Organizational Learning in a Platform Team Environment
and the Development of Hard-Top Doors

by

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B.S., Electrical Engineering, GMI Engineering & Management Institute, 1989

Submitted to the MIT Department of Materials Science and Engineering
and the Sloan School of Management
in partial fulfillment of the requirements for the degrees of

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and
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Master of Science in Management

ABSTRACT

This thesis describes research conducted regarding efforts to enhance
organizational learning within an automobile manufacturing PTO. A framework for
organizational learning is presented which emphasizes the need for both single- and
double-loop learning. Two specific initiatives undertaken by the PTO, the Book of
Knowledge and manufacturing tech clubs, are examined in the context of their
development as organizational learning systems. The Book of Knowledge is a computer
based tool to be used by platform team members to share significant learning throughout
the organization. This research assisted in establishing initial system specifications and
developing a prototype system. Tech clubs are cross-platform groups organized
by function or technical expertise. The communication patterns between club members are
examined using experimentally designed survey techniques. Additionally, an example
related to implementation of a hard-top door design is investigated via designed
experimentation to examine organizational learning in the context of problem solving.
Finally, a learning history is prepared and its contents analyzed to assist the PTO in
understanding the issues surrounding the hard-top door implementation.

Recommendations are presented related to enhancing the overall learning system
of the PTO, based on the research and prevalent theory related to organizational learning.
Dedicated resources with primary responsibilities linked to development of the Book of
Knowledge are suggested, along with expanded responsibility and authority for the tech
clubs. Learning histories are recommended as tools to document single-loop learning, with
the potential for dissemination meetings as forums to stimulate double-loop learning.

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### TABLE OF CONTENTS

**Abstract** .................................................................................................................................................................................. 3  
**Acknowledgments** ........................................................................................................................................................................ 4  
**Table of Contents** ........................................................................................................................................................................... 5  
**Table of Figures** ............................................................................................................................................................................... 8  
**Table of Tables** ................................................................................................................................................................................ 8  

**Chapter 1. Introduction** .................................................................................................................................................................... 9  
1.0  Background and Problem Definition ................................................................................................................................. 9  
1.1  Framework for Organizational Learning ............................................................................................................................. 10  
1.1.1  Foundations .............................................................................................................................................................................. 10  
1.1.2  Evidences .................................................................................................................................................................................. 12  
1.1.3  Barriers to learning ................................................................................................................................................................. 14  
1.1.4  Promoting Learning ................................................................................................................................................................. 14  
1.2  Methodology .................................................................................................................................................................................. 15  

**Chapter 2. The Book of Knowledge** .......................................................................................................................................... 17  
2.0  Introduction ............................................................................................................................................................................... 17  
2.1  Methodology ................................................................................................................................................................................ 18  
2.2  System Analysis .......................................................................................................................................................................... 20  
2.3  Process Evaluation .................................................................................................................................................................... 21  
2.4  Conclusion .................................................................................................................................................................................... 23  

**Chapter 3. Tech Clubs** ................................................................................................................................................................. 25  
3.0  Introduction ............................................................................................................................................................................... 25  
3.1  Research plan .............................................................................................................................................................................. 27  
3.2  Research results ......................................................................................................................................................................... 29  
3.2.1  Tech Club objectives ............................................................................................................................................................ 29
3.2.2 Communication patterns ................................................. 31
3.2.3 Observations from the Intervention ......................... 33
   3.2.3.1 Meeting attendance ........................................ 33
   3.2.3.2 Relationships between Tech Club members ........ 35
   3.2.3.3 Objective of the Tech Clubs .............................. 36

3.3 Conclusion ............................................................................. 37

Chapter 4. Door Issues: Experimentation ..................................... 39
4.0 Introduction ........................................................................... 39
   4.0.1 Background ................................................................ 39
   4.0.2 Implementation issues ........................................... 41
   4.0.3 Potential quality issues .......................................... 43
4.1 Major contributor: hinge design ......................................... 44
4.2 Experimentation: extra welds .............................................. 46
   4.2.0 Background ........................................................... 46
   4.2.1 Designed experimentation ....................................... 47
4.3 Potential sag issues with aluminum doors ......................... 52
4.4 Conclusion ............................................................................. 53

Chapter 5. Door Issues: Learning History .................................... 54
5.0 Introduction ........................................................................... 54
5.1 Learning History methodology ......................................... 55
5.2 Dominant theme: teamwork ............................................... 56
5.3 Ancillary themes ................................................................. 60
5.4 Cultural analysis ................................................................... 64
   5.4.1 Artifacts .................................................................. 64
   5.4.2 Espoused values ..................................................... 65
   5.4.3 Basic assumptions .................................................. 65
   5.4.4 Implications ........................................................... 67
### TABLE OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>Book of Knowledge key elements</td>
<td>19</td>
</tr>
<tr>
<td>Figure 2</td>
<td>Elements of an organizational learning system</td>
<td>20</td>
</tr>
<tr>
<td>Figure 3</td>
<td>Book of Knowledge double-loop learning opportunities</td>
<td>21</td>
</tr>
<tr>
<td>Figure 4</td>
<td>Tech Club charter</td>
<td>26</td>
</tr>
<tr>
<td>Figure 5</td>
<td>Experimental design</td>
<td>28</td>
</tr>
<tr>
<td>Figure 6</td>
<td>Communication inhibitory loop</td>
<td>37</td>
</tr>
<tr>
<td>Figure 7a</td>
<td>Full-frame door</td>
<td>40</td>
</tr>
<tr>
<td>Figure 7b</td>
<td>Hard-top door</td>
<td>40</td>
</tr>
<tr>
<td>Figure 8</td>
<td>Door sag contributing factors</td>
<td>42</td>
</tr>
<tr>
<td>Figure 9</td>
<td>Hinge pillar welds</td>
<td>46</td>
</tr>
<tr>
<td>Figure 10</td>
<td>Door measurement points</td>
<td>48</td>
</tr>
<tr>
<td>Figure 11</td>
<td>Door experiment run charts</td>
<td>50</td>
</tr>
<tr>
<td>Figure 12</td>
<td>Door experiment XY charts</td>
<td>51</td>
</tr>
<tr>
<td>Figure 13</td>
<td>Learning history development process overview</td>
<td>56</td>
</tr>
<tr>
<td>Figure 14</td>
<td>Inhibitory loop</td>
<td>58</td>
</tr>
<tr>
<td>Figure 15</td>
<td>Organizational defensive routine</td>
<td>59</td>
</tr>
<tr>
<td>Figure 16</td>
<td>Relational diagram</td>
<td>63</td>
</tr>
</tbody>
</table>

### TABLE OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 1</td>
<td>Summary: tech club survey data</td>
<td>32</td>
</tr>
<tr>
<td>Table 2</td>
<td>Door weld experiment results summary</td>
<td>49</td>
</tr>
</tbody>
</table>
CHAPTER 1 - INTRODUCTION

1.0 Background and Problem Definition

In an effort to reduce the lead-time and increase the effectiveness of the product development cycle, many companies have institutionalized cross-functional teams or product platform teams. A significant challenge for the platform team organization (PTO) is to promote learning between the various teams so that, in the very least, successes are replicated and errors are minimized. Many organizations have sought to do this by embracing the concept of organizational learning. Generally, organizational learning can be defined as:

*the ability to capture, retain and incorporate knowledge, expertise and lessons learned from individual and collective perspectives for the continued growth and development of the organization.*

This definition implies both a learning product and a learning process, as well as different types of organizational learning. The definition will be augmented in the framework presented in the next section, which draws upon the works of Argyris and Schon\textsuperscript{1,2,3}, Schein\textsuperscript{4}, Senge\textsuperscript{5,6} and other scholars of organizational learning.

This thesis describes research conducted regarding efforts to enhance organizational learning within an automobile manufacturing PTO. Two specific initiatives undertaken by the PTO are examined in the context of the development of organizational learning systems. Additionally, an example related to implementation of a particular door
design is investigated via designed experimentation to examine organizational learning in the context of problem solving. The methodology section of this chapter will further define these activities.

1.1 Framework for Organizational Learning

Since the 1980's numerous publications have been offered related to organizational learning and many corporations have aspired to become "learning organizations". To help accomplish this, these organizations should consider a series of questions:

1. What does organizational learning mean for us and what are its benefits and evidences?
2. What conditions impede organizational learning and are these conditions present within our organization?
3. What conditions promote productive organizational learning, and how can we help these conditions occur while canceling impeding conditions?

This framework attempts to provide help to answer these questions by presenting concepts from prevalent theory on organizational learning.

1.1.1 Foundations

Central to organizational learning ideology is the concept of theory of action, which is used to examine the behavior of an organization. In Organizational Learning: A Theory of Action Perspective, Argyris and Schon give the following discussion of the concept:
A full schema for a theory of action would be as follows: in situation S, if you want to achieve consequence C, under assumptions a ... n, do A ...

The theory of action is a control mechanism for the user, and can be used to explain or predict behavior. There is a distinction between the espoused theory that one posits and communicates to others, and the theory-in-use which governs the actual behavior of the user. The theory-in-use may be constructed from observations, and is implicit in the performance of a pattern of activity. The theory-in-use may conflict with the espoused theory, and the user may be unaware of the inconsistency.

From the broad definition of organizational learning given in the previous section and the behavioral concepts discussed above, two types of organizational learning can now be distinguished. The distinction employed in this framework was originated by Ashby and has been popularized by Argyris: single- and double-loop learning. Single-loop learning employs error detection feedback to adjust the organization's actions such that the error is resolved. This type of learning, similar to continuous process improvement, leads to enhanced performance of organizational tasks but leaves the theory-in-use unchanged. Double-loop learning explores and can restructure the values and criteria through which the organization defines what it means by improved performance. Unlike single-loop learning, double-loop learning can result in altered values, strategies and assumptions underlying the theory-in-use.
Both forms of learning are productive and necessary for organizational development. However, many companies tend to define and attempt to encourage organizational learning solely in the single-loop context. This is likely insufficient for the ultra-competitive environment that most firms face. Indeed, companies are embracing management philosophies which call for discontinuous improvement and / or dramatically re-engineered processes; often these philosophies call for radical cultural change. Of the distinctions described, double-loop learning is the only mechanism by which cultural change may occur. Culture is defined by Schein as:

\[ A \text{ pattern of shared basic assumptions that a group learned as it solved its problems of surviving and adapting to its external environment and integrating its internal processes to ensure the capacity to continue to survive and adapt. } \]

These shared basic assumptions correspond to theories-in-use. Schein discusses espoused values as a level of culture, and promotes observation of visible organizational structures (artifacts) and espoused values as tools to analyze basic shared assumptions. If this model is embraced, then cultural change can only occur via double-loop learning.

1.1.2 Evidences

When both single- and double-loop learning occur as the norm, then by definition the organization should experience improved performance and cultural change. These experiences can be manifested in numerous forms. The work of Senge3 et al. suggests that the evidences of a learning organization include the following:
1. Synergy exists in teams/work groups that will allow them to be more effective (intelligent) as a group than as individuals. The members challenge and build on each other's ideas to develop superior products and processes.

2. The organization is aware of and values the underlying tacit knowledge base of its people. Systems and processes are developed to extract, cultivate and make implicit understandings explicit.

3. People are encouraged to embrace a system's perspective of the organization by learning what's going on at all levels and understanding how their actions influence others. This experience is facilitated and institutionalized through cross-training, job rotation and dialogue which (among other things) links causes and effects.

4. People are encouraged to take risks, openly assess results and acknowledge yet learn from mistakes, rather than being punished. Systems and processes allow the entire organization to benefit from such learning.

In evaluating this list, one finds that the items correlate to values commonly espoused by many firms. Terms such as "empowered work-force" and "teams" are examples. If this is the case, then one must ask why these organizations have not attained the goal of being learning organizations since they espouse the concepts. Evidently, the theories-in-use are not in total alignment with the espoused values. Certain behaviors or activities occurring in the firm must be at work impeding organizational learning.
1.1.3 Barriers to Learning

Argyris and Schon present several systems of behavior that work to impede organizational learning. These include inhibitory loops and organizational defensive routines. **Inhibitory loops** are self-reinforcing cycles where conditions for error in organizational theory of action provoke behaviors which reinforce the error conditions. The conditions for error include vagueness, ambiguity, untestability, undiscussibility and uncertainty - all of which conceal error and make it uncorrectable. As an example, when an issue is potentially embarrassing, people tend not to discuss it, and the fact that they are not discussing the issue is also undiscussable. This may exacerbate the level of vagueness and ambiguity surrounding the issue, and the issue continues unresolved for lack of discussion. **Organizational defensive routines** are actions and policies that are intended to protect individuals from experiencing embarrassment or threat, while at the same time preventing individuals (or the organization as a whole) from identifying the causes of the embarrassment or threat so that the appropriate problems can be corrected. As may be surmised, inhibitory loops and organizational defensive routines are interconnected.

