Honeywell

Demand Activated Manufacturing Architecture

Federal Manufacturing & Technologies

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Final Report/Project Accomplishments Summary

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A. Parties

The project is a relationship between

Honeywell International Inc.

Federal Manufacturing & Technologies

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Kansas City, MO 64141-6159

and

Demand Activated Manufacturing Architecture (DAMA) Cooperative Business Management Program

B. Background

(Note: Honeywell Federal Manufacturing & Technologies (FM&T) engineers John Zimmerman and Tom Bender directed separate projects within this CRADA. This Project Accomplishments Summary contains their reports independently.)

Zimmerman: In 1998 Honeywell FM&T partnered with the Demand Activated Manufacturing Architecture (DAMA) Cooperative Business Management Program to pilot the Supply Chain Integration Planning Prototype (SCIP). At the time, FM&T was developing an enterprise-wide supply chain management prototype called the Integrated Programmatic Scheduling System (IPSS) to improve the DOE's Nuclear Weapons Complex (NWC) supply chain.

In the CRADA partnership, FM&T provided the IPSS technical and business infrastructure as a test bed for SCIP technology, and this would provide FM&T the opportunity to evaluate SCIP as the central schedule engine and decision support tool for IPSS. FM&T agreed to do the bulk of the work for piloting SCIP. In support of that aim, DAMA needed specific DOE Defense Programs opportunities to prove the value of its supply chain architecture and tools. In this partnership, FM&T teamed with Sandia National Labs (SNL), Division 6534, the other DAMA partner and developer of SCIP. FM&T tested SCIP in 1998 and 1999. Testing ended in 1999 when DAMA CRADA funding for FM&T ceased.

Before entering the partnership, FM&T discovered that the DAMA SCIP technology had an array of applications in strategic, tactical, and operational planning and scheduling. At the time, FM&T planned to improve its supply chain performance by modernizing the NWC-wide planning and scheduling business processes and tools. The modernization took the form of a distributed client-server planning and scheduling system (IPSS) for planners and schedulers to use throughout the NWC on desktops through an off-the-shelf WEB browser. The planning and scheduling process within the NWC then, and today, is a labor-intensive paper-based method that plans and schedules more than 8,000 shipped parts per month based on more than 50 manually-created document types.

The fact that DAMA and FM&T desired to move from paper-based manual architectures to digitally based computer architectures gave further incentive for the partnership to grow. FM&T's greatest strength was its knowledge of NWC-wide scheduling and planning with its role as the NWC leader in manufacturing logistics. DAMA's asset was its new knowledge gained in the research and development of advanced architectures and tools for supply chain management in the textiles industry. These complimentary strengths allowed the two parties to provide both the context and the tools for the pilot.

Bender: Honeywell FM&T participated in a four-site supply chain project, also referred to as an Inter-Enterprise Pipeline Evaluation. The MSAD project was selected because it involves four NWC sites: FM&T, Pantex, Los Alamos National Laboratory (LANL), and Lawrence Livermore National Laboratory (LLNL). FM&T had previously participated with Los Alamos National Laboratory in FY98 to model a two-site supply chain project, between FM&T and LANL. Evaluation of a Supply Chain Methodology is a subset of the DAMA project for the AMTEX consortium. LANL organization TSA-7, Enterprise Modeling and Simulation, has been involved in AMTEX and DAMA through development of process models and simulations for LANL, the NWC, and others. The FY 1998 and this FY 1999 projects directly involved collaboration between Honeywell and the Enterprise Modeling and Simulation

(TSA-7) and Detonation Science and Technology (DX1) organizations at LANL.

C. Description

Zimmerman: The goal of this partnership was to:

- construct the supply chain IPSS test bed application
- integrate SCIP PRM and SCIP GO engines into the test bed
- assess the value of the engines

Developing the IPSS test bed:

The IPSS development team designed a multi-tier software application in Java to gain user requirements and a facility for integrating in SCIP technology. The software test bed included a capability to read in weapon orders legacy order files; a bill of material editor; a simple requirements schedule generator for testing purposes; and a schedule output facility for selectively viewing schedule outputs.

