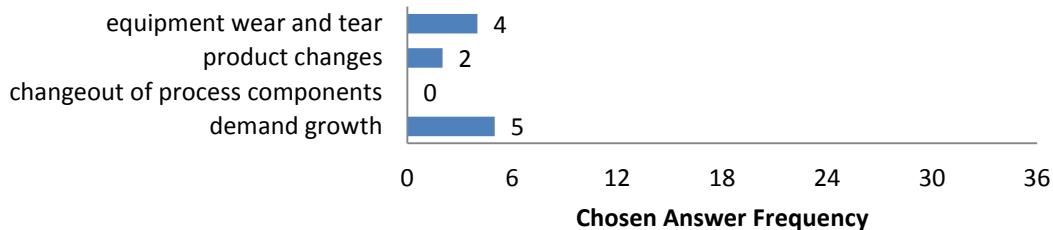


Figure 4. Question Four Responses

Question five allowed for multiple responses for pre-project conditions. Fifty percent of the projects responded to the question with less than two answers chosen. About thirty percent of responses stated that the throughput time was too long and about twenty-five percent of the responses indicated that the process components were mismatched and did not seem to work well together. All possible responses appeared at least once in the projects analyzed as shown in figure 6. This question had no “other” option.

## Traits of process before improvement

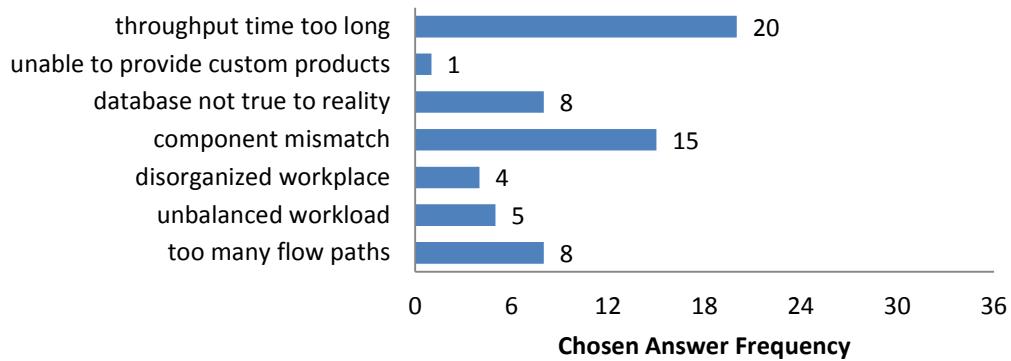


Figure 5. Question Five Responses

Question six, shown in Figure 6, focuses on what changed to improve the process and had multiple responses per project. About fifty-three percent chose less than two responses for question six. Interesting, and perhaps reassuring for the maturity of our partner companies, in no case was the process improved by simply using a different employee. The highest frequency was eleven for “we changed to a new technology, a different way of processing.” Work assignment changes, removing unnecessary equipment, material and tools from the workplace/process (red tagged items in 5S), and the “other” category were the responses with the next highest frequencies. The other category included training, adding another position, and creating a standardized process.