1.1.4 Promoting learning

In order to promote learning, incongruent theories-in-use must be aligned with the organization’s vision and espoused theories for learning. In short, the organization must work to create an environment where the evidences described in section 1.1.2 can flourish. It is accomplished through double-loop learning, examining the theories-in-use and their underlying values for inconsistencies and impediments. This involves developing a culture
where conditions for error can be eliminated. It includes a medium where mistaken assumptions can be reformulated, vagueness made specific and previously undiscussable issues become discussible. The nature of a learning organization is evolutionary, with continual learning and improvement of the learning process being primary goals. Modern theory presents variables and action strategies to help work towards achieving these goals.

Argyris and Schon propose a theory-in-use where significant actions are evaluated in terms of the degree to which they help generate valid and useful data, share problems in a manner leading to productive dialogue, and solve problems such that they remain solved without reducing existing levels of problem-solving effectiveness. This involves double-loop learning as individuals confront basic assumptions behind others' present views (and actions) and invite confrontation of their own basic assumptions. The end result of such a model is that the mechanisms for learning impediments are destroyed as the conditions for error and protective (defense) routines are eliminated. Necessary competencies for materializing the model include skillful dialogue and situational analysis tools such as the left hand column exercise. Finally, these conditions and activities must be institutionalized through structures and processes so that the learning is truly organizational.

1.2 Methodology

Chapter two of this research examines the development of a computer-based organizational learning initiative called the Book of Knowledge. Chapter three
investigates Tech Clubs, cross-platform teams that endeavor to share knowledge and
develop (some) common standards. These undertakings are contemplated as
organizational learning systems in terms of their abilities to institutionalize single-loop
learning and to stimulate double-loop learning. Chapter four examines hard-top door
design and implementation in the context of single-loop problem solving efforts including
designed experimentation. The fifth Chapter investigates hard-top door implementation
issues employing a Learning History, which contemplates related double-loop learning
efforts and the existence of learning impediments. The conclusions and recommendations
from the research are presented in Chapter six.
CHAPTER 2 - THE BOOK OF KNOWLEDGE

2.0 Introduction

With the advent of technology, many companies seek to enhance organizational learning utilizing computer tools such as shareware and various electronic databases. While the use of computer technology is a logical advance, many organizations find it challenging to determine exactly how to optimize the use of technology such that single-loop learnings are institutionalized and double-loop learning is developed within the organization. A significant part of the challenge lies in determining the scope of the project and the particular application. The applications can vary from the very broad to more specific uses of technology. A major aluminum manufacturer is working to establish a global communications network so that employees may share data around the world, while a major auto manufacturer is developing process leadership homepages (accessed via internal networks) that detail the benefits of various continuous improvement projects. Each application described above represents a major allocation of time and resources, with the broader, more ambiguous applications requiring a greater level of commitment for successful implementation. The goal of each application is the same: to share significant learning throughout the organization, with the intended benefits described in the first chapter of this document.

In an effort to capitalize on computer technology and obtain the noted organizational learning benefits, the PTO initiated development of the Manufacturing
Book of Knowledge (BoK). The BoK was broadly defined as a computer based tool to be used by platform team members to share significant learning throughout the organization.

2.1 Methodology

The goal of this portion of the research was to assist in the planning and development of the BoK, and to present recommendations for its continued development. To accomplish this, the following methodology was employed: 1) development of initial system specifications, and 2) prototype development and evaluation. Recommendations for future development are presented in chapter six of this document.

The researcher was part of a team assembled to develop the BoK using the above described methodology. The initial system specifications were developed using data from platform management personnel who advocated development of the BoK. A nominal group technique was employed at a meeting of the managers, where they were asked to describe the ideal system and its attributes. This data was used to develop preliminary system design requirements. Figure 1 shows the key elements of the BoK as defined by the managers.
Once preliminary design requirements were established, prototype development began. The researcher was part of a lead-user team whose mission was to develop a beta test version of the BoK for the lead-user group area. The team employed a rapid prototype development process where actual computer screens (i.e. input / output options) were designed in team meetings, and mock-ups were available for evaluation in the next session. This initial phase of the BoK focused on best practices for the lead-user area and was completed in a time-period shorter than the target of 90 days. Later phases of the lead-user BoK were planned to cover other areas specified in the BoK design requirements.

2.2 System Analysis

The key elements of the BoK align with a model of organizational learning systems as defined by Nevis et al.\textsuperscript{10}, shown in figure 2.
The BoK’s correlation to the first two elements of this model largely involve single-loop learning efforts. In terms of the first element, acquisition of knowledge, the BoK’s benchmarking data is representative of performance gap assessment and the scanning imperative. The continuous improvement information is an example of the experimental mind-set presented in the model. The second element involves various modes of
documentation and dissemination of the data. While some data may be developed through informal or evolutionary modes, inherently the BoK forces a formal mode of documentation and dissemination of data by virtue of its existence as a computer-based tool. The final element of utilization characterized by learning focus corresponds to double-loop learning, or the extent to which the organization tests its theories-in-use. The general data structure of the BoK does not appear sufficient to incorporate this feature. However, certain categories of information in the data structure and system requirements expressed during the nominal group technique may lend themselves to stimulate double-loop learning (D.L.L.). Figure 3 illustrates examples of this potential.

**System requirement:** Objective, analytical method to evaluate best practices

**D.L.L. Potential:** Evaluation is conducted at the level of examining the theories-in-use underlying the best practices and making appropriate changes to the practices and theories

**BoK Category:** Things gone right and wrong (TGR/W)

**D.L.L. Potential:** Analysis and utilization of this information results in changes to basic assumptions that influenced the things gone wrong.

**Figure 3 - BoK Double-loop learning (D.L.L.) opportunities**

2.3 **Process Evaluation**

In completing the lead user beta test version of the BoK, several global issues became evident. First was the issue of ensuring that the BoK was a “living” document
rather than an encyclopedia or pure reference document. Because some of the resource
data for the BoK was historical, there was concern that the intended end-users might
neglect to reference the data on a regular basis - much as individuals tend to neglect use of
encyclopedias. This reinforced the requirement that the data in the BoK had to be useful
for individuals' in their routine responsibilities as well as in those occasions where a
historical reference is necessary. Because of the diversity and magnitude of intended end-
user groups, a great deal of time and effort would be necessary to meet this specification.
The resource allocation for such an effort became the second global issue.

The lead-user group was selected (in part) because of their level of preparation for
developing the BoK. This particular group had its "best practices" defined, which
facilitated incorporation into the prototype. There was also an underlying assumption by
this group that "best" practice was a relative term, and they sought to design a feedback
system in order to revise or update their best practices as necessary. This represented an
effort to institutionalize single-loop learning, as the group did not seek to explore the
theories-in-use behind the best practices in this example. However, the potential for
stimulation of double-loop learning from these practices exists as discussed in the previous
section.

Other areas of the organization did not have best practices defined, and would
need to spend a great deal of time establishing those practices for incorporation into the
BoK. The lower level of preparation caused a dilemma relative to the development of the
BoK: who would be responsible for establishing the best practices and incorporating this data into the BoK? The magnitude of the task could require a “librarian” to organize and update data in the BoK. However if responsibility for data input and update was taken away from the end-users, then the BoK might be treated as an encyclopedia because the end-users can become detached from the system.

The issues of resource allocation and overall preparedness for implementation of the BoK were directed to platform management. At this point in the research, the phase two beta prototype has been postponed, and the scope of the project is being re-evaluated.

2.4 Conclusion

As the analysis demonstrated, the BoK is an organizational learning system whose key elements primarily work to institutionalize single-loop learning. As discussed in the process evaluation, many parts of the organization are unprepared to offer data for the knowledge acquisition phase. Because this represents a project of extremely broad scope, a good deal of effort will be required to facilitate the institutionalization of single-loop learnings from the entire organization.

Interaction with the advocates of the BoK indicated a desire to stimulate double-loop learning. However, as the framework suggests, this type of learning is heavily dependent on dialogue and other forms of interaction to observe and explore the actual theories-in-use. In this regard the human element is inextricable from the process. Organizational defensive routines and inhibitory loops are detected via observation of
behaviors which at this point can not be fully ascertained with the use of computerized learning systems. Therefore, what the BoK can contribute to the pursuit of double-loop learning is the presentation of valid information to support the dialogue process for exploration of the theories-in-use underlying its contents.
CHAPTER 3 - TECH CLUBS

3.0 Introduction

One of the biggest challenges for a platform team organization is to transfer technical knowledge across the different platforms, so that expertise and superior practices are shared within the company. Such sharing accelerates single-loop learning throughout the organization and avoids error repetition. To encourage this sharing of knowledge the platform team organization formed a number of Tech Clubs - cross platform groups organized according to function or technical expertise. The manufacturing based Tech Clubs are related to:

- *Aluminum*
- *Assembly*
- *Body-in-White*
- *Controls, Architecture & Robotics*
- *Dimensional control*
- *Technical systems*
- *Welding*
- *Stamping*

Each club is led by the executive of a particular platform and meeting attendance, although encouraged, is on a voluntary basis. The clubs meet regularly, with meeting frequencies varying from once a month to once a quarter. The ultimate goal of the Tech Clubs is to help keep the platforms informed of each other's activities, discuss new technologies or process improvements, and to facilitate communication and sharing of knowledge by building relationships between its members. In light of the personal interaction and
relationship building potential, Tech Clubs could become forums for stimulating double-loop learning. Figure 4 details the original (1991) charter for the Tech Clubs.

**CHARTER**

- Develop objectives by Platform and model, exhibiting continuous improvement; focus on investment, lead time, flexibility, ergonomics, variable cost / productivity and specific technology where applicable
- Communicate current level of Technology and future plans by platform
- Review existing technologies that are capable of meeting objectives and make recommendations
- Recommends standards revisions where necessary
- Identify recommended suppliers with which to work
- Develop investment and timing plans to support recommendations
- Develop process / product design recommendations for future products
- Communicate with engineering Tech Clubs

**Figure 4 - Tech Club Charter**

Each tech club adopted the charter verbatim as a mission statement, or used the charter to develop more specific objectives for the club.

Formation of technically based clubs for sharing purposes is not limited to platform team organizations. Many decentralized organizations or those with distinct product group centers have also attempted to benefit from technical sharing groups. For the last
decade, a major aircraft manufacturer has held technical forums which meet biannually to work towards a mission similar to that of the tech clubs. The meetings last for several days and include personnel from each division of the corporation. While the benefits of these meetings have not always been financially quantifiable, tangible benefits have been noted. Most significantly, the forum members developed common specifications for a particular type of capital intensive equipment that each division had previously specified separately. They were able to approach the vendor as a unified group, and to obtain the equipment at lower cost based on their common specifications. As such tangible benefits are experienced within organizations, the formation of technically based clubs should increase.

3.1 Research plan

This research attempts to investigate the overall effectiveness of the Tech Clubs as organizational learning systems based on their success in encouraging communication among the club members and across platform teams. In order to do so, the following research hypothesis was formed:

*Clubs with explicit objectives and which meet regularly will show a higher communication index than those with no explicit objectives (i.e. less specific) and that have less frequent meetings.*

Explicit objectives are defined in terms of goals or assignments for accomplishment by year-end.
To evaluate the hypothesis, Tech Club objectives were reviewed and club members were randomly surveyed to determine their communication patterns. The survey was conducted following an experiment devised from *Foundations of Behavioral Research* by Kerlinger. This particular experimental design was chosen to compensate for the *researcher's phenomenon* that often occurs during surveys: participants will respond affirmatively to questions simply because they are being asked - regardless of the validity of the statement. This phenomenon is analogous to espoused values conflicting with the actual theory-in-use. The design does not question the integrity of the participants, but helps ensure conclusive results by calling attention to the aforementioned phenomenon if it occurs. The experimental design is shown in Figure 5.

**Four group form - Experimental and Control**

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<th>Y₀</th>
<th>X</th>
<th>Y₁</th>
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<tr>
<td>M₀</td>
<td>X</td>
<td>Y₁</td>
<td></td>
</tr>
<tr>
<td>(~X)</td>
<td>Y₁</td>
<td></td>
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*Key:*

Y₀ = observations before intervention
Y₁ = observations after intervention
X = intervention
~X = no intervention

*Figure 5 - Experimental design*
The groups were matched (hence the $M_k$) inherently because the study involved specific tech clubs. In addition, the meeting frequency influenced which groups were experimental and which were control; to facilitate the intervention, only clubs that met more often than quarterly were considered for the experimental group. From the candidate clubs, the final designation for the four survey groups was randomly assigned. The observations were made over a nine week period, and the intervention started in week six. The intervention consisted of attending a Tech Club meeting to become familiar with personnel, and asking additional questions in the survey related to Tech Club meeting attendance and perceived objectives for the club. The detailed survey research plan is contained in Appendix A.

3.2 Research Results

3.2.1 Tech Club Objectives

Most of the Tech Clubs investigated in the research used the original charter to develop a mission statement or objectives specific to the club. However, the depth and content of these articles varied greatly. This section will examine the explicit objectives of the clubs.

The experimental group goals are documented in a one page summary sheet, and are very similar to the general Tech Club charter. Overall, the goals are broad: to share cross platform information, new process technology, tooling and equipment issues, and to support specific cross platform work teams (e.g. teams formed by the company to optimize resource allocation such as ergonomics). The Tech Club’s goals are established
at the beginning of each year, and revised as necessary by the membership. The one page summary also establishes the meeting schedule for the year and notes membership for the year - implying that each platform may send different representatives each year.

Interestingly, membership and participation issues are documented on the summary sheet as follows:

"Participants still view this activity as an optional / non-essential task. Participants are unwilling and/or not able to accept work assignments from the Tech Club. Representatives do not have (specific) information to share. Comments are often based on opinions, rather than measurements."

It is probable that this documentation of issues along with the yearly goals is the result of efforts by the participating members to solicit additional participation in the club. I interacted several times with this particular club, and found that participation generally consisted of members from the same platform as the Tech Club leader (e.g. their platform executive). This pattern was not evident in the two other clubs that I interacted with; later sections of this chapter will discuss the issue of participation in greater detail.

The first control group had a mission statement summarized as three key activities: developing a business plan for (specific) production applications, acting as a focal team for knowledge and expertise, and proposing production applications as necessary for an area of interest. As can be ascertained, this particular Tech Club is concerned with an application and technology that is relatively new to the company, hence the goals of establishing the plan and proposing applications. In addition, a one page action plan was
developed to support the mission and sub-groups were formed to address four major areas of concern for the club.

The second control group had the most extensively defined objectives of all the experimental groups. The mission is summarized as sharing cross platform process and tooling information, investigating new technology, updating standards and developing cross platform training programs. In order to support the mission this club established a detailed prioritized list of work requirements related to each area of the mission statement, as well as process improvements, maintenance, supplier participation and cross platform technology teams.

The final control group produced no mission statement or objectives other than the original charter for the Tech Clubs. This was the only group where I did not attend a meeting either before or after the survey period.

3.2.2 Communication patterns

During the survey period more than 130 observations were made concerning communication patterns in the tech clubs. In general, communication indices were low for each of the clubs surveyed. The indices were calculated according to equation 1 detailed in the research plan in Appendix A, and represent the level of intragroup communication in the Tech Clubs. While communication was low between members of the clubs, the data in table 1 show that the specific Tech Club topic (i.e. welding) is being regularly discussed by
club members. The discussion typically occurs with individuals in the same platform team who are not members of the Tech Club. This pattern of communication with individuals in close proximity is repeated in the data related to general technical conversations held during the day. This correlates to Allen’s research on communication and distance which showed that the probability of two people talking in an office increases significantly only when they are seated less than 30 feet apart. This notion reinforces the importance of attendance at Tech Club meetings as a stimulus for conversation.

<table>
<thead>
<tr>
<th></th>
<th>Experimtl</th>
<th>Experimtl'</th>
<th>Control 1</th>
<th>Control 2''</th>
<th>Control 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of participants</td>
<td>18</td>
<td>15(^b)</td>
<td>15</td>
<td>20</td>
<td>18</td>
</tr>
<tr>
<td>Communic. index(^e)</td>
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<td>0.010</td>
<td>0.029</td>
<td>0</td>
<td>0.007</td>
</tr>
<tr>
<td>Discussed topic</td>
<td>72%</td>
<td>80%</td>
<td>67%</td>
<td>65%</td>
<td>89%</td>
</tr>
<tr>
<td>*w/ptfm co-worker</td>
<td>62%</td>
<td>67%</td>
<td>60%</td>
<td>77%</td>
<td>75%</td>
</tr>
<tr>
<td>Technical discussion</td>
<td>56%</td>
<td>33%</td>
<td>100%</td>
<td>65%</td>
<td>39%</td>
</tr>
<tr>
<td>*w/ptfm co-worker</td>
<td>50%</td>
<td>80%</td>
<td>73%</td>
<td>92%</td>
<td>71%</td>
</tr>
</tbody>
</table>

Notes - a: prime denotes observations after intervention (e.g. Control 2'')
  b: Three of the original participants were unavailable for observations after the intervention
  c: Communication index calculated using equation 1 (see Appendix A)

Table 1 - Summary: Survey data

The original research hypothesis was disproved because none of the Tech Clubs had a high communication index, and the club with the most explicit objectives and regular meetings (Control 2) had the lowest intragroup communication index (zero). It is interesting to
note that the club with the highest communication index (Control 1), involves technology that is most unfamiliar to the industry. While the difference is not extreme (i.e. none of the clubs had a high index), this finding is generally consistent with that of Clark and Fujimoto which concludes that rapidly changing industries exhibit higher communication between groups. The newer technologies investigated in the Control 2 tech club represent greater potential change for the industry than the technologies of the other clubs, so there is more communication between the Control 2 tech club members. Accordingly Control 1, in spite of its explicit objectives, represents one of the more familiar technologies of the industry and correspondingly has a low communication index.

As the findings between groups before and after the intervention are fairly consistent, the researcher’s phenomenon described in Section 3.1 does not appear to have been a factor in this experiment.

3.2.3 Observations from the Intervention

During the intervention tech club members were questioned concerning their meeting attendance habits, relationship with other tech club members and the overall objective of the tech club. This section presents key observations related to those topics.

3.2.3.1 Meeting Attendance

While some of the participants reported regular attendance of tech club meetings, approximately half of the survey respondents reported infrequent attendance of meetings.
There were three main reasons given for the lack of participation in the tech club: 1) launch activities, 2) disincentives for attendance and 3) movement to unrelated areas.

Approximately 55% of the infrequent participants cited launch activities as the primary reason for their lack of tech club meeting attendance. These respondents reported absences from the tech clubs ranging from 6 to 24 months because of higher priority launch activities. The theory-in-use was that tech club activities were secondary to launch. Since none of the respondents reported the assignment of alternative tech club representatives to fill in for them while launch activities occurred, the theory-in-use is supported with secondary observational data.

Roughly 35% of the infrequent participants cited reasons which correspond to disincentives for attendance at tech club meetings. Generally these respondents said that they were either too busy to attend the meetings (general responsibilities - not launch related), or that the meeting time and / or location was inconvenient. There was a theory-in-use that the aforementioned issues were valid reasons for discontinued participation in the tech club, and the respondents expressed no fear of reprisal for their lack of participation. These factors combined are disincentives for attendance at tech club meetings.

The final portion of respondents reported that they did not participate in tech club activities because they had moved to new areas and had responsibilities which were
unrelated to the particular club. They expressed some frustration because they seemed to be on outdated tech club mailing lists. However, none of these respondents had mentioned their inactive status during the survey until they were specifically asked about their meeting attendance habits during the intervention. One implication of this behavior is that the respondents assume a sort of “life membership” in the tech clubs. Another potential implication is that the responses of these participants could have produced artificially low communication indices because of their inactivity in the tech club(s). However, the small number of respondents involved (an average of one per club) would not have biased the indices to any great extent. In addition, their responses could be indicative of the strength of relationships formed within the tech clubs, whether “life” membership produced continued communication among members.

3.2.3.2 - Relationships between tech club members

When asked to specifically identify tech club members with whom they consult on a regular basis (i.e. weekly), approximately 50% of the intervention participants reported that they communicated most often with those members who are part of the same platform team. Only 25% reported regular communication with tech club members from different platforms. In most of these cases the respondents consulted with specific colleagues from different platforms who, because of their previously demonstrated expertise, are recognized as technical “gatekeepers” within the organization. This finding is consistent with Utterback and Taylor’s research which suggests that individuals with key technical communication roles prior to some organizational change re-emerge as gatekeepers in the
changed groups. The final 25% of the respondents reported no regular communication with tech club members. It is the researcher’s opinion that the number of respondents reporting weekly communication with other tech club members may be biased by the researcher’s phenomenon because such frequent communication between club members should have been manifested in higher intragroup communication indices. It is likely that the respondents consult with their peers as noted, except on a less frequent basis than weekly. However, in agreement with earlier data it is likely that the relative proportion of responses is accurate in that most participants confer with colleagues within their platform team as opposed to those in different platform teams.

3.2.3.3 - Objective of the Tech Clubs

A majority of the intervention participants responded that a fundamental objective of the tech clubs is to share information between platforms, particularly relative to new technology. Most expressed belief that this objective was generally being met. However a large portion of these participants said that the other fundamental objective of the tech clubs was to develop standards for cross platform adherence. These respondents expressed frustration that the clubs were not meeting the standards-related objective. Most stated that the clubs lack the formal authority necessary to enforce standards, but offered no explanation as to why they believe that the development of standards has not been a priority for the tech clubs.
3.3 Conclusion

In terms of encouraging communication among tech club members and across platforms, data indicate that the tech clubs have not been as successful as the platform team organization would expect. In discussions with tech club members, some expressed frustration that attending the meetings did not add value to their work-day. Because of this perception, these members did not fully participate in the tech clubs and the low level of communication in the clubs was exacerbated. This is an example of an inhibitory loop as described in the framework. Data from the surveys and intervention indicate several root causes for the perceived low added value of the tech clubs. These root causes are pictorially represented in Figure 6.

![Communication inhibitory loop](image)

Figure 6 - Communication inhibitory loop
The Tech Clubs are operating in a culture where launch responsibilities supersede all other responsibilities, and Tech Club representation in this case in non-essential. This assessment of non-essentiality is supported by intervention observations of the disincentives for participation. In order for the tech clubs to meet their objectives, these root cause issues must be addressed. Specific recommendations are presented in chapter six of this research. Additionally, the example of a successful implementation of Tech Clubs cited in the introduction to this chapter may be examined for applicable strategies. The tangible benefits noted are important for the continued support and success of technical forums within the organization; they encourage both participation by members and support by management. In light of the accomplishments, participation in the forums is considered a priority and an honor.

As previously stated, Tech Clubs provide potential forums for double-loop learning. As an example, the development of standards provides opportunity to begin dialogue which examines the underlying assumptions of the standards. This could result in a change of these assumptions (or new theories-in-use) and the development of a new standard. However, the cultural conditions must exist to stimulate and support such dialogue. A challenge then for a PTO desiring to use Tech Clubs as forums for double-loop learning is to create an environment within the clubs and in the larger organization which promotes double-loop learning.
CHAPTER 4 - DOOR EXPERIMENTATION

4.0 Introduction

The preceding chapters have examined organizational learning in the context of specific enhancement initiatives. While this analysis is important, it is equally important to examine learning in the context of customary work completion within the organization. To accomplish this, the research will now focus on the specific example of hard-top door development.

4.0.1 Background

Historically, small cars were not profitable for US automakers but all produced various small car models because such models provide a strategic market entry point. In their effort to become the leading automaker in the world, the PTO endeavored to make a profitable small car - referenced in this research as the case study vehicle. In order to make the case study vehicle profitable, aggressive cost and weight targets were established. As one enabler to reach these goals, the decision was made to use a hard-top door design.

Traditional, or full-frame, vehicle doors consist of interior and exterior panels which connect to form the rectangular box or foundation of the door, and a header assembly which serves as the housing for the door glass. A hard-top door consists only of the rectangular box; there is no header assembly. The door glass fits directly into the car.
aperture, with weather-strip materials providing a seal for the glass. Figure 7 shows a full-framed door and a hard-top door design.

![Door Diagrams](image)

**Figure 7 - (a) Full-frame door (b) Hard-top door**

Because a hard-top door consists of less material, substantial cost and weight savings were expected for the case study vehicle. In addition the hard-top design was selected because it provides a distinct styling benefit for small cars, the "greenhouse effect". The lack of a header makes a larger glass section visible in the door and as a result the interior of the car seems to have more room.
4.0.2. Implementation issues

For ergonomic and efficiency considerations the plant uses a "doors-off" assembly process, described below.

Doors-off Assembly Process

Body Shop:
- doors are attached (set) to the vehicle
- doors are adjusted for fit

Paint Shop:
- vehicle is painted

Door Assembly:
- doors are removed
- door hardware (i.e. window mechanism, etc.) installed on separate assembly line

Final Assembly:
- fully trimmed doors re-attached to vehicle
- doors adjusted to ensure proper (final) fit

As indicated above, the doors are adjusted in two areas to ensure proper fit. The doors are fit in the body shop to ensure proper coverage during the paint process. The final assembly fitting ensures that door gaps are evenly spaced. Fitting is typically accomplished by assembly personnel, or "door fitters", hammering the door hinge area and then physically pulling the door into place. This fitting process is employed to some degree in most automotive assembly plants. While the process may seem unrefined, door fitters are traditionally among the most skilled assembly personnel because of the potential for damage or poor fit because of the process.
When the case study vehicle went into production the plant had problems with excessive door sag, where the door hardware weight caused the door assembly to deflect or sag below its optimal position in the door opening. Potential contributing sources for door sag are summarized in figure 8.

![Venn Diagram](image)

**Product factors:**
- Door Panels
- Hinges
- Vehicle Aperture
- Door hardware weight

**Process factors:**
- Operating Procedures
- Fixtures
- Fitting
- Painting

Figure 8 - Door sag contributing factors

The mechanical and material properties of the door panels, hinges and vehicle aperture influence stiffness and subsequent resistance to sag. Process factors which can influence sag include the variability introduced from personnel, equipment, and the body shop door fitting process. Additionally, the paint process may contribute to sag by influencing the door set position. When vehicles are painted the doors are held closed with a temporary fixture (slave) because the permanent door closure system is not yet installed. Variability in the position of the door slaves as vehicles go through the paint baking cycle may
influence sag by altering the body shop door set position. Although most people agree that the factors listed in figure 8 are likely to influence sag, the exact contribution from each of these factors remains uncertain.

Most doors experience a small amount of sag which is typically compensated for in the door setting process. In plants benchmarked for excellence in door assembly, the doors are set 0.5 - 1.0 mm above level to compensate for sag. For the case study vehicle, the doors had to be set 4.0 mm high to compensate for sag. The practice of setting the doors high was problematic because the assembly plant workers experienced difficulty in repeatably setting the doors at 4mm. The high setting caused the door character lines to be misaligned, and fitters were no longer able to visually evaluate the proper fit of a door. These factors increased the variation of the door setting process with potential negative influence to the variation of subsequent downstream door assembly processes. Increased variation in the system caused increased effort to ensure proper door fit in the final assembly operations, which negatively affected the efficiency of the assembly line.

4.0.3 Potential quality issues

Door sag can ultimately contribute to aesthetic problems such as uneven gaps or a lack of flushness between door panels. Additionally, poor panel fits resulting from door sag can contribute to mechanical problems such as wind noise, water leakage and increased door closing effort. Earlier PTO vehicles employing a hard-top door design had experienced greater incidences of wind noise and water leakage as reported by customers. The case study vehicle ratings for both of these warranty areas were higher than the
industry average in the JD Powers initial quality survey\textsuperscript{13}, and higher than those of other vehicles manufactured by the PTO.

The assembly plant difficulties and potential quality issues made resolution of the excessive door sag problem a high priority.

4.1 Major contributor: hinge design

In order to understand the issue, doors from cars with similar hard-top designs were evaluated for sag. Over a range of loads the case study vehicle generally exhibited more sag than the other cars in the study. During the evaluation it was noted that the door hinges of the other cars had more structure than those on the case study vehicle, even though the vehicle doors were of comparable size and weight. The distinctive styling of the case study vehicle door required close clearances in the area of the hinge, which had resulted in a more compact hinge design. This compact hinge was considered adequate for the case study vehicle, as the same design was used on other cars in the PTO. However, the observations from the study led to further testing and analysis to attempt to quantify the effect of the hinge on door sag.

The total hinge contribution to sag was estimated by isolating the sag contributions from other product factors and eliminating the process factor contributions. To accomplish this, laboratory tests were conducted for three load conditions:

- *Sag due to sheet metal weight*
- *Sag due to sheet metal and door hardware weight (fully trimmed)*
• *Sag with fully trimmed door and graduated loading to corporate standard*

The doors were supported by hydraulic jack, fitted with an electronic deflection transducer and then mounted to a rigid pillar at a predetermined open position. A zero deflection data point was recorded, the jack was removed and the door was allowed to sag. After the deflection was recorded, the door was returned to zero and the process was repeated for the load conditions described above. Next the entire process was completed for doors with rigid hinges. Finally, the relative contribution of the hinge was extrapolated through application of the theory of superposition. From this analysis, the hinge contribution to door sag was estimated at 70%. This value was confirmed through similar tests conducted in the assembly plant.

Subsequent finite element analysis of the hinge showed an area of extremely high stresses which could contribute to excessive deflection. A hinge was modified to strengthen the suspect area, and a door with the modified hinge was tested for sag as described above. This particular door showed a marked improvement in total sag, with the hinge contribution substantially lowered from 70% to approximately 12%.

As a result of the investigation, a decision was made to redesign the hinge. The modification made for the laboratory tests was not feasible for production use because it exceeded the available clearance in the hinge area. Because of tooling lead times and other coordination issues, the hinge redesign was slated for the next major style revision of
the case study vehicle. The hinge vendor, engineering and manufacturing personnel are collaborating to incorporate design changes which will strengthen the suspect area and reduce the contribution of the hinge to door sag.

4.2 Experimentation: extra welds

4.2.0 Background

Because the next major vehicle style revision was approximately three years away, an interim solution was sought to help alleviate the issues at the assembly plant. After process engineers from the Mexican plant (which assembled the same product) noted that the door sag problem seemed to be less apparent there, the platform team began to evaluate differences between the door assembly processes of the two plants in an effort to find an explanation for the perceived difference. The assessment concluded that the Mexican plant used a different weld pattern, with 10 additional welds, for the hinge pillar which could conceivably increase the stiffness of the member and help reduce door sag. The hinge pillar with the additional welds is shown in figure 9.

![Figure 9 - Hinge pillar welds](image-url)
The US assembly plant was unable to incorporate all of the extra welds into the hinge pillar without significantly increasing the cycle time of the robotic welding station. Additionally, analysis of the placement of the extra welds indicated that as many as half were in positions which would not significantly add to the stiffness of the member. Due to these factors and because five welds could be added without detrimental effects to the welding station cycle time, a decision was made to evaluate the effects of five extra welds on the hinge pillar.

4.2.1 Designed experimentation

In an effort to quantify the effect of the extra welds on door sag values, a designed experiment was conducted at the plant. Because the contribution of the assembly process to the level of door sag is unknown, the original designed experiment included a factor to help evaluate the process contribution. However, due to production constraints, the process factor was not included in the actual experiment. The experiment was subsequently a single factor design with two levels of treatment: doors with the standard hinge pillar weld pattern vs. doors with the standard pattern plus the addition of the five extra welds.

Because the additional welds necessitated reprogramming the welding robot, the door groups were run in single batches to minimize production interference. Door gap measures were taken in the body shop (after the initial door installation), and on the final
assembly line (after the doors were re-installed on the car). Door sag values were calculated by subtracting the values of measurement point 5 (shown in figure 10) in the body shop and assembly areas.

\[
\text{Sag} = \text{Point 5 (body shop)} - \text{Point 5 (assembly)}
\]

\[
\text{Kentucky windage} = \text{Point 5 (body shop)} - \text{Point 4 (body shop)}
\]

*Note: this is door set position*

**Figure 10 - Door measurement points**

In addition to sag values the "Kentucky windage", or the door set position, was calculated by subtracting the values of measurement points 5 and 4 in the body shop. The Kentucky windage value reflects the ability of operating personnel to repeatably set the doors at the target of 4 mm high. Operating personnel were instructed to set the doors as normal during the experiment. Table 2 below summarizes the results of the door weld experiment.
Table 2 - Experiment results summary

Testing of the data indicated that the average sag values of the sample groups were statistically different. The data was tested for normality using Bartlett’s test; once confirmed T-tests were run to validate the statistical significance of the results. Statistical results are found in Appendix B. The practical benefit of the difference in average sag values is questionable when the sources of error of the process and experiment are considered. The 0.33 mm difference in average sag values is close to the limits of precision for the door setting fixture. In addition, because only one factor (welds) was tested it is not possible to give a comprehensive answer on the true difference in sag values because of the lack of process variable input. As discussed in the introduction to this section, an expanded designed experiment would need to be run in order to give such an answer. The original design called for the Kentucky windage to be varied as part of the experiment. Although windage was not varied as a factor in the experiment, it was calculated as indicated in the above table. This was done because of the potential for interaction between the windage and door sag. Preliminary graphical analysis (see figures 11, 12) indicates that the interaction may exist.
Figure 11: run charts
Figure 12 - XY charts
The run and XY plots show a potential interaction that may be lessened with the addition of the five extra welds. The run plots overlap for the samples without the extra welds while sag is consistently lower than the windage with the extra welds. The XY plots do not show a linear pattern (i.e. a direct interactive relationship) but the relative spatial displacement of the data-points confirm the bias for lower sag values than windage for cars with the extra welds. While this analysis is grossly approximated and would require further experimentation for validation, it supports previous laboratory testing that also indicated an interaction between windage and sag. The extra welds appeared to lessen the intensity of this interaction, even though the practical difference of the average sag values of the two sample populations is questionable. These findings imply that quantifying and reducing the process contribution to door sag may be the next logical effort for interim resolution of the issue.

4.3 Potential sag issues with aluminum doors

As automakers seek to improve fuel efficiency and recyclability, aluminum is being used increasingly as the material of choice for vehicles. The vehicle examined in this case study has had limited production as an aluminum intensive vehicle, where all of the major body panels and structural members were made of aluminum. As the probability of production of aluminum intensive vehicles increases, the issue of door sag becomes more significant. As noted earlier, the low weight of the door panel structure relative to door hardware weight was a contributing factor to the door sag issue. Additionally, as vehicles incorporate more features the door hardware weight will continue to increase. In
consideration of these issues, a lighter weight aluminum door can potentially experience more sag due to the difference in material moduli between aluminum and steel.

4.4 Conclusion

One of the most important outcomes of the root cause analysis was the renewed collaborative approach adopted by the personnel involved, and the resulting change to the hinge design. This resolution represents the institutionalization (across the vehicle platform) of a single-loop learning process for the case study vehicle door issues.

The door weld experimentation served as an empirical means to enhance organizational learning in two ways: 1) it provided data to help quantify the effects of a process change for which the results might not have been as well documented elsewise and 2) it helped reinforce the notion of designed experimentation as a means for process measurement. These effects are important at both engineering and manufacturing levels. The experimentation served as a feedback mechanism between engineering recommendations (e.g. the additional welds) and manufacturing outcomes (e.g. quantified effect on door sag). This provided the mechanism for single-loop learning to occur in terms of quantifying the effects of the extra welds on door sag.
CHAPTER 5 - DOOR ISSUES: LEARNING HISTORY

5.0 Introduction

In considering the issues surrounding hard-top door implementation the PTO is challenged to internalize these issues, examine the underlying assumptions and institutionalize the learning such that problems do not reoccur in future projects. To assist with this goal, a learning history was created to answer the question “what went wrong for the hard-top door implementation?” with specific attention to the issue of door sag. The goal for the learning history in single-loop context is to document significant learning related to hard-top door design and implementation, and to assist with the transfer of this knowledge across the corporation. The goal in double-loop context is to disseminate the document in order to stimulate dialogue which examines and restructures the theories-in-use that allowed the problem to propagate.

The learning history technique was developed by the MIT Organizational Learning Center (MIT-OLC). The learning history document is a combination of exposition and analysis written by the author(s) and a “jointly told tale” of the event narrated in the voice of the participants in the learning initiative. However, the quotes are anonymous in order to allow focus on the issue at hand rather than the participant. In addition to describing the facts and events of what occurred in the initiative, the history focuses on what the participants thought about the events, and how they perceived their own actions and the actions of others. This recreation of the experience of “being there” helps the reader understand what happened and presents perspectives that are not always discussed in
typical business settings. It is this open evaluation and discussion of the situation that allow the organization to overcome defensive routines that have traditionally discouraged learning by making the true issues undiscussable. Dissemination of the learning history via team enhancement workshops is crucial to encourage development of organizational skills and the culture necessary for double loop learning.

5.1 Learning History Methodology

To create the learning history, interviews were held with key personnel involved in the learning initiative to record their perspectives of both the successes and shortcomings of the project, focusing on implementation issues. These perspectives were subsequently compiled and analyzed for recurring themes that represented pivotal issues for the group. The themes became the foundation for the learning history. Figure 13, below, details the learning history development process employed by the author.
For the purpose of analysis, only the major themes and findings will be discussed in this chapter. The learning history in its entirety is included in Appendix C.

5.2 Dominant Theme: Teamwork

Less than optimal team performance is an issue that all organizations contend with to varying degrees. In a platform team environment, effective team performance is not only desirable, but is mandatory for the survival of the organization. As teams are composed of individuals with a variety of backgrounds and experiences, the platform team organization must overcome individual and collective issues of diversity to create the high performance teams required in the organization.
A major factor contributing to the problem of door sag was the apparent lack of teamwork in resolving the issue. Perceived barriers between groups within the door systems team has inhibited effective communication and negatively affected teamwork. Differences in education level, experience and functional alliances were but a few of the barriers that the team had to overcome to build more effective communication and teamwork.

From analysis of the learning history interviews, the lack of teamwork for resolution of the door sag problem followed a negatively reinforcing cycle, and became an inhibitory loop. Because communication of the issues between groups was not successful, the problem was investigated on a sporadic and individual basis. As the problem continued to remain unsolved, frustration and animosity built between the parties involved. The ultimate effect was strained working relations and ineffective teamwork for resolution of the door issues. This cycle is depicted below in Figure 14.
The cycle began with ineffective communication of the issues involved. Numerous factors influenced and contributed to this lack of communication. Aside from issues of diversity which can inherently make effective working relationships more challenging to build, the nature of the issues being discussed profoundly influenced the lack of communication. Because the communication involved a problem which was potentially embarrassing to the individual contributors, organizational defensive routines activated and hindered communication of the true issues. As Argyris proposes in Overcoming Organizational Defenses, the common reaction to defensive routines is a sense of helplessness, which migrates to cynicism and blaming others in the organization for the problems that have arisen. This reactionary loop, or organizational defensive routine, is depicted in figure 15.
The phenomenon is clearly operational as evidenced in the following excerpts from the learning history:

**Engineering - person C**
I think we were all talking and trying to do the same thing, but the defense mechanisms go in at a certain point. And this is all human nature. You’re proud of what you did and someone points a finger and says that it could be done better; you dig your heels in and say - - “It’s right. We’ve proved it.”...

**Manufacturing - person D**
It went in one ear and out the other. I mean, I guess they understood my concern, but they didn’t do anything about it. ...We couldn’t begin to tell them how to change the design to improve it. ...When we did try they said “it’s too expensive, too late, etc.”. So we just gave up.
Manufacturing - person F
I tried to communicate to my cohorts at the research center about the problems we were having in the plant. They seemed cooperative -- wanting to listen. I see that we “listened” but we didn’t do anything about it ... we still have the same problems we had when we started.

Manufacturing - person B
It seemed that there was a lot of mud slinging going on between the Product people and all of Manufacturing, at the research center and the plant. ... There were some nasty notes generated that pinpointed the whole problem on process ... I know I’ve told people that their product was poor which was (I guess in the way that I conveyed my message) mudslinging ... it just seemed that we really didn’t work together on this problem as a team.

From a systems perspective, numerous other issues identified in the learning history influenced the eventual lack of teamwork in resolving the door problems. These issues will be discussed in subsequent sections of this chapter.

5.3 Ancillary themes
A significant reason why the door sag problem was not resolved quickly related to the complexity of the problem. Its root cause was tangled in the interdependencies of the door system and the assembly process as discussed in the previous chapter. Solving such a compound and somewhat ambiguous problem required a high level of teamwork, analytical skills, time and effort. Additionally, previous experience and learnings about
hard-top door design had not been well documented or disseminated. The learning curve associated with hard-top door implementation and the relative inexperience of some personnel encumbered the problem solving effort for door sag.

As Senge wrote in *The Fifth Discipline*, "today’s problems come from yesterday’s solutions" and "cause and effect are not closely related in time and space". These epithets were true for the door sag problem. Some of the actions completed to make the door as light-weight and as low cost as possible had adverse affects on the manufacturability of the door. Indeed, a significant factor in the door issues was rigid and sometimes conflicting objectives for the vehicle program. The platform sought to develop a profitable small car, which had been unheard of for North American automakers in recent years. In order to meet this goal, calculated risks were taken to make the car as lightweight and low cost as possible. The hard-top door design was implemented for its styling and weight benefit, but with the known risk of related wind-noise and water-leak issues. These warranty issues are a by product of improper door fit and glass sealing / adjustment - all of which can be linked to door sag and fit issues in the assembly plant.

Just as ineffective teamwork can hinder problem solving efforts, rigid or conflicting objectives may foster “territorial” behaviors and activate organizational defensive routines that subsequently impede problem resolution. This happens when rigid objectives discourage a systems approach to problem solving, and instead individuals territorially protect their own interests of meeting the goals rather than pursue the best
systemic solution for the problem. These ancillary themes are demonstrated in the following learning history excerpts.

**Manufacturing - person B**

It seems that we were limited in budget, and they wanted to make this a real lightweight car. Trying to achieve those goals, they maybe put the other objectives to the wayside, or they weren’t really concentrating on making the door robust.

**Engineering - person E**

We were immersed in a situation that mandated that we design a small car to meet very aggressive functional, cost, weight and investment targets. After it was demonstrated how much we didn’t spend, in the last 6-8 months before launch, management said ‘okay spend some money to make it even better’. By then the structure was set and the additional money that was spent did not achieve the level of results that could have been accomplished if these dollars were available earlier in the program.

**Engineering - person E**

... I think that if someone had foreseen the problems that we were going to have then maybe we would have gone through some panic phase to change the door. But other areas would have been affected like the aperture. If we had changed the door we would have had to do some really difficult things with the rest of the car.

**Manufacturing -person D**

We saw early on that there were going to be problems. But sometimes I guess it’s easier to take the excuse than to pursue the solution that you
know is not easy. I think what happened was that we didn’t have people that could come up with solutions to the problem that was identified. That was probably due to general inexperience and perhaps a lack of cross-functional experience.

The interaction of the dominant and ancillary themes can be summarized by the relational diagram shown in figure 16.

**Figure 16 - Relational diagram**

The themes and influence factors identified above were propagated due to the operation of learning impediments in the larger organizational culture. The root issues were, in some respects, undiscussable because of potential embarrassment for personnel involved. This
assessment of the organizational culture is supported by the following analysis that employs Schein's model for assessing the levels of culture as presented in Organizational Culture and Leadership.

5.4 Cultural Analysis

In the data collection process for the learning history, behaviors were observed which implied some incongruity between the organization's espoused values and theories-in-use. These incongruities formed the basis of the learning impediments referenced above. The observations are analyzed in light of the artifacts presented, values espoused and basic shared assumptions constructed from the behavior.

5.4.1 Artifacts

Thirteen people were interviewed for the learning history. Most were extremely candid even though they were being taped. During the interviews people spoke of poor working relationships within the group and a tendency to avoid addressing problems in certain areas. After the interviews were transcribed and quotes were edited, everyone had the opportunity to view their specific quotes which had been selected for inclusion in the Learning History and to revise them as necessary. An interesting phenomena occurred: the non-management people made only a few very minor revisions, while the managers deleted or extensively revised entire sections of their quotes. Most expressed alarm that their quotes sounded "negative". When reminded that the primary emphasis of the Learning History was on the things gone wrong in the implementation of hard-top doors
relative to the door sag problem, the personnel still remained preoccupied with avoiding any "negative" remarks.

5.4.2 Espoused values

A manager who was considered a key supporter of the Learning History process commented on the concern about the selected quotes. This person stated:

"I don't want to be seen as a 'nay-sayer'. People learn best when you reinforce positive things. I want people to know that I said some positive things about the hard-top door implementation."

When questioned about the value of learning from mistakes and the need to candidly address issues in the learning history, the manager commented that the organization would not readily accept such feedback.

The PTO has a process where the "things gone right" and the "things gone wrong" for a project are formally evaluated at project completion. The product of this process is typically a large document of bullet points and sentences giving some pros and cons of the project. The existence of this process espoused the belief that equal value was placed on learning from mistakes as well as victories.

5.4.3 Basic assumptions

To understand the seeming incongruity between the espoused values and the actual behavior of managers in the group, the supportive manager was again questioned. At this point, a concern was expressed relative to making other manager(s) feel that someone was
"pointing the finger" at their area(s). The other managers who were interviewed echoed these sentiments. One manager said that the quotes had to be restated in a more “politically correct” manner because of the potential for the quotes to be taken out of context by some other manager, or to have them feel that someone was “pointing the finger” at their area. These conversations along with other supporting data led to the formulation of a shared basic assumption, or theory-in-use:

- **Managers must avoid conveying information that is negative or potentially embarrassing for another managers area.**

The implied underlying assumptions are numerous: relationships could be damaged; there might be some form of repercussion; a manager is expected to have his or her “turf” controlled enough such that problematic or embarrassing situations do not catch the attention of other managers - negative data then questions management skill. Each of these issues may have been a factor. This is suggested because the managers readily discussed the issues in private, but balked at public dissemination due to reluctance to “point the finger” at another manager.

The “things gone right and wrong” report also reflected the hesitancy to convey negative information about specific areas. In 55 pages of documentation concerning the case vehicle launch and production ramp-up, there were only a few ambiguous references to problems with the door. In fact, in the initial perusal the document seemed to be absent of door issues. A more rigorous search found the references, and noted that the tone of the “things gone right” section differed from that of the “things gone wrong”
The positive comments usually identified specific departments or functions; the negative comments were generally not specific to areas and were weighted with issues related to shortfallings of the vendors involved in the product launch.

5.4.4 Implications

The propensity to make negative issues undiscussable appears to be a barrier to learning which is operating within the PTO culture. This works to inhibit the surfacing of important issues, as has been evidenced in this analysis. In this case, although the non-management personnel were more comfortable with their candid quotes being used almost verbatim in the learning history, they also had an increased measure of anonymity relative to the managers. Although no names were used, the learning history originally distinguished personnel by title in order to help illuminate the context of the expressed perspective. Although the titles were eliminated, because of statistics (i.e. less managers in the population), comments from managers were perhaps more easily distinguished than those of non-managers. In situations where anonymity is not possible, non-management personnel may model the managers behavior and also hesitate to convey negative information. The “things gone right and wrong” report is compiled by all levels of personnel associated with a project, but it is distributed as a document from the platform executive. It is not discernible whether the document was composed such that negative information appeared more palatable, or if the door issues were not discussed as part of the document.
5.5 Conclusion

5.5.1 Culture

It is likely that the undiscussability of negative issues is not limited to the case of the managers in the preceding cultural analysis. Such undiscussability was a contributing factor to the inhibitory loop (figure 14) which resulted in the lack of teamwork in resolution of the door sag issue. When personnel attempted to address the issues, the defensive response evoked feelings of helplessness and blame, which eventually caused the issue to become undiscussable. Therefore, undiscussability not only impedes double-loop learning, but is also an impediment to single-loop learning as illustrated by the lack of teamwork in resolving the door sag issue.

5.5.2 Learning History: Double-loop learning tool

The learning history interview process elicited candid information which had been previously undiscussable. The reaction to potential dissemination and subsequent analysis of the learning history brought the undiscussability of the issues to the surface, and revealed a potential theory-in-use by management personnel. In these respects, the learning history has the potential to be a useful tool for double-loop learning. Clearly, it is the discretion and decision of the participants whether or not the learning history will be used in this fashion, and whether the theory-in-use and its underlying values will be restructured.
CHAPTER 6 - CONCLUSIONS AND RECOMMENDATIONS

6.0 Introduction

As has been evidenced in the research, organizational learning is a field laced with technical and behavioral challenges. In its efforts to become a learning organization, the PTO is faced with some unique issues due to its structure and cultural norms. It seeks to enhance organizational learning while maintaining the proper balance between the autonomy of the platform teams and the collaboration needed for single- and double-loop learning. This chapter presents conclusions and recommendations for the PTO based on the research and prevalent theory related to organizational learning.

6.1 Enhancing the Learning System

These recommendations are presented in order to assist the PTO in addressing the questions introduced in section 1.1 of this research. A team of internal learning advocates along with external participants may provide the optimal facilitation for this effort because of the balanced perspectives encompassed in such a group.

1. Revisit the organizations’ vision for learning. This entails identifying the desired qualities of how the PTO will function as a “learning organization”. If a shared vision is not yet established, then the strategies found in The Fifth Discipline Fieldbook may assist in its development.
2. Explore the organizational culture, seeking to understand the theories-in-use of the organization, its learning oriented aspects as well as its barriers to learning. Using a framework such as that presented by Schein in *Organizational Culture and Leadership* is recommended. Other tools for analysis include those found in chapter eight of Argyris' *Overcoming Organizational Defenses*, and use of learning histories with subsequent discussion and analysis similar to that in the preceding chapter.

3. Develop skills and tools across the organization to assist in overcoming the identified barriers. Continue and broaden the "Leading Learning Communities" work that is underway. Along with this training, the Argyris and Senge books provide exercises for the development of these skills.

4. Focus on making the environment more conducive to learning. An environment void of barriers to learning is insufficient to stimulate learning. There should be processes and strategies in place to help continually explore and restructure organizational theories-in-use as needed. All of the tools described above may be helpful for this. Additionally, some form of sensitivity training to help identify and reduce barriers within and between platform teams may also support this effort. When teams are newly formed or experience a great deal of personnel turn-over, team-building exercises may also be appropriate. Finally, periodic job-rotation and cross-functional training will help team members understand each others' requirements and constraints.
6.2 Book of Knowledge Development

The following actions are recommended for the continued development of the Book of Knowledge:

1. Dedicate resources from each manufacturing group represented in the book (i.e. stamping, assembly, etc.) to lead development of the best practices for their areas. The lack of documented best practices was identified as an inhibitor to the development of the book. Dedicated resources from these groups and others (e.g. Tech Clubs) will facilitate its completion.

2. Integrate use of information in the book with primary responsibilities of end-users to add inherent value and incentive for use. This will help address the concerns about the book being an “encyclopedia” rather than a living document. Examples of strategies to accomplish this include real-time postings of plant issues, results from continuous improvement workshops and learning laboratory line updates as opposed to hard documentation.

3. Use on-line bulletin board areas as forums for exploring underlying assumptions of the information listed (i.e. best practices) and recommending appropriate changes. As recognized by the lead-user group, such feedback provides opportunities for both single- and double-loop learning.
6.3 Tech Clubs

In order to address the issues revealed in the survey, the following items are recommended with recognition that some clubs may have already accomplished these actions:

1. **Elevate the status of the clubs by adding responsibility and authority.** In order for the clubs to achieve their purpose they should have both responsibility for tasks and the authority to complete the tasks. Standards definition and best practice development are two areas where the clubs' leadership would prove very beneficial.

2. **Provide incentives for participation.** As discussed in the research, many participants have relative disincentives for participation. Once the first recommendation has been implemented, the perceived value of participation in the clubs should rise. After this is accomplished, then additional incentives for participation may also help the situation. Specifically, tech club participation should be an explicit performance expectation for the members, with opportunity for reward when participation is outstanding.

3. **Encourage development of the clubs as forums for double-loop learning.** If the clubs take leadership in best practice and standard development, then they have the opportunity to explore the underlying assumptions.
6.4 Door Issues

6.4.1 Experimentation

1. Continue designed experimentation to increase understanding of the interaction between assembly process and product design factors. In the case of door sag, an expanded DOE should be run to quantify the effects the contributing factors referenced in the chapter.

2. Continue to build the linkage between vendor designers and plant concerns. The identification and resolution of the hinge issue may have been hastened with earlier participation of the vendor designers.

6.4.2 Door Learning History

1. Begin dissemination of the information within the door systems group and continue dissemination of the information across platform teams. Learning history and proposed workshop invitation included in Appendix C.

2. Develop internal resources for creating learning histories; include external participants (if possible) for varied perspective. Learning histories should be created in teams of 2 - 4 people, so that workload is manageable. If external resources are used, then a team with one or two other PTO resources would suffice, assuming the external resource has time devoted solely for the creation of the history.
APPENDIX A

Tech Club Survey Research Plan

This document outlines the research plan that will be carried out in the study of Organizational Learning within a Platform Team environment. The research will be conducted for a ten week period beginning October 3, 1995.

Hypothesis: Communication patterns within Tech Clubs is being studied; the hypothesis is that Clubs with well defined objectives and which meet regularly will show a higher communication index than those with no explicit objectives (i.e. less clear) and that have less frequent meetings.

To evaluate the hypothesis, an experiment has been devised following design 17.6 in Foundations of Behavioral Research by Kerlinger.

Four group form - Experimental and Control

<table>
<thead>
<tr>
<th>Mr</th>
<th>Yb</th>
<th>X</th>
<th>Ya</th>
<th>Experimental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yb</td>
<td>(~X)</td>
<td>Ya</td>
<td>Ya</td>
<td>Control 1</td>
</tr>
<tr>
<td>Yb</td>
<td>(~X)</td>
<td>Ya</td>
<td>Ya</td>
<td>Control 2 (Exp. 2)</td>
</tr>
<tr>
<td>Yb</td>
<td>(~X)</td>
<td>Ya</td>
<td>Ya</td>
<td>Control 3</td>
</tr>
</tbody>
</table>

The only difference between this design and design 17.6 is that the groups are matched (hence the Mr). The matching is inherent (in part) because the study involves specific Tech Clubs. In addition, the meeting frequency has influenced which groups are experimental and which are control. Because the intended intervention is a Tech Club meeting (which I will attend), only the Clubs that meet more often than quarterly could be considered for the experimental groups. From the candidate Clubs, the final designation was randomly assigned (by the flip of a coin).

Yb observations will be made during the (approximate) period of 10/3 - 11/3. During this time, five to seven members from each club will be randomly selected each week for the telephone survey detailed in the attached script. The intervention(s) will take place during last week in October or first week in November. After this Yb observations will be made following the same sampling plan and script. All data will be collected using the attached form; once the data has been collected, intra-group communication indices (CA) will be calculated according to equation one from Managing the Flow of Technology:

\[
C_A = \frac{\left( \sum \sum c_{ij} \right)}{Na(Na - 1)}
\]
where: $C_A = \text{strength of communication index within group A}$  
$e_{ik} = 1$, when person $k$ reports weekly communication with person 1 or vice versa  
$= 0$, elsewise  
$N_a = \text{number of members of group A}$

Tech Club Survey Script

* Hello, this is Cheryl Oates in the ******* Group. I was wondering if you have two or three minutes to answer a brief telephone survey?

* Can you name a colleague with whom you spoke today concerning an important technical issue?

* Why did you select this colleague?

* Where does (this colleague) work? (platform team and work group)

* Can you give me a brief summary of the issue?

* Can you name a colleague with whom you spoke today concerning a technical issue related to ________________? (the functional or technical nature of the club)

* Why did you select this colleague?

* Where does (this colleague) work? (platform team and work group)

* Can you give me a brief summary of the issue?

~~~ Intervention questions ~~~

* Do you typically attend Tech Club meetings? (If not, why)

* Can you tell me about the last meeting that you attended?  
  - When was it?  
  - Was there anything specific gained that helped you do your job better or different?  
  - Do you often get such input from a meeting (i.e. was this unusual?)

* Are there certain members of your TC that you speak with (i.e. 2 or more times/month) on technical issues? Who are they?

* Also collected background information on the club members

75
**APPENDIX B**

**Door weld statistical results**

Two sample T for Standard welds (Std) vs. Extra welds (Extra)

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>StDev</th>
<th>SE Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Std</td>
<td>69</td>
<td>3.333</td>
<td>0.748</td>
<td>0.090</td>
</tr>
<tr>
<td>Extra</td>
<td>44</td>
<td>3.003</td>
<td>0.681</td>
<td>0.100</td>
</tr>
</tbody>
</table>

95% C. I. for mu Std - mu Extra: (0.059, 0.60)

T-Test mu Std = mu Extra (vs not =): T = 2.41  P = 0.018  DF = 97

P < 0.05 therefore results statistically significant

Bartlett’s Test (normal distribution)

Test statistic: 0.456

p value: 0.499

Data fits normal distribution
APPENDIX C

Learning History Methodology and Acknowledgment

This learning history has been prepared as a means to document significant learning associated with hard-top door design and implementation, and to assist with the transfer of this knowledge across the PTO. To accomplish this, interviews were held with numerous people on the platform team to record their perspective of the things gone right and wrong with the design and implementation of hard-top doors for the case study vehicle. These perspectives were then compiled and analyzed for recurring themes that represented pivotal issues for the platform team. These themes are the foundation of the learning history.

The author gratefully acknowledges the participation of the platform team in the preparation of this document. The reflection, insight and candor of everyone involved proved essential to the process of making the learning history a "living document" that speaks with the collective knowledge and experience of its contributors. In addition, the management of the platform team must be applauded for their willingness to volunteer the organization as a learning laboratory. Hopefully, the learning history will stimulate discussion and evoke actions that support the PTO's commitment to organizational learning.

Things gone right

The phenomenal success of the case study vehicle is affirmation of the large number of "things gone right" for the car. The accomplishments of platform team personnel enabled the PTO to achieve a goal that other automakers had been unable to attain: volume production of a profitable small car. This feat required extensive effort from everyone involved with the vehicle. In recognition of this, each individual interviewed commented on the hard work and dedication of the people involved in developing and producing this vehicle. Numerous significant technical accomplishments were noted for the door system including: a well coordinated Geometric Dimensioning and Tolerancing scheme with the datum and PLP's defined early in the process; a good door panel build process and the development of a new door hanging process; use of Variation Simulation Modeling Techniques (V-SAT) to simulate the assembly process; product and process variation reduction in design and assembly. These achievements helped the door systems group package a large glass into a relatively small door, implementing the cab forward design that has helped the case study vehicle remain a customer favorite.

It is very important to celebrate accomplishments and positively reinforce successful behavior so that the organization learns to repeat the pattern. Experience has shown that learning histories are most beneficially employed when initiated with an emphasis on the positive. This is not difficult to do: platform team personnel can consider how far the organization, its people, and its leadership have come rather than notice that there is still a gap between where they are and ideal. The case study vehicle program was the first time that platform team personnel from diverse functions worked together on a vehicle from concept to volume production. This was a significant accomplishment in its own right.
Were there “things gone wrong” along the way? Of course. Every corporation has some oversights in the execution of its programs and plans. Mistakes are an inevitable part of life, as is learning from mistakes. What is not as common is to be able to talk openly and honestly about the things gone wrong in a process, and to help develop a learning process to subsequently avoid some of the things gone wrong the second time around.

**Things gone wrong**
The learning history attempts to answer the question “what went wrong for the case study vehicle hard-top door implementation?”, with specific attention to the issue of door sag. As the reader will note, the focus is not on individual technical issues but on human issues that often work to impede efficient technical resolution of the problem. Many people agree that American organizations typically possess the technical expertise necessary for success; the difficulty lies in the execution of specific processes and procedures which enable the organization to achieve its goals.

**A note on reading the Learning History**
The format for the learning history is the “jointly told tale”. There are no “rules” concerning how to read the document, but the following explanation and suggestions may help. The contributors to the learning history are only identified by functional group title e.g. engineering or manufacturing. This helps shift the focus from the person speaking to the issue being discussed. The document has sections of exposition and analysis completed by the author which stretch across the page. Under each theme are two columns. The italicized left hand column is analysis prepared by the author; it is a “conversation starter” meant to ask questions and expose issues or implications that may be buried in the comments on the right hand column of the page. This section may be skimmed first or entirely avoided until after the individual quote has been read. The right hand column contains quotes from people interviewed for the learning history. The quotes are grouped by chronology whenever possible to document facts and events. But the learning history focuses on what people thought about the event, how they perceived their own actions and the actions of others. By recreating the experience of “being there”, the learning history helps the reader understand what happened and presents perspectives that are not always discussed in typical business settings.

The reader is asked to do two things when reading the learning history: **First, use it as a vehicle to better conversations.** Read the document simultaneously with other team members in preparation for a workshop to discuss the content of the learning history and how it applies to the team’s efforts. **Second, take on the mind set of a beginner when reading.** Listen to what people say and why they did what they did. Try to suspend your judgment; don’t automatically condemn the people who made mistakes, or make assumptions about why the mistakes occurred. Yet notice how you react. Mark those reactions in the document. Think about how this story is similar and different from issues that face your team. Be prepared to talk to other team members about your reactions and thoughts in reading this document. Come to the workshop prepared to learn with one another about this learning and change initiative and its implications for your efforts.
What does it take to get a group of talented individuals to work as a high performance, effective team? The case study corporation has been lauded for knowing what to do by forming its Platform Team Organization (PTO) structure. Initiated for vehicle design and assembly, the PTO has been credited with breathing new life into the company by developing award-winning vehicles.

While the successes have been applauded, has the PTO taken time to learn from its failures? The platform team has had enormous success with its case study vehicle, but the Achilles heel for the car has been a problem with sag in the hard-top door. Despite the overall effectiveness of the platform team, the issue of door sag has not been successfully resolved.

**TEAMWORK**

A major factor contributing to the problem of door sag is the apparent lack of teamwork in resolving the issue. Perceived barriers between groups within the door systems team has inhibited effective communication and negatively affected teamwork. Differences in education level, experience and functional alliances are but a few of the barriers that the team must overcome to build more effective communication and teamwork.

**COMMUNICATION OF ISSUES:**

*Communication of the issues between groups is not successful. This is due in part to the questionable root cause of door sag.*

*Teamwork seems hindered by cycles of blame and denial within door, groups.*

*There are numerous examples of “drawing sides” where teamwork is hindered by a “them vs. us” attitude.*

Engineering - person A

Ever since I've started, I've heard complaints about the door sag issue. And there have been discussions about is the sag in the door, is it in the hinge, and a lot of animosity between groups. The Plastics Lab says it's in the hinge, the Design Engineers don't want to believe the hinge is the problem, they want to believe it's in the door, but yet when we go and look at possible changes to the that does nothing.

Manufacturing - person B

For about three months, we waited for direction, then we just got fed up with the lack of teamwork, and went to our management and got an agreement that we could investigate it on our own. When we came back with the results, that was when Design started listening to us.

Manufacturing vs. Engineering

We (the manufacturing side) were trying to convey messages to Product design, and they were just brushing our suggestions under the rug and kind of
avoiding us. Trying not to comply with our demands, you know?

Manufacturing - person D
It went in one ear and out of the other. I mean, I guess they understood my concern, but they didn't do anything about it.

Engineering guys don't quite understand what we see while we are having a problem ... that we are concerned about this because of the plants. They don't quite understand the severity of our concern.

Now on our side, we couldn't help Engineering. We know there's a problem, but they're saying, "tell me what I should do, tell me what I should change to" and we couldn't begin to tell them how to change the design to improve it. We can only very broadly tell them what they need to do, but we can't tell them in specifics. When we did try, they said "it's too expensive, too late, etc.". So we just gave up.

Drawing Sides:
Manufacturing vs. Engineering

Perceived lack of teamwork allows problem to continue unsolved - groups "give up"

Door engineering personnel were switched from sheet metal to full door responsibility - new working relationships resulted and team effectiveness was hindered due to learning curve effects.

A distinct difference in the (expressed) assessment of the level of teamwork

I didn't notice any major roadblocks, if that's the right word there. Everyone seemed to be working well together. If anything -- It's like anything after awhile. There were noticeably some arguments about the system, and the right things to do, or the wrong things to do. And those issues get resolved. I didn't see any major roadblocks or stumbling blocks in the way that stopped anything from progressing.
I tried to communicate to my cohorts at the research center about the problems that we were having in the plant. They seemed to be cooperative -- wanting to listen. I see that we listened but we didn't do anything about it. Here we are two years later and we still have the same problems that we had when we started.

**FEEDBACK - CLOSING THE LOOP:**

*People weren't sure of progress made on the problem, test results or how tests were run. The lack of communication builds mistrust and animosity. This negatively reinforcing cycle further erodes team efforts.*

*Manufacturing - person B*
I think that Product wants to keep their own little entity separate from Manufacturing and everyone else involved. They have their own little secretive labs, I mean, they are invited out to the shops, they look at all of our processes, but they want to keep to themselves.

I don't have a full understanding of what they do, how they set up tests. I feel that if we are going to work as a team, everybody ought to be involved. I mean, they stick their nose into our business, and they want to keep their side kind of hidden to the rest of the PTO world.

*Engineering - person C*
I always fed information back -- but whether it went back to the right people or not is another story. You communicate with whom you deal with ... that may be 2 or 3 folks on a team. Closing the loop is a hard thing; maybe that's where some of the errors and the personal feelings kind of get involved, when the loop isn't completely closed to the requester's satisfaction.

Maybe we did a poor job in telling them why we didn't -- we couldn't make changes. Maybe we thought we came across and we didn't come across that much. Maybe it's because of the defensive mechanisms kicking in. We just didn't close the loop effectively enough.
RELATIONSHIPS:

Frustration due to the unsolved problem helps further animosity between groups

Drawing Sides:
Lab A vs Lab B

Engineering - person E
It certainly is our intent to keep communications open and to keep everyone involved. Sometimes you get caught up in your own work and leave someone out, but when that happens it's unintentional.

Engineering - person A
(The animosity is obvious in) the backstabbing comments you hear. It's all "they", it's never person, said this; it's the Plastic's Modeling Lab, or the Stress Lab, "they" say this, "they" say that.

It's the way we are referring to each other behind our backs. It makes me feel very uncomfortable working on this project.

Drawing Sides:
Product vs Manufacturing

Manufacturing - person B
It seemed that there was a lot of mudslinging going on between the Product people (Engineering) and all of Manufacturing, at the research center and the plant. At one point, the plant personnel were so fed up that they told a few of the Product guys 'why don't you just quit coming down here, you are wasting the company money and time; it's not really worth you just coming down here to throw up a little smoke screen.'

There were some nasty notes generated that pointed the whole problem on process, written to higher ups. I know I've told people that their product was poor which was (I guess in the way that I conveyed my message) mudslinging because I wasn't really political about it, but it was true, and it just seemed that we didn't really work together on this problem as a team.
**Drawing Sides:**
**Engineering vs. Plant**

The biggest issue has to be the understanding or the misunderstanding between Engineering and the plant after the fact, after Design. I think we were all talking and trying to do the same thing, but the defense mechanisms go in at a certain point. And this is all human nature. You're proud of what you did and someone points a finger and says that could be done better, you dig your heels in and say -- "It's right. We've proved it. It's right. It's there." And so that was some of the barriers that were hard to work through when we first started as a new group coming in.

**Engineering - person C**

The assembly plant pointed (all the problems) everything in the body shop. It seemed that's where the problem is. I think it is at the plant level. There was a lot of in-plant fighting.

Is there room for individual pride in a team effort?

**Drawing Sides:**
**Body Shop vs Glass Install**

I feel that a lot of the problems to begin with weren't necessarily due to the body shop. I feel that our counterparts on the other side of the house installing the glass was a big part of the problem. They would call us over and say that the door position was a problem, but the doors were okay. We would get blamed for problems on the other side that weren't really our problem.

**Manufacturing - person F**

I talked with my manager and the Engineering manager about the problem. He was just avoiding the issue. He didn't want to help, you know, he was very sarcastic the way he talked. He kind of would talk down to us. A lot of Process Engineers aren't educated with degrees, where Product people are. We are a Union, they are non-Union. I feel that I don't get a lot of respect from Product people because of these issues. It's not a real harmonious working atmosphere.

**Drawing Sides:**
**Degreed vs Non-degreed**
**Union vs Non-union**

Manufacturing - person B
OVERALL RESULT: LESS EFFECTIVE TEAMWORK

Example: Wasted effort and unsuccessful design
Manufacturing - person D
Oh there’s always conflicts in the teams. The younger (product) engineers are better trained, but they really don’t quite know how to design fixtures. They would try to design the fixtures and some of the older (process) engineers would sit back and let them do it, and let them screw it up just to have a little fun. You know how those guys are. It was a problem, but it worked out, I guess, eventually.

Drawing Sides:
Training vs. Experience
Product vs. Process

Example: Process input on test accuracy not given
Manufacturing - person B
You know, if I saw how they were setting up a test, maybe I would say, 'well, is that the right way to do it to check the correct sag here, or would you want to do this.' But that doesn’t happen.

Example: Additional engineering analysis not done
Engineering - person A
Sometimes it gets very frustrating, and sometimes, just in my own group, we throw up our hands and say 'well, if they won’t listen, what can we do?' We could help them, but they don’t want the help. And other times when you feel just real strongly and it’s something you can do on your own just to test it, then we will go ahead and test it. Sometimes we are wrong, sometimes we are right, and we just go from there.

While perceived barriers between groups hinder effective teamwork and subsequent resolution of the issue, numerous other factors influence the case study vehicle door sag problem. A most basic issue is the identification of the problem. Does anyone really understand exactly why and how a door sags? If so, can the problem be solved?

PROBLEM SOLVING

A significant reason why the door sag problem has not been successfully resolved is the complexity of the problem. Its root cause is tangled in the interdependencies of the door system and the assembly process. Solving such a compounded problem requires a high level of teamwork, analytical skills, time and effort. The learning curve associated with hard-top door implementation and the relative inexperience of some personnel impeded the problem solving effort for door sag.
A LEARNING CURVE:

The PTO does not appear to have a good method for transferring knowledge across platforms so that recurring problems are avoided and significant learnings are captured. A Learning History may be a start for this process.

It is a very necessary job - to "keep things going". If you get the job done while other areas of the project suffer have you successfully completed the job?

Engineering - person C
I think some of the problems came about because it was the first time in a long time that anybody in our area had done any design with the hard-top system. Most of the people who had worked on earlier hard-top designs were either retired or moved to another project somewhere else in the corporation. So, there was a big learning curve and we didn't have that knowledge base to fall back on.

There were a lot of things going on. We had done lots of testing and had data piled up to the ceiling. We were trying to analyze it real quickly, and keep things going - everyone was busy doing their job. There wasn't a lot of time left over to analyze and evaluate what was really going on during the build-up, when we may have been able to make design changes.

Engineering - person E
We picked the hard-top door knowing that the glass system would be difficult ... something we'd really have to control. After the decision was made to go hard-top and we were at a point of no return, the decision was made to move to a doors off process. We had to do this because of OSHA and ergonomic considerations. After that, adjusting the door fit became a bigger issue because the doors off process doesn't allow compensation for the door fit after the glass is adjusted.

I think that if someone had foreseen the problems that we were going to have then maybe we would have gone through some panic phase to change the door. But other areas would have been affected, like the aperture... if we had changed the door we
A QUESTION OF EXPERIENCE:

Is it necessary for an individual on a cross-functional team to have cross-functional experience?

It seems that the skills of the two groups should complement each other. However, these skills appear mutually exclusive at times. Is there a better way to team individuals to get the proper mix of experience and knowledge? Is a non-degreed product engineer or degreed process engineer an option?

How does one find the balance between finding (quick) solutions to everyday problems and performing the detailed analysis for solutions to be implemented in the long term?

Personnel transitions should allow time for cross-training -- not only training in the job function but transferring information about issues or problems.

would have had to do some really difficult things with the rest of the car.

Manufacturing - person D

We saw early on that there were going to be problems. But sometimes I guess it's easier to take the excuse than to pursue the solution that you know is not easy. I think what happened was that we didn't have people that could come up with solutions to the problem that was identified. That was probably due to general inexperience and perhaps a lack of cross-functional experience.

Process Engineers, in general, are very well experienced. They've spent years on the same products and they've seen all kinds of problems. They have experience, but not really knowledge - they may not understand why a certain thing works. Some of the new young Product Engineers, they have the knowledge, but they don't know what to do because they lack experience.

Engineering - person A

It seems there's a lack of insight because people have not worked long enough in a group to have seen problems on another vehicle and to carry over those experiences to the next vehicle. Sometimes I get the impression that everyone is so caught up in today's fire that they don't look ahead and think if there could be a problem with this in the future, or if the work they're doing now could affect something down the road. They are just looking at today's fire, and how to get through it.

Manufacturing - person B

In Manufacturing, I was given the door system at the end of Pilot and I followed it all the way through to the plant. In Product,
Is there a method for documenting fundamental questions and answers for use in training new personnel?

there were numerous times that they handed off door systems to various Product Engineers. It seems a lot of communication and knowledge was lost in the hand-off.

Manufacturing - person G
It’s tough to solve a problem when a team has a lot of personnel turnover. In the plant we end up with a lot of turnover in the door setting area. The area is frequently observed by engineers and other team members to evaluate the process for improvement, and some operators don’t like the added attention. We have made changes to the process to reduce operator sensitivity. However, some portions of the door installing process can still be operator sensitive, so turnover of people can cause a problem.

In Door Hardware the design supervisor, senior engineer and product engineer have changed. It makes teamwork difficult because we’re starting at the beginning with each new person who is added to the team over the course of long term problem resolution.

The Process Engineering group has turnover in another sense related to overtime equalization. If you want a process engineer you can get the person you need for a while, but then he’s high on overtime hours. This causes us to start the process with an engineer who is new to the specific issues the team has been working on, or to continue on without firsthand process engineering support.

UNDERSTANDING REQUIREMENTS:

It is difficult to come up with a mutually agreeable solution unless the involved parties understand each

Manufacturing - person B
We tried to get changes to the door, but nobody from Manufacturing really understood what it takes to design a door, to
other's constraints and requirements.

When interdependencies are not understood, the result can be that individual parts are optimized, but the system does not perform as expected.

get prototype pieces made to test it out. It seemed to us that when we asked for what we thought was a simple change we were given ridiculous dates like a year to a year and a half to come up with something. We really weren't sure if they (design) had a good grasp of what it actually takes to build a door, because they didn't seem to understand our problems.

Engineering - person C
I don't know if Manufacturing understood how the design process actually works, or when and how changes can be made. Sometimes they may have thought a certain change was easy to make when there were actually a lot of ramifications for making that change.

I don't think people fully understood each other's requirements. There were probably instances where we thought we understood Manufacturing's requirements, and went one way. When all was said and done, maybe it didn't turn out exactly as they would have liked.

The biggest issue that's out there right now is understanding the total interdependencies of all the door systems and the body. For example, we went through with a certain parameter to set the door to the body for gaps. Another group set the parameters for the glass adjustment (for sealing). Individually, each parameter seemed okay. But when the two were put together, we ended up with a lot more variation than we really thought we had.

FINDING THE ROOT CAUSE:

The rush to produce a finished product reduces the time allotted to perfect the product.

Engineering - person C
We never really stopped the pilot productions to find out what was going right and what was going wrong. There was
The PTO has institutionalized the Kepner-Tregoe problem solving process to assist in decision analysis and root cause identification. Were these tools (or others) used to help with this problem?

Are people rewarded or punished for bringing out problems?

There seems to be a perception that a person must be able to "fix" all of the problems in his or her area. This can discourage or delay people from surfacing difficult problems.

always a push to build the vehicle that reduced our time for problem solving.

Manufacturing - person B
I think you basically have people that don't know how to use data to work through a problem correctly. It didn't seem like they followed trouble shooting procedures, or used tools like a fishbone chart.

Engineering - person E
Most of the time when things aren’t getting done it doesn’t mean that no one’s working on the problem. It usually means that the problem is not easy to solve.

Manufacturing - person G
One issue is that process engineers are not set up to function as plant-level problem solvers. This isn’t their fault -- it’s systemic. They are asked to manage the funding and the timing. The contracted vendor is expected to do the design. We have team design and fabrication reviews. But it is very difficult to predict how a process is going to function when it’s only on paper, or when it’s in a build shop cycling and it’s not observed at production speeds using production parts. When we do get the process in the plant we can watch it run and see where there are issues that need improvement. It’s at this point in time that we need the most support from problem solvers, and we seem to come up short for one reason or another.

Once we get processes and designs into the plant, we get a lot of feedback as to which processes and designs are top priority and which need to be improved the quickest. One problem is that we each tend to be slow to react to our portion or responsibility on the big major issues. It’s like we say to ourselves, “I have a few problems I need to work on, but by no means is my area of
responsibility the biggest root cause. I might not even need to improve my portion at all if the other areas improved themselves”. We all tend to sit back and wait it out to see if the other areas improving will make the situation better. Then finally we each realize that it takes fixing each and every problem related to a certain issue. In the end we fix what needs fixing but the waiting to see what happens makes it take much longer than it should.

Manufacturing - person D
Problem solving is really tricky, you know? It's not enough to have a person or a team working on the problem, you really need some people with hands on experience that can come up with creative ideas for changing the product or process.

Eventually, a manufacturing executive was given the responsibility to lead the problem solving effort. He assigned the task to an engineer. The only problem was that the kid was a new graduate; he was good as far as documenting information and trying to coordinate meetings, but I think that he lacked some experience in solving problems. But anyway, once they had someone assigned to it and had formed a team, I sort of backed out of it because I had so much other stuff to get done.

RIGID / CONFLICTING OBJECTIVES

A significant factor in the case study vehicle door issues is rigid and sometimes conflicting objectives for the program. The case study vehicle platform team sought to develop a profitable small car - which had been unheard of for domestic automakers in recent years. In order to meet this goal, calculated risks were taken to make the car as lightweight and low cost as possible. The hard-top door design was implemented for its styling and weight benefit, but with the known risk of related wind noise and water leak issues. While customer satisfaction data suggests that this car has fared better than other PTO products
in those categories, the problem of door sag and other design / assembly issues have prompted reevaluation of the hard-top door design.

*Strict Adherence to Cost and Weight Objectives*

Engineering - person E
Cost and weight were two of the most important goals to achieve without sacrificing quality. We did extraordinary things to get cost and weight out of the car. We were daring, we took a lot of risks and we were creative. We did what I think was an exceptional job.

Engineering - person C
Well, the case study vehicle was the first vehicle that we did where we really had cost constraints laid on us. Usually in past times there was a group that was kind of controlling costs; engineers were never privy to detailed information and there seemed to be more flexibility in the cost objective. So now cost was very strictly followed and engineers were responsible.

The objective of the car was to be made with the cost of another PTO vehicle as its target. That car had been out of production already for two or three years and it was a low-priced car, so this objective was quite a challenge. The result was a lot of internal pressure to maintain costs. First of all the focus was not to go over the budgeted dollar amount. If you did, that money had to be approved. And if the money was approved, the idea was to try to get that money someplace else out of the car. So a lot of the designs were cost driven early in the program.

Manufacturing - person B
It seems that we were limited in budget, and they wanted to make this a real lightweight car. Trying to achieve those goals, they maybe put the other objectives to the
wayside, or they weren't really concentrating on making the door robust.

Manufacturing - person D
The Program Manager adapted an objective management type of technique; the defined objectives of the case study vehicle program were piece cost, investment and functional objectives to meet measurable customer expectations. Other objectives, such as process capability and hours per car, were less well defined but still very important to us. Unfortunately, the objectives of investment and piece cost were so strong that they overshadowed those other priorities.

By the time that the vehicle was launched, the problems with the door had surfaced and everyone struggled with the best way to resolve the problem. Was it too late to spend money to modify the door design?

PROBLEMS SURFACE

Is there a way to identify and approve of additional spending before the structure is set?

Engineering - person E
We were immersed in a situation that mandated that we design a small car to meet very aggressive functional, cost, weight and investment targets. After it was determined how much we didn’t spend, in the last 6-8 months before launch management said 'okay spend some money to make it even better'. By then the structure was set and the additional money that was spent did not achieve the level of results that could have been accomplished if these dollars were available earlier in the program.

Manufacturing - person B
It didn’t seem like product was held accountable for the performance of their design at launch. During this time we wanted to get the cars out as quick as possible to meet cycle time objectives, with the best quality possible. When improvements were made, more of the
Is the spending decision based on economic analysis of the cost vs. benefit or is it an attempt to conceal a systemic error of underspending?

Who has the responsibility of reconciling objectives that seem to conflict?

PERFORMANCE OBJECTIVES

There is a perception within Engineering that plant audit criteria don’t correlate to customer satisfaction measures. The implication is that the plant incentive structure encourages attention to issues that are of benefit to the plant but are of questionable benefit to the customer.

Has this perception led Engineering emphasis was put on the manufacturing process than on engineering issues.

I think this emphasis had a lot to do with the possibility of increasing the cost and weight of the vehicle if they made (design) improvements. They wanted to keep to their target goals for weight and cost, and they just didn’t want any egg on their face. They didn’t want to admit that they had erred in the first place by not spending the money.

Manufacturing - person D

We had conflicting objectives. Assembly labor was considered an objective for Manufacturing, but not for Engineering. So even though we were working together to reduce the assembly labor, it was still more important to Manufacturing to control those costs.

Engineering watched its costs by controlling changes made to the design. When you are holding the line on investment levels it's expensive to start making changes. It would have taken time and money and I think that was the reluctance we faced in trying to resolve the door issues. That was a problem that we didn't address and it hurt us.

Engineering - person E

The plant has different audits than Engineering. Our numbers, QTS, are customer driven. They have CSA and parts of VQA at the plant. One of the problems is that originally, VQA numbers didn’t correlate to customer satisfaction, they correlated to build issues. The correlation between VQA and our numbers have gotten better, but we're targeting QTS numbers that correlate to JD Powers. When it comes down to it, the customer doesn't give two
to believe that the plant has "cried wolf" about door problems?

This perception is refuted by plant personnel

END RESULT - NEXT GENERATION VEHICLE GETS A DIFFERENT DOOR

Team members feel that a hard-top door could have worked...

... and aren't sure of the styling consequences of a full-framed door.

The tangible benefits associated with the hard-top door are outweighed by the lack of robustness inherent to the design.

hoots about a plant audit -- they’re only interested in how the car performs and its perceived quality level.

Manufacturing - person F
The plant doesn’t use VQA anymore. Our CSA audit is based on customer satisfaction measures. This helps us stay on top of issues that affect the customer and the audits correlate to JD Powers ratings.

Manufacturing - person B
A hard-top door could have worked if money was allocated in the system to make a more robust design. I hope the full stamped door will help us avoid the problems we’ve had up to this point.

Manufacturing - person D
I think we could have made the hard-top door work. I like the hard-top look because it makes the car seem roomier; I think that helped make the car popular. I’m a little concerned that the 2000 case study vehicle with its full-framed door won’t give the same feeling. It’s just too bad that we as a team couldn’t have made the hard-top door work better.

Engineering - person E
The case study vehicle numbers for windnoise are equivalent to other PTO vehicles. In spite of this we’re going to full-framed doors for 2000 model year case study vehicle. That decision was made because we couldn’t see how to get the robustness in the design that we need. There were a lot of (hidden) costs associated with hard-top glass. We could probably solve the
windnoise issue if we want to throw a lot of money at the car. We’re not going to do that when a full-framed door can help solve our problem.

The case study vehicle is in its third year of production. Door sag is still an issue. In the next major design revision hard-top doors are to be replaced with a more traditional full-framed design. Plant personnel report that the case study plant has one of the most cost effective stamping plants in the world because the hard-top door allows all four doors to be made out of the same die. It’s not clear if that information and the resulting capacity and scrap issues were considered in the decision to go with a full-framed door; one can only assume that the benefits outweigh the risks.

For case study vehicle platform the risks associated with hard-top door design have proven to be too great. An even greater risk lies in the failure to learn from the mistakes of the past. The door systems sub-team is attempting to learn from the things gone wrong with the hard-top door implementation through a learning history. It is hoped that the lessons learned from the case study vehicle hard-top experience will be used to improve the next generation vehicle.
(The following memo is adapted from a format recommended by Reflection Learning Associates, Cambridge, MA)

**Sample Learning History Dissemination workshop memo**

To: “Learning Leadership” ad hoc team

From: Learning History team

Subject: Learning History dissemination meeting

Attached you will find the learning history for the hard-top door implementation. I ask that you read the learning history carefully and thoughtfully in preparation for our meeting tomorrow. Please plan on spending at least a half hour, preferably an hour, uninterrupted to read this document.

As part of our the learning process, individual and group interviews were conducted among members of the door systems sub-team. Those interviews helped the team members reflect on their own progress. This learning history takes what people have shared in those reflections and distills their remarks into materials for us to consider as a group, along with contextual introductions and some reflective notes. What people have said raises some important items for us to consider as a group.

When reading the learning history please note your reactions - they will be a key component of our conversation in the meeting. Thus, mark up the document where you feel it is appropriate. We are interested in what strikes you as important, or surprises you, and exactly where in the text that comes from. Also as you read the right hand (story) column narratives, please feel free to add your interpretations in the left hand (interpretation, observation, questions) column.

In the workshop tomorrow we will talk about:

- Additional interpretations and questions about the issues;
- Whether the issues raised here are limited just to the door systems team, or whether they can apply to other teams and organizations throughout the corporation;
- How we can generalize from this to move forward in our projects.

We will be meeting on x/x/9x from x:xx to x:xx in the xxxx room to discuss the contents as a group.

See you tomorrow!

*A learning historian*
REFERENCES

Thesis footnotes


Additional References


