Massachusetts Institute of Technology

Lean Aerospace Initiative

Summary of Research Conducted by the Manufacturing Systems Team

DRAFT

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Research conducted by the Manufacturing Systems Team
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Introduction

The Manufacturing Systems team is one of the focus groups within the Lean Aerospace Initiative whose goal is to document, analyze and communicate the design attributes and relationships that lead to significant performance improvements in manufacturing systems in the defense aerospace industry. This paper will provide a usable record of what work has been done by the Manufacturing Systems team and it is aimed at releasing research conducted by the LAI in the field of manufacturing systems.

The purpose of this paper is to present the research conducted by the Manufacturing Systems team in the framework provided by the Transition-To-Lean Roadmap. The research results are presented briefly within this framework and each phase of the paper ends with and extensive list of resources for further reference.

Phase I Research

Since LAI is based on findings from the International Motor Vehicle Program (IMVP), the first research effort targeted an area highlighted in IMVP research. This resulted in a Phase I start-up Focus Team known as "Fabrication and Assembly Focus Team."

As noted in IMVP research, the level of inventory serves as an important barometer to the "lean" health of the industry. Consequently, the first major effort of the team was to develop an inventory survey intended for wide distribution within the industry. The survey yielded significant findings and revealed additional areas that warranted investigation. Shortly after completing and reporting on the inventory survey, the Focus Team opted to update its perceived restrictive name and became known as the "Factory Operations Focus Team."

Although this team recognized that there was no "Toyota" in the defense aircraft industry, it did recognize pockets of "lean" activity. In an effort to highlight the enablers, barriers and results from these pockets, the team embarked on a course of case studies. This resulted in a set of five case studies documenting some lean changes, a very detailed case study on precision fabrication, and a case study on operator certification.

In conjunction with the MIT research, the Factory Operations Focus Team, under the leadership of an LAI industry member, organized and led several non-member benchmarking trips to sites that had accomplished a lean transition. The benchmarking team collected information about the transformation process, the results of the transformation, and the applicability to the defense aircraft industry. A report on each visit was completed and disseminated within LAI.

Research results from the case studies indicated that flow optimization of the product was an important factor in achieving lean results. Research in this topic area was subsequently expanded. The team identified products representative of each sector (airframes, engines, and electronics) yet manageable for research and benchmarking. A questionnaire was

developed and a thorough validation of this questionnaire was conducted to assure consistency of results. This effort resulted in a major report.

In the last year of Phase I, the Focus Team was interested in obtaining research that would facilitate an understanding of implementation. Tapping existing resources, the team was able to develop a hypothesized model of lean implementation and test this model with case studies that had already been completed, new case studies specifically started to test the model, and a literature review.

Phase II Research

During Phase I research, we learned that organizations differ widely and companies have vastly different data collection systems. We also found that there were few common operation definitions and operation characteristics varied drastically. There were few metrics that were common and the control methodologies employed varied. These types of differences make detailed findings from surveys and case studies problematic. Therefore, in Phase II we wanted to conduct research that was mindful of the breadth in the industry but focused on more depth of understanding in each sector.

With the concurrence of the focus team, a strategic research approach was developed that was founded on the Lean Enterprise Model and focused on the first overarching practice, "Identify and Optimize Enterprise Flow". To accomplish a more detailed understanding of operations in the industry, it was decided to conduct on-site field research and to drill down on those practices that enable reduction in the metric, "order to point of use delivery cycle time". This approach would allow careful observation and data collection in a field environment.

The theme that was chosen by the team was to identify features that minimize cost, optimize flow, improve quality and enhance flexibility while considering labor and worker empowerment as operation issues. In conducting our research we considered three main thrusts: (1) design and management of complex manufacturing systems, (2) production control in factories and supply chains and (3) transition to production (which manifested itself into improving cross-functional communication). The first two produced products in the Phase and the third continued into Phase III. In the first thrust there were three sub-thrusts: (1) a study of each sector's manufacturing system design, (2) a study of the elements of "lean" system design and (3) a study of "lean" system implementation in the space sector. Of these sub-thrusts, the first two produced products in the phase and the third continued into Phase III.

In the first sub-thrust the objective was to understand the manufacturing system. We did this by identifying those manufacturing system elements that enabled reduced cycle time. We chose to segment this research by sector and to investigate similar product in each sector. We focused on assembly operations and collected key system and performance data. This research first focused on the engine sector followed by the airframe and electronic sectors. In each sector exploratory research was necessary to understand the

sector operational characteristics, however, with each sector studies we gained more knowledge of the manufacturing system characteristics.

In the second sub-thrust the objective was to characterize what was meant by a "lean" manufacturing system design. There is a plethora of literature on lean but very little system level analysis of the design of a "lean" manufacturing system. This research focused on creating this framework. Initial studies were in the automotive industry but additional industries including the defense aerospace industry were also studied. The result has been the development of a production system decomposition to understand a "lean" system from a systems level.

The final sub-thrust was started in Phase II of the Initiative but will be completed in Phase III.

Phase III Research

The research goal for all of the Lean Aerospace Initiative through the current phase is to study the concept of "Best Life Cycle Value" for aerospace systems. This entails work to develop a fundamental understanding of value added practices offering best life-cycle value. Doing this will entail addressing the barriers that prohibit a lean implementation.

The concept of providing best life-cycle value has led to the identification of five key research themes:

1. Measuring value to the Enterprise
2. Time
3. Organizations and People
4. Knowledge and Information Infrastructure
5. Government as a Lean Customer and Operator

We have learned many things about the defense aerospace industry and other industries over the last few years and feel we are now positioned to assist in providing guidance on manufacturing system design. The research for phase III will attempt to develop guidelines for the design of manufacturing systems particularly related to the complex industry environment faced by defense aerospace companies. To reflect this increased scope of focus beyond the factory floor to include the overall manufacturing system, the team changed its name to the Manufacturing Systems Team.

Specific details of each of these major research areas are presented in the appropriate phases of the Transition to Lean Roadmap. For your convenience, the specific Transition-to-Lean Roadmap phase sections capture all relevant research related to Factory Operations in one place while providing direct links to referenced information.

The Transition-To-Lean Roadmap

The Production Operations Transition-To-Lean (TTL) Roadmap (Figure 1) provides a guide for transitioning an exiting production operation to one that fully implements a lean manufacturing philosophy and lean best practices. The roadmap defines a systematic implementation process, specific actions in order of precedence that are milestones in the journey from mass to lean production. The model is organized into major phases with the points of interface defined with other systems that are both internal to production operations and external to the business enterprise.[1]

The Production Operations Level Roadmap (see Figure 1) consists of eight phases of implementation overlaying two broad interfaces shown as backdrops. The first backdrop represents the interface of the Production System to the remainder of the business enterprise. Those business systems and processes that will require changes and/or new interfaces to be developed are noted in this area of the Roadmap. The second backdrop represents the overall supply chain to the ultimate customer that lies outside of the immediate business enterprise and the regulatory and legal requirements of the environment in which the business enterprise operates. Each of the eight phases of implementation shows a number of specific actions in a recommended order of precedence. Phase 7 is unique in that the actions shown may take place at any and at numerous times concurrently with Phases 2 through 6. Phase 7 is indicative of the fact that transitioning an organization to Lean is a learning journey. Each organization is unique and a common path for all will not always work. Internal progress review or feedback should be taken often and the path to Lean may need some alteration or enhancement once underway to get the performance results desired.[2]

The TTL Roadmap lays a framework from which the interpretation and adaptation to each manufacturing system can be achieved. But a formal understanding of the full process is needed before any tailoring can take place.

[1] Crabill, John et al., Production Operations Level Transition-To-Lean Roadmap Description Manual
[2] Crabill, John et al., Production Operations Level Transition-To-Lean Roadmap Description Manual