Expedite Requests in Raytheon's North Texas Supply Chain

by

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S.B., Mechanical Engineering,
Massachusetts Institute of Technology, 2000

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

Master of Business Administration
and
Master of Science in Electrical Engineering and Computer Science

In conjunction with the Leaders for Manufacturing Program
at the Massachusetts Institute of Technology, June 2006

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Submitted to the Sloan School of Management and the
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Abstract

In December 2004, a manager at Raytheon Company articulated in the form of an LFM (Leaders for Manufacturing) internship proposal his belief that someone should do something about the amounts of time and money that Raytheon's North Texas plants spent handling expedite requests—requests that someone provide goods or services more quickly than normal. This thesis attempts to summarize the thoughts, learnings, initiatives, and outcomes associated with the ensuing effort. In particular, a large section of the paper is devoted to a case study of the most involved initiative: the devising and implementing of a new dispatching method in one small but central operation in an organization with a long history of processing things first in, first out. While for the project team the compelling factor was achieving a specific dollar impact, the reader of this paper will probably be more interested in the methodology than in Raytheon's ROI.

Research for this thesis was conducted during a six-month internship with Raytheon Company's Space and Airborne Systems Supply Chain Management group in McKinney, TX, and Dallas, TX. The internship was affiliated with the Massachusetts Institute of Technology's Leaders for Manufacturing (LFM) Program.

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Acknowledgements

For the first time in recent memory, I am in the fortunate position of having so many people to thank that it would be nearly impossible for me to name them all. The number of Raytheon contributors alone would easily exceed fifty people. Everyone involved was an important part of this project, so I begin by acknowledging the contributions of all those that I am unable to mention by name in this section.

I would like to thank Raytheon Space and Airborne Systems for sponsoring this internship. In particular, I acknowledge the efforts of Directors Bob Chatterson, Dennis Coyner, Michael Paquee, and Lee Sode in ensuring the logistical success of the first LFM internship in Raytheon North Texas.

A big thank you goes out to Robert Tevis, my manager at Raytheon. I could not have asked for a better internship supervisor. Unfortunately, despite our efforts, it looks like quality of supervision still loses to other factors. Perhaps 2007 will play out differently.

My teammates on the Expedite RCCA team were crucial to this project for their depth of expertise and knowledge of the organization. Thank you for teaching me so much about the operation, and for accomplishing so much in such a short time.

Thank you to Allan Dickson, Ken Johns, Jean Raml, Ronnie Rollins, and their teams for piloting the new dispatching system. Also, thank you to Mike Fields, Rick Hallmark, Dennis Lanier (CSC), and Jeff Willeford (CSC) for making the RTD enhancement a reality. Finally, thank you to Leta Stanley for doing more with boxes—dating them and thinking outside them—than either of us anticipated going into this project.

On the MIT front, I would like to thank my thesis supervisors, David Simchi-Levi and Janice Klein, for their support and involvement in this project, especially in the beginning when traction was hard to find. Thank you also the LFM program for providing a fantastic growth experience, and to my LFM classmates for being outstanding friends and colleagues.

To Dad, Mom, and Lauri: thank you for your unconditional love and support. It's easy to fly when someone's there to catch you if you fall.

Above all, thanks be to God for seeing me through to this point in my life. Romans 8:28-30.

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Introduction

In December 2004, a manager at Raytheon Company articulated in the form of an LFM (Leaders for Manufacturing) internship proposal his belief that someone should do something about the amounts of time and money that Raytheon's North Texas plants spent handling expedite requests—requests that someone provide goods or services more quickly than normal. More precisely, the concern was that the quantity of expedite requests and the extra cost of processing each request combined to form an undesirably large amount of non-value-adding spend. There was minimal supporting data to quantifiably support or oppose this belief; however, the project was approved, and this thesis work thus commissioned.

We conducted this thesis work in Raytheon's McKinney and Dallas Expressway manufacturing plants (henceforth "McKinney" and "Expressway," respectively). These sites house programs—manufacturing groups and their relevant account management infrastructure—from several different Raytheon businesses. Throughout the duration of the internship, all programs within these plants received Supply Chain Management (SCM) services from a team reporting to the SAS Director of Texas Supply Chain Management Operations. These services include Sourcing, Logistics, Incoming Inspection, Packaging, and Shipping. Raytheon is a dynamic entity that is constantly reorganizing; Appendix A contains one version of an organizational chart for the organization just described. Other related services, such as Material Program Management, Planning, Quality, and Sales Order Activation, were also involved in this project, though their reporting hierarchies differ.

Problem Statement and Thesis Goal

The purpose of this thesis work was to improve the state of Raytheon North Texas with regard to expedite requests. This immediately led to the following goals:

- Understand the initial state.
- Determine how to make an impact within the duration of the LFM internship.
- Implement the relevant changes.

As the intent was to add maximum value to Raytheon, the following goals were also addressed:

- Improve the collecting and reporting of data related to expedite requests.
- Enable Raytheon to conduct related continuous improvement projects in the future.

At the project's outset, management set a goal of $300K as the impact this project attempted to achieve. Management arrived at this number by starting with the amount invested in the LFM internship and working backward to calculate what amount of impact would give a respectable ROI. As such, a primary activity at the beginning of the project was determining whether there was actually $300K of impact available to make.

(As per the Raytheon Six Sigma accounting standard, the impact of process changes can be evaluated out to a three year horizon. It is assumed that, after this time, the process change will be made obsolete by other continuous improvement initiatives.)

Organization of this Paper

This paper attempts to summarize the thoughts, learnings, initiatives, and outcomes associated with our effort to address expedite requests. We begin by providing a large amount of information on the organizations, systems, and processes initially in place in Raytheon North Texas. This information provides the context necessary to understand the decisions and developments discussed in the remainder of the paper.

After providing the relevant context, we discuss our approach to the problem. We do this in two ways: a high-level overview of the entire project, and a deep-dive case study of the most involved initiative: the devising and implementing of a new dispatching method in one small but central operation in an organization with a long history of processing things first in, first out. The intent is not that readers will blindly follow our steps to the letter, but rather that they will understand our thought processes and may do the same critical thinking about which solutions make sense for their organization and which require local innovation.

Finally, we conclude with a brief discussion of our results. This project was successful in exceeding the dollar goal set forth by management. However, while for the project team the compelling factor was achieving a specific dollar impact, the reader of this paper will probably be more interested in the methodology than in Raytheon's ROI.

Raytheon Background

At the time of this writing, "Raytheon is an industry leader in defense and government electronics, space, information technology, technical services, and business aviation and special mission aircraft" and is "aspiring to be the most admired defense and aerospace systems supplier through world-class people and technology."[1] It is comprised of a number of businesses, of which Space and Airborne Systems (SAS), Network Centric Systems (NCS), and Integrated Defense Systems (IDS) have operations in McKinney and Expressway that draw significantly on the SCM services mentioned above. According to the company's 2004 annual report, Raytheon had 2004 net sales of $20.2B, to which SAS, NCS, and IDS contributed $4.1B, $3.1B, and $3.5B, respectively.[2]

Raytheon states in its annual report that customer focus is primary to its business mentality. There are, as the LFM intern quickly learned, multiple meanings of the word "customer." The US government, primarily the Department of Defense, accounted for $15.0B, or 74%, of Raytheon's sales in 2004.[3] This makes the US government a customer. It also makes the US taxpayer a customer, as the taxpayers ultimately pay for the items that the government purchases. SCM uses the term "customer" to refer to the program within Raytheon making the product for

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[1] Raytheon Company. "Raytheon Company: About Us: Home." 9 September 2005. <www.raytheon.com/about/index.html>.
[2] "2004 Raytheon Annual Report." 2005. Raytheon Corporate Communications. 12 May 2006. <http://library.corporate-ir.net/library/ 84/841/84193/items/155916/2004ar.pdf>.
[3] "2004 Raytheon Annual Report." 2005. Raytheon Corporate Communications. 12 May 2006. <http://library.corporate-ir.net/library/ 84/841/84193/items/155916/2004ar.pdf>.

the government. Finally, there is the term, "end-customer," which within Raytheon refers to the warfighters—the men and women of the US armed forces that use and depend on Raytheon products. A representative from Sourcing stressed at the first project meeting that, in contrast to companies in other industries, Raytheon has a goal of supporting the warfighter in addition to a goal of making money.[4]

Two other notes about Raytheon: First, being a defense contractor, Raytheon employs more ex-military personnel and has more contact with the military than most US businesses. This increases the amount of military culture—such as prevalence of acronyms and acceptance of hierarchy—that one finds in the workplace. Second, Raytheon uses both union labor and outsourcing in running its businesses, necessitating different processes than one might encounter in organizations that use neither. In particular, the outsourcing of certain Information Technology (IT) services to Computer Sciences Corporation (CSC) led to different challenges than would have existed if Raytheon internally ran those same IT services.

Raytheon North Texas – Other Factors

In understanding the operating environment in Raytheon North Texas, it is important to consider that the McKinney and Expressway facilities, and much of the personnel in each, are formerly from Texas Instruments (TI). The present Raytheon is a composite of operations originally belonging to several companies including Raytheon, E-Systems, Texas Instruments, Hughes Aircraft, Beechcraft and others.[5] The acquisition of Texas Instruments' Defense Systems and Electronics Group, announced on January 6, 1997, and the Raytheon merger with Hughes Aircraft announced ten days later,[6] define the way some of plant personnel experience their work environment. Longtime employees suggested that enough time has not yet elapsed for the TI culture to merge fully with the Raytheon culture. One manifestation of this is the story of a Raytheon employee, married to a current TI employee, who incorrectly assumed that she had a day off from work because TI had a holiday. Some former TI employees also expressed that the ex-TI personnel "lost" when the three companies came together—the "merger" put Raytheon and former Hughes personnel and processes on equal footing, whereas the "acquisition" gave the ex-TI employees and systems a reduced influence.[7] The point of this discussion is to highlight that one may have to consider cultural differences when attempting to transfer a successful solution from one facility to other facilities.

Raytheon Six Sigma

While some cultural differences remain between the former TI facilities and the rest of Raytheon, continuous improvement is one area where this is not the case. Raytheon Six Sigma

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[4] Rush, James. Comment during the Expedite RCCA Kickoff Meeting. 16 June 2005.
[5] Raytheon Company. "Raytheon Company: Special Interest Stories: At a Glance: Past, Present and Future." 9 September 2005. <http://www.raytheon.com/feature/80years/glance/index.html>.
[6] Raytheon Company Corporate Communications. "Raytheon/Hughes Merge to Create $21 Billion Dollar Business." 16 January 1997. 12 May 2006. <http://www.fas.org/man/company/docs/970116-raytheon.html>.
[7] Various Raytheon personnel. Discussions with the author. 2005.

(R6Sigma), the company's own version of the six-sigma process, is widely accepted and used throughout both facilities. One example of this ubiquity is the following anecdote: 2.5 months into the project, the LFM intern walked into one of the team's meetings with several handfuls of sticky notes and markers, expressed his unfamiliarity with the Raytheon-specific processes involved in its version of six-sigma, and asked for help from the team. To a person, every Raytheon employee in the room dove right in, knowing exactly what to do with the sticky notes and markers—Brainstorming followed by Affinity Diagrams—and the team collectively talked the LFM intern through the process. (The LFM intern actually had a very good idea of what was supposed to happen, but approached the task this way to foster team ownership and ensure that Raytheon vocabulary rather than MIT vocabulary prevailed.) Rather than reinvent the wheel, this project took advantage of the R6Sigma infrastructure already in place in Raytheon North Texas.

R6Sigma officially launched in January 1999, but was at work in the company as early as 1998.[8] Raytheon based its process on benchmarking with Allied Signal and General Electric, expanding the Motorola Six Sigma process to include all organizational processes and functions.[9] It consists of the following six steps[10]:

- Visualize – "*Create* a vision of the future with a clear and pressing need for change."
- Commit – "*Develop* a committed sponsor and team aligned with the vision, accountable and energized to make change."
- Prioritize – "Using *facts and data, assess and prioritize* improvement opportunities, expected results, change readiness, and needed resources."
- Characterize – "*Understand and document* current state performance (metrics, process flow, and critical factors); *translate* the current state opportunities into a plan for improvement."
- Improve – "*Design and implement* integrated improvements and control systems to maximize value."
- Achieve – "*Deliver* measurable results that change the way people think and act, *create* knowledge, build momentum for continuous improvement, *celebrate* success, and *get people excited* about doing Raytheon Six Sigma repeatedly."

One notable aspect of R6Sigma is its acknowledgment that teams sometimes need to (or should) revisit steps or perform the steps out of order. For example, this project began in the Prioritize step—verifying that there was enough potential impact to be worthwhile—before returning to Visualize to envision the future state of the world. As such, the six R6Sigma steps are typically depicted in a ring, with arrows pointing around the ring in both directions to remind people that problem solving does not always occur in a linear manner.

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[8] Baldrigeplus.com. "Exhibit: Six Sigma." 1999. 17 March 2006. <http://www.baldrigeplus.com/Exhibits/Exhibit%20-%20Six%20Sigma.pdf>.

[9] Egan, Sarah. "Six Sigma Process Improvements and Sourcing Strategies Following Factory Fire." Published MBA/MS Thesis. Leaders for Manufacturing Program, Massachusetts Institute of Technology, Cambridge, MA. 2005.

[10] "Raytheon Six Sigma Specialist Training: 'Engineering One Day with DFSS': Participant Guide." Version 101204. McKinney, TX: Raytheon, 2003: slides 43-48.

SAS Supply Chain Transformation

Throughout the duration of this project, the change initiative receiving the most mindshare from the North Texas plants was the SAS Supply Chain Transformation (SCT). Led by the SAS Director of Texas Supply Chain Management Operations, SCT was a massive reorganization of the entire SAS SCM organization, to be rolled out over an 18-month period with the first major set of job postings going up on June 29, 2005.[11] Among other changes, procurement of materials, historically done by a large Sourcing organization with input from peripheral organizations such as Product Design and Quality, would now be done by smaller (roughly four people), cross-disciplinary commodity teams.

SCT affected this project in several ways. First, the SAS Director of Texas Supply Chain Management Operations spent a significant amount of time in California, minimizing his involvement in a project that touched many facets of his organization. Second, some employees were concerned over having to reapply for their current jobs, albeit in a new configuration. At the project outset, the concern was greatest in Sourcing, where the SCT was first being rolled out, however by the project's end concern was beginning to intensify in the MPM organization where the rollout was headed. A few employees, however, looked at the new commodity teams as an opportunity to be taken advantage of.

Third, employees tapped for the pioneering efforts began SCT training, reducing the staffing of their legacy departments without reducing the workload. As one Sourcing employee expressed, this led to a vicious cycle of overworked Sourcing employees who made more mistakes which made them more overworked.

Finally, the emotions related to the SCT easily pervaded the entire plant. Employees in some cases had over 40 years of professional and personal contacts within the company, and many had spouses in the company as well. Also, as previously discussed, SAS SCM serviced SAS, NCS, and IDS programs; perturbations to this one operation affected everybody in the plant. Thus, even persons outside the SAS SCM organization were well aware that the general feeling was one of mild concern and not eager anticipation.

Expediting

In a case study of the company "Fast Growth Electronics," Sterman acknowledges the existence of expediting processes in a supply chain, right alongside processes for production scheduling, demand forecasting, materials requirements planning, and other processes traditionally associated with supply chains.[12] This was refreshing, in that many of the process documents the project team saw did not discuss expediting processes, despite their being very well institutionalized in several Raytheon organizations.

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[11] Internal Raytheon communication, 2005.

[12] Sterman, John D. Business Dynamics: Systems Thinking and Modeling for a Complex World. Boston: McGraw-Hill, 2000: 744.

Sterman includes expediting in the category of, "last-minute heroics."[13] The general idea implied here is true, although at Raytheon the heroics can take place at any point in the timeline; For example, if a buyer successfully persuades the supplier to deliver early, then the heroism has taken place many weeks ahead of the buyer's company's ship date. The author also points out that the time at which heroic action takes place should not be confused with when it was known that heroic action had to occur. At Raytheon, the need to expedite is sometimes known months in advance; for example, when the supplier of a part with a six-month lead time tells the buyer, "You ordered it one month late, so you're getting it one month late," the buyer could tell everyone downstream five months in advance to anticipate a month's worth of heroism.

[13] Sterman, John D. Business Dynamics: Systems Thinking and Modeling for a Complex World. Boston: McGraw-Hill, 2000: 743.

Definitions

The following terms will be used throughout this report. These are functional definitions, as opposed to dictionary definitions, and are intended to help the reader better understand the ideas being described.

ACQ – An IT system related to accounting processes. For example, many items arriving at the plant are soon scanned into ACQ so that the supplier can receive payment for the supplies provided.

Chris Jones (not his real name) – A particular McKinney Warehouse employee in the Receiving organization. At the start of the project, Chris' manager informed us that Chris was devoted full-time to handling expedite requests (over the course of the project, we learned that Chris performed several other tasks as well, but that expedite requests were his primary concern). McKinney personnel requesting expedites would get in touch with Chris, informing him of the part number that they needed and any other relevant information. Chris would then use a combination of IT systems and physical searching to find the part and ensure that it was processed through all remaining warehousing, transportation, and inspection steps as quickly as possible. Chris emphasized that he was successful because he was "customer-focused," which happened to be one of the values of Raytheon. Chris even went so far as to expedite some parts before receiving expedite requests. With 25 years of experience, training in a variety of IT systems, and daily exposure to many internal operations, Chris was an institution and an essential part of expedite request handling in McKinney. Expressway, in contrast, did not have a Chris Jones.

Dock-to-Stock (DTS) – The steps in the supply chain process flow between when a part first arrives at the plant (typically coming in through the dock doors, hence "Dock") and when a part is first put into stock (described elsewhere in this section). Dock-to-stock cycle time is a major metric for the Warehousing operations.

Earliest Due Date (EDD) – A dispatching method in which the item needed first is the item worked on first, regardless of the number of operations separating the current state of the item from its final state.

Earliest Operation Due Date (ODD) – A dispatching method which considers items to have multiple due dates, one for each intermediate operation, leading up to the final due date. An operator considers the relevant intermediate due dates of each item in his queue and works on the item with the most immediate intermediate due date.

Expedite Fee (a.k.a., Expedite Lot Charge) – A fee that some suppliers sometimes charge for providing goods or services more quickly than normal. Expedite Fees are currently charged only by Raytheon's external suppliers; however, it has been suggested on several occasions that SCM charge expedite fees internally as a means of putting a price tag on Expedite Requests. This fee appears as a lot charge line item on the PO.

Expedite Request – A request that goods or services be provided more quickly than normal. There are many different types of Expedite Requests at Raytheon; however, this report will consolidate them into the following four categories:

- Sourcing – Requests that suppliers deliver more quickly; for example, producing a widget in three months instead of the usual six-month lead time. Parts chasers typically initiate these requests by speaking with buyers in the Sourcing organization, and the buyers typically negotiate with the relevant suppliers.
- Transportation – The choice of a more expedient and often more expensive means of shipping than one would choose if time were not an issue.
- Warehousing/Inspection – Requests that a lot already in the plant be accelerated through the warehousing and inspection operations in order to arrive at the line sooner.
- Packing – Requests that the Pack-Ship organization work on packing a particular item first, before packing other items.

First In First Out (FIFO) – A dispatching method in which items are processed in the order of arrival.

GDT (also GD&T) – An abbreviation for the General Dimension and Test laboratory, a part of the Inspection & Test organization. QCs (described elsewhere in this section) in McKinney route to GDT many items that require specialized inspection equipment or processes. GDT does not exist at Expressway; hence, Expressway QCs do more complicated inspections than the McKinney QCs, and materials involving very complicated inspections must be routed elsewhere.

Incoming Inspection – See *Incoming Quality Control.*

Incoming Quality Control (IQC) – The organization responsible for inspecting material received by the plant, before the material is delivered to the intended recipient or put into stock. IQC also inspects material that has been removed from stock and needs to be put back into stock. IQC is also called "Incoming Inspection," or simply "Incoming." Occasionally referred to in documentation as "RIT," as this is the function most commonly associated with the Inspection & Test organization.

Inspection & Test – An organization consisting of seven functional areas across the McKinney and Expressway facilities. At the time of this project, the manager of Inspection & Test was a direct report to the SAS Director of Texas Supply Chain Management Operations.

Kit Pull Date – A material-tracking IT system used to keep track of the last-known location of lots as they are moved around the plant. When a person moves a lot to a new location (drop zone), he or she uses an electronic gun to scan the barcode of the drop zone and the barcode of the lot. Other MTrak users can then use a web application to query the lot and learn its current whereabouts.

Lot – A particular shipment of a part number (described elsewhere in this section). Typically, one box corresponds to one lot. It is also common to have a single box that contains multiple

lots. Conversely, when shipments are large, sometimes the supplier uses several boxes to deliver a single lot. Inspectors typically apply their sampling plans on a per-lot basis.

Lot Number – A subdivision of a lot, perhaps corresponding to a batch number. Expressway QCs are sometimes required to apply sampling plans on a per-lot-number basis.

Material Program Manager (MPM) – A job title within some parts of Raytheon. The one-sentence job description of an MPM, in one MPM's words, is "Making sure the material gets to the program on time to meet schedule."[14]

Material Review Area (MRA) – Effectively a mini-warehouse where non-conforming material is stored until a Quality Engineer or other responsible party decides how to disposition the material. MRA was once a part of the Inspection & Test organization, and this is still the case at Expressway. In McKinney, MRA has been moved into another organization; however, the change occurred recently enough that the two groups still work together and share certain resources.

MTrak – A material-tracking IT system used to keep track of the last-known location of lots as they are moved around the plant. When a person moves a lot to a new location (drop zone), he or she uses an electronic gun to scan the barcode of the drop zone and the barcode of the lot. Other MTrak users can then use a web application to query the lot and learn its current whereabouts.

Non-Conforming Material Report (NCMR) – A report filed when inspectors find a problem with inspected material. Such material is usually sent to MRA to await disposition by the manufacturing group.

Part Number – A sequence of numbers, letters, and dashes that identify a particular type of part within Raytheon. For example, copper washers with a screw size of 8mm, an inner diameter of 8.2mm, an outer diameter of 11.8mm, and a thickness of 0.8mm might have a part number of H123456-7890 (not a real part number). In some cases, the term "part number" may also refer to just the characters preceding the first dash; the term "dash number" refers to characters following the first dash. In this report, we will use the term "part number" to refer to the entire sequence.

Parts Chaser – An individual, sometimes an MPM (described elsewhere in this section), who determines where needed parts are currently located and, if necessary, requests that the parts be expedited to the line. This is not an official title, but rather a descriptive term for referring to a person executing this particular task. The term "parts chaser" applies only to persons whose primary affiliation is with programs; for example, Chris Jones (described elsewhere in this section) is not a parts chaser because he does not report directly or indirectly to any programs.

Program – A manufacturing group and its associated account management infrastructure.

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[14] Meiseman, James. Discussion with the author. 6 August 2005.

QC – An inspector in the IQC organization. Primarily responsible for inspecting material on its way to stock, but also performs numerous other tasks including participating in process improvement initiatives. QCs are the first line of quality control once an item has arrived at the plant. After doing their initial inspections, QCs are often asked to route the material to other inspectors in manufacturing groups, in laboratories, or in other parts of the Inspection & Test organization.

RCCA – An abbreviation for "Root Cause analysis and Corrective Action." While readily understood in some circles, this acronym is not universally used within Raytheon—new member to the Expedite RCCA team often asked that the acronym be explained. Part of the confusion may have come from the existence of the Circuit Card Assembly operation, commonly referred to as CCA.

Receiving/Travel Document (RTD) – A piece of paper, printed at the end of the Receiving process, which communicates certain information about the lot such as part number and receipt date. The Receiver affixes the RTD to the box containing the lot, and the RTD travels with the lot until the lot is put into stock. Appendices H and I contain two representative RTDs.

Request for Test Analysis (RFTA) – A process through which inspectors request that another entity (often a laboratory or an engineer from a manufacturing group) perform a particular part of the inspection process. After the RFTA is filed, the material is routed to the other entity to be inspected. Upon completion, the RFTA is closed out and the material routed to the originating inspector, who continues the inspection process.

RIT – An abbreviation for Inspection & Test. The "R" in the abbreviation comes from word "Receiving"; at one time, Receiving, Inspection, and Test were a single organization, and the abbreviation "RIT" persisted even after the groups were reorganized. In some other Raytheon plants, Receiving, Inspection, and Test still exist as a single organization.

RIT Traveler – A document, printed by SFDM, that details the test plan for a lot and allows a QC to stamp off each step in the test plan as it is completed.

Sampling Plan – A statistically determined plan for assuring a certain level of quality without inspecting every item in the lot. The inspector inspects a predetermined number of items and approves the lot if he finds less than a certain number of defects. The number of items that the inspector must sample and the number of defects he is allowed to find varies with the lot size and desired level of quality.

"SCM Expedite & Saturday Coverage Request" Web Application – Henceforth, the "web app." A software application that serves two purposes: making expedite requests relating to parts that are already on the premises, and requesting that Receiving and Inspection personnel be on hand to handle a part that arrives on a Saturday. (The Saturday request is a version of an expedite request, in that the requester is suggesting that the arriving item cannot wait until Monday.) The version of the web app in use at the beginning of the project was designed and coded by Inspection & Test personnel and is the second incarnation of such a program. Parts

chasers visit a webpage where they enter certain relevant information such as the part number and what type of expedite they are requesting (see Appendix E for a list of the different types of expedite requests—note that "Sourcing" and "Post-manufacture pack-ship" are requested via other processes and thus are not available via the web app.)" Various Receiving and Inspection personnel receive email regarding the request, and take action on the appropriate lots. After fully servicing the request, the final Receiver or Inspector in the process uses the web app to mark the request "Closed." This sends email to the requester informing him of the completion of the requested actions. Appendix K contains screenshots of the web app.

Shop Floor Data Management (SFDM) – A software application providing, among other functionality, the ability for an inspector to sign off on different parts of the inspection process.

Shortest Processing Time (SPT) – A dispatching method in which the item that will take the least amount of time to process is processed first. This implies that the item that will take the largest amount of time to process will never be processed unless it is the only item left in the queue.

Stock – A generic term for the areas of the warehouse where material is stored prior to being consumed. Consumption usually takes the form of a kit pull (pulling material out of stock and putting it into a kit). Material may also be pulled out of stock for other purposes, most commonly engineering prototyping or testing.

Supplier Managed Inventory (SMI) – An inventory management scheme in which the supplier, rather than Raytheon, ensures the availability of material. Raytheon runs SMI on a two-bag system—parts are consumed from one bag until it is emptied, at which point consumption moves to the second bag while the empty bag is restocked—with bag sizing being among the most critical Raytheon decisions. A single PO is written for the entire year, affording the buyer more time to proactively manage this and other suppliers than he would have if writing multiple POs during the year. Some of the requirements for moving a part to SMI include:

- Minimal inspection requirements
- Used in sufficient quantities throughout the year. This is currently measured as whether a part is ordered six or more times per year, with a potential weakness in this measure being that the buyer may consolidate into a single bulk order what could alternatively be ordered on multiple occasions.
- Be a low-cost item. Currently, the generic threshold is $50 per piece, but on some occasions $75 or $100 parts are considered.

Warehouse Automation and Control (WAC) – An IT system that facilitates "random stocking" within the warehouse. In layman's terms, random stocking allows one to store parts wherever he wants as long as he tells the computer. When someone later needs the part, he asks the computer and the computer can tell him where it is located. Random stocking eliminates the need for dedicated shelves that sit empty when devoid of materials.

Web App – See *"SCM Expedite & Saturday Coverage Request" Web Application.*

North Texas Operations

Appendix C contains a very high-level flowchart of the McKinney operations. The diagram for Expressway is essentially the same, but the intricacies of the processes and some of the names differ. This section attempts to supplement that diagram, giving the reader a better understanding of the operations discussed later in the paper.

While many detailed lower level process flowcharts abound, it is notable that no individual interviewed at the outset of this project was able to point the LFM intern to a document containing a higher-level flowchart. Thus, creating a succinct, high-level summary of flow through the plant became one of the first contributions of the project. While used only internally within the project team, this diagram educated several people about the flows of material and information. As an example of this, it was about three months into the project when a non-team member pointed out that Sales Order Entry was missing from the diagram, drawing comments from two twenty-year employees that they had never before heard of the organization.

As noted in Appendix C, there are many variations on the process described here. For example, in some cases Sourcing will handle almost all the interaction between Raytheon and the supplier, while in other cases an MPM will handle the majority of this interaction. The intent of this section is not to discuss all possible variations on delivering product to the customer, but rather to give the reader a baseline understanding of the process.

Finally, it should be noted that both the diagram and the discussion in this section skim over or assume very important parts of the process, such as product design and supplier qualification. This choice is deliberate. While anything that possibly affected expedite requests was in scope for this project, the project team quickly chose to focus its efforts in other areas. This section focuses on communicating only what is necessary to understand the discussion in the rest of this paper.

Steps in the Process

Prior to a Purchase Order Request

As a government contractor, Raytheon's process typically begins when the government issues a request for proposals relating to a particular contract. If Raytheon chooses to compete for the contract, it prepares and submits such a proposal. Depending on the competitiveness of Raytheon's proposal vis-à-vis the other submitted proposals, Raytheon sometimes wins the contract, at which point the Sales Order Entry team (renamed "Sales Order Activation Team" in the middle of this project) can begin entering the contract details into Raytheon's planning systems. A Bill of Materials (BOM) is also developed during this time.

Procurement

Programs consider the scheduled deliverables and decide what products they want to build when. MRP and other tools help manufacturing engineers, procurement specialists, and other personnel to determine when to file purchase order requests (RPs) or IOTs (similar to RPs, but used for intra-company purchases) with Sourcing. Among other information, the RP or IOT communicates what must be purchased, when it is needed, and who the preferred supplier is, if any (this is the preferred supplier from the program's point of view, which may differ from the Sourcing or overall Raytheon perspective).

Sourcing uses the information from the RP or IOT to begin negotiating with suppliers. Once the buyer has found a suitable supplier, he or she then cuts purchase orders for the material, and the supplier can begin working on delivering the ordered material.

Transportation In

Transportation of the ordered material is one of the levers the buyer has in his negotiations with the suppliers. Sometimes Raytheon will pay for the transportation, and sometimes the supplier pays. (We were not incognizant of the fact that, in both cases, the cost may then be passed on, directly or indirectly, to the payer's customers or suppliers.) Type of shipping—1st day air, 2nd day air, or ground—is potentially up for negotiation; in some cases air is chosen not for expediency but rather because of a perception that there is less potential for damage. Also, sometimes the program will dictate what type of shipping the buyer should use. Ultimately, most parts are delivered to the plants by parcel delivery services, with DHL being the current preferred supplier, and FedEx used only occasionally. Regardless of the service level used, the final delivery to the plant is usually by truck.

A third lever is Clause T412. Typically a supplier will be penalized in the internal Supplier Rating System (SRS) if they deliver outside a "+5/-0" window (i.e., delivering more than five days early or more than zero days late is bad). Clause T412 relaxes the +5 side of this window; the supplier can deliver as early as it wants without penalty. Since parts that arrive early incur additional inventory carrying cost for the program, this lever is not used without first obtaining permission from the program. Clause T409 is similar to T412, but applies only to the first lot or unit shipped.

Receiving

The parcel delivery trucks arrive at the docks, delivering both manufacturing parts and other materials, such as printers and office supplies, which the manufacturing process does not directly consume. The trucks are rarely loaded exclusively for Raytheon deliveries, so the delivery person is typically involved in the unloading of the truck.

Members of the Receiving operation set to work on the delivered items, inspecting the packages for external damage and scanning the carrier tracking numbers to record the initial receipt. Packages are then sorted by size and weight, sent through an import compliance process if necessary, and sorted according to their destination:

- All items that must be "received" into ACQ
- Items that do not need to be Received:
    - Items destined for the Bond Room
    - UPS Red and Airborne packages addressed to individuals
    - Non-expedited shipments addressed to individuals and that do not require a receipt
    - SMI Material

The items that do not need to be received are sent via various processes to their respective destinations.

Every item requiring receipt is scanned or manually entered into ACQ. This act of entering things into ACQ is the heart of the Receiving process, in which Raytheon acknowledges receipt of items in its IT systems so that suppliers can be paid and MRP can be updated. As a part of this receipt, one or more RTDs are automatically printed, one for each lot contained in the box just received. The receiver affixes the RTDs to the box.

In the top center of each RTD is an Inspection Code, an alphanumeric code telling Warehousing and Inspection & Test personnel what kind of inspection, if any, the lot requires. The receiver uses this code to route the box to its next destination:

- Material with the inspection code "01RS" goes directly to stock. The receiver affixes to the box a bright orange label with the word "Rush" and stamps the RTD with a Quality Stamp. The material is then sent to the Make Ready process.
- Material to be delivered to an individual ("destination material") is staged for the inter-plant delivery process and eventual delivery at a drop zone near the individual.
- Pretin Vendor material is placed on a cart where it awaits the relevant processing.
- All other material requires inspection and is sent to Incoming QC.

Inspection & Test

Incoming QC scans the RTDs into SFDM, printing a RIT Traveler for each lot. A QC then follows the test plan described on the RIT Traveler, stamping off each step as it is completed. The test plan may instruct that the lot be sent to one or more labs for engineering evaluation or more detailed inspection; in this case, the QC writes up an RFTA and sends the material out to the other labs for the additional tests. If after all inspection the lot is rejected, the QC writes up the lot on NCMR and sends it to MRA. If the lot is determined acceptable, the inspector closes out the lot SFDM and moves the lot to a shelf from which it can be transported to the Make Ready operation.

MRA

Non-conforming material is stored in MRA until a Quality Engineer or other responsible party decides how to disposition the material. Sometimes the material is sent back to the supplier for repair or replacement, sometimes it is declared scrap, and sometimes it is examined and found acceptable (despite still failing the inspection criteria) to "use as is." The MRA attendant then closes the NCMR and routes the lot per the disposition instructions, returning the lot to the originator of the NCMR if the part is to continue on its way to stock.

Make Ready and Stocking

Make Ready is the process of preparing materials for stocking. It involves things such as de-trashing of boxes, counting the items in the boxes to ensure proper inventory counts, and doing the relevant computer transactions including entering the parts into WAC. Once this is complete, Stocking physically places the parts in the warehouse.

Picking and Kitting

Parts sit in the warehouse until manufacturing groups "on-line" their parts, effectively telling the Warehouse what parts in which quantities must be pulled out of stock and placed into kits. Warehousing personnel do the kitting, relying on WAC to help create kit manifests and exception reports (for example, if there is a stockout of some items needed to complete a kit). Kits are delivered to the line via Interplant Delivery or Tailor Logistics. Because of the number of "pedestrians" in the McKinney plant, kit deliveries in McKinney typically occur only after 5pm when the forklifts and other heavy machinery can operate with less chance of injuring plant personnel. Expressway kit deliveries do not have the same restrictions.

Manufacturing or Assembly

As alluded to in the rest of this section, programs are involved at several points in the process including winning contracts, loading MRP, and requesting materials. Now, materials have finally arrived on the line, and programs can begin manufacturing or assembling their products or components.

With so many manufacturing groups and limited understanding of which were the most problematic, the project team treated this part of the process as a black box—SCM delivered material to the line, and some time later manufacturing had an item ready to be shipped. As Raytheon collects more data on which programs generate the most expedite requests, deeper dives into the manufacturing processes of the more prolific groups to look for potential process improvements are certainly in order.

Pack-Ship

Program personnel needing to ship their finished work transport it to the Pack-Ship area. There, they visit with a pack-ship employee who acts as pack-ship's customer service representative. There is a form to fill out, asking for information such as destination and type of shipping required (air, ground, etc.). This is also where negotiations take place for expedited packing service. There are about 20 such requests per day, but the supervisor only allows an average of five per day to become "whiteboards"—their term for items that get to skip the FIFO line.

Transportation Out

The service level of transportation out is determined by what the program representative filled out on the form when he visited with Pack-Ship. The same air-versus-ground cost discussion applies as did with the Transportation In process. Again, sometimes Raytheon pays the freight charges, and sometimes the customer pays; however, this time the parties in the negotiation are the Raytheon program and the customer's buyer (unless the service level is already agreed upon in the contract). If everything goes well, the delivery is timely and the customer satisfied!

Miscellany

MTrak

MTrak is an IT system for tracking material as it moves about the plant. It is implemented with barcode scanners, barcodes that print on every RTD, and barcodes at every material drop zone or staging location. Individuals moving lots between drop zones scan the destination drop zone's barcode and the lots' barcodes. This updates the computer system, such that other employees can query the system for lots to learn their last known locations.

MTraking begins at the Receiving process and occurs at multiple points as lots make their way toward stock. As such, no attempt was made in the above discussion to enumerate all the points at which plant personnel track material movements using MTrak. Also, as in any large organization, not all employees are as diligent as they should be about MTraking their material moves. Finally, while the intent is that the MTrak software application be used by all personnel looking for material, it is common that a parts chaser will forget to use this capability when attempting to locate parts in the plant.

Funding for Various Operations and Performing of Various Tasks

Not all departments in Raytheon are funded in the same way. For example, Warehousing is funded on a cost-per-service basis; 5% of all POs go to pay the warehouse, regardless of how much effort warehousing devotes toward a particular program's material. On the other hand, Incoming QC charges directly to programs; programs are charged internally in proportion to the

amount of time IQC spends handling their material. This makes solutions such as "letting QC borrow a person" somewhat more complicated than it might be in other organizations.

Another aspect of this is that, in its contracts with the government, Raytheon sometimes states which personnel are allowed to perform certain tasks. Thus, in addition to finding ways to transfer funds between organizations, Raytheon may also have to revise its paperwork before temporarily reassigning personnel to other tasks.

Metrics

Appendix D contains selected metrics from several programs and SCM teams. In this section, we comment on some of the noteworthy items therein.

Warehousing and Inspection & Test

The primary metric within the Warehousing and Inspection & Test organizations is cycle time. Warehousing measures a "dock-to-stock" cycle time—the time that elapses from when a part enters the warehouse ("arrives on the dock") to when a part is placed in an appropriate storage location in the warehouse ("stocked" for future consumption by programs). Included in this are some operations—Receiving, Make Ready, and Stocking—that are under the warehouse manager's jurisdiction. Also included are operations such as Inspection & Test that do not report to the warehouse manager.

Inspection & Test also has a cycle time metric—the time that elapses from when Receiving gives a part to Incoming Inspection, to when Incoming Inspection delivers the part to Make Ready. Some of this time, for example, the queue time and processing time in IQC, is more directly under the IQC Manager's control. (The control is not total, in that the program rather than the Inspection & Test organization determines what the sampling plan is, and indeed whether a part has to be inspected at all.) However, some of this time, most notably the time a lot spends on NCMR and RFTA, is not under the IQC manager's control. In these cases, IQC takes it upon itself to coax organizations for quicker dispositions and faster testing, but has no authority to force such behavior.

The SAS VP Quality and Operations set a goal of three days as the average dock-to-stock cycle time that should be experienced by all material in McKinney, creating a dependence of McKinney Warehousing on the McKinney QCs. A similar goal for Expressway likewise creates dependence of Expressway Warehousing on the Expressway QCs. Realization of this has led to Warehousing tracking two sets of numbers, DTS cycle time with IQC and DTS cycle time without IQC, to better monitor their internal progress independent of how IQC (and by extension the responsible parties for NCMRs and RFTAs) happen to perform in a given month.

(On the subject of cycle time, the project team noted that reducing dock-to-stock cycle time does not reduce Raytheon's inventory carrying cost in the short term. Raytheon's inventory carrying cost is essentially determined the moment a part arrives on the dock. Accelerating the movement

of material to stock simply increases the time the material sits in stock before being pulled from stock on the originally-scheduled kit pull date; the total dock-to-kit-pull time, and thus Raytheon's inventory carrying cost, is the same. Dock-to-stock cycle time reductions affect the inventory carrying cost only when the reductions make their way into the planning factors and cause material to be sourced in a more just-in-time manner. That said, some Raytheon contracts incorporate "progress payments" in which customers pay programs for hitting certain milestones. In contracts where progress payments are tied to the stocking of certain amounts of material, speeding the arrival of material in stock is a lever for smoothing fiscal performance or accelerating cash flows. In such cases, there are financial benefits to moving a part into stock faster; however, reduced inventory carrying cost is not one of them.)

It is notable that Expressway Warehousing, McKinney Warehousing, and Inspection & Test do not have metrics related to whether their customers' parts reached stock on time for a scheduled kit pull. In addition, of the three groups, only Inspection & Test has a Customer Satisfaction metric. This begs the question: Why does either Warehousing group processing expedite requests? A second question can also be asked: Why does McKinney Warehousing, which has neither metric, have on its payroll an individual who is "fully devoted to expedite requests?" This leads to the observation that processing of expedite requests is based on knowledge of the corporate good, willingness to help someone with a problem, or generally something other than how the groups are being rated.

Other

Similar to Warehousing and Inspection & Test, most other teams from which we obtained metrics also have some metric related to cycle time or inventory turns. However, it was not obvious that the clock on these metrics began when the parts first arrived at the dock, as opposed to when they first arrived in stock or when they were first pulled from stock and placed into a kit.

In contrast to Warehousing and Inspection & Test, most other teams from which we obtained metrics do have some type of "on-time" metric, either being on-time to MRP or delivering product on-time to customer. This raised the question, and unfortunately no definitive answer, as to whether Warehousing or Inspection & Test or both should also incorporate some manner of on-time measurement into their metrics.

Finally, R6Sigma involvement—both having members of an organization qualified as R6Sigma Specialists and having each Specialist either lead one project or participate in two projects over the course of a year—was a common metric in many organizations. This makes it somewhat easier for change agents to assemble project teams, as, regardless of the project's scope or outcome, managers receive some metric-related payback in exchange for their employees' time.

Forming the Team and Understanding the Problem

Team Formation

As is typical of most larger-scale Raytheon Six Sigma projects, a team of diverse stakeholders was assembled to establish buy-in amongst the relevant parties, provide varied perspectives for identifying improvement opportunities, and create a resource base that could assist in implementing change. Before the project's outset, the internship supervisor had done a significant amount of legwork in assembling stakeholders who agreed to support the project. Appendix F shows the personnel initially committed to the project team, which, for lack of a more creative title, was called the Expedite RCCA team.

While this initial garnering of support was instrumental to the success of the project, we identified even prior to the first team meeting that certain stakeholders were still missing from the team. For example, it was anticipated in the project proposal that we might need to enhance the web app; however, the software developer ("Inspection & Test Support Tools") was not a member of the team. Likewise, there was minimal customer representation—only the representative from Quality worked for a program, and his job description rarely saw him requesting expedites. In fact, except for testing purposes, no one on the initial list had ever used the web app to request expedites. This led to the inclusion of parts chasers from McKinney and Expressway as resources (people who were not able to commit to team activities, but agreed to make themselves available for consultation), and the Inspection & Test Subcontract Manager as someone who had prior professional contact with many programs and could bring some understanding of program perspectives (since we had difficulty getting the programs themselves) to the team meetings.

Similarly, after several meetings, the title "MPM" had been mentioned so often that the LFM intern was advised to interview an MPM learn more about their role in the organization. No one had a good MPM contact to recommend at the time, so the LFM intern approached a total stranger who, as a vice-president of the Raytheon Young Engineers and Scientists Network (YESNet) happened to be collecting money for a social activity. As was typical of the culture in these plants, this SAS MPM willingly gave up some time to teach the LFM intern, and ultimately agreed to become part of the team. (Gaining information truly was the primary reason for the interview; successfully recruiting this MPM afterward was a welcome bonus.) The SAS MPM was later joined by an NCS MPM and a representative from Sales Order Entry as conditions of receiving a second Sourcing resource when we realized that Sourcing was an area requiring closer investigation.

Good fortune also played a factor in two instances. After the first meeting, during which the LFM intern realized that he was unable to lead meetings and take copious notes, the Inspection & Test manager asked one of his support personnel to assist the LFM intern with this and other tasks. While nobody initially expected much more than the occasional Word document or benchmarking interview, the support person was instrumental in designing and giving credibility to the new dispatching process—she was one of the few team members who had actually worked

as an inspector. And, when an unfortunate miscommunication led to our scheduling the project team meetings at the same time as the McKinney Warehouse manager's staff meeting, the warehouse manager offered as a proxy for his Receiving manager an individual who had recently transferred to McKinney Warehousing. This warehousing representative was the first within that organization to see the merit of tracking all expedite activities in an IT system so that Raytheon could quantitatively monitor its performance, and after several sometimes-heated conversations was able to convince the Receiving manager to acquiesce.

Prior to the First Meeting – Already Learning About Leadership

From various pre-internship discussions both inside and outside the LFM Leadership curriculum, the LFM intern had in his head the idea (possibly incorrect) that the best way to approach the internship was to mill around for about a month, building relationships and getting to know the lay of the land—Relating and Sensemaking in the Sloan Distributed Leadership Model—before diving into the project. In fact, the LFM intern was personally admonished by the former Deputy Dean of the MIT Sloan School of Management to not to fall into the trap of getting mired in the data too early, but rather step back and see the big picture.[15]

To put it bluntly, that did not happen. The major factor here was that the stakeholders gathered to be part of the initial project team were looking for ROI, and the internship supervisor who gathered them thought it inadvisable to disappoint them. The LFM intern unknowingly took a page from the Raytheon CEO's (literal) book. Rule number 16 in Swanson's Unwritten Rules of Management states: "Don't overlook the fact that you are working for a boss...Whatever the boss wants, within the bounds of integrity, takes top priority."[16]

The boss wanted the LFM intern to do an initial analysis of any data the LFM intern could get his hands on present the findings in a kickoff meeting. The point was not so much to reach earth-shattering conclusions as to make a few interesting observations and prove that the stakeholders were quickly receiving something for their investment in the project. In a sense, this approach may be related to the idea of getting "small wins" when first arriving in an organization to develop credibility for future large-win efforts that require leaps of faith, although no one had advised the LFM intern as to how quickly the small wins ought to be won. In the internship supervisor's opinion, the kickoff meeting ought to happen at around the one-week mark. The LFM intern thought three weeks were necessary to do justice to the data (and may have been right; there were some analyses that were on the "to-do" list for the entire duration of the project that never got done). Ultimately, the meeting was scheduled for the 1.5 week mark, with the internship supervisor wisely suggesting that the LFM intern reserve the room and invite the attendees—the LFM intern was, after all, the lead on this project.

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[15] Bitran, Gabriel. Discussion with the author. 28 March 2005.

[16] Swanson, William H. Swanson's Unwritten Rules of Management. Waltham, MA: Raytheon, 2005: rule number 16.

The Kickoff Meeting – A Learning Experience

The LFM intern obtained fourteen months of data from the web app that he was able to slice in ten ways prior to the kickoff meeting. (He also made the decision not to sift through the electronic equivalent of 10,346 pages of expedite-related email generated outside the web app.) These data allowed the discussion in the kickoff meeting to be data-centric rather than opinion-driven. Appendix N shows two of the slides used in the meeting. Slides such as these elicited observations such as:[17]

- If we address the needs of the top 20 expediters, we'll have cut the problem at least in half.
- The application went live in Mar-04, so we do not have a full month's worth of data.
- There would have been a phase of people learning to use the application.
- Dec-04 numbers may be low because many people take vacation.
- Jan-05 was the changeover to the APEX system (a new accounting system), and many operations were on hold for a while.
- Feb-05 management was telling people to use APEX.
- Mar-05 may have been when people were recovering from APEX.
- APEX was originally supposed to go happen in Jul-04. Perhaps people were anticipating the change.

Several months later, when a faculty member from the MIT Sloan School of Management came to visit, she pointed out that the LFM intern made a key mistake in his slides. Everybody knew that, if this project was going to succeed, it would have to be internalized as a Raytheon project, not an LFM, MIT, or MIT Sloan project. Why, then, were the LFM and MIT Sloan logos on the slides?[18] The LFM intern had thought about this part of the way through, consciously placing the Raytheon logo above the other two, but never considered that the LFM and MIT Sloan logos ought not to be there at all. The LFM and MIT Sloan logos quickly disappeared from the presentation template, and even the Midstream Review and Knowledge Review presentations given back at MIT sported only the Raytheon logo.

The LFM intern later learned that one of the accomplishments of this and future meetings was getting all the parties to sit down in the same room and talk rather than point fingers. While even newcomers rarely had to be introduced, it was rare to get the quality of cross-functional dialogue that this and future meetings generated.[19] As one of the team members expressed several weeks later, he was learning a lot about how the other organizations operated, and likewise about disconnects between his and other operations.[20] A non-Raytheon person who visited with the team remarked that she found the dynamic in the room to be "interesting" and "very cordial"[21]— the LFM intern later learned that complaining occurred outside the room within social networks.

A final point of the first meeting was to establish that the LFM intern would be undergoing R6Sigma training in the upcoming weeks. Thus, this project would be a Specialist-qualifying

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[17] Expedite RCCA Team team members. Comments during the Expedite RCCA Kickoff Meeting. 16 June 2005.
[18] Klein, Janice. Discussion with the author. 1 August 2005.
[19] Tevis, Robert. Discussion with the author. 2005.
[20] McInchak, Robert. Discussion with the author. 2005.
[21] Klein, Janice. Discussion with the author. August 2005.

project for the LFM intern, and any team members would get credit for being Specialist project participants. In the perspective of one R6Sigma Expert, the magnitude of the project was actually "on the level of an Expert project"[22] rather than that of a Specialist project; however, the idea of more work for the same level of recognition did not seem to faze the team members.

Expedite Dollarization

As previously discussed, one of the first objectives of the team was to determine the magnitude of the expedite issue in dollars, so that it could tell the internship supervisor and project sponsor upfront if a $300K impact was an unrealizable goal. This effort became known as "Expedite Dollarization." A secondary use of the dollarization would be to approximate how much a single expedite request cost the company—if the cost per expedite was large, the team could publicize the cost and let programs determine whether expediting was cost effective. Appendix O shows one of the initial versions of the expedite dollarization effort, and Appendix P shows one of the final versions. The rest of this section discusses the methodology behind the dollarization and why the two versions look so different.

The dollarization was accomplished by necessity in an amalgam of methods. Where possible, we took data collected by IT systems—for example, the web app recorded every expedite request filed through it, so we could use this as a lower bound for the number of non-Sourcing, non-Shipping expedite requests. Chris Jones and others at McKinney and multiple sources at Expressway provided estimates for what percentage of expedite requests they received outside the web app. Interviews with personnel from key in-plant operations gave us an idea of how much "extra time" each expedite request cost them—for example, if a batch of five lots normally takes 30 minutes to process, but takes 40 when one of the lots is expedited, we wrote down "10 minutes" as the cost of that expedite request. These times multiplied by the fully burdened labor rate gave a cost per expedite request at each operation. Summing together the extra costs at the various operations, keeping in mind that different expedite types involved different operations (see Appendix E), gives a costs per expedite request for each expedite type, and multiplying these numbers by the estimated frequency of each type of request gives a total annualized cost for in-house expediting.

Extra cost for expedited shipping Transportation expedites was derived through email and phone discussions with one of the logistics managers, who related that for domestic parcels there is roughly an $8 difference per parcel between shipping via ground and shipping via air. This approximation corresponds with the numbers in a case study in a paper by Graves and Willems: "product can either be shipped by ground transportation at a cost of $12 and a transportation time of five days or it can be shipped by air at a cost of $20 with a one-day transportation time."[23] The logistics manager was also able to provide the number of air shipments that Raytheon North Texas paid for each month, from which we derived the initial cost of transportation expedites.

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[22] Miller, Ann T. Email to the author. 3 January 2006.

[23] Graves, Stephen C., and Sean P. Willems. "Optimizing the Supply-Chain Configuration for New Products." Management Science. Vol. 51, No. 8. Institute of Management Sciences, August 2005: 1171.

(After initial versions of the chart in Appendix O had been circulated amongst team members for several weeks, the logistics manager contacted the LFM intern and said that, in his opinion, it was a mistake to treat all the air shipments as contributing to expedite costs. There was some difference of opinion here since, as air freight is an expedited level of service, investigating ways to reduce the plants' reliance on air freight might be considered within the scope of the project. However, when the logistics manager pointed out that Raytheon was already addressing this issue on a larger scale, with involvement from the SCM Traffic Lead, the LFM intern and the logistics manager agreed on an alternative method for calculating transportation-related expedite cost for this project: it would be assumed that any expedite request received by Receiving or Inspection & Test was preceded by an air shipment, and that any whiteboard in Pack-Ship was followed by an air shipment. If this project reduced these types of expedites, presumably by making things happen on-time, then expedited shipping would also be avoided. These were areas that the larger Raytheon effort was not focusing on, and that the logistics manager said he would be pleased to have somebody address. Of course, some material probably came via ground and was only expedited once it arrived at the plant, but the two called it even because there was probably other material in which air shipping eliminated the need to expedite within the plant. The LFM intern then had the difficult task of telling a subset of the team to stop the investigation they had already begun on reducing transportation expedites, and the team as a whole was faced with trying to squeeze $300K out of a much smaller pie.)

The final aspect of the dollarization effort was Sourcing. There were no processes by which Sourcing tracked the number expedite requests it received, and no central person such as a Chris Jones through whom the requests were routed. Additionally, at the time, no member of the team knew that expedite fees were recorded on the mainframe (and even when we later learned this, it took several months to create a report that pulled these data, a report whose accuracy was in dispute at the end of the project). So, the team created a "Buyer Survey," an eleven-question survey, almost entirely multiple-choice, from which we could approximate both expedite-related labor and expedite fees. The survey was designed to be very quick and completely anonymous for the buyer, which limited its approximating power—for example, we did not know whether a respondent was on the high or low side of the "51-100 POs per month" range and had no identifying information from which to look up the actual number—but contributed to getting a good response rate. We received responses from roughly 50% of the buyers, a respectable result in an environment where 30% survey response was considered "good."[24] The Supply Chain Transformation probably affected the response rate—some buyers may have wanted to express themselves, while others might have viewed the survey with distrust—as would the assistance of four of the five Sourcing managers in both writing the survey and asking their employees to take the survey seriously (the fifth manager did not manage buyers).

Fishbone Diagrams and Causal Loop Diagrams

Based on the Expedite Dollarization diagram in Appendix O, the team attempted to do root cause analysis by starting from three symptoms—spend in Sourcing, Transportation, and McKinney Warehousing and IQC (the three major buckets of spend)—and working backward. Appendix Q

[24] Hunt, Connie. Discussion with the author. 2005.

shows the fishbone diagrams that three subteams developed. The Memory Jogger II suggests that, once the diagram is created, one can interpret or test for root causes by several methods, including looking for causes that appear in multiple places.[25] The exercise unearthed two possible root causes:

- Trust – People may request expedites because they do not trust another organization to work diligently or to deliver on time.
- Misaligned metrics – Some groups' metrics may conflict with other groups' metrics or with the idea of not expediting.

It was then suggested that the team try Causal Loop Diagrams, a tool in the R6Sigma toolkit, but not taught at the specialist level. The first diagram in Appendix R shows one of the most eye-opening causal loop diagrams; in addition to showing that expedite spend affects even programs that pass on all internal costs to the customer, it also reveals that there are some "good," or "value-adding," expedite requests. The idea of good expedite requests was later confirmed by another LFM intern (he referred to them as "strategic").[26] For example, a program may be offered a lot of money to make something that it knows it does not have the standard lead time for. However, if the program feels that it can make up the time, and the cost of making up that time is small, then they may take the business (lots of money) despite the cost of expediting (less money). So long as the costs are considered from the big picture (cost to the entire company, not just to the particular program), most Raytheon employees and shareholders would likely approve of such a decision. That said, not all companies are willing to make this kind of tradeoff; a buyer related that there are several Raytheon suppliers that refuse to expedite orders, regardless of how much money Raytheon Sourcing throws at them.[27]

(The example just described was generally agreed upon by all project team members as an example of a value-adding expedite request. Likewise, expedite requests made when there was no real need—for example, if a parts chaser just wanted to "look busy"—were generally agreed upon as being non-value-adding expedite requests. However, in between these two extremes are many examples where the project team was divided over whether the expedite request was value-adding or non-value-adding. The debate over these continued until the last team meeting, where the team agreed to disagree. Nevertheless, it was one of the great realizations of the project that some expedite requests can be universally agreed upon as adding value.)

A second causal loop diagram, also in Appendix R, was used by a team member from the Sourcing organization to show a Sourcing manager the reinforcing effect that working overtime (because of being shorthanded and losing more people to the SCT) was having on buyer productivity. This second diagram may have factored into the Sourcing representatives' strong opposition to introducing new processes that increased workload during the SCT, even if there was a net payoff to the process change.

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[25] The Raytheon memory Jogger™ II. Salem, NH: GOAL/QPC, 2002: 28.
[26] Landivar, Jose. Discussion with the author. 5 February 2006.
[27] Mischkot, Philip. Discussion with the author. 2005.

Tip-of-the-iceberg Analysis

"Tip-of-the-iceberg analysis" is a term first encountered by the author while employed as a software developer at TenFold Corporation. Use of this term is apparently not widespread, as a Google search[28] yields only 218 results, most of which are not related to the meaning intended here. We will attempt to describe this analysis technique here, and acknowledge that the version described here may differ from the intent of whoever originally coined the phrase.

Tip-of-the-iceberg analysis is similar to root cause analysis, and is often performed at the same time as root cause analysis. Indeed, TenFold's Support webpage[29] mentions it right on the heels of root cause analysis when discussing the company's incident resolution procedures. However, whereas root cause analysis asks, "why did this problem occur" with an emphasis on depth, tip-of-the-iceberg analysis asks, "where else might this problem occur or be occurring" with an emphasis on breadth. The analysis is so named because the problem currently being solved may just be the first observed instance of an "iceberg" of similar problems.

The team used this analysis technique briefly during its root cause analysis. For example, on the issue of trust: people ship by air because they think it is physically safer than ground, parts chasers request expedites on parts that have not moved because they think inspectors are loafing; where else might we be spending money because one group does not trust another? One proposed answer is that a parts chaser expedites when he needs a part on a certain day corresponding to the historical average cycle time and does not trust IQC to process the part in that amount of time. This is certainly justifiable, as the average cycle time is inherently less than the upper bound; however, sometimes such an expedite request will result in unnecessary spend—the part would have made it through on time even without expediting. (Why people assume that an organization is not doing its job when something takes longer than the average is a completely different matter...)

[28] Google. "tip of the iceberg analysis." 28 February 2006. <http://www.google.com/search?hl=en&q=%22tip+of+the+iceberg+analysis%22>.
[29] TenFold Corporation. "TenFold Support." 28 February 2006. <http://www.10fold.com/support.php>.

Setting the Vision

Having now established that there was $300K to be saved, and having some idea of the nature of the problem, the team was equipped to return to Visualize, the first step in R6Sigma. In addition to the $300K, the expedite dollarization had also given us a "burning platform"—there was a lot of money being left on the table that the company could get excited about taking back.

The Visualize step of R6Sigma is to "*Create* a vision of the future with a clear and pressing need for change."[30]: The burning platform was the need for change; now the process suggested that the team needed a vision—a utopia state—slightly better than "reduce expedite requests"; if nothing else, the team had to specify that "good" expedite requests should not be reduced. Also, as the first project really exploring this issue, we had a blank slate on which to draw our blue sky.

The team used the method of Brainstorming followed by Affinity Diagrams, two R6Sigma tools with which the team members were very familiar. Appendix S contains a picture of the completed Affinity Diagram. This was followed by an email discussion over content and phrasing, and ratification at the next team meeting. The following was the vision statement the team put forth:

- A documented process lets us distinguish between value-added and non-value-added expedites.
    - Data-driven metrics around value-added expedites alert us to opportunities to add more value by improving our processes.
    - Data-driven metrics around non-value-added expedites alert us to opportunities to minimize such expedites and save/avoid cost.
- Once process changes have been implemented, data-driven metrics let us verify the effectiveness of the process changes as well as alerting us to new improvement opportunities.

This vision was deemed by the Six-Sigma coach as far too lofty to accomplish in the five months remaining on the project. It also did not promise any return for the effort. So, under the vision statement, we declared a goal:

- To save/avoid cost or add value equivalent to $300,000 over the next three years

The team would attack the $300K target, keeping in mind that whatever it did should move the company closer to the state described in the vision statement.

[30] "Raytheon Six Sigma Specialist Training: 'Engineering One Day with DFSS': Participant Guide." Version 101204. McKinney, TX: Raytheon, 2003: slides 43-48.

Addressing the Problem – "Characterize" and "Improve"

With a vision and a goal in place, the LFM intern opened up the floor for ideas on how to reach the goal (i.e., achieve the $300K impact). What emerged from the discussion was a three-pronged approach along the lines of Sourcing, Warehousing/I&T, and data collection. The R6Sigma steps of Characterize and Improve involve understanding the "opportunities for improvement" within the current state, designing improvements to the current state, and implementing those improvements. This section discusses the initiatives the project team undertook. In addition, several other simultaneous R6Sigma projects also served to decrease expediting—as R6Sigma accounting goes, these projects also counted toward our cost impact.

Sourcing

The buyer survey, still our only information on Sourcing expedites, suggested that there was a lot of money lost in expedite fees and in expedite-related Sourcing labor. Our approach on this front was to convert any expedited parts we could to SMI. Since the supplier rather than Raytheon is responsible for making sure that SMI parts are in stock, this reduces the time buyers spend expediting, and the amount of in-house parts chasing that parts chasers do making up for late supply shipments. It also reduces the number of POs that buyers must cut, a further labor savings. Seventeen part numbers were identified as being eligible for SMI candidacy and recommended to the SMI conversion team. A large number of other part numbers would be eligible if they had a different inspection code, and Inspection & Test manager expressed his intent to review their inspection requirements and quality history in 2006.

Another opportunity for improvement was in reducing the time between Sales Order Entry and RP placement. A Sourcing manager estimated the current state at ninety days, and proposed that every day reduced here gave the people downstream an extra day to accomplish their tasks.[31] The low-hanging fruit was that obtaining a list of Master Planners would reduce time in the upstream process by an estimated one day.[32]

Warehousing and I&T

Every Saturday at McKinney, at least one employee from Receiving and one inspector come in to cover Saturday expedites. This occurs even if no one has requested a Saturday expedite, because the programs have come to expect this Saturday service. Both the Receiver and the inspector typically collect overtime pay for their Saturday attendance that Raytheon would not have to pay if there were no Saturday coverage. The time spent handling expedite-related material on a Saturday is small relative to the amount of time spent at the plant, and while the employees do not loaf during the rest of the time, neither are they doing work that could not be done during the regular work week.

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[31] Cottier, Terry. Comment in meeting with Expedite RCCA Team representatives. 2 September 2005.
[32] Rench, Rebecca. Comment in Sourcing Subteam meeting. 15 September 2005.

The proposed approach to this issue was that perhaps only one individual ought to come in each Saturday, thus requiring that only one person be paid overtime. This could be achieved if either Receiving or I&T or both cross-trained a few members of the other organization to do the other task. Such cross-training would also facilitate the loaning of resources between the organizations if one group became swamped during the course of normal operations. MRA also got involved in the discussion, because one of its employees was qualified as an inspector and was already a part of the Saturday inspector rotation. The managers of all three groups sat on the project team, so understanding of the purpose was not an issue. One of the managers was, however, noticeably dragging his feet—apparently this had been tried before without much success.

The team overcame several roadblocks. The largest was figuring out how an employee would charge his time while doing another department's task. The team also had to determine what training was needed to qualify a Receiver to inspect, and vice versa. Third, each manager had to develop a list of people to undergo the cross-training; first, some of the Raytheon paperwork was very specific in which individuals could perform which tasks, and second, the managers wanted to ensure that they were getting high-quality employees from the others—for a brief period each Saturday, a department's reputation would be placed in the hands of someone from the another department.

Due to a number of factors, the cross-training initiative never got past the planning phase. This was fortunate, because an unrelated set of circumstances led both Warehousing and I&T to consider a redefinition of work schedules such that Saturday became a regular work day for some employees. This was an idea that the project team briefly raised, then killed because it would upset too many people in Receiving and I&T. However, it is even more cost effective than the cross-training option, as it incurs no additional training cost and pays no one overtime whereas the cross-training idea still paid overtime to one person. A discussion with the I&T manager after the project's conclusion confirmed that this is indeed the direction that I&T is taking.[33]

A second opportunity for improvement was to change the dispatching method used in I&T. I&T operates on a FIFO process, as do many of the operations at Raytheon. According to Blackstone, FIFO tardiness performance is roughly equivalent to random selection.[34] The idea was to choose an alternative dispatching process so that fewer parts would be tardy in their arrival to the line. The alternative we arrived at is a modified slack-time process. The next section covers in detail the design, implementation, and development of the process in I&T.

Data Collection

The efforts of expedite dollarization and root cause analysis revealed the following opportunities for improvement in Raytheon's expedite-related data collection:

- Nobody tracks how much labor is spent on Sourcing expedites.

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[33] Tevis, Robert. Discussion with the author. February 2006.

[34] Blackstone, John H., Jr. Capacity Management. Mason, OH: South-Western College Publishing, 1989: 157.

- Data on the amount we spend in Expedite Fees is captured but not in a format that can be looked up.
- The web app does not include some fields necessary for effective root cause analysis.
- Expediters do not always use the web app, so analysis of the web app data does not see the entire picture.

It was proposed by a Sourcing manager that a process for tracking labor on Sourcing expedites might be as simple as every buyer having a piece of paper on which they could write down, "Today so-and-so expedited me three times."[35] Other ideas included creating separate charge numbers for expedite-related activities and enhancing the web app to facilitate (and track) requests for Sourcing expedites. Ultimately, the team decided to put this initiative on hold; any change would result in additional work for buyers in the short term in exchange for potential medium-term improvements, a tradeoff that the team felt buyers would be loathe to go along with given the morale and staffing situation at the time. It remains an open item that a future R6Sigma team can pick up once the SCT has moved on and buyer morale and workload are back to normal.

It was initially thought that there was no IT system keeping track of expedite fees; however, the second Sourcing representative to join the team was aware of a way to get these data from the mainframe. The team worked with an employee from CSC on a report that pulled this information. Early versions of the report pulled back more records than necessary, and not enough information about each record; however, at the close of the project the team had received approval from Sourcing management to finish the report, and had identified the fields that would be useful in helping Sourcing to monitor and understand its expedite fee spend.

In analyzing the web app data at the beginning of the project, the LFM intern realized that certain information was missing that might prove useful in doing root cause analysis. The web app never asked a parts chaser why a part was being expedited, so unless the parts chaser voluntarily provided information in a free-text field, there was no way to distinguish between, for example, a request with a root cause in poor planning and a request that resulted from a freak breakage on the line. Also, the web app had no knowledge of which program was filing the expedite request, making it difficult to determine which programs contributed most to the expedite situation (and thus ought to be made part of the solution). These shortfalls in the web app were certainly understandable; the web app was designed to facilitate standardized communication between parts chasers and SCM personnel, not to support decision making about how to reduce non-value-adding expedite requests. The team added two quick questions to the web app:

- (Multiple choice) Why is this part being expedited?
- What GLA is the part for? (GLA is a four-character alphanumeric code that, with some difficulty, rolls up to the program level.)

Most parts chasers would be able to answer the two questions in seconds, but the data collected during those seconds would replace hours of interviews and enable interested parties to see where the opportunities for improvement lay. Appendix T shows one example of using these data. In September 2005, a large percentage of expedite requests were for parts used in engineering evaluation or prototyping. In October, the modified slack-time dispatching method

[35] Cottier, Terry. Comment in meeting with Expedite RCCA Team representatives. 2 September 2005.

was rolled out to both McKinney and Expressway IQC, with engineering materials receiving a special place in the queue. As the graph in Appendix T shows, from October through December, prototyping/engineering is no longer the largest cause of expedite requests, suggesting that the new dispatching method made a positive impact on this issue. It is hoped that these data will prove equally useful in suggesting and evaluating other process improvements.

It should be noted that, in addition to gathering data, asking "Why is this part being expedited?" in multiple-choice format served several strategic purposes. First, by not providing "Because we need the part" as a possible answer, and instead providing options such as "Already inside lead time when asked to order," the web app forces parts chasers to begin thinking about the root causes behind their expedite requests. Second, it was hoped that asking the question would cut down on frivolous expedite requests—employees with moral convictions against lying (which one hopes is the majority of Raytheon employees) would have difficulty requesting expedites without a good reason, but no qualms about asking for expedites they needed.

Finally, we addressed the issue of not all parts chasers using the web app to request expedites. This was accomplished by the Receiving manager at McKinney and the Warehouse manager at Expressway asking Chris Jones and other gatekeepers of the expedite process to ask anyone who dropped by with or phoned in an expedite request to kindly use the web app while their request was processed. At Expressway, this was facilitated by a computer terminal less than ten feet from the customer service window. A corresponding computer terminal at McKinney was slightly farther—39 paces by the LFM intern's count—but parts chasers were already familiar with being sent to it for MTraking purposes. Expressway was the first to institute such a policy sometime during the first full week in September; the McKinney Receiving manager had implemented the same policy by the time the modified slack-time process went live in McKinney IQC in late October.

Other Projects

Three other projects were deemed by the R6Sigma coach as being related to this project from an impact-accounting standpoint. The "On Demand" Document Management project sought to manage various documents, including supplier documentation, electronically. This would reduce the number of NCMRs written because of bad or missing supplier paperwork. This in turn would reduce expedite requests resulting from material sitting in MRA for extended periods until someone finally realized that they needed it on the line. The "On Demand" Document Management project was entering its pilot phase at the time the Expedite RCCA project ended.

The Point-to-Point pilot project was an attempt to create a new process that took certain supplied materials straight from the McKinney dock to a production line. This effectively gave an expedite level of service to such parts, and would eliminate the need for the program to request expedites every time these "hand-to-mouth" parts arrived at the dock. The project was led by a Sourcing manager, and was put on hold in light of the Sourcing staffing situation and the Sourcing manager's being tapped for the SCT.

Finally, the FAL-to-SFDM project was an effort to get the Failure Analysis Laboratory (FAL) to use the SFDM system. This eliminated the need for QCs to write up RFTAs for items being sent to FAL, resulting in significant cycle time and WIP reductions for certain material. While the cycle time reductions probably reduce expedite requests, the main reason for the FAL-to-SFDM project's association with the Expedite RCCA project is that the FAL-to-SFDM project was the outgrowth of one individual looking at data generated by the Expedite RCCA effort and asking, "I wonder why my team files so many expedite requests?"

Designing and Implementing a Modified Slack-time System

This section is a case study of one of the project initiatives: implementing a modified slack-time process in the Inspection & Test organization (see Appendix B for an organizational chart of I&T). We hope bring to light some of the challenges and successes ahead of an organization seeking to do a similar implementation in a comparable environment. We make some suggestions as to what the future state of this process might look like. Finally, we close with a discussion of some of the implications of this system.

Background on the Pre-existing Dispatching Method

According to a 40-year TI/Raytheon veteran, Incoming Inspection had operated on a FIFO dispatching method for at least 30 years.[36] Warehousing, Pack-Ship, and the laboratories to which Inspection & Test often sent work also initially claimed to process work via a FIFO dispatching method.[37] However, further questioning typically revealed that these operations actually operated on a "FIFO with exceptions" method. Some of the reasons that exceptions would be made include:

- Expedite requests (or, in the case of Pack-Ship, whiteboards) – There were usually ways for customers to request that items be moved to the front of the line.
- Easy/fast items – A single item requiring minimal processing time might be worked in advance of items that had arrived sooner, but would take much longer to complete. There are several possible reasons for this:
    - Cycle time improvement – Processing the fast item immediately removes it from the queue, as opposed to letting it sit in the queue accumulating cycle time while we process slower items. This saves cycle time for the operation. Note, however, that this reduction in cycle time does not save Raytheon money—inventory moved more quickly out of one operation will only sit in front of the next operation waiting to be processed. Also, the lower cycle time does not imply more productivity; 1 hours of work is still one hour of work, whether one spends it on one 1-hour task (high cycle time) or twelve 5-minute tasks (lower cycle time).
    - Personal metric improvement – For example, Incoming Inspection keeps track of the number of lots that a QC processes each day. While not formally a part of an individual's metrics or compensation scheme, some QCs might perceive that processing larger numbers of lots makes one a more valued employee. Since the difficulty of each lot is not currently tracked, working the easy lots is a way of raising your numbers vis-à-vis employees who work the harder lots.
- Resource constraints – Some individuals are not qualified or able to perform certain tasks, and might thus have to skip over the next item in the queue. Conversely, work might be pulled out of the queue and set aside for these individuals so that they would be assured of having things to work on.

[36] Raml, Alice. Discussion with the author. 2005.
[37] Various Raytheon employees. Discussion with Leta Stanley or the author. 2005.

- (We anticipated that batching of like work would be another reason, however it was not a factor in the operations we observed.)

Part of the FIFO culture at Raytheon probably had its roots in the contracts that the company had made with the government, specifying that parts pulled out of stock had to be pulled in the order they reached stock. In other words, if there were five of a particular widget in stock, and a manufacturing group needed to consume one, the group was contractually obligated to consume the one that had arrived in stock first. By extension, the kitting operation that pulled the widget from stock had no choice over which of the five widgets it would kit.

However, while there were contractual agreements regarding the order in which parts were pulled from stock, there was generally no mandate saying that parts had to reach stock in the same order they arrived at the dock. Thus, we saw that a non-FIFO dispatching method might be reasonably implemented in any operation prior to kitting.

(Depending on the wording of the contract, there may also be non-FIFO dispatching opportunities after stock. For example, if there are two different types of widgets that both need to be pulled, the contract may not specify that type A must be pulled before type B. However, to reduce confusion over where FIFO did or did not apply, we constrained our efforts to the pre-stock operations.)

Motivation for an Alternative Dispatching System in I&T

Several factors motivated the search for an alternative dispatching system I&T. First, it was one of the only courses of action directly addressing expedite requests that survived discussion in the team meetings. For example, the following two options were also considered but rejected:

- **Pure FIFO with no processing of expedite requests** – This option inherits the current FIFO processes already in place at Raytheon. By ignoring expedite requests, SCM ensures that its processes and people are never interrupted, and thus saves the cost of the interruption. Also, parts chasers will cease to labor at requesting expedites, because the parts chasers know that their requests will fall on deaf ears.

  However, while there might be some benefits to such a system, the cost of this policy is great. For example, a line may be shut down for several extra days while waiting for the part that will bring the line back up. Since at Raytheon the cost of a downed line often outweighs the cost of expediting, this is probably not the right approach.

- **Charging an internal expedite fee** – This suggestion encompasses two ideas: that there is a cost associated with expediting, and that a service has value if someone is willing to pay for it. By passing on to the programs the cost of expediting, SCM makes programs more aware of the idea that expediting is not free for the company. This would reduce the quantity of frivolous expedite requests. It would also let SCM charge less for its shared services to programs that do less expediting, and more to the programs that do more expediting.

There are several difficulties with this system. First, it would involve a complete redesign of the way SCM charges programs for shared services. Second, the cost of expediting is so low compared with the cost of being late that there might actually be an increase in the number of expedite requests. Third, once SCM begins charging expedite fees, programs will demand a certain level of service for their money. Fourth, since there is now a financial penalty for filing expedite requests, there will be a rise in the number of "underground" expedite requests. Underground expedite requests are undesirable because they cannot be tracked by the web app, and thus Raytheon will be unable to determine the full number of expedite requests being processed. These difficulties made the idea of charging internal expedite fees unattractive.

Second, the project team had determined by this time that fear of a part being late for a kit pull was the primary reason for expedite requests. Several sources, including Blackstone's statement that FIFO has "a tardiness performance comparable to that achieved by random selection,"[38] and the following table emailed from the I&T manager to several of his employees suggested that there were options other than FIFO that performed better on a tardiness metric:[39]

	CT	Tardiness	Inventory in Work
First In First Out / First Come First Served	High	High	High
Shortest Processing Time	Low	Avg	Low
Earliest Due Date	High	Low	High

Third, it was realized via a thought experiment that the size of a queue was not inherently responsible for expedite requests. A queue could be as short as two items, but if someone needs the item at the back of the line, he will file an expedite request to move it to the front of the queue. Alternatively, a queue could be hundreds of items long, but if no one has a pressing need for any of the items, then no expedite requests will be made. This convinced some members of the team that better ordering of items in a queue could reduce expedite requests even if the queue length never improved. This belief was reinforced by the realization that expedite requests were the parts chasers' only means of reordering a queue they perceived to be out of order.

Fourth, the project team came to accept the idea, expressed most forcefully by Chris Jones but echoed by some program representatives, that expedite requests are never going to go away.[40] Or, phrased another way, that the supply chain will always have hiccups that need to be compensated for. Indeed, this is what Simchi-Levi et al suggest: "Uncertainty is inherent in every supply chain; customer demand can never be forecast exactly, travel times will never be certain, and machines and vehicles will break down. Supply chains need to be designed to eliminate as much uncertainty as possible and to deal effectively with the uncertainty that remains."[41] Pure FIFO does not permit for such compensation—a part that arrives behind schedule will forever be behind schedule, unless everything in front of it happens to go faster than expected. However, dispatching methods that include due dates in their prioritization scheme have some

[38] Blackstone, John H., Jr. Capacity Management. Mason, OH: South-Western College Publishing, 1989: 157.
[39] Tevis, Robert. Email to the author and others. 11 July 2005.
[40] Brown, David, and Steve Jonse. Discussion with the author. October 18, 2005.
[41] Simchi-Levi, David, Philip Kaminsky, and Edith Simchi-Levi. Designing and Managing the Supply Chain. 2nd ed., rev. Chicago: McGraw-Hill/Irwin, 2003: 3.

compensation built in—a part that arrives behind schedule but is not yet late skips toward the front of the queue, possibly finding a place in the queue where it can be on time.

Fifth, the IQC staff at McKinney had just implemented some process changes, brought over by the Expressway QC supervisor after being successfully implemented in her operation, which would enable changing the dispatching method. At the time the project began, a McKinney QC looking for his next task would each pick up whichever boxes he wanted off the shelf, print the respective SFDM routers, and begin inspecting. However, by early July, McKinney IQC had switched to a process in which a single QC (the assignment rotated each month) was responsible for printing all SFDM routers for all lots. He would also write the Receipt date on the exterior of the box with a fat black permanent marker so that everyone could see on what date the box had been Received. Other QCs were required to work FIFO according to the date written on the box. By simply changing what the QC wrote on the box—perhaps to a priority code or a due date—one could order the work any way one desired. (The project team was only interested in changing the McKinney IQC process because the dollar impact was greater at McKinney than would be a similar change at Expressway, and because most of the team sat in McKinney, making implementation easier. However, the I&T manager desired that both QC groups operate on the same process, opening up Expressway as a potential pilot site.)

Finally, regardless of the Expedite RCCA effort, there was a pull from the I&T manager to try changing the dispatching process in his, if not all, organizations. Pulled change was much easier to work with than pushed change, and this pull happened to be aligned with a proposed objective of the project. It was fortunate that the pull came from this particular manager; Receiving, for example, was not in a position to do anything but FIFO, since in many cases processing times and due dates are not known until one Receives the box and figures out what is inside.

Defining the New Dispatching Method

Nailing down the right dispatching method proved to be more challenging than making the case for it. We started our investigation looking at earliest due date, then earliest operational due date. Eventually, we realized that a number of assumptions we had made when considering earliest operational due date resulted in a system that could be more accurately described as a slack-time process.

Further discussion led to the discovery that a pure slack time system was probably not the right answer—parts arriving many months early would have a lot of slack and thus sit on a shelf in IQC for many months waiting for their first operations. IQC management realized the humanity of its organization—specifically, the ability to lose things that sit on shelves for long periods of time—and suggested that a part should sit for no more than five to ten days before its first operation.

The author notes that managers with purely metrics-driven mentalities would have attempted to force the project down the path of Shortest Processing Time (SPT), because it promises the best cycle time performance. That they did not do this suggests that they are motivated by things beyond their metrics radar. Similar evidence exists in the fact that we worked on this project at

all; as previously mentioned, the Warehousing and I&T organizations had few metrics related to customer satisfaction, and none related to expedite-related spend or being on time.

The following paragraphs attempt to give some insight into how we arrived at and explained slack-time as our dispatching method of choice. Most of the process development and refining involved two- or three-persons holding impromptu discussions and thought experiments. Many of the better examples involve grade school—grade school is a universal experience in the plant, whereas inspecting lots is an experience specific to Inspection & Test. In addition, in the event that an employee had children or grandchildren currently in grade school, the example would be all the more poignant.

School as a Counterexample to FIFO

One such discussion and thought experiment while three persons were eating lunch together in the cafeteria. The thought experiment considered a hypothetical student about to take midterms, and went something like this: The history exam was scheduled for Wednesday and the math exam was scheduled for Friday. As one diner pointed out, all else equal, the student studies for the exams in the order he will take them: "You don't study math first just because you went to [math] class on Monday."[42] This thought experiment demonstrated that we, in our personal lives, do not blindly apply FIFO to all circumstances.

School Illustrating That There Are Smarter Ways to Order Work

A second such thought experiment also involved school. This time, there are three hypothetical students beginning a term. On Monday morning, they all attend history class and are assigned term papers, due at the end of the term, which will take 40 hours to complete. On Monday afternoon, they attend math class and receive a syllabus outlining one hour's worth of homework due each day for the rest of the semester.

The first student chooses to apply FIFO, taking F's on every math assignment until the term paper is complete. The second student spends one hour each night doing the next day's math homework, and three hours each night working on the term paper. The third student works on all the math homework at the beginning of the term, doing four math assignments each night, then uses the rest of the term to complete the paper. (Incidentally, this student also generates better cycle time performance than does student #2.)

This example exhibits several points. First, the second and third students provide on-time performance that the first student (FIFO) cannot possibly match—the history paper just takes too long. Second, the difference in cycle times does not necessarily imply that any student is lazier. Both the second and third students work four hours per day—the second student's approach just happens to provide better cycle time performance. And both of these students probably work less feverishly at the beginning of the term than the first student, who is trying to get the term paper

[42] Tevis, Robert. Discussion with the author. 2005.

out of the way as soon as possible so that he can begin catching up on all of the math homework that he has not yet started. Third, comparing the second and third students gives evidence that SPT provides the best cycle time performance for a given amount of work (but this point was not emphasized as the goal was improved on-time delivery and not improved cycle times).

People at an Airport Illustrating the Different Dispatching Methods

A final thought experiment illustrates the various dispatching methods through an example to which many people might be able to relate. The example is people arriving at an airport at different times and trying to catch flights departing at different times. One potential drawback to this thought experiment is that those Raytheon employees who are not seasoned travelers will have to use more imagination than those who are. However, we choose the airport scenario over, for example, a grocery store scenario, for several reasons:

- The cost of missing a flight and having to purchase another ticket (or, alternatively, not travel) is significant, as is the cost of missing a kit pull date. The cost of not getting through the grocery line expediently is harder to describe.
- The fear of missing flights causes some individuals to arrive at airports very early, incurring opportunity costs. Likewise, the fear of missing a kit pull date causes some programs to bring in some materials very early, incurring inventory carrying costs. Except for large sales and very important engagements, the same behavior is not typical of grocery shopping.
- One must go through several queues at airports (agricultural inspection, ticketing, security, etc.). Lots also must go through multiple queues before they reach stock. In contrast, checkout is the only queue one typically encounters at a grocery store.
- Certain delays in an airport, for example the random screening in security, are uncommon but expected as part of life. Likewise, certain delays in the plant, such as receiving parts with poor quality, are also uncommon but expected as part of life. In contrast, people tend to view delays for price checks as flaws in the store's internal operations.

We begin the thought experiment by assuming that the airport uses pure FIFO queues, and that each passenger cares nothing about the interests of the others. People who arrive at the airport well ahead of their flight have nothing to fear. People who arrive just in time bite their nails until they actually make their flight. People who arrive late—be it their fault, another party's fault, or a freak accident—miss their flights and pay the associated penalties.

We next consider an airport that operates on a "FIFO with expedites" policy and passengers that again care nothing about each other's interests. Such an airport employs an individual who, at the request of any individual passenger, personally takes that passenger to the head of each line (first agricultural inspection, then ticketing, then security), no questions asked. We apply the same process to all requesters; even if a late passenger could make his flight by bypassing just one of the three queues, he gets the full treatment anyway. Of course, all the late passengers take advantage of this service so that they make their flights. This line jumping makes the formerly just-in-time passengers now not-quite-in-time, so they too need to use the service. Only the early passengers do not need to take advantage of the service, although some will anyway just because they do not like the idea that someone arriving after them will get to go first, or would rather wait

at the gate for 2 hours than spend the same 2 hours waiting in queues. This is the closest description of the expediting process at Raytheon at the beginning of this project.

Finally, consider the case of an airport that uses a "FIFO with expedites" policy, but where every passenger in the airport is a close family member operating on shared finances. When Uncle Ted shows up thirty minutes later than he should have, nobody insists that Uncle Ted remain at the back of the line, because if he misses his flight, then he—and thus the entire family—will have to pay for a new ticket. Rather, everyone in the agricultural inspection line insists that Uncle Ted go ahead, until he is right behind Uncle Hank who is one hour late. Let us say this saves Uncle Ted twenty minutes. Once they get through agriculture, Uncles Hank and Ted move to the ticketing queue, where the family again ushers them ahead of everyone who has time to spare. Let us say that this saves Uncle Ted another twenty minutes. Once they receive their tickets, Uncles Hank and Ted head to security. The family has already saved Uncle Ted forty minutes—he is now ten minutes ahead of schedule!—and can comfortably take a spot toward the back of the queue. Uncle Hank, however, is still behind schedule, and the family hustles him toward the front of the line in hopes that he makes his flight.

This third scenario exhibits several points. First, when everybody incurs the cost of one person being late, everybody tries to ensure that everyone is on time. Second, neither Uncle Ted nor Uncle Hank had to involve the expediter; the airport is free to reassign him to another task—perhaps assisting with whatever queue happens to be the bottleneck. Third, considering due dates and expected wait times let the family see that Uncle Ted should go ahead of many people, but not ahead of Uncle Hank. Fourth, simply by looking at due dates and expected wait times, the family could see that Uncle Ted did not need to bypass the security queue. Fifth, any family member caught trying to cheat the system (or alternatively, not letting the two tardy uncles cut in line) would have been disciplined by the rest of the family if either late uncle missed his flight. Finally, and perhaps most important, if a late uncle attempted to impose social justice on himself, saying "it's my fault that I showed up late; I'll just take my place at the back of the line, and I'll (we'll) pay for another flight when I inevitably miss the original," the entire family would rush him to the front of the line, then rebuke him for being both late and wasteful.

Piloting in GDT

By early September, the team members involved in this effort had a very good idea of what the new dispatching system, if implemented, would be: a slack-time system with some sort of accommodation for parts that had arrived significantly early. At the time, the team thought that the key stumbling block was the inability to stage material in the proper order in the McKinney IQC area. However, while they were wrestling with this problem, the MRA manager mentioned that he had just walked through the GDT area and thought that it would be an excellent location for a pilot. The team had been debating the idea of piloting in Expressway IQC—problematic because most of the team members involved worked in McKinney. GDT, on the other hand, was in McKinney. It also received only a fraction of McKinney's inspection workflow; accidentally gumming it up would be less disastrous than accidentally gumming up an Expressway IQC operation that processed all of Expressway's inspection workflow.

"When You Get the Keys to the Bus..."

Discussion with the I&T manager about possibly piloting in GDT eventually produced the following remark: "I'm looking for someone to shake things up a bit."[43] Up until now, the LFM intern especially had been very careful about getting buy-in from multiple stakeholders, not coming in with all the answers, and generally having "a lower key approach"[44] that avoided putting people off. This was so much the case that, when rolling out the web app modifications, the I&T manager eventually told the LFM intern to just "pull the trigger" instead of first getting buy-in from six different managers in the plant. However, this was different. Here was authorization from a manager in a hierarchical organization to pilot the new dispatching process with his employees.

Raytheon CEO William Swanson wrote a booklet titled, *Swanson's Unwritten Rules of Management* containing one management gem for each year he had been at Raytheon. However, in a subsequent interview, he states that one of the rules he might have included had there been a 34th rule might be: "When in charge, be in charge. I've noticed that new managers will be hesitant to be in charge. When you get the keys to the bus, it's time to drive."[45]

And drive we did. We received the go-ahead from the Inspection & Test manager on a Monday at around 11:00am, took lunch, had a meeting with the GDT personnel at 1:00pm asking them to try the new process, and had completed all the prep work for the new process by 7:30pm that evening.

You Learn a Lot by Teaching

The LFM intern and the I&T Support person were the ones who introduced the new process; they were the ones who would be helping GDT to scratch out the dates that IQC was writing dates on the boxes and replacing them with new dates, written with a red marker (IQC used black markers). After much stumbling over terms—there were three dates involved in the calculation—the new date to be written on a box was called a "GDT 'Start By' Date"; according to the lead times loaded in the MRP system, this was the last date on which GDT could start inspecting a lot and still expect all subsequent processes to get the part to stock on time. Thus, whichever lots had the earliest Start By date inherently had the least slack—these lots would now be processed first.

(The term "GDT 'Start By' Date" was something of a misnomer. The planning factor termed "Move" was a dock-to-stock lead time; for ease of calculating the GDT "Start By" Date, which for now had to be done manually, we used MRP REQD DATE (i.e., the "Due Date") minus Move. So, in reality, the date printed on the box was the last date on which the lot could be

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[43] Tevis, Robert. Discussion with the author. 12 September 2005.
[44] Klein, Janice A. True Change: How Outsiders on the inside Get Things Done in Organizations. San Francisco: Jossey-Bass, 2004: chapter 6.
[45] USATODAY.com. "USATODAY.com – Raytheon CEO turns lessons learned into hit booklet." USA TODAY. 18 December 2005. 16 March 2006. <http://www.usatoday.com/money/companies/management/2005-12-18-raytheon-advice_x.htm>.

Received in order to reach stock on time—a "Receiving 'Start By' Date" if there was going to be such a thing. Someone really interested in when GDT had to start work on a lot could figure it out by remembering that it took about two days get from Receiving to GDT. However, after explaining this to GDT, it appeared that they were happy to ignore this detail—an attitude similar to what we later observed with the McKinney QCs. The important thing was, as long as all the parts were offset by the same number of days, all parts would be worked in the correct order. The managers and supervisors, who paid somewhat more attention to this calculation, could set their teams' goals as "stay one day ahead" or "don't fall more than one day behind" according to how far ahead or behind they wanted to be. Calling the date on the box the "GDT 'Start By' Date" might thus be an extension of the KISS principle or akin to the idea of teaching beginning physics students that F=ma, then telling them once they become more advanced that Newton got it slightly wrong.)

The LFM intern learned a number of things in the 24-hour period that followed the meeting as he and the I&T Support person tried to address GDT's concerns and get the boxes dated for the following day. In fact, this was the only day in which so many lessons were learned that he decided to write them down. Most of them fall into the category of Murphy's Law:

- Want to publicize this as a pilot/experiment, because this is our first time trying it and things will go wrong along the way.
- MRP Required Dates are only Fridays (Wednesdays on Thanksgiving weekend). Why no one realized this until today, I don't know. Why this is, I also don't know. If I had done sufficient homework, I would have known. Lesson: looking at RTDs individually (even 11 of them) doesn't tell you about an all-Friday pattern [unless you know what you are looking for].
- When we subtract the Move number, we have to subtract working days rather than calendar days. [We] should have thought about this before publishing the basic process.
- Too many 99/99/99's. However, if we had investigated in the most efficient way possible, [GDT] would have learned this first, as opposed to me learning it first.
- Many people think the MRP Required Dates are wrong. But [the SAS Director of Texas Supply Chain Management Operations] says to assume that they are right. And for now, that's the best we can do.
- There is currently no process by which I&T can revise Move dates. [The I&T manager] says that, when he tries to get them fixed, the pushback is that he shouldn't care because he doesn't use them anyway.

("99/99/99s" were sometimes printing in the MRP REQD DATE field on the RTD—see Appendix I for an example. The investigation into why this occurred will be discussed later. However, prior to the GDT pilot, the estimate from Warehousing was that about 10% of the lots printed with 99/99/99s. What was encountered in GDT was closer to 50%.)

Continuous Improvement

As the pilot went on, the LFM intern and the I&T Support person refined their process for calculating Start By dates. The refinement continued as the process rolled out to Expressway IQC and McKinney IQC. Appendix U shows one of the early processes used, Appendix V shows the final process, and Appendix W gives the thought process behind the final process. The final

process is simpler for a number of reasons. First, the I&T Support person was asked to date many boxes each day at McKinney, so simplifying assumptions were made to reduce the time she would have to spend on this task. Second, McKinney IQC wanted its QCs to learn to date boxes so that the lone I&T Support person would not become a bottleneck, so we simplified the process—sometimes at a small cost to its effectiveness—to make it easier to learn.. Third, people learned the lower level processes well enough that they could be abstracted—"Use ACQ" now replaced "Go to Operations Data Warehouse logon page. Log on with Directory Services employee number. Click 'Acquisition System' (ACQ). Enter Requisition Number from RTD. Click 'Search' button. Locate 'Proc Code' (Procurement Code)." Finally, we learned that some of the details we originally paid attention to were unnecessary for making the correct calculation.

Seeing and Selling the Benefits Early

The new dispatching process had its unbelievers, both within and outside the team. Thus, it was important for proponents of the process to get a few wins early, before the naysayers took advantage of any losses.

The New Process Almost Averts an Expedite Request

Shortly after the new process was introduced, GDT began redating its preexisting queue of boxes, scratching out the Receipt date and writing the Start By date instead. One of the inspectors saw that there was a part that should have been started back in July (it was now the middle of September) and set to work on it. Just as he was finishing up, Chris Jones walked in prepared to put an "Expedite" sticker on the box—evidence that the new process had inspectors working on lots in the order customers needed them worked. This story was shared with the project team as the first success. It was also shared with the inspector himself, just in case he missed the significance of what took place.

(It could also be argued, and in another circle it was, that this was just a lucky coincidence. In fact, the single occurrence was probably not statistically significant. However, the process proponents claimed what looked like a win—opponents were free to find other evidence to prove them wrong.)

(It has also not escaped notice that, had the inspector begun this work a short time earlier, the part might have reached Make Ready without anyone filing an expedite request, and the win would never have been observed. Likewise, if the inspector had begun dating the boxes a short time later, Chris Jones' "Expedite" sticker might have caused the box to be inspected and whisked away before anyone could figure out what the Start By date should have been. If luck was involved, the process proponents certainly got some at an opportune time.)

There Is a "Lift" When People Realize That Things Aren't Out Of Control

QMC, an area within GDT, historically had a large backlog of lots waiting to be inspected. However, with the Start By dates on the boxes, it was easy to see that many of the parts in the QMC queue actually had lots of slack time before they had to be on the line. The MRA manager voluntarily shared with the team that, in his opinion, one of the biggest effects of the new process was the "lift" that the QMC employees got from realizing that, despite the large backlog, they were actually on top of what their customers needed.[46] This was summarized in a draft of the meeting minutes in the following words: "Unexpected lift from project. Inspection & Test employees are now able to look at work load to determine what material is actually needed instead of just looking at the backlog. They can determine if they are working OT for a real reason."[47]

Dialog around Customer Needs

The I&T manager pointed out a third win from the new process. For the first time, a QMC employee who encountered him in the hall volunteered the fact that he would be working overtime that weekend because they were behind what their customers needed. This was, in the I&T manager's opinion, much more powerful than a dialog about working overtime because the backlog was large.[48]

Rolling Out To IQC

By early October, the process was refined enough that the team decided it was ready to take to Expressway IQC. The I&T manager was a driving force in this decision, so it surprised the LFM intern when the I&T manager suggested that the LFM intern, rather than the I&T manager, should sell the process to the Incoming Inspection manager, one of the I&T manager's direct reports.

The Incoming Inspection manager and the LFM intern had a thirty-minute discussion about the new process. The first ten minutes were rather heated—in the LFM intern's opinion, one of his least favorite conversations of the summer—involving whiteboard diagrams and discussions of who beat up on the Incoming Inspection manager regarding cycle time. The LFM intern is not quite sure what won the Incoming Inspection manager over, but the second half of the conversation was more cordial, and ended with the Incoming Inspection manager leading the LFM intern to the McKinney QC area to determine how they could stage material in the new process (a showstopper for McKinney at the time of the conversation).

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[46] Grove, Paul. Comment in Expedite RCCA meeting. 4 October 2005.
[47] Hunt, Connie. Expedite RCCA Meeting Minutes 10_04.doc. 6 October 2005.
[48] Tevis, Robert. Discussion with the author. 2005.

The Incoming Inspection manager, in turn, made the LFM intern sell the new process to his direct reports: the two IQC supervisors. The IQC supervisors expressed concern about their cycle time metric. A twenty-minute whiteboard discussion ensued, with the LFM intern demonstrating two examples. The first was that one could increase the number of tasks completed on-time without affecting either cycle time or the amount of labor involved. The second was that, if one really desired low cycle time, then SPT and not FIFO was the optimal dispatching method. The discussion was non-heated, and ended with the LFM intern and the Expressway supervisor making plans to roll the pilot into the Expressway IQC area.

(The LFM intern had realized early on that, of the two IQC supervisors, the Expressway IQC supervisor was the early adopter of new ideas. This fact and the relative volumes of the two operations were two reasons that it made far more sense to roll out first to Expressway and then to McKinney.)

The Expressway IQC rollout was unremarkable, except that it exposed new corner cases not covered by the existing process. It did, however, produce a discussion about whether the McKinney and Expressway IQC operations were apples and apples or apples and oranges. The I&T manager's opinion following the discussion was that the two operations were apples and apples,[49] leading the LFM intern to believe that it was acceptable to pilot the process just at Expressway and not McKinney, and extrapolate the Expressway results up to the larger McKinney site.

The reason for not rolling out the process to McKinney was concern that an enhancement to the mainframe software that would make the Start By date print automatically on each RTD would not be finished in time. (The RTD Enhancement is described in more detail later in this section.) Manual calculations of the Start By date consumed much time even for the tens of lots flowing daily into GDT and Expressway IQC. In contrast, McKinney IQC saw hundreds of lots come in on some days—this was deemed by the LFM intern as too much of a burden on the I&T Support person. In the LFM intern's opinion, it was more prudent to wait until the RTD enhancement was complete, and roll out to McKinney at that time.

The I&T manager disagreed. He wanted the modified slack-time dispatching system piloted in McKinney IQC for a full month prior to the project's completion, so that he would know before the project's end whether it would work.[50] (This was the original plan; the incomplete RTD enhancement was the only reason for proposing a deviation.) After ensuring that the I&T manager understood the opportunity cost of this course of action, the LFM intern approached the I&T Support person with the I&T manager's proposal. The I&T Support person reluctantly acknowledged her sentence and immediately excused herself for a break outside.

The two discussions above happened on a Thursday. On Friday, the LFM intern passed on the news to the IQC manager, and the two gentlemen together went to inform the McKinney IQC supervisor. These three gentlemen quickly called the QCs together and explained the new dispatching method right in the middle of the IQC workspace. References were made to the non-disastrous implementations in GDT and Expressway IQC, and emphasis was placed on the idea

[49] Tevis, Robert. Discussion with the author. 2005.
[50] Tevis, Robert. Discussion with the author. 20 October 2005.

that the only process difference would be what date was on the box. The LFM intern knew that the battle was basically won when one of the more vocal and change-resistant QCs commented, "No problem; it's just like what we were doing before."[51]

The extent of the McKinney QCs' concern with the new process was a single question about how the new process would affect cycle time, a concern that was satisfied with about 30 seconds of verbal assurances from the IQC manager and the LFM intern. Shortly afterward, the QCs readily agreed that the modified slack-time system made sense, and the discussion turned to their curiosity in how the I&T Support person would be deriving the magical new Start By date.

(The LFM intern discovered in his many discussions regarding the new dispatching process that "making sense" depended a lot on to whom one was talking. Persons outside Raytheon easily agreed that the modified slack-time system made sense, even if their own companies used different dispatching methods.[52] An R6Sigma expert whose job function was rather far removed from Warehousing and I&T was appalled that ICQ was using a FIFO dispatching method when, in her opinion, better methods were available.[53] One of the lead parts chasers in the Circuit Card Assembly (CCA) shop was originally skeptical, but later made the statement that, when he thought about it, the only thing he really cared about was being on time to kit-pull, and that after such thought he was not opposed to the new system.[54] A survey of Inspection & Test's stakeholders, receiving responses between October 25, 2005, and November 10, 2005, included the question "I&T currently uses FIFO to process lots through the inspection cycle. Would MRP due date better meet the needs of your production schedule?" 61% of respondents thought that the new process would better meet their needs, while 39% thought that it would not.[55] A McKinney production controller first heard about the new process from an R6Sigma Expert in late November, and said that it sounded fine to him and asked when it would be starting, not realizing that it had been in place for just over a month.[56] However, at least one Program Manager and his leadership team were concerned enough to call a meeting during their end-of-year vacations to meet with the LFM intern, the Expressway IQC leadership, and the Expressway Warehousing leadership (the meeting is discussed later in this section). The author proposes that the levels of both scrutiny and skepticism regarding the new process varied with the amount an individual had to lose if things went poorly.)

The 99/99/99 Issue

Early in the effort to find a new dispatching method, team members identified the "MRP REQD DATE" field on the right side of the RTD as a possible source for a due date to be used in due-date-based dispatching methods. The McKinney Receiving manager then raised the issue that some RTDs printed with "99/99/99" in this field (See Appendix H for a sample RTD with a normal MRP REQD DATE, and Appendix I for an RTD with a 99/99/99). The estimation was

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[51] Pockrus, Shirley. McKinney IQC team meeting. 21 October 2005.
[52] Various inteviewers Discussions with the author. 2005.
[53] Wright, Susan. Discussion with the author. 2005.
[54] Allen, Ken. Discussion with Paul Grove. 2005.
[55] I&T 3rd quarter customer survey. 2005.
[56] Wilcox, Reggie. Discussion with the author. 29 November 2005.

that these occurred infrequently, so plans were made and the GDT rollout begun. The team later learned that a terminal application would allow the box dater to look for the due date in the mainframe, so a 99/99/99 made determining a due date more difficult, but not impossible.

The magnitude of the issue became known just after the GDT rollout was announced. The LFM intern and the I&T Support person began calculating Start By dates and writing them on the boxes, and in doing so observed that the percentage of lots with 99/99/99 was closer to 50% than 10%. Date-writing efforts over the next few days confirmed this observation, and the Expressway IQC rollout confirmed that the same issue existed there on roughly the same percentage of lots.

Inquiries were made through multiple channels attempting to determine why "99/99/99" might appear in the MRP REQD DATE field. CSC was the first to respond, with the explanation that there was no MRP requirement for the part—an explanation entertained for a while, as engineering materials and material for "black projects" are not planned in MRP, but quickly rejected by the team's Quality and Sourcing representatives who insisted that there was no way 25% of the material coming into North Texas (a rough estimate was that I&T received half of what the dock Received, and the team was observing 99/99/99s on 50% of the material in I&T) was being planned outside MRP. Individuals from many organizations including CSC, Quality, MPM groups, Warehousing, and I&T aided in the investigation. Part of the difficulty was that the software developers assigned to the investigation had never before seen this code; the part of the IT system we were investigating had been built roughly twenty years prior, with the last revision made roughly four years in the past.

The major impacts of the 99/99/99 issue were increased labor spent looking up due dates and reduced confidence in the new dispatching method. The new process was, after all, taking values from a field that sometimes produced what looked like incorrect values.

The investigation closed on the following note: CSC, with help from the Raytheon investigators, was able to draft two long emails (one jokingly called "the epistle") detailing in technical terms how the MRP and ACQ systems interacted to produce the value in the MRP REQD DATE field. The email suggested that the RTD printed with 99/99/99 if there was no MRP need (for example, if the material was planned outside MRP) or if its need date fell outside an eight-month window extending from five months prior to the current date to three months beyond the current date. (For example, a lot needed 6 months ago would print with a 99/99/99, but a lot needed 5 months ago would print with a real date. Likewise, a lot arriving 3 months before its need date would print with a real date, but a lot arriving 4 months before its need date would print with a 99/99/99.) This explanation was inline with what the Raytheon investigators had observed, so the project team considered the matter closed. However, one program did not believe this explanation and vowed to assign an employee to continue the investigation in the months ahead.

Changing the RTD

The RTD enhancement alluded to earlier was to change the RTD-printing software such that it would print the Start By date on the RTD. This process was fraught with enough learning

opportunities for the LFM intern that the following paragraphs may prove useful to other persons attempting similar changes.

The first learning opportunity was that, since maintenance of the mainframe was contracted out to CSC, the software enhancement would likewise be contracted out to CSC. This involved getting a quote, a process that ultimately took over three weeks in this particular case. The LFM intern, being a software developer and also having worked with the I&T Support Tools developer on the web app enhancement, did not anticipate the quotation process to take as long as it did. In hindsight, far more time should have been allocated for the quotation process.

Second, as the RTD was a document shared by several plants other than McKinney and Expressway, the Change Review Board (CRB) requested that the project team obtain approval from the other sites. Since the change was adding a new field, rather changing, moving, or deleting an existing field, and since no other sites were being asked to change their processes in light of the new field, getting approval from the other sites was painless. It was, however, unplanned for; the team should have been aware of this detail and planned accordingly.

(This process was accelerated by the genius of the gentleman making the request on the team's behalf; since many stakeholders were involved, the requester's emails detailed the change and asked that any objections be raised by a certain date about a week out. Only a handful of the stakeholders responded, none with any issues, so the change could be approved. Had the email instead asked that people respond with their assent, we may have spent days badgering any persons who were amenable to the change but too busy to reply.)

Third, the promised delivery date slipped when CSC resources were pulled off this project to address an emergency in another Raytheon IT system. The other emergency involved purchase orders and was thus of high-dollar value, so the project team (having spent the entire summer talking about emergencies that were material in nature) knew that it could not and should not protest—such resource allocation was in the best interest of the company. However, there was insufficient slack in the project schedule to recover from the slip, and this cost the team the labor of dating boxes in McKinney IQC for longer than expected. The plan should have accounted for other projects' emergencies in addition to the project's own. (Ironically, the project team that had identified lack of trust as a source of expedite requests, was now put off schedule by its trusting of the promised delivery date.)

Fourth, the project team did not anticipate a formal User Acceptance Testing process. This had not been an issue with software developed internally; however, it was required for this particular arrangement between Raytheon and CSC. Instead of a "turn it on and see if it works" approach, testing first had to occur in a mock CSC environment before it could be rolled out to the plants. This effort was also complicated by hardware differences between the CSC environment and the Raytheon environment; RTDs from the CSC environment had differences such as different-sized barcodes that concerned the project team—misshapen barcodes could shut down all operations involving barcode scanners—and yet CSC was asking the project team to sign off that the development had been done correctly. (The project team responded with a conditional "okay," which was not sufficient from CSC's perspective. CSC then set up a testing environment with

the same hardware as the North Texas facilities, assuaging Raytheon concerns, at the cost of additional delays in the rollout.)

Fifth, the project team did not learn CSC's code promotion schedule until very late in the process. CSC's process at the time was to approve changes for rollout once per week, and roll them out the following evening. This ultimately did not affect the Expedite RCCA project, but other projects should endeavor to learn the relevant deployment schedules—slipping the development schedule by a day might slip the deployment schedule by a week!

Finally, CSC and Raytheon had an agreement that from November 14, 2005 through January 15, 2006 no code could be rolled out through normal channels for reasons related to Sarbanes-Oxley. The above circumstances delayed things long enough that, by the time the software was ready to go live, the two organizations were already into the code freeze period. The project then had to file for several levels of approval authorizing an exception to the code freeze. CSC personnel, knowing the process, graciously did almost all the legwork for the project team, and the RTD enhancement finally went live on the last day of the project. Given that the RTD enhancement was initially scheduled to complete well before November 14, it is not surprising that no one ever mentioned the code freeze. No one on the project team would be expected to ask so specific a question as whether there was a Sarbanes-Oxley code freeze at the end of the year; however, the team could have asked if there were scheduling issues other than the standard weekly cycle that it should be aware of.

Appendix J shows one of the first RTDs to print with the new field. The field was called "MRP RQD DT LESS MV" for two reasons: it eliminated ambiguity as to how the date was derived, and it avoided the problems that a field named "START DATE" would generate if a visiting executive found a lot that had not yet been started by the printed date. (As previously discussed, this was just a way of representing the slack time calculation; a manager could instruct his employees to stay so many days ahead or behind this date as he saw fit. "START DATE" would have also created confusion at other Raytheon sites, where no one would know who was supposed to start what.)

Meeting With a Program Manager

Background

In early December, an Expressway Program Manager and his leadership team asked the LFM intern, the Expressway IQC leadership, and the Expressway Warehousing leadership to meet to discuss the new dispatching process in Expressway IQC. The project team anticipated a difficult meeting, as the Inspection & Test Subcontract Manager was familiar with this particular program and knew the program's representatives to be a tough crowd. It was also learned that several of the attendees were giving up some of their vacation time to come in especially for this meeting, and furthermore refused to negotiate on the date to allow the I&T manager to attend. (Both the I&T manager and the Expressway Logistics manager were required to be in McKinney that morning for a meeting with the SCM Director and had to call in.)

There were actually several factors that provided impetuses for this meeting. First, there was a new dispatching system in Expressway IQC. Second, the program manager had personally visited Expressway IQC, picked out a lot with a need date, and looked it up in MRP to discover that hundreds of these parts were already in stock, suggesting that the need date printing on the RTD was incorrect. Third, the program manager was unsure that changes to MRP requirements made their way through the system to the RTD. Fourth, cycle time in the Expressway Warehouse had jumped in recent months. Finally, unrelated to the Expedite RCCA project, I&T had floated the idea of consolidating the two IQC groups into a single group located in McKinney (parts would be sent to Expressway by truck after inspection was complete), something that made the Expressway programs uncomfortable. In the I&T manager's opinion, this meeting was not about a dispatching method, it was about the program feeling as though I&T was making a lot of changes without considering its customers, and what the program really wanted was to dialogue with I&T.[57] That said, the I&T manager was not even on the invite list for the meeting, inviting himself when concern over the meeting grew.

(It is worth noting that the I&T Subcontract manager had spoken with this program manager at the beginning of the project, and that this program even had someone designated as a resource to the project team. However, as a program representative pointed out, the resource on the project team had "no authority to make decisions" for the program.)

"Know What the Goal Is..."

On March 3, 2006, Motorola Vice-President and LFM alumna Liz Altman shared some of her leadership gems with the LFM Class of 2006. One of those gems was, "Know what the goal is and have a plan" when going into a meeting or negotiation.[58] The LFM intern had heard this in other places as well; however, where he usually paid the idea lip service, this time he was completely on top of it. The goal was:

Don't get lynched

(There was also the very secondary goal of making the program feel comfortable enough with the new process that they would not ask the plant manager to dismantle it. However, that could wait until any verbal cruelty had been survived.)

"Be Prepared"[59]

The LFM intern had ten slides and eleven backup slides, in soft copy, hard copy, and transparency, for the meeting; technical difficulties were not going to screw up achieving the goal. The one thing the LFM intern did not worry about was practicing; he had presented the new

[57] Tevis, Robert. Discussion with the author. December 2005.
[58] Altman, Liz. Guest lecture at MIT, course 15.317. 3 March 2006.
[59] "Boy Scout Motto." 31 May 2005. 25 March 2006. <http://www.usscouts.org/advance/boyscout/bsmotto.html>.

dispatching method on enough occasions to feel very comfortable with the material and the pitch.

"A Jury Trial Is About Assigning Blame"[60]

As the meeting progressed, the issue of Expressway's increased cycle time arose. This concerned the LFM intern; he was sure that the new dispatching process itself was not the culprit—not for the magnitude of the increase—but could not offer any alternative at which the program could throw stones. Fortunately, the Expressway IQC supervisor could. Apparently another program had been asking IQC to hold parts while they worked out an issue with their supplier. Now, after weeks of sitting on a shelf, the parts had been released from the hold and were making their way to stock, each one increasing the average cycle time as it arrived. This segued to a discussion about the current workload in IQC. The program manager came to the conclusion that IQC had a capacity issue (true at the time), and volunteered to have some of his Quality personnel help IQC with its inspection load, as three of this program's lines were currently shut down anyway.

"Know When You Have Somebody"

The presentation had reached slide nine when the program manager said that, while he did not see how Raytheon could benefit from the new dispatching process until we publicized it to the programs, neither did he see anything in the new system that he was overly concerned about. The follow up to the Ms. Altman's gem was that one should "Know when you have somebody"[61] and not do anything to mess it up once you get to that point. While the LFM intern thought that there was already a small impact, and was prepared to make such a case, he kept his mouth shut as the program staff packed up their belongings and left the room. The meeting was over, and everybody in the room was still alive!

Enabling Factors

Several factors enabled the success of this initiative. As mentioned previously, one of these was that both IQC groups were already prioritizing work according to dates on boxes, making changing the prioritization as easy as changing the date on the box.

A second factor was a directive from the SCM Director to "assume that MRP is correct."[62] The project team was questioned on many occasions about the validity, not just of the MRP REQD DATE field, but of MRP in general. Common conjectures were that the user-loaded lead times were wrong and that not all parts of MRP updated when due dates changed. This led to further discussion on whether the entire MRP process was trustworthy and revealed that some program personnel supposedly manipulated the system in an attempt to "do better" than MRP, while

[60] "A Few Good Men Script - transcript from the screenplay and/or Tom Cruise and Demi Moore movie." 25 March 2006. <http://www.script-o-rama.com/movie_scripts/f/few-good-men-script-transcript.html>.
[61] Altman, Liz. Guest lecture at MIT, course 15.317. 3 March 2006.
[62] Paquee, Michael. Discussion with the author. 19 September 2005.

others insisted that their production schedules changed so frequently that MRP held no value for them. Still other discussion suggested that not all programs kept MRP up to date. At one point, an individual berated the project for "building a process around a broken system."[63] As Steinbrunner states, "Too often, team members know that the information loaded into the [MRP] system is useless and therefore have no faith in the resulting data that is intended to guide their ordering, systems, processes, and operations — a classic case of garbage in, garbage out. However, if team members have confidence in the data, they will have confidence in the system."[64] The author does not know whether there was indeed garbage flowing into or out of MRP; however it was clear that confidence in the MRP system was lacking. Without such a strong directive from the SCM Director—heavily leveraged whenever such objections arose—the new dispatching method might never have been developed for fear that due dates and lead times were too wrong to be useful.

A third factor was the existence of change agents at three key positions in the organization. Klein terms the most effective change agents "outsider-insiders," individuals with the openness to see how ideas from the "outside" can be applied to their organization, and the interpersonal leverage that comes from being accepted as an "insider" in the organization.[65] Three such people were the I&T manager, the Expressway IQC supervisor, and the SCM interface to CSC and CRB. In Raytheon's hierarchical organization, the buy-in of the I&T manager ensured that GDT would pilot the new dispatching method (in fact, the I&T manager did not even attend the GDT kickoff meeting; GDT accepted on hearsay that he was backing the initiative, and that was good enough). Likewise, the Expressway IQC supervisor sold her team on legitimately trying the new process; if she had instructed her QCs to give the new process lip service, the Expressway IQC pilot would have failed and the McKinney pilot would never have gotten started. The SCM interface to CSC and CRB had actually worked on a similar project to print the word "Expedite" on certain RTDs; his willingness to support this project, despite its implication that his previous effort had not totally resolved the expediting issue, allowed the RTD enhancement to be finished before the project's completion.

(The author did not spend sufficient time with the SCM Director to comment on whether he was an outsider-insider. However, the following quote might prove insightful. When discussing the possible implications of the new dispatching process on the I&T manager's career, the I&T manager stated that, "[The SCM Director] is not going to shoot me for trying to do the right thing."[66])

Future State

At the project's close, the modified slack-time dispatching process had been in place at McKinney IQC for eight weeks, and longer in GDT and Expressway IQC. Furthermore, several

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[63] Various Raytheon employees. Discussions with the author. 2005.
[64] Steinbrunner, Dan. "The Happy Marriage of Push and Pull." Industrial Management. Vol. 47, Issue 1. Jan/Feb2005: 30.
[65] Klein, Janice A. True Change: How Outsiders on the inside Get Things Done in Organizations. San Francisco: Jossey-Bass, 2004.
[66] Tevis, Robert. Discussion with the author. 2005.

other organizations had begun paying attention to either Start By dates or due dates, and managing their operations accordingly. The RTD enhancement had just come online, eliminating the need to manually calculate the Start By date. (The author later learned that, while the new software ran fine in North Texas, it reportedly caused a crash in El Segundo and was backed out of the system until early February so that the crash could be addressed.) The following paragraphs discuss what a possible future state might look like for this process.

Automatic Updating of Due Dates On Lots

A common concern with the modified slack-time process was that due dates sometimes change, but that Receiving prints RTDs and IQC dates boxes only once per lot. What would happen if a due date changes after the RTD is printed and the box dated?

Currently, nothing happens if the due date is pushed out. If the due date is pulled in, nothing happens if the new due date is still sufficiently far out. If the new due date is near enough to concern a parts chaser, then the parts chaser files an expedite request and the lot given top priority at every process.

In a slightly better state of the world, the expedite request would result not in parts automatically going to the front of the line, but in a manual revision of the due dates on the box and the RTD. Thus, a part that was previously right on time and is now needed one day earlier is not automatically expedited to the front of the line ahead of parts that were needed two weeks ago. Revising the due dates is sufficient to get parts processed in the right order.

In a much better state of the world, the due-date revision would be automatically reflected on either the box or the RTD or both. In one possible solution, when someone makes a change to MRP, some manner of wireless transmitter broadcasts this change throughout the plant. The signal is received by sensors on the lots, and the appropriate lots then update their electronically displayed due dates. This is, unfortunately, pie-in-the-sky thinking, as the system described is technologically feasible but not financially feasible for this particular usage.

The Modified Slack-Time Equivalent of a Flow Rack

A flow rack is a shelving unit designed to facilitate FIFO use of items on the rack. In one common design, an object is loaded onto the rack from the back and slides down an inclined plane to the front of the rack. Subsequent objects are also loaded from the back of the rack, sliding toward the front where they queue up behind the first object. Objects are consumed from the front of the rack; as the first object is removed, those behind slide forward so that what was previously the second object in the queue is now at the front of the rack for easy consumption. Such a configuration provides for easy identification and consumption of the first object and for easy loading of subsequent objects. In addition, no human intervention is required to ensure that the proper order of objects is established or maintained. Finally, one only needs enough space on the rack to hold the maximum items that would ever queue up.

However, consider that we instead want to order objects for processing by Start By date. (Due-date based processing is sufficient to demonstrate the difficulties one would encounter with a slack-time process.) Imagine that we start on January 1 with an empty shelf, and will order things on the shelf by Start By date from left to right. The first item which, let us say has a Start By date of January 5, can be placed anywhere on the shelf; we'll place it in the middle. The second item which, let us say has a Start By date of January 7, can be placed anywhere to the right of the first item; we'll put it a bit to the right, leaving a bit of space between the two.

Problems arise when the third through tenth items arrive, all having a Start By date of January 6. We left some space between the first and second items, but certainly not enough for that many items. Either the first or second item, or both, will have to be moved so that the new items can be placed between them. When the eleventh item arrives, it is possible that more shuffling of boxes will occur. Shuffling of boxes costs labor, and increases with the number of boxes on our shelf.

A subtler problem also leads to shuffling boxes. As days pass and workers work from left to right consuming the items on the shelf, the left side of the shelf will get emptied out, while the right side will accumulate more and more items. By the time January 5th rolled around, one hopes we are at the point where it is silly to have the first item (which, has a Start By date of January 5) sitting in the center of the shelf; we should slide it and everything else to the left to make room for the items due in late January. This shuffling is conceptually easy—everything moves to the left—but we must move every single item.

We could avoid shuffling boxes if we had infinite shelf space. Then, we could partition off large sections of it for each Start By date and place items once in their appropriate sections. Unfortunately, infinite shelf space is infinitely costly, so this may not be the correct solution either.

Finally, we could choose to not order the boxes, and simply let the workers look at the Start By dates on the boxes to see what item should be worked next. This is a perfectly acceptable solution when there are only a handful of items, but becomes increasingly time intensive as the number of boxes grows.

Our implementation was a "rolling" shelf system, with shelves being re-designated to hold material with later due dates when they were emptied of material from prior due dates. This was the best that our resources would permit at the time, and reduced some box shuffling while minimizing the amount of shelving we had to procure.

A superior solution from a box-shuffling standpoint would be some sort of computer-controlled random stocking system, for example a computerized carousel of some sort. With such a system, the computer does the "box shuffling" in memory and directs the worker to the next item to be worked (or, in a carousel, retrieves the item for the worker). This permits the most efficient use of true shelf space, although certain implementations such as carousels have large footprints for the amounts of shelf space they provide. There are also labor costs involved with stocking the system, as any item's Start By date and identifying features must be entered into the computer before the item is placed on the shelf; however, the current material tracking processes at Raytheon already involve entering similar information into a computer system and so Raytheon's

cost would not increase appreciably. The major costs involved here are in creating or purchasing such a system and integrating it with the current IT infrastructure.

More Sophisticated Rules for the Dispatching Method

Since cycle time will be the dominant SCM metric for the foreseeable future, the best dispatching method for I&T (but not necessarily for Raytheon) is probably "shortest processing time without allowing anything to become late." The project team realized this, but avoided this process for several reasons. Of greatest concern was that, with the focus primarily on SPT, an item might fall through the cracks and become late, garnering "I told you so's" from persons who preferred the FIFO system. There is also a degree of arbitrariness in predicting processing time; the inspection code, quality clauses, number of parts per lot, and length of the SFDM router are all clues as to how long an inspection will take, but the inexperienced observer would have a hard time determining which lots will take the longest. And while working the fast lots is metrically good for QCs, without the ability of a manager to easily predict processing time, a QC might decide to skip over a very fast but difficult inspection in favor of a technically easy inspection that took slightly longer. (The team members briefly contemplated the idea of writing software that would make such predictions and print them on either the SFDM router or RTD, but abandoned the idea when they learned of the technical complexity of such a task.) Finally, such a process makes it harder to justify to customers why their part has a certain place in the queue. As a real-life example of this, a shopper with 50 items in his shopping cart might allow a shopper with only 1 item to cut in line, but would probably tell an individual with 49 items to wait his turn. The same shopper with 50 items may even let four or five customers cut in line; however, at some point he will become upset about his queue time and demand service. (One possible benefit of such a policy is that it would motivate programs to improve supplier quality so that inspection—a non-value-adding activity in some definitions—can be reduced or eliminated.)

(It turns out that Expressway IQC is already moving toward such a dispatching system. Following surgery, one of the QCs was unable to stare into a microscope for extended periods of time. Her team now siphons off some of the fast lots for her, so that her work has more frequent breaks built into it. The unintended but desirable result is that this QC sends all the fast lots quickly to stock, lowering cycle time, while her colleagues order their work by Start By date and thus ensure that slow lots still arrive in stock as close to on-time as possible.)

A final consideration is whether a part that is four months late should receive (as it currently would) priority over a part that is one day late. The question arises because, while a one-day schedule slip might still be recoverable, a four-month schedule slip is probably unrecoverable. The answer is complicated, in part because penalties associated with lateness vary between contracts (one contract may incur a one-time lateness penalty whereas another incurs a penalty for each additional day of lateness) and in part because it is difficult to know where to draw the line—a two day schedule slip is probably easily recoverable as well. In the future, I&T may investigate defining when parts are late beyond further repercussion and changing its prioritization scheme accordingly.

Final Thoughts

The Root Cause of Expedite Requests

The root cause of expedite requests (but not of the need to expedite) is rather simple. A parts chaser will request an expedite when:

E(Benefit of making the request) + E(Cost of not making the request)
>=
E(Benefit of not making the request) + E(Cost of making the request)

An example of a benefit of making an expedite request might be being viewed as a proactive parts chaser. A cost of not making an expedite request might be that a contract is breached. A benefit of not making an expedite request might be being viewed as a parts chaser who effectively manages her tasks such that expediting is not needed. A cost of making an expedite request might be the labor involved in making the request.

The modified slack-time dispatching process addresses first half of the inequality. It reduces (ideally, eliminates) the cost of not making an expedite request—if parts are already headed to stock in the most desirable order, then the parts chaser loses nothing by not shuffling that order. Likewise, there is no longer a benefit to making expedite requests—making requests that everyone knows gain one nothing might be considered futility rather than proactivity. (The author does submit that the new dispatching method may not yet have parts going to stock in the optimal order, either because the Start By date calculation process described in Appendix V needs more refining, or because the manufacturing schedule is too dynamic to be handled by a process that calculates the Start By date only once, at Receipt.)

(The root cause of the need to expedite is, in contrast, rather complex. Appendix T, which captures parts chasers' thoughts on why they had to expedite, suggests that there are multiple reasons including schedule changes, part breakages, not having enough lead time, and "it just arrived late." The project team tried to do a "deep" investigation on a handful of expedite requests; however, the cases we chose turned out to be one-off occurrences—for example, one parts chaser related that a delivery service which had never before given him problems had recently misrouted two of his packages. This individual unwittingly did some tip-of-the-iceberg analysis and alerted other personnel that this delivery service might be having some temporary problems; however, misrouting of packages was a new phenomenon and probably not responsible for most of the hundreds of expedite requests filed before and after this incident. Even if we propose that the primary cause of expedite requests is that suppliers do not get their material to Raytheon on time (this was proposed by one Sourcing manager),[67] further investigation reveals that this is not a root cause but a common symptom of many root causes—one can easily ask, "Why do suppliers not get their material to Raytheon on time?" The answers one would receive to even this high-level question—supplier A has problems with sub-supplier

[67] Cottier, Terry. Comment in project debrief meeting. December 2005.

B, supplier C has problems with sub-supplier D, supplier E just changed MRP systems, supplier F just laid off half its workforce, etc.—are numerous enough to suggest that, as a Raytheon Warehouse manager in El Segundo stated, "there are many root causes of [the need to expedite]."[68] It is in Raytheon's interest to address each of these; however, the author proposes that it is best left to teams with appropriate domain knowledge—for example, the buyer, MPM, and Quality engineer who often work with a problematic supplier—to address each root cause. The contributions of this project are in providing tools to help such teams determine where the improvement opportunities are and in minimizing expedite-related spend as root causes are continually identified and resolved.)

Motivating the Accuracy of MRP

As noted previously, a number of employees expressed a lack of faith in various facets of the MRP system, whereas Steinbrunner suggests that persons having confidence in the inputs into MRP will have confidence in the outputs.[69] (The author generally agrees with this notion, although in this case a second factor is mistrust of what "magic" MRP does in formulating its recommendations.) If there are indeed incorrect inputs to MRP, building a process around the assumption that MRP is correct may in fact motivate better attention to future input accuracy. For example, the I&T manager related that on several occasions he had identified what he believed to be incorrect lead times. However, his request that these specific lead times be corrected was rebuffed with an answer to the effect of, "What do you care? You don't use them, anyway!" Now his organization does use one of these lead times (Move), and programs desiring fair treatment under the new dispatching process will attempt to ensure that both their and other programs' lead times and due dates are correct and kept up to date.

(One of the possible contributions of this project may be getting planning factors onto the SCT radar. Prior to this project, many individuals were unfamiliar with the terms "Pull," "Make," and "Move." However, in an email dated November 11, 2005, the individual heading up the SCT (this happened to be the North Texas SCM Director) communicated that: "On November 14 and 15 a meeting will be held in El Segundo with cross-site representation from Procurement, Production Control, and MPMs...Additionally, the participants will discuss the development of an enhanced process to maintain the Push [sic], Make, and Move planning parameters..."[70] Team members were unsure whether this was a side effect of the team's effort, but thought it might be, and were regardless pleased that better attention would be paid to planning factors in the future.

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[68] Ord, Michael. Discussion with the author. 2 February 2006.
[69] Steinbrunner, Dan. "The Happy Marriage of Push and Pull." Industrial Management. Vol. 47, Issue 1. Jan/Feb2005: 30.
[70] Paquee, Michael. Email, sent by Pamela M. Bailie to Robert Tevis and others. 11 November 2005.

Fairness

Bitran and Lojo state that, "Generally, after customers have been segmented based on some prescreening process, perceived social justice depends on a first-come-first-served queueing [sic] discipline."[71] In his 1987 paper on the psychology of queuing, Larson in fact defines the queuing attribute of "*social justice*, as measured by adherence to (or violation of) *f*irst *i*n, *f*irst *o*ut (FIFO)."[72]

The modified slack-time dispatching process does not honor FIFO-based social justice. This is perhaps why there was such strong resistance to it from some individuals—for example, a program representative who suggested that the process "rewarded" programs who brought in their parts late.[73] (There are two counterarguments to this claim. First, any program whose parts came in late under the previous "FIFO with exceptions" system was already in the habit of filing an expedite request, expending Raytheon labor to skip the lot to the very front of the line. The modified slack-time dispatching process puts the late lot at the right place in the line, which may or may not be at the very front, and does so without extra labor cost. Second, we may not be thinking correctly about things if we consider "cutting in line so that one will not be late" a "reward," although since the material does incur less inventory carrying cost by going more quickly from dock-to-line, there is indeed a windfall for programs whose materials arrive late. If such thinking is universal, then perhaps this is an area where metrics alignment is worth investigating.) Project team members are familiar with this feeling of social injustice, in fact experiencing it when the RTD enhancement was put on hold to allow CSC to address a more recent, but more serious, issue. However, as team members learned through both the RTD enhancement experience and the airport though experiment, "I got here first" is a relatively weak argument when dollars are at stake in an environment where people are expected to be team players.

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[71] Bitran, Gabriel, and Maureen Lojo. "A Framework for Analyzing the Quality of the Customer Interface." European Management Journal. Vol. 11, No. 4. Great Britain: Pergamum Press Ltd., 1993: 390.
[72] Larson, Richard C. "Perspectives On Queues: Social Justice And The Psychology Of Queueing." Operations Research. Vol. 35, Issue 6. Nov/Dec 1987: 895.
[73] A program representative. Discussion with the author. December 2005.

Results and Conclusion

Project Results

Appendix X contains slides graphically depicting the results of our efforts. The project team tells the story that:

- Expedite requests historically tracked roughly with Receipts. However, in October 2005 and November 2005, Receipts increased while expedite requests either remained constant or decreased. Another way of saying the same thing is that expedite requests per receipt decreased in those two months.
- The number of expedite requests per month can be combined with the expedite dollarization work done in the beginning of the project to produce a cost of expediting per month. The cost of expediting has a downward trend in October 2005 and November 2005.
- All significant changes to the web app, other data collection processes (such as asking parts chasers to log all requests in the web app), and the I&T dispatching process went live on or after September 5, 2005.
- The numbers of expedite requests are taken from the web app data. Since Warehousing managers now ask that all expedite requests be logged in the web app, one would expect that, all else equal, the number of expedite requests recorded in the web app would increase, not stay constant or decrease, during these two months.
- Eight initiatives have made sufficient progress that the team expects their completion. Two of these are already complete, and two more at the point where the return can be estimated in dollars. The estimated impact of these four initiatives is in excess of $600,000. If the other initiatives complete in a timely manner, their impact will add to this figure.
- It is hoped that, as was the case with the FAL-to-SFDM project, that the improved data collection and reporting tools developed during this project will spawn other R6Sigma projects. Such projects would also add to the $600,000 figure.
- The IQC manager has agreed to lead a monthly RCCA meeting that will use the new reports as a starting point for monitoring the state of expedite requests and determining where new R6Sigma investigations might have the greatest impact.

A foundation is now laid for many potential improvement projects, including monitoring and addressing of Sourcing expedite-related labor and expedite fees, further reducing the time between Sales Order Entry and RP placement, improving data collection and reporting abilities, and unearthing and addressing the root causes behind the need to expedite. In addition, cultural changes—such as knowledge of due dates, better upkeep of MRP, and awareness of the cost of expediting—have begun but can go much further. There is much future work to be done.

Broader Significance

As suggested at the outset of this paper, the key takeaway for most readers should probably be not what we did, but rather why we did it. Each organization has its own context that will render

some of our implementation decisions more or less effective in one's own environment. The following are some questions the author feels may be useful in thinking about an organization's general expedite situation:

- Does expediting occur in our organization, and if so, should we acknowledge it in our metrics, process descriptions, process flow diagrams, etc.?
- Do we know what it costs to handle expedite requests? Do we know how many we handle every month? Will we be aware if either quantity begins to go out of control?
- Can we distinguish value-adding expediting from non-value-adding expediting? Can we monetize our ability to do value-adding expediting?
- Why are we using our current dispatching system? Are people requesting exceptions to the current system? Are there other systems that might serve us better from financial, metrical, or social justice perspectives?
- What are the attitudes of our company, management, organization, partners, and customers toward changing processes that already work reasonably well in order to address expedite-related spend? Is this the right time for change? Given our environment, what is the best way to prototype, roll out, and communicate the change?

The Expedite RCCA team wrestled with many of these questions. In some cases, it failed to find answers, but the answers it did find were sufficient to produce a good ROI for Raytheon North Texas. The author expresses his hope that this thesis is of use to anyone attempting to address expediting in his or her organization.

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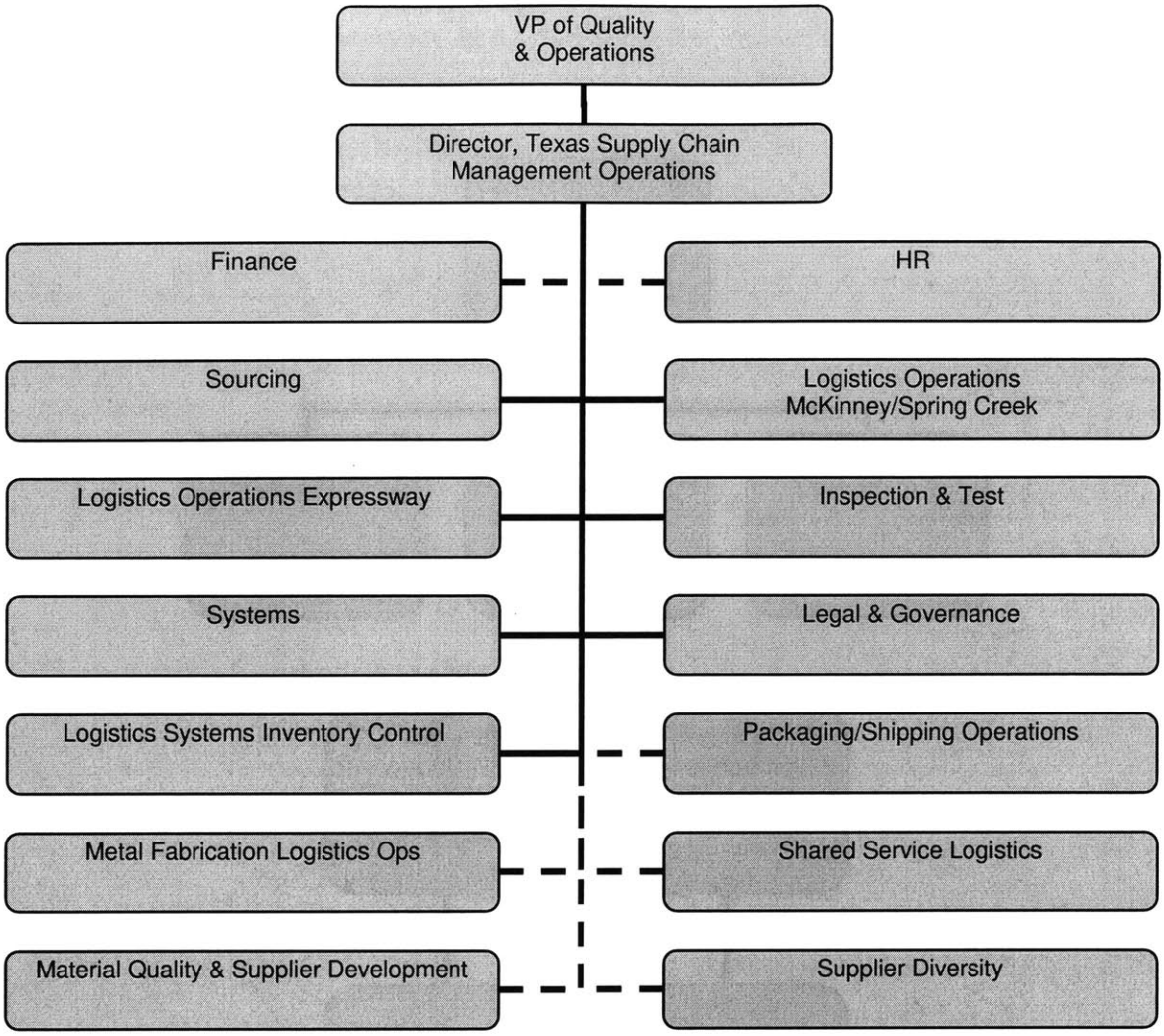
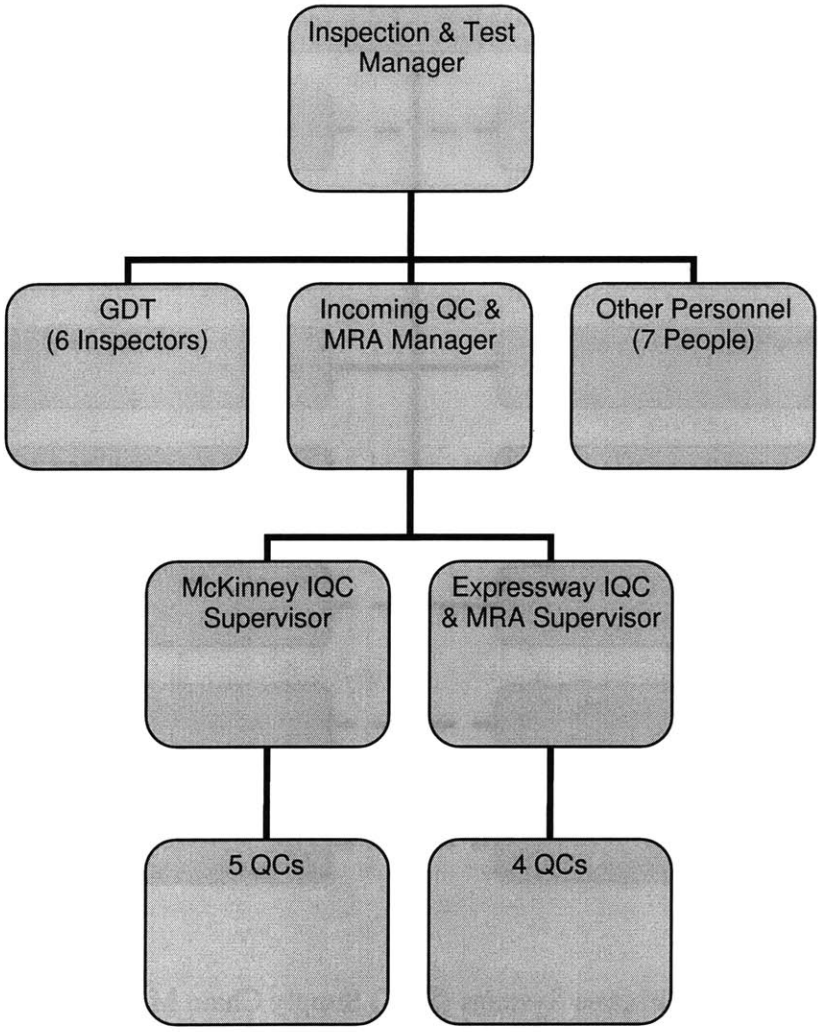
Appendix A: SAS North Texas SCM Organizational Chart



Adapted from: "Space and Airborne Systems (SAS) Supply Chain Management." Internal document of Raytheon SAS SCM group, printed and hand-revised by Robert Tevis on 2 May 2005. 1 August 2004.

Appendix B: Inspection & Test Organizational Chart

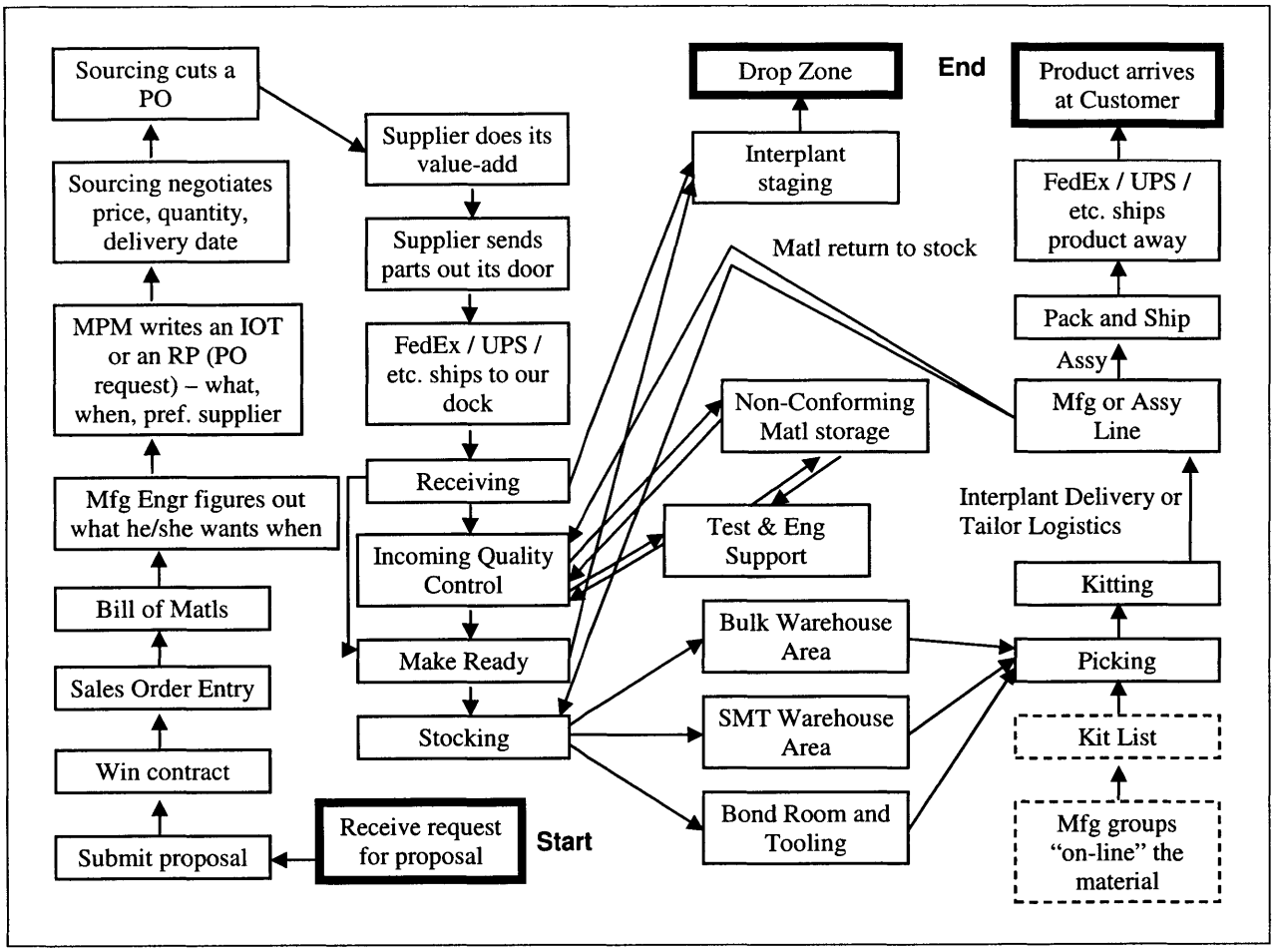


Adapted from: "RIT Receiving Inspection and Test: 2005 Communication." Internal document of Raytheon. April 2005.

Appendix C: The McKinney Supply Chain Process Flow

This is a highly simplified view of the general supply chain process flow at the McKinney plant. Exceptions abound, and no attempt will be made to identify all of the alternatives routes through the process. This is the fifth version of the diagram, and while there may still be inaccuracies, intentional or accidental, this diagram was accepted by the project team with no suggested revisions from September 6, 2005, until the end of the project.

The diagram for Expressway is essentially the same, but the intricacies of the processes and some of the names differ.



Appendix D: Selected Metrics and Goals

Organization	Metric or Sequencing Goal
Sourcing	% PO OTD
MPMs for a particular manufacturing group	% OTD to Kit Pull
McKinney Warehouse Operations	Dock-to-Stock Cycle Time
Expressway Warehouse Operations	Dock-to-Stock Cycle Time
Incoming Inspection/Test	Static Cycle Time
Manufacturing Group 1	% CLIN OTD
Manufacturing Group 2	% CLIN OTD
Manufacturing Group 3	Dynamic Cycle Time
	% OT to MRP (Project A)
	% OT to MRP (Project B)
Manufacturing Group 4	Dynamic Cycle Time
	Static Cycle Time
	% OT to MRP
Manufacturing Group 5	Dynamic Cycle Time
	CRM Static Time
	% OT to MRP
Manufacturing Group 6	CRM TAT Calendar Days
	% OT to Mfg. Schedule
Manufacturing Group 7	Dynamic Cycle Time
	% OT to MRP

Appendix E: Types of Expedite Requests

		Types of expedite requests									
		Sourcing	"Incoming"	"Receiving"	"Kit"	"MRT"	"PRSA"	"RTS" - Purchased material	"RTS" - Fabricated material	Post-manufacture pack-ship
Operations involved	Sourcing	√								
	Air Freight in	√								
	Receiving		√	√						
	Incoming Inspection		√					√		
	Make Ready		√	√				√	√	
	Stocking		√	√		√		√	√	
	Kitting				√		√			
	Line QC*								√	
	Pack-Ship									√
	Air Freight out									√

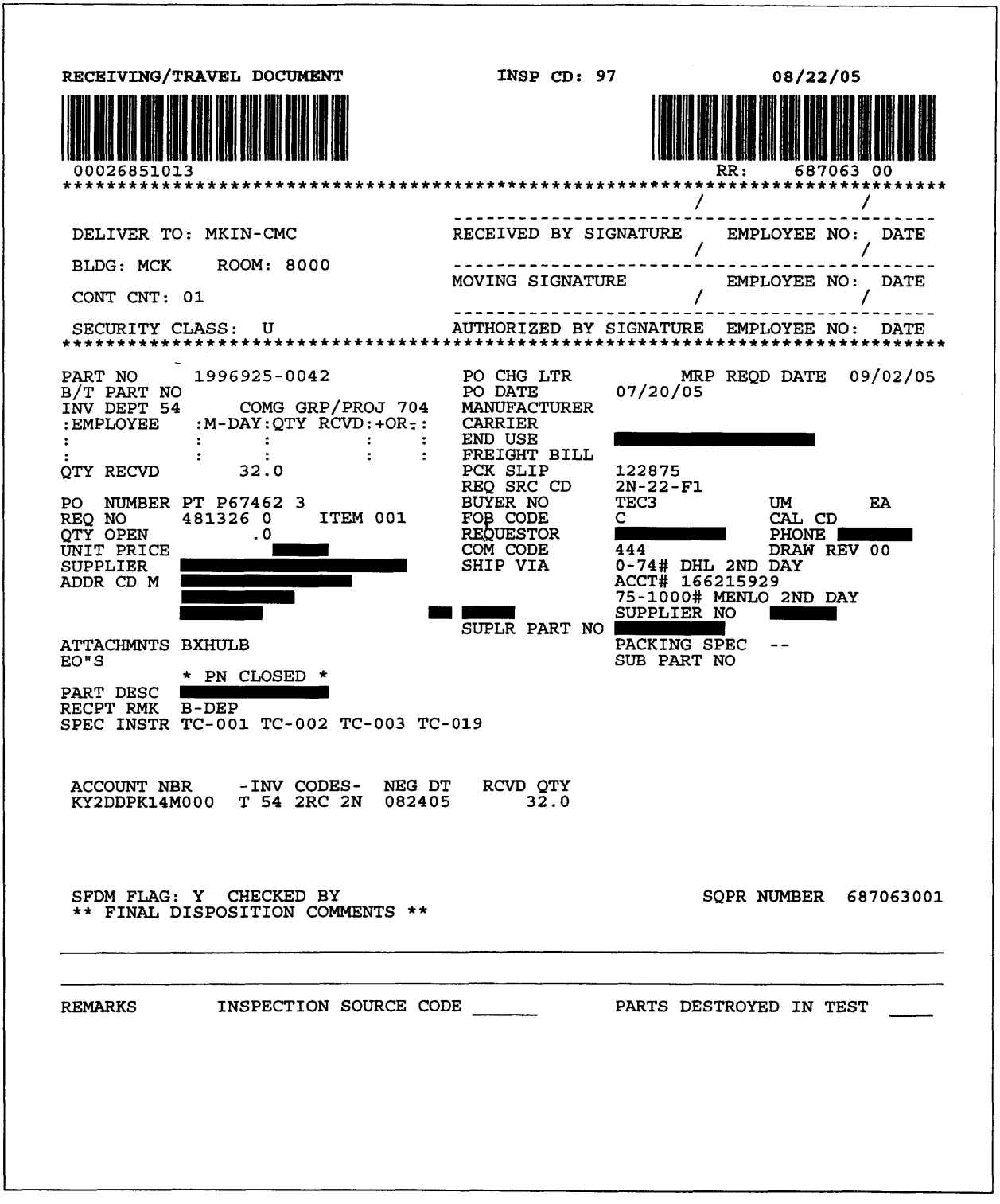
Appendix F: RCCA Team – Initial

Expressway Warehousing
Inspection & Test
Logistics
McKinney Warehousing
MIT LFM Intern
MIT School of Engineering Faculty
MIT Sloan School of Management Faculty
Quality
R6Sigma Coach
Sourcing

Appendix G: RCCA Team – Final

Expressway Warehousing (x 2)
Inspection & Test
Inspection & Test Subcontract Management
Inspection & Test Support Tools
Inspection & Test, Support
McKinney Warehousing (x 2)
MIT LFM Intern
MIT School of Engineering Faculty
MIT Sloan School of Management Faculty
MRA
NCS MPMs
Quality
R6Sigma Coach
Sales Order Activation
SAS MPMs
Sourcing - Low value items, shared across many projects
Sourcing - High-value items, project-specific
(Resource) Expressway Expediters
(Resource) McKinney Expediters

Appendix H: Receiving Travel Document (RTD)



RECEIVING/TRAVEL DOCUMENT INSP CD: 97 08/22/05

00026851013 RR: 687063 00

DELIVER TO: MKIN-CMC
BLDG: MCK ROOM: 8000
CONT CNT: 01
SECURITY CLASS: U

RECEIVED BY SIGNATURE EMPLOYEE NO: DATE
MOVING SIGNATURE EMPLOYEE NO: DATE
AUTHORIZED BY SIGNATURE EMPLOYEE NO: DATE

PART NO 1996925-0042
B/T PART NO
INV DEPT 54 COMG GRP/PROJ 704
:EMPLOYEE :M-DAY:QTY RCVD:+OR-:
QTY RECVD 32.0

PO NUMBER PT P67462 3
REQ NO 481326 0 ITEM 001
QTY OPEN .0
UNIT PRICE
SUPPLIER
ADDR CD M

ATTACHMNTS BXHULB
EO"S
* PN CLOSED *
PART DESC
RECPT RMK B-DEP
SPEC INSTR TC-001 TC-002 TC-003 TC-019

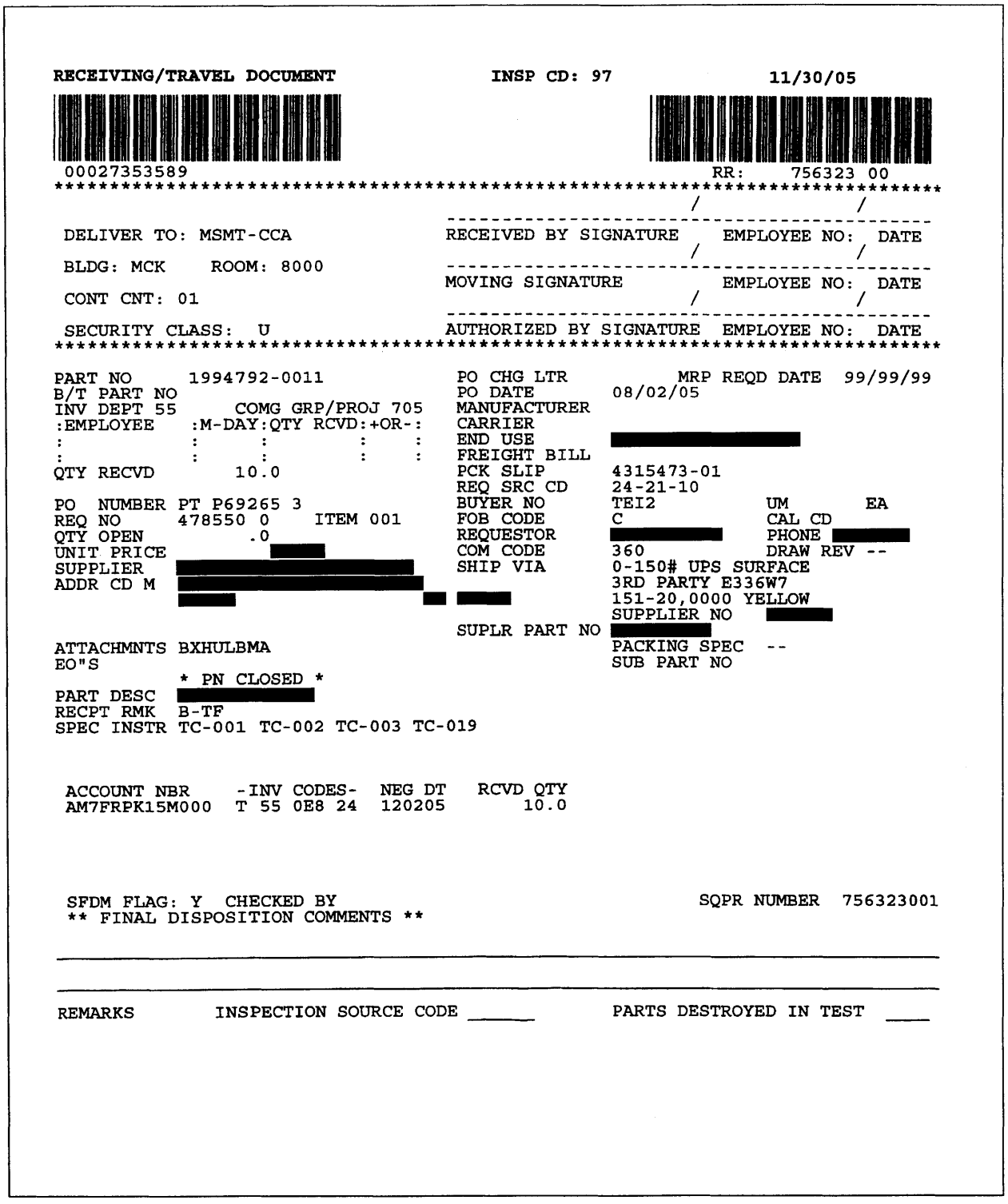
PO CHG LTR MRP REQD DATE 09/02/05
PO DATE 07/20/05
MANUFACTURER
CARRIER
END USE
FREIGHT BILL
PCK SLIP 122875
REQ SRC CD 2N-22-F1
BUYER NO TEC3 UM EA
FOB CODE C CAL CD
REQUESTOR PHONE
COM CODE 444 DRAW REV 00
SHIP VIA 0-74# DHL 2ND DAY
ACCT# 166215929
75-1000# MENLO 2ND DAY
SUPPLIER NO
SUPLR PART NO
PACKING SPEC --
SUB PART NO

ACCOUNT NBR	-INV CODES-	NEG DT	RCVD QTY
KY2DDPK14M000	T 54 2RC 2N	082405	32.0

SFDM FLAG: Y CHECKED BY SQPR NUMBER 687063001
** FINAL DISPOSITION COMMENTS **

REMARKS INSPECTION SOURCE CODE _____ PARTS DESTROYED IN TEST ____

Appendix I: RTD with a 99/99/99 MRP RQD DATE



RECEIVING/TRAVEL DOCUMENT INSP CD: 97 11/30/05

00027353589 RR: 756323 00

****

DELIVER TO: MSMT-CCA RECEIVED BY SIGNATURE EMPLOYEE NO: DATE

BLDG: MCK ROOM: 8000 MOVING SIGNATURE EMPLOYEE NO: DATE

CONT CNT: 01

SECURITY CLASS: U AUTHORIZED BY SIGNATURE EMPLOYEE NO: DATE

****

PART NO 1994792-0011
B/T PART NO
INV DEPT 55 COMG GRP/PROJ 705
:EMPLOYEE :M-DAY:QTY RCVD:+OR-:
QTY RECVD 10.0

PO NUMBER PT P69265 3
REQ NO 478550 0 ITEM 001
QTY OPEN .0
UNIT PRICE [redacted]
SUPPLIER [redacted]
ADDR CD M [redacted]

ATTACHMNTS BXHULBMA
EO"S
* PN CLOSED *
PART DESC [redacted]
RECPT RMK B-TF
SPEC INSTR TC-001 TC-002 TC-003 TC-019

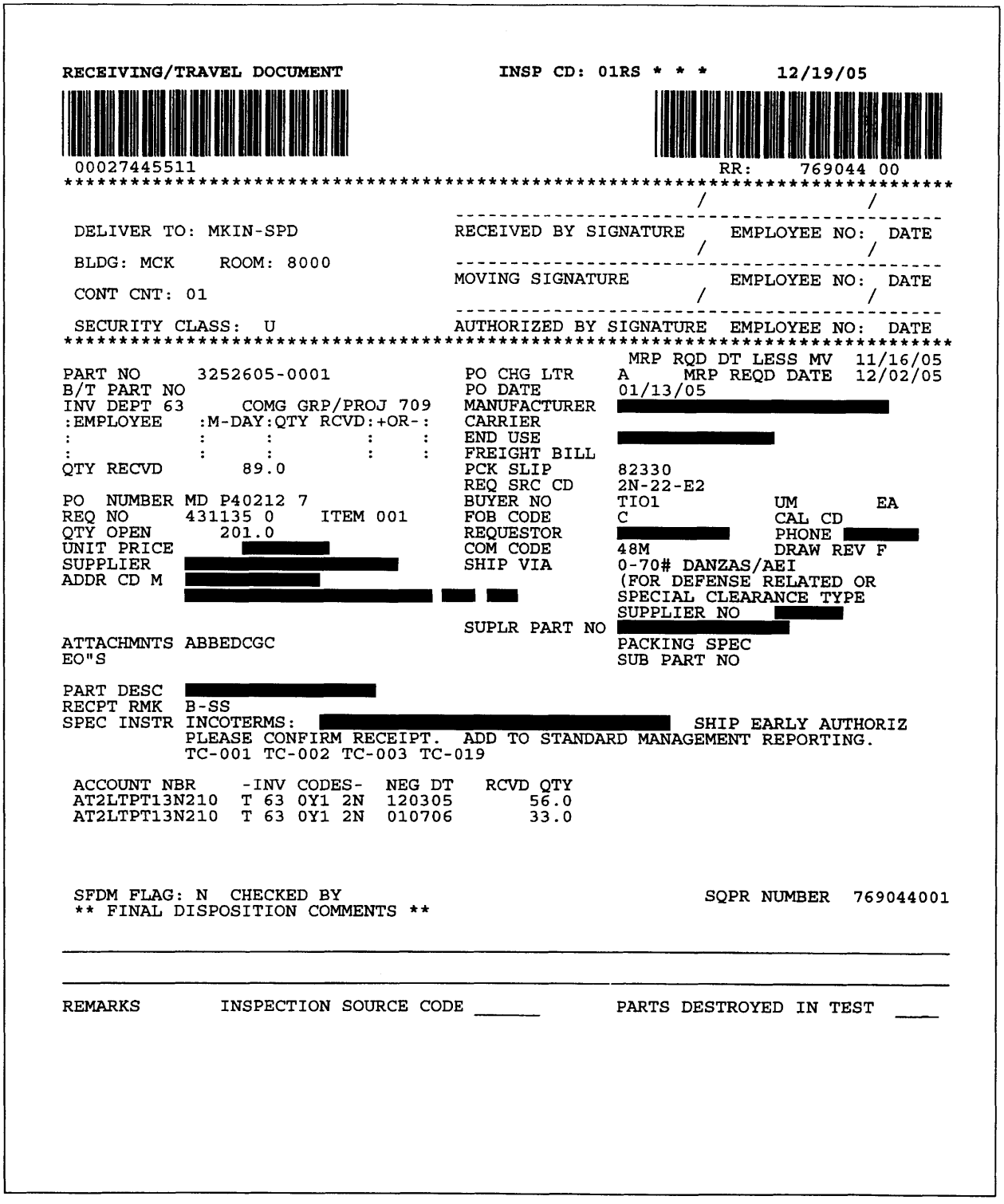
PO CHG LTR MRP REQD DATE 99/99/99
PO DATE 08/02/05
MANUFACTURER
CARRIER
END USE [redacted]
FREIGHT BILL
PCK SLIP 4315473-01
REQ SRC CD 24-21-10
BUYER NO TEI2 UM EA
FOB CODE C CAL CD
REQUESTOR [redacted] PHONE [redacted]
COM CODE 360 DRAW REV --
SHIP VIA 0-150# UPS SURFACE
3RD PARTY E336W7
151-20,0000 YELLOW
SUPPLIER NO [redacted]
SUPLR PART NO [redacted]
PACKING SPEC --
SUB PART NO

ACCOUNT NBR	-INV CODES-	NEG DT	RCVD QTY
AM7FRPK15M000	T 55 0E8 24	120205	10.0

SFDM FLAG: Y CHECKED BY SQPR NUMBER 756323001
** FINAL DISPOSITION COMMENTS **

REMARKS INSPECTION SOURCE CODE _____ PARTS DESTROYED IN TEST ____

Appendix J: RTD with New MRP RQD DT LESS MV Field



RECEIVING/TRAVEL DOCUMENT INSP CD: 01RS * * * 12/19/05

00027445511 RR: 769044 00

DELIVER TO: MKIN-SPD
BLDG: MCK ROOM: 8000
CONT CNT: 01
SECURITY CLASS: U

RECEIVED BY SIGNATURE EMPLOYEE NO: DATE
MOVING SIGNATURE EMPLOYEE NO: DATE
AUTHORIZED BY SIGNATURE EMPLOYEE NO: DATE

PART NO 3252605-0001
B/T PART NO
INV DEPT 63 COMG GRP/PROJ 709
:EMPLOYEE :M-DAY:QTY RCVD:+OR-:
QTY RECVD 89.0

PO NUMBER MD P40212 7
REQ NO 431135 0 ITEM 001
QTY OPEN 201.0
UNIT PRICE [redacted]
SUPPLIER [redacted]
ADDR CD M [redacted]

ATTACHMNTS ABBEDCGC
EO"S

PART DESC [redacted]
RECPT RMK B-SS
SPEC INSTR INCOTERMS: [redacted] SHIP EARLY AUTHORIZ
PLEASE CONFIRM RECEIPT. ADD TO STANDARD MANAGEMENT REPORTING.
TC-001 TC-002 TC-003 TC-019

PO CHG LTR
PO DATE 01/13/05
MANUFACTURER [redacted]
CARRIER
END USE [redacted]
FREIGHT BILL
PCK SLIP 82330
REQ SRC CD 2N-22-E2
BUYER NO TI01 UM EA
FOB CODE C CAL CD
REQUESTOR [redacted] PHONE [redacted]
COM CODE 48M DRAW REV F
SHIP VIA 0-70# DANZAS/AEI
(FOR DEFENSE RELATED OR
SPECIAL CLEARANCE TYPE
SUPPLIER NO [redacted]
SUPLR PART NO [redacted]
PACKING SPEC
SUB PART NO

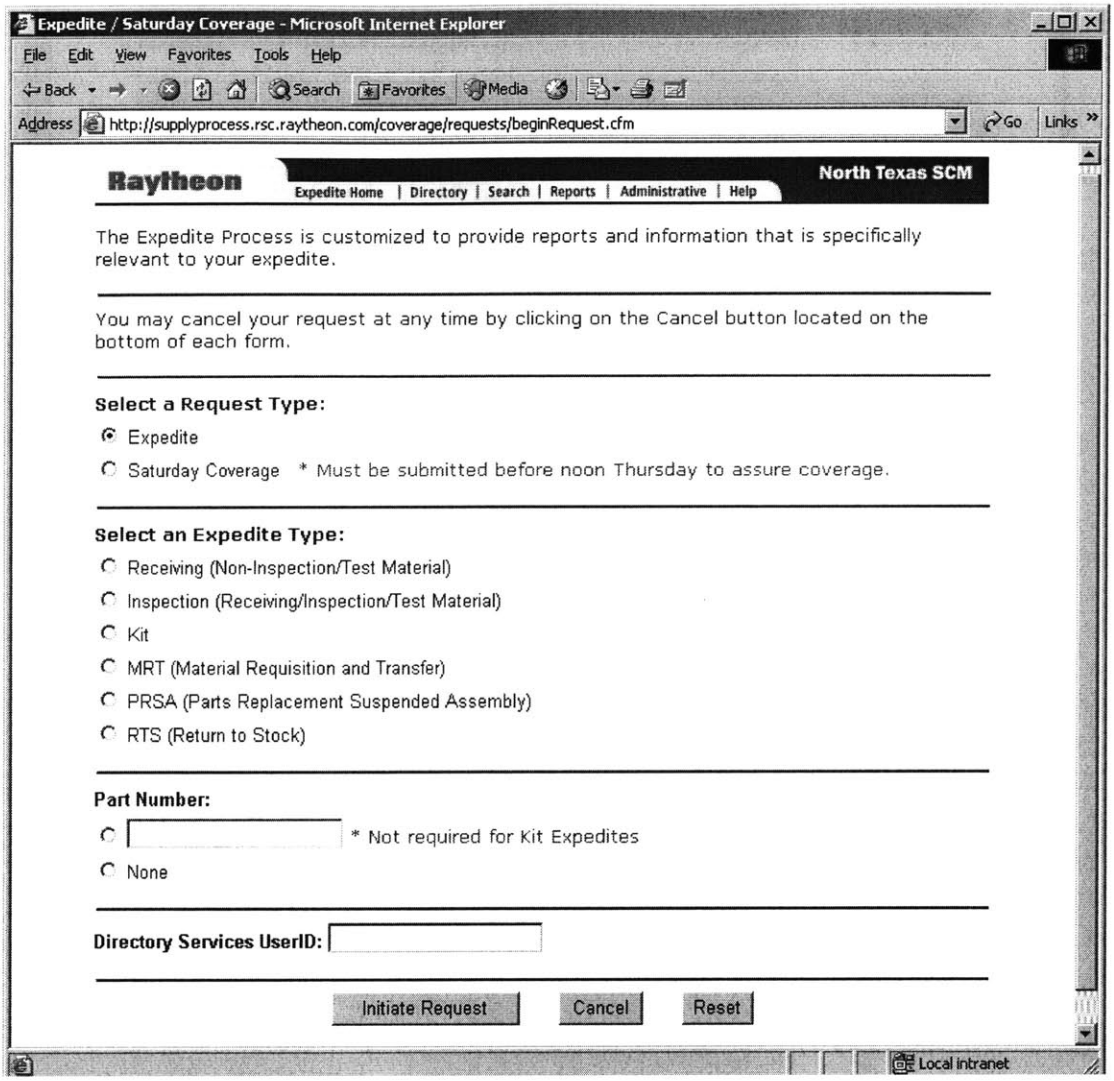
MRP RQD DT LESS MV 11/16/05
MRP REQD DATE 12/02/05

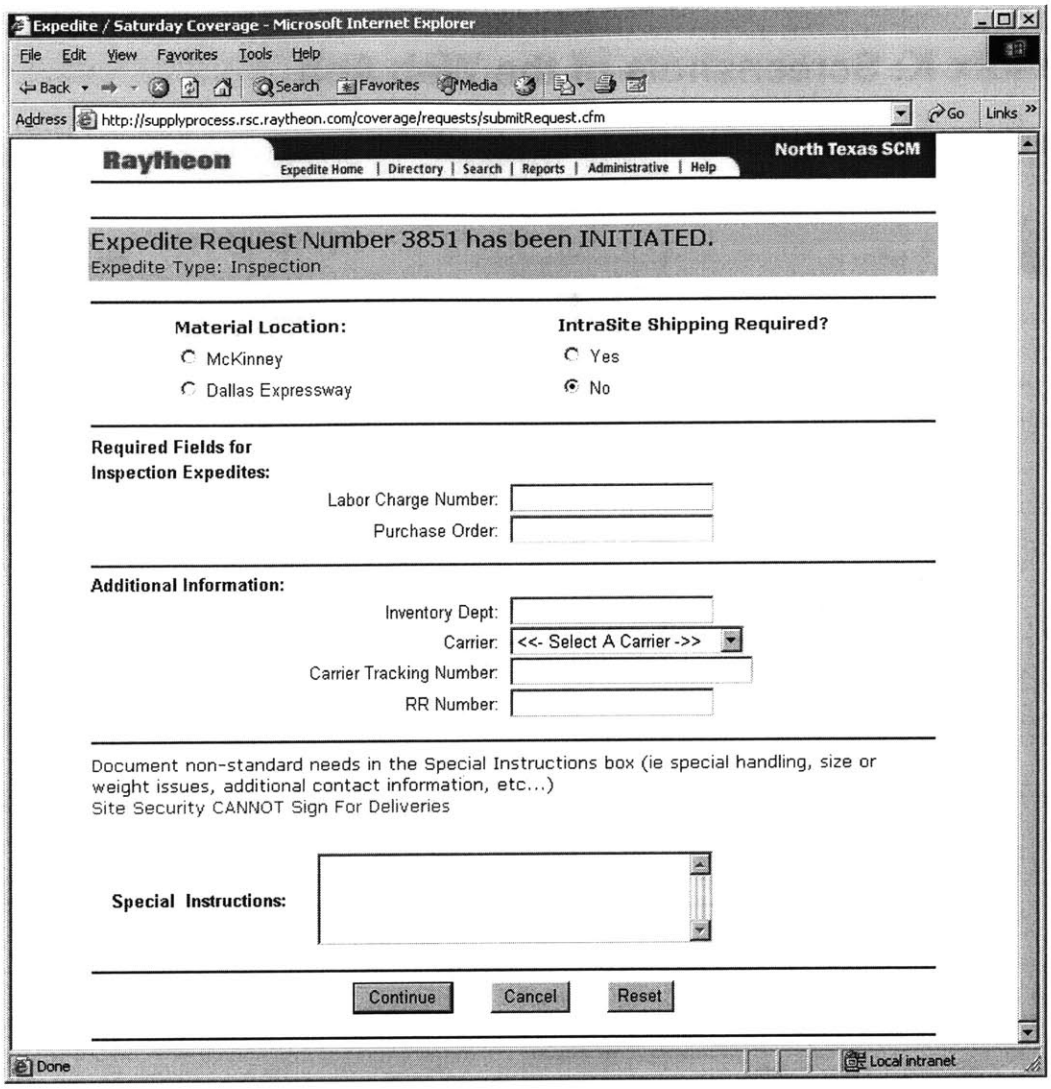
ACCOUNT NBR	-INV CODES-	NEG DT	RCVD QTY
AT2LTPT13N210	T 63 0Y1 2N	120305	56.0
AT2LTPT13N210	T 63 0Y1 2N	010706	33.0

SFDM FLAG: N CHECKED BY SQPR NUMBER 769044001
** FINAL DISPOSITION COMMENTS **

REMARKS INSPECTION SOURCE CODE _____ PARTS DESTROYED IN TEST ____

Appendix K: Screenshots of the Web App




Expedite / Saturday Coverage - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites Media
Address http://supplyprocess.rsc.raytheon.com/coverage/requests/submitRequest.cfm
Go Links
Raytheon
Expedite Home | Directory | Search | Reports | Administrative | Help
North Texas SCM
Expedite Request Number 3851 has been INITIATED.
Expedite Type: Inspection
Material Location:
McKinney
Dallas Expressway
IntraSite Shipping Required?
Yes
No
Required Fields for Inspection Expedites:
Labor Charge Number:
Purchase Order:
Additional Information:
Inventory Dept:
Carrier:
<<- Select A Carrier ->>
Carrier Tracking Number:
RR Number:
Document non-standard needs in the Special Instructions box (ie special handling, size or weight issues, additional contact information, etc...)
Site Security CANNOT Sign For Deliveries
Special Instructions:
Continue
Cancel
Reset
Done
Local intranet

Appendix L: Sample Email from the Web App

[redacted]@raytheon.com
Sent by:
owner-mkexstk@da02c00.directory.ray.com

06/08/2005 07:53 AM

To mkexstk@da02c00.directory.ray.com
cc [redacted]@raytheon.com
bcc
Subject UPDATED Expedite Request: 3265 - McKinney - PN: [redacted]

Updated Expedite - Request - RTS
Requested by: [redacted]
Updated by [redacted]
Site: McKinney

Contact Information:
Email: [redacted]@raytheon.com
Telephone: [redacted]
Cell Phone: [redacted]
Pager: [redacted]

View Request ID: 3265

Expedite Information:

Inv Department: None
WO Number: None

Part Number: [redacted]

Material Move Ticket (MTrak): 1RYN00097263

New Comments (check web site for entire comment log) :
Need this kit stocked up in a temp location, to immediately be pulled/csh'd for SC bldg... Hot....

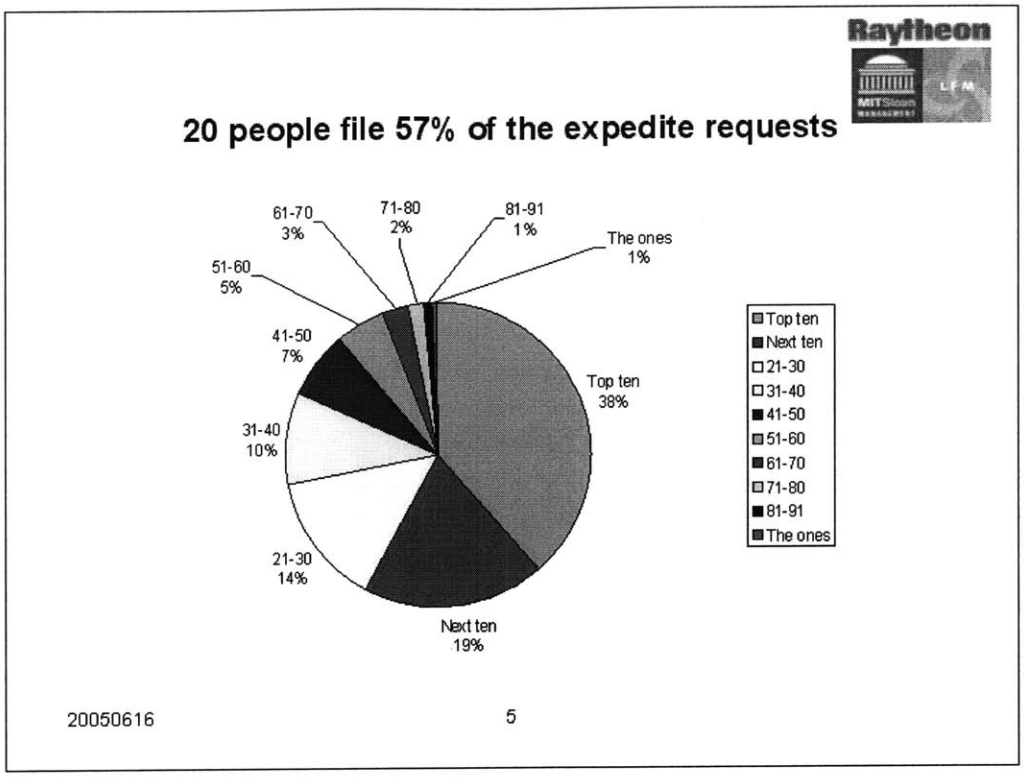
=-=-= To unsubscribe from mkexstk, send mail to majordomo@list.app.ray.com with 'unsubscribe mkexstk' as the body

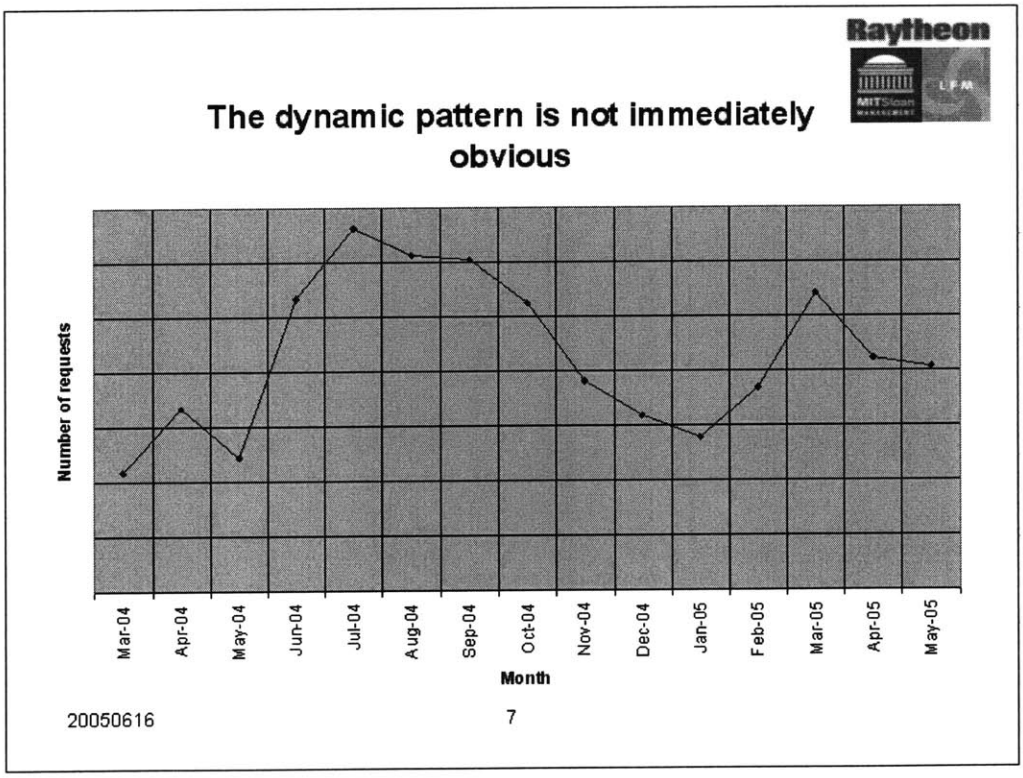
Appendix M: Approximate Project Timeline

Date	Event
Monday, June 6, 2005	Project begins
Wednesday, June 16, 2005	First team meeting
Tuesday, August 23, 2005	Team brainstorms for the vision statement
Thursday, September 1, 2005	Meeting with Sourcing manager to request an additional Sourcing resource
Friday, September 2, 2005	Request made to CSC for quote on RTD enhancement
Wednesday, September 7, 2005	Expressway Warehousing begins asking all parts chasers to record expedite requests in the web app
Monday, September 12, 2005	Meeting with GDT introducing the modified slack-time dispatching process
Tuesday, September 13, 2005	GDT begins working to the modified slack-time dispatching process
Monday, September 19, 2005	New "Why" and "GLA" fields added to the web app
Monday, September 26, 2005	CSC gives a quote for the RTD Enhancement. I&T manager gives go-ahead on RTD Enhancement.
Thursday, September 29, 2005	IQC manager agrees to try the modified slack-time dispatching process
Friday, September 30, 2005	Meeting with McKinney and Expressway QC supervisors introducing the modified slack-time dispatching process. Expressway QC supervisor agrees to try the new process.
Tuesday, October 4, 2005	Request for the RTD enhancement receives stakeholder approval and is added to CRB (Change Review Board)
Wednesday, October 5, 2005	Meeting with Expressway QCs introducing the modified slack-time dispatching process.
Thursday, October 6, 2005	Expressway QCs begin working to the modified slack-time dispatching process.
Tuesday, October 18, 2005	McKinney Warehousing begins asking all parts chasers to record expedite requests in the web app
Thursday, October 20, 2005	I&T manager states that he wants the modified slack-time dispatching process piloted in McKinney before the project's end.
Friday, October 21, 2005	McKinney QC supervisor agrees to try the modified slack-time dispatching process. Meeting with McKinney QCs introducing the new process.
Monday, October 24, 2005	McKinney QCs begin working to the modified slack-time dispatching process
Friday, November 18, 2005	Code changes complete for the enhanced RTD
Tuesday, December 13, 2005	Meeting with an IDS program manager and his team to discuss the modified slack-time dispatching process
Tuesday, December 13, 2005	Final team meeting.
Thursday, December 15, 2005	Meeting with Sourcing manager regarding our findings.

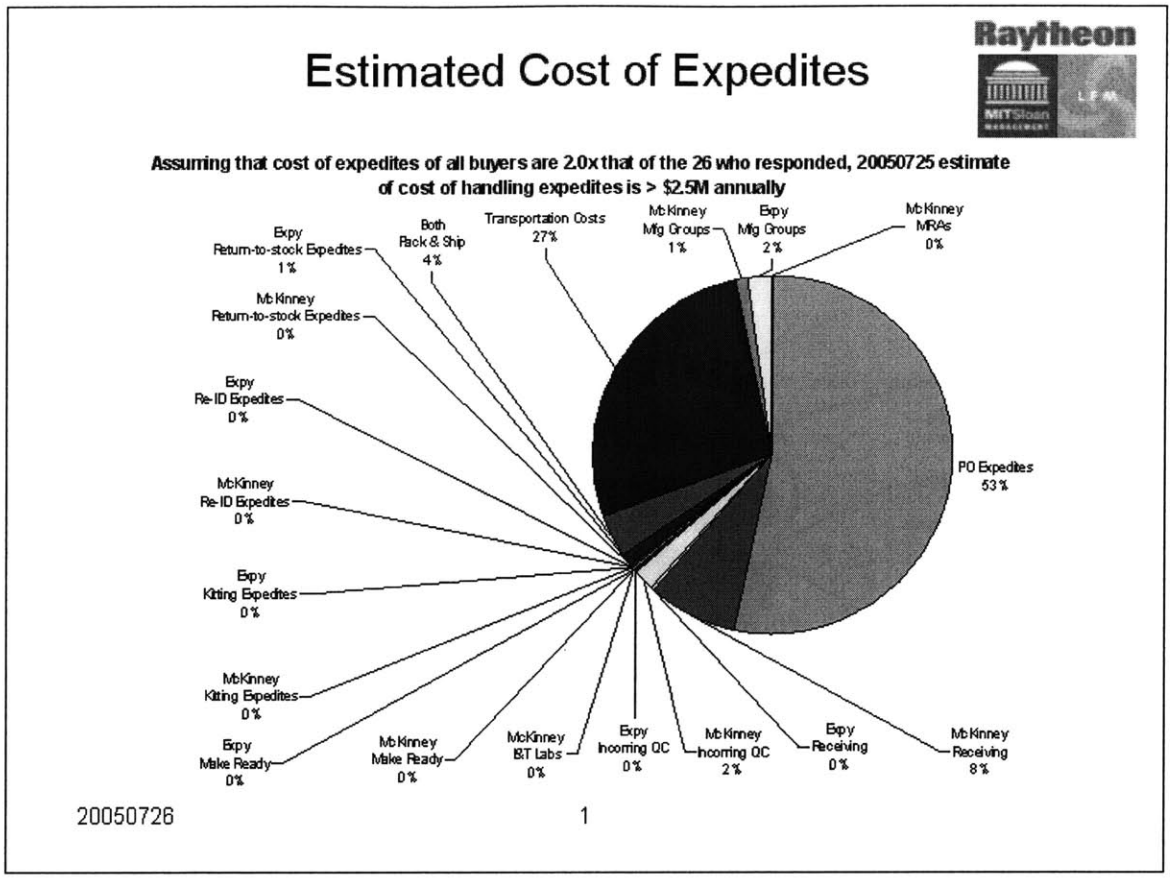
Date	Event
	Sourcing manager agrees to let CSC finish the Expedite Lot Charge report.
Monday, December 19, 2005	Enhanced RTD comes online
Monday, December 19, 2005	Project ends

Appendix N: Sample Slides from the Kickoff Meeting