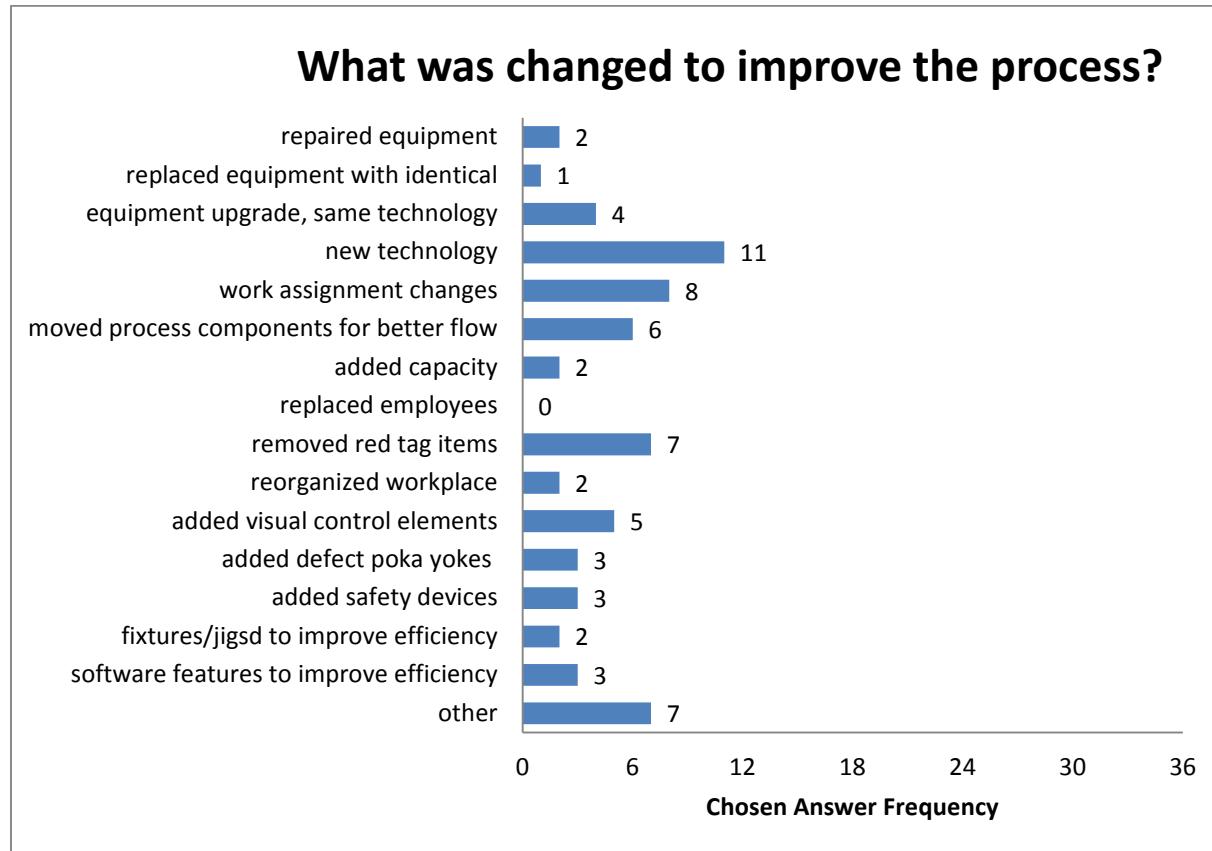


Figure 6. Question Six Responses

Question seven was perhaps not well suited to our exploratory sample. Due to the small number of companies, only a limited number of perspectives were employed, primarily lean and six sigma. It is possible that we will find this still to be true as we enlarge our sample, due to the present popularity and enduring influence of these two approaches to continuous improvement. Note also that Industrial Engineering had a strong representation in our sample, and constraint management was common. The “other” category included visual management and process standardization, which we will consider adding to our survey options. See full results in figure 7.

The project documentation used for our study was sparse on concrete information about the impact of the project. This also supports the hypothesis that the fidelity of data tracked in CI projects does not provide adequate insight on performance. Only one project documented

“significant improvement” in productivity, (question 8), two projects documented significant improvement in quality(question 9), three projects saw “a little improvement” in on-time delivery (question 10) and four saw the same in safety (question 11). No projects documented an improvement in the ability to provide customization (question 12).

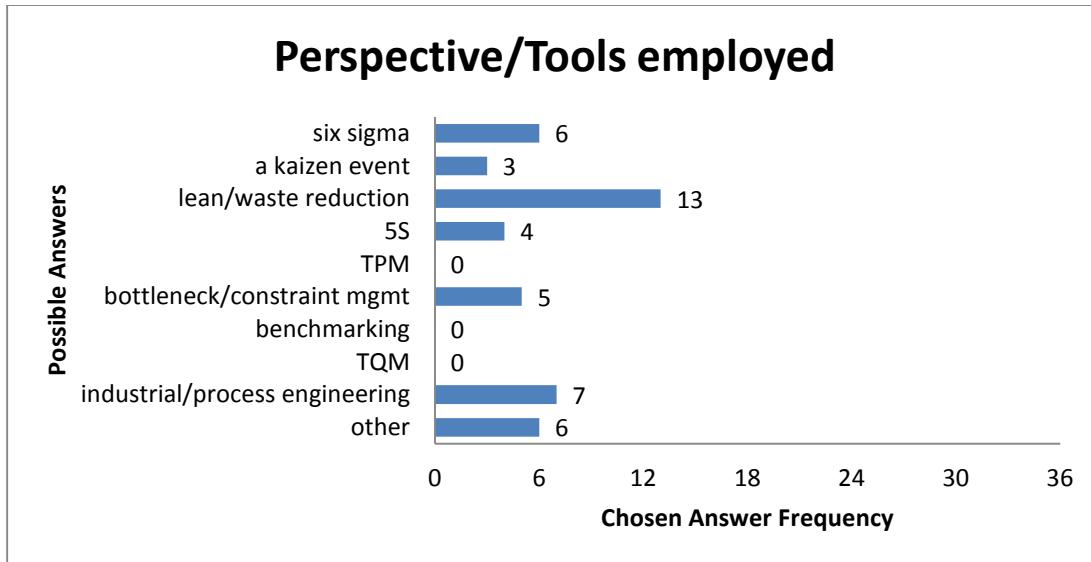


Figure 7. Question Seven Responses

## Recommendations and Future Work

One of the outcomes from this pilot study are changes to the instrument. We mentioned above the addition of several options on the questions. A second recommendation is to revise and extend question seven. Question seven asks about perspectives employed within the continuous improvement project of interest. Some of the responses are broad while others are specific tools. For example, 5S is a practice or tool, but also a lean technique. It would be interesting to write an extension question asking for more details on the tools used in the completion of the continuous improvement project. Potential responses to this question may be A3s, 5S, 5 Whys, Fishbone Diagram, Process Mapping, Kanban, Poka-Yoke / Error Proofing, Going to the Gemba, Pareto Charts, Gap Analysis, or Gantt Charts. Question seven would then be altered to remove 5S and possibly include some more broad categories such as Visual Management or Standardization Techniques.

We plan next to explore the use of an internal survey or an interview. The external analyst was unable to answer the degree of improvement questions (questions 8 through 12) for most of the cases, and data for some of the other answers was, at times, sketchy. A second pilot study will determine the feasibility of this approach, both in terms of willingness of companies to allocate time to the survey and in the ability of respondents to provide answers for the questions.

If such an approach turns out to be feasible, or if we encounter a data set with more complete project information, we plan to extend the study to a larger number of companies for a diverse set of industries. Another option is to develop simple tools that companies can use to track the information requested in our survey. In addition to serving our research interests, this information would also be helpful to the company in evaluating their CI efforts.

## Acknowledgements

Thank you to Mallory Johnson, Drake University, for her work in analyzing the survey instrument and applying it to several companies from which we collected data. Thank you to Jim Noble, University of Missouri, for his help developing the project selection framework referenced in the methodology section.

## Bibliography

Brannon, N. G. & Koubek, R. J., 2001. Towards a conceptual model of procedural knowledge degradation. *Theoretical Issues in Ergonomics Science*, 2(4), pp. 317-335.

Bumblauskas, D., Meeker, W. Q. & Gemmill, D., 2012. Maintenance and recurrent event analysis of circuit breaker data. *International Journal of Quality & Reliability Management*, pp. 560-575.

Bumblauskas, D., Nold, H. & Bumblauskas, P., 2014. *Data collection, analysis and tracking in industry*. Atlanta, POMS, p. TBD.

Efron, B., 1967. *The two sample problem with censored data*. Berkeley, s.n., pp. 831-853.

Hong, Y., Meeker, W. & McCalley, J., 2009. Prediction of Remaining Life of Power Transformers Based on Left Truncated and Right Censored Lifetime Data. *The Annals of Applied Statistics*, pp. 857-879.

Kumar, E. & Chaturvedi, S., 2009. *True degradation estimation of industrial equipment with fuzzy sets: a case study*. s.l., Institution of Mechanical Engineers, pp. 167-179.

Kwak, Y. H. & Anbari, F. T., 2004. Benefits, obstacles, and future of six sigma approach. *Technovation*, pp. 1-8.

Maillart, L. & Pollock, S., 2002. Cost-Optimal Condition-Monitoring for Predictive Maintenance of 2-Phase Systems. *IEEE TRANSACTIONS ON RELIABILITY*, pp. 322-330.

McKone, K. E., Schroeder, R. G. & Cua, K. O., 2001. The impact of total productive maintenance practices on manufacturing performance. *Journal of Operations Management*, pp. 39-58.

Meyer, B. C., 2006. *UNDERSTANDING PROCESS DEGRADATION: WHY DO BAD THINGS HAPPEN TO GOOD PROCESSES?*. San Antonio, Texas, DSI, pp. 31221-31226.

Peng, H., Feng, Q. & Coit, D. W., 2011. Reliability and maintenance modeling for systems subject to multiple dependent competing failure processes. *IIE Transactions*, pp. 12-22.

Shafer, S. & Moeller, S., 2012. The effects of Six Sigma on corporate performance: An empirical investigation. *Journal of Operations Management*, pp. 521-532.

Turnbull, B., 1976. The Empirical Distribution Function with Arbitrarily Grouped, Censored and Truncated Data. *Journal of the Royal Statistical Society. Series B (Methodological)*, pp. 290-295.

Upton, D. M. & Bowon, K., 1998. Alternative methods of learning and process improvement in manufacturing. *Journal of Operations Management*, pp. 1-20.

Warwood, S. J. & Knowles, G., 2004. An investigation into Japanese 5-S practice in UK industry. *The TQM Magazine*, pp. 347-353.

## **Appendix 1 Continuous Improvement Survey Instrument © Daniel Bumblauskas and Bradley Meyer**

1. What prompted this improvement project? (circle all answers that apply)
  - a. quality issues (defects)
  - b. safety issues
  - c. profitability issues (poor productivity, time wasted, high process costs)
  - d. benchmarking with other firms
  - e. new technology available
  - f. frustrated employees
  - g. a creative idea
  - h. we had to think of something to fulfill management's project quota
  - i. other \_\_\_\_\_
  
2. Had the process *declined* in performance in some way since it was originally put in place? Or did the process always have the deficiency addressed in the project?
  - a. performance had degraded – continue with questions 3
  - b. the process had not degraded, but there had always been a deficiency in this process – go to question 5
  - c. this project was about improving the baseline performance of a process and not a response to declined performance
  
3. How would you classify the root cause of the process performance decline? (circle all that apply)
  - a. wear and tear on equipment.
  - b. the product changed, but we didn't adequately update the process.
  - c. we had to replace some tools, machines, software, or workers and things weren't working as well together anymore
  - d. growth in demand on the process was pushing it against capacity limits.
  
4. How would you classify the *dominant* root cause of the process performance decline? (this time, you may circle only one – select the one that was the biggest factor.)
  - a. wear and tear on equipment.
  - b. the product changed, but we didn't adequately update the process.
  - c. we had to replace some tools, machines, software, or workers and things weren't working as well together anymore
  - d. growth in demand on the process was pushing it against capacity limits.
  
5. Circle as many of the following as apply to the process before the improvement
  - a. there were too many different flow paths through our process
  - b. the work required of the various people or machines in the process was not well balanced. (some people or machines had too much to do, others not enough.)
  - c. the workplace was disorganized and cluttered, it was confusing to work in.
  - d. various components of the process did not seem to work well together
  - e. the data stored in our computers or in people's minds did not match reality
  - f. we were not able to provide as much customization as customers required

g. we wanted to reduce the throughput time of the process

6. What was changed to improve the process? (Circle all that apply.)

- a. we fixed various problems with the equipment
- b. we replaced equipment with basically identical equipment
- c. we replaced equipment with newer equipment, same technology, but better
- d. we changed to a new technology, a different way of processing
- e. we made work assignment changes
- f. we moved things around physically or in sequence of steps to make the flow better
- g. we added capacity
- h. we replaced employees
- i. we removed unnecessary equipment, material, and tools from the workplace/process
- j. we reorganized the workplace
- k. we added signage or visual control elements
- l. we put error proofing devices in place (to protect the product)
- m. we put safety devices in place (to protect the employee)
- n. we added fixtures or jigs to make the task more efficient
- o. we added some new features to the software to make the task more efficient
- p. other \_\_\_\_\_

7. Were any of the following perspectives / tool techniques employed? (You may circle more than one.)

- a. Six sigma
- b. a kaizen event
- c. lean / waste reduction
- d. 5S
- e. TPM
- f. bottleneck or constraint mgmt
- g. benchmarking
- h. TQM
- i. industrial / process engineering
- k. other \_\_\_\_\_

8. After the project, **productivity** (output compared to costs) saw

- a. a change for the worse
- b. no change
- c. a little improvement
- d. a significant improvement

9. After the project, **quality** (defects, mistakes) saw

- a. a change for the worse
- b. no change
- c. a little improvement
- d. a significant improvement

10. After the project, **on time delivery** saw

- a. a change for the worse
- b. no change
- c. a little improvement
- d. a significant improvement

11. After the project, **safety** saw

- a. a change for the worse
- b. no change
- c. a little improvement
- d. a significant improvement

12. After the change, ability to deliver more **customization** saw

- a. a change for the worse
- b. no change
- c. a little improvement
- d. a significant improvement