Weapon orders for all major weapon programs were loaded and bills of material were built for some of the weapon-to-assemblies. Schedules were created for the bills of material that were contained in IPSS and validated to be correct. At this point, development of the schedule generator ceased until SCIP could be integrated with IPSS. The IPSS development team didn't want to develop a full-featured schedule generator if they could instead integrate SCIP into IPSS. In addition, the SCIP contained a linear programming decision support module that could be used by IPSS to do "what-if" analysis. The goal of the test bed was to provide a source of data that had been validated and then provide an output facility for flexible viewing of generated schedules. At this point the test bed objective had been met.

Testing SCIP PRM:

The next goal was to integrate SCIP technology into the test bed. Initially SCIP software had embedded within it the IBM PRM schedule engine and linear program solver, known as SCIP PRM. The ultimate goal was to test the IBM schedule generator within SCIP PRM to see if it met IPSS requirements.

The IBM PRM engine is a very large piece of software designed for other vendor systems as OEM software. The IPSS development team, however, didn't want to invest time in building a tight interface from IPSS to the IBM PRM engine until the engine was proven to work with IPSS. Fortunately, SNL built an ASCII exchange file test interface to the IBM PRM engine to quickly couple to other systems. This interface included only a portion of the capability of IBM PRM functionality but enough for validation. FM&T linked the IBM PRM engine to the IPSS test bed using this exchange file interface. This coupling was sufficient to move DOE Defense Program part data, bills of material data, and demand data from the IPSS test bed into the IBM PRM engine. Unclassified portions of a weapon program were loaded into the IPSS test bed and then transferred to the IBM PRM engine where a schedule was generated.

Testing SCIP GO:

In 1999 SNL chose to move away from the embedded IBM PRM schedule engine and linear program solver, replacing it with its own genetic algorithm-based technology. The IBM PRM engine required a large, expensive computing footprint on the PC client. In addition, it was difficult to add new capability to IBM PRM through the IBM development group. SNL believed that a lighter-weight, less expensive engine would yield greater commercialization opportunity. As a result, a new version of SCIP based on genetic optimization was created and became known as SCIP GO. The partnership changed drastically when SCIP GO became a reality. SCIP GO had no file-exchange interface so the IPSS development team decided to convert SCIP GO to the native language of IPSS, JAVA, and tightly integrate SCIP GO with IPSS. The goal then was to test SCIP GO as an integral part of the IPSS Java code. All modules of SCIP GO were converted to Java, and unit testing of all modules was completed. The project halted at this point and the modules were never integrated with IPSS.

Roles:

FM&T developed the IPSS and performed the integration and testing of SCIP PRM and SCIP GO. SNL developed SCIP PRM and SCIP GO software and provided the software to FM&T for evaluation.

Results:

FM&T integrated SCIP PRM into the IPSS test bed and moved weapon program parts, bills of material, and ship logistics data into SCIP PRM. FM&T also computed and validated the inter-project ship schedule. FM&T wasn’t able to trace back to lower-level bills using any of the pre-established SCIP PRM queries to understand impact due to lower-level assemblies. This requirement, called "pegging," was a mandatory requirement for SCIP PRM. The exchange file linkage between IPSS and SCIP PRM was awkward and slow but did allow FM&T to evaluate SCIP PRM. Because SCIP PRM couldn’t perform the pegging function, FM&T did not put more effort into building a tighter link between SCIP PRM and IPSS. SCIP PRM use was subsequently abandoned.

FM&T put much effort into creating a high-quality translation of the GO simulator and optimization engines into the Java language. Unit testing proved that the translated units functioned identically to the original units. Where integration testing with actual test cases occurred in the original SCIP GO, funding was discontinued. The final result of the SCIP GO evaluation is a set of unit-test software modules in Java. The Java modules were sent to SNL.

Value of working together:

FM&T gained much value interacting with DAMA SCIP PRM and SCIP GO developers at SNL. As a result of working with SCIP PRM, FM&T evaluated the written documentation on the IBM PRM engine and better understood optimization in planning and the need for capacity data. FM&T soon learned that manufacturers are making planning and scheduling engines that can be integrated into higher-level applications. FM&T also learned to be satisfied with the performance of off-the-shelf engines.

FM&T found genetic optimization, particularly as it applied to scheduling, to be completely foreign and spent much time being educated by SNL. Clearly, the genetic optimization engine must be "tuned" to the application to be useful. It is doubtful that FM&T would have gained sufficient knowledge in genetic optimization to tune the SCIP GO engine for IPSS. The conclusion reached by FM&T regarding applying genetic optimization to scheduling is that it’s very difficult to get the size of solution spaces down to a tractable size. Also, FM&T was concerned about the fragility of the genetic optimization applications and adaptability to different business modes and tactics. FM&T ceased efforts to integrate SCIP into IPSS and built a simple requirements schedule generator tuned to IPSS needs.

Bender: The purpose of the project was to apply the Supply Chain Methodology to the Mechanical Safing and Arming Device (MSAD). MSAD is produced at FM&T. LANL Detonation Science and Technology organization DX1 supplies components, packaging materials, and destructive testing of MSADs. LLNL supplies components to LANL to perform destructive testing. The timeliness of destructive testing at LANL is vital to timely completion of FM&T production schedules. The MSAD is shipped to Pantex for assembly. The Supply Chain methodology for this CRADA was based on MSAD reprocessing activity, in that MSADs are returned to FM&T from Pantex for reprocessing, and then returned to Pantex for assembly. (See Chart 1, "MSAD NWC 4-Site Supply Chain," at the end of this document.) For this CRADA project, FM&T and LANL used existing EXTEND software from ImagineThat, Inc. to model the Supply Chain methodology. This software was suggested by LANL because both LANL and FM&T had previous experience utilizing EXTEND software. (See Chart 2, "MSAD EXTEND Model," which is an example of a model using the EXTEND software).

Specific purpose/objectives:

- Document the product flow
- Identify processes
- Analyze NWC pipeline
- Identify opportunities

Results and Roles:

Based on existing knowledge, FM&T created the following:

Four-site NWC map (see Chart 1);

Process flow maps for MSAD processes at FM&T, LANL, Pantex, and LLNL; and

Detailed process flow maps that were used to develop initial LANL models for FM&T including:

- Product flow
- Equipment and layout
- Major Processes

Because of their modeling and simulation prior experience, LANL (TSA-7) created the following, after interviews and evaluation of FM&T processing:

- Initial maps and initial EXTEND model of joint FM&T and LANL flow
- LANL model of DX1 process/activity

Initial development of the model of LANL packaging process developed in parallel, as a separate activity from this CRADA.

FM&T and LANL TSA-7 then collaborated to:

- Complete the KCP model (See Chart 2 for a portion of the model.)
- Validate the model against ERP production system at FM&T
- Refine the model
- Create additional models

Conclusions:

1. The EXTEND models created by FM&T and LANL accurately reflect FM&T

processes in these areas:

- Process flow and layout,
- Process times,
- Product flowtime

1. Reductions in flowtime (parallel processing to prevent exceeding deadlines) at LANL were accomplished through implementation of advanced shipment notification, with specific product details, by FM&T.
2. Improved interactions and customer service between FM&T and customers. Step 2 was subsequently implemented between FM&T and LLNL shipments.
3. Multiple versions of EXTEND models for the FM&T MSAD process were created, tested, and validated by FM&T and TSA-7.
4. FM&T gained an additional tool to evaluate processes. Training was provided to six FM&T associates in engineering, industrial engineering, and LEAN manufacturing.
5. Simulation and process modeling that was previously performed by experts (simulation, mathematics, processes, IE's) was developed and performed by the user/principal investigator (Production Engineer).

D. Expected Economic Impact

Zimmerman: The linking of SCIP with IPSS shouldn't have significant impact on FM&T, SNL, or other industrial partners within DAMA. The extension to IPSS functionality and architecture, as a result of the test bed experience, and the follow-on production version of IPSS, will have a positive impact on DOE Defense Programs as schedulers and planners begin to replace manual processes with IPSS. A vital function gained from the SCIP experience was scheduling in the "large," discovered when loading the various versions of the program. This is a global form of scheduling, in which all demands are brought together into a unified demand. From this unified input a global output schedule results that contains all build requirement, site logistics, lead time variations, and multiple use of parts. The test bed experience using SCIP showed FM&T the value of scheduling in the large and led FM&T to duplicate this function in the production version of IPSS. Furthermore, the production version of IPSS can be placed on a common server to share across a secure network by authorized NWC planners and schedulers. The impact of creating the large view through a schedule generator and then allowing instant access to the view throughout the NWC will have significant cost savings from shortened planning and scheduling cycle time, better planning visibility, and proposing schedule options quickly.

The production version of IPSS is expected to go into initial production in the NWC SecureNet in late FY 2001. FY 2001 will be spent assisting the various user sites in obtaining security accreditations needed to connect to IPSS across the NWC SecureNet. IPSS will be used by those authorized in the NWC who have a need to know about weapon production orders, inter-site ship logistics, inventory allocation to schedule demands, allocation of shop floor parts to demand, or NWC-wide decision support based on "what-if" demand scenarios. FM&T's use of production IPSS will improve cycle time of the Logistic Manufacturing Center businesses, for which the plant has a lead in role in NWC. Most of these processes are planning and scheduling related. In addition, the business processes of any NWC site that has ship entity scheduling will be impacted. These business processes will be enhanced via embedding business process controls centrally in IPSS that today are scattered across multiple documents. IPSS will present a single point of access to all Weapon Programs directives, part attribute data, product structure, requirement schedules, adjustments to requirement schedules, and inventory allocation. IPSS will replace more than 50 different paper sources and improve data visibility. IPSS will allow the direct expression of product ship demands placed on each NWC site and express weapon schedules as part schedules. IPSS will allow all sites to consider inventory balance and lead times to create more accurate schedules. IPSS will allow easier access to product assignments at each site and simplify and streamline the basics of scheduling. Faster recognition of effects from weapon changes will occur due to standard inventory provisioning categories, a standard business model and a unified scheduling capability.

E. Benefits to DOE

Zimmerman: DOE will be benefit from the available information on IPSS. Also, tools that will help DOE write and maintain weapon part orders are being added to IPSS. The underlying data associated with weapon part orders is tightly integrated with scheduling data so tracing forward and back queries can be answered. IPSS will enhance the dialog between Defense Programs and NWC sites through the shared database and general associative note capability that allows ad hoc comments to be attached to any IPSS information object. Because the sites will be able to generate schedules more quickly, DOE will eventually have the option to pose a demand schedule for site consideration and then modify that demand schedule based on site response. Ultimately, IPSS will allow the creation of a more accurate inter-site schedule for the DOE Weapons Programs organization.

The CRADA partnership resulted in a significant time reduction to understand the requirements for an embedded schedule engine within IPSS. Testing SCIP with IPSS allowed DOE to see an actual schedule generation earlier.

Bender:

Participation in a four-site supply chain project of a part in production.

Collaboration between FM&T and LANL to:

- Complete model simulations at FM&T and LANL;
- Validate these models against ERP production system; and
- Refine these models.

DOE, FM&T, and LANL benefit from reductions in flowtime of actual production, and improved interactions and customer service between FM&T and customers.

Additionally, FM&T gained an additional tool to evaluate processes.

F. Industry Area

Zimmerman: Industries requiring high levels of data security in business-to-business communications and supply chain management would benefit from the communications infrastructure in which the production IPSS will work. FM&T did considerable work to create a HTTPS secure socket protocol that allows clients using web-enabled browsers to communicate with a central secure server. This protocol makes extensive use of the WEB XML data exchange format that is widely used in industry today.

G. Project Status

Zimmerman: SCIP PRM and SCIP GO testing ceased due to funding. The IPSS test bed was further developed in FY 2000 using DOE ADAPT funding. ADAPT funding will be used to complete the full development of IPSS up to and including the first NWC-wide production pilot of IPSS in FY 2001. In FY 2002, IPSS should become a full-fledged NWC production application.

Bender: The project was completed on time as scheduled in September 1999. Follow-on tests would have been performed if additional funding in FY00 had been available:

- Validate process and product changes at FM&T
- Simplify the EXTEND models
- Gain confidence in the EXTEND modeling software

H. Point of Contact for Project Information

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I. Company Size and Point of Contact

Not applicable

J. Project Examples

See Charts at end of report.

K. Technology Commercialization

Bender: AMTEX has similar "Supply Chain Methodology" applications, simulation software, and success examples.

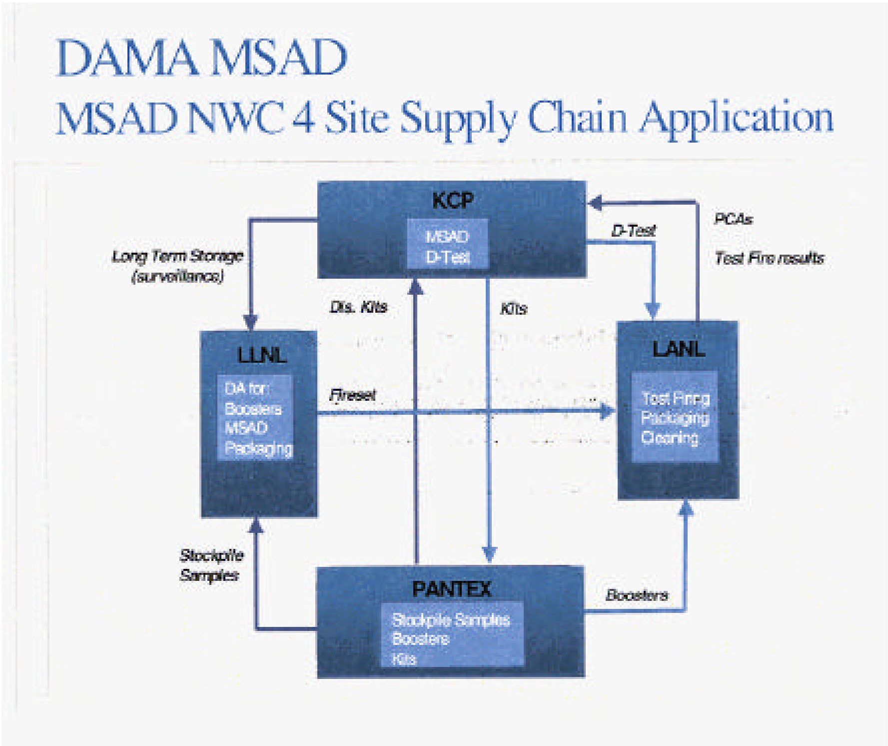

Chart 1. MSAD NWC 4-Site Supply Chain

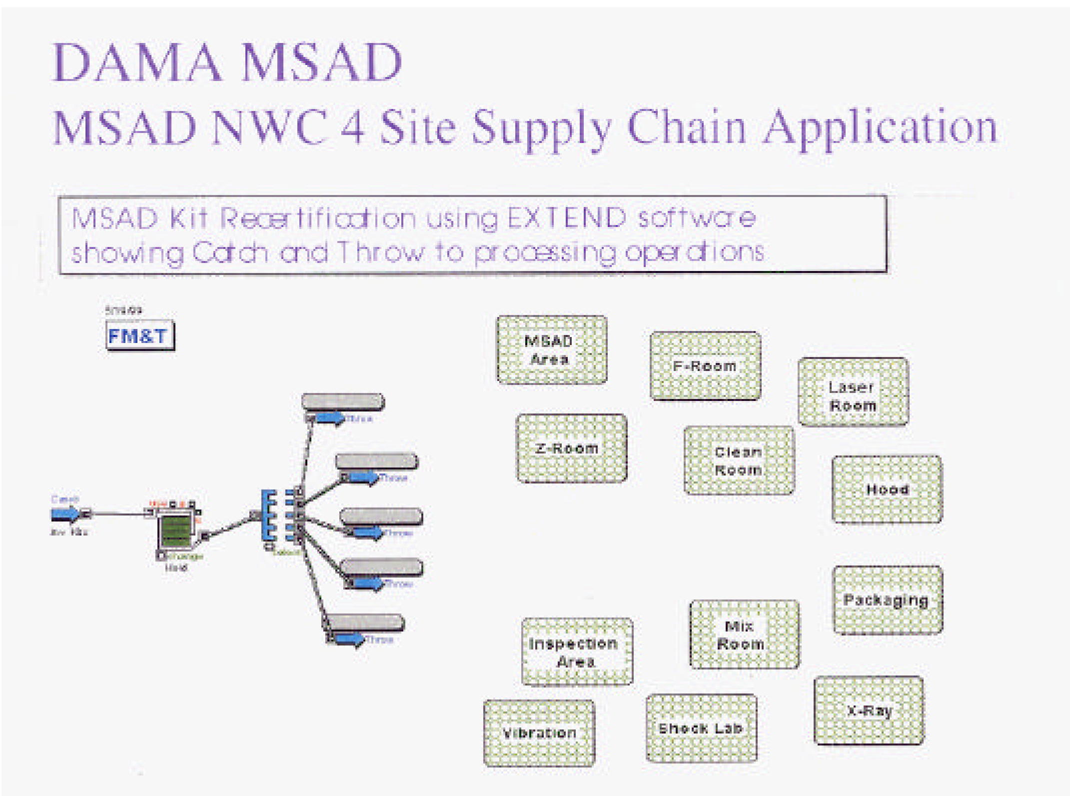

Chart 2. "MSAD EXTEND Model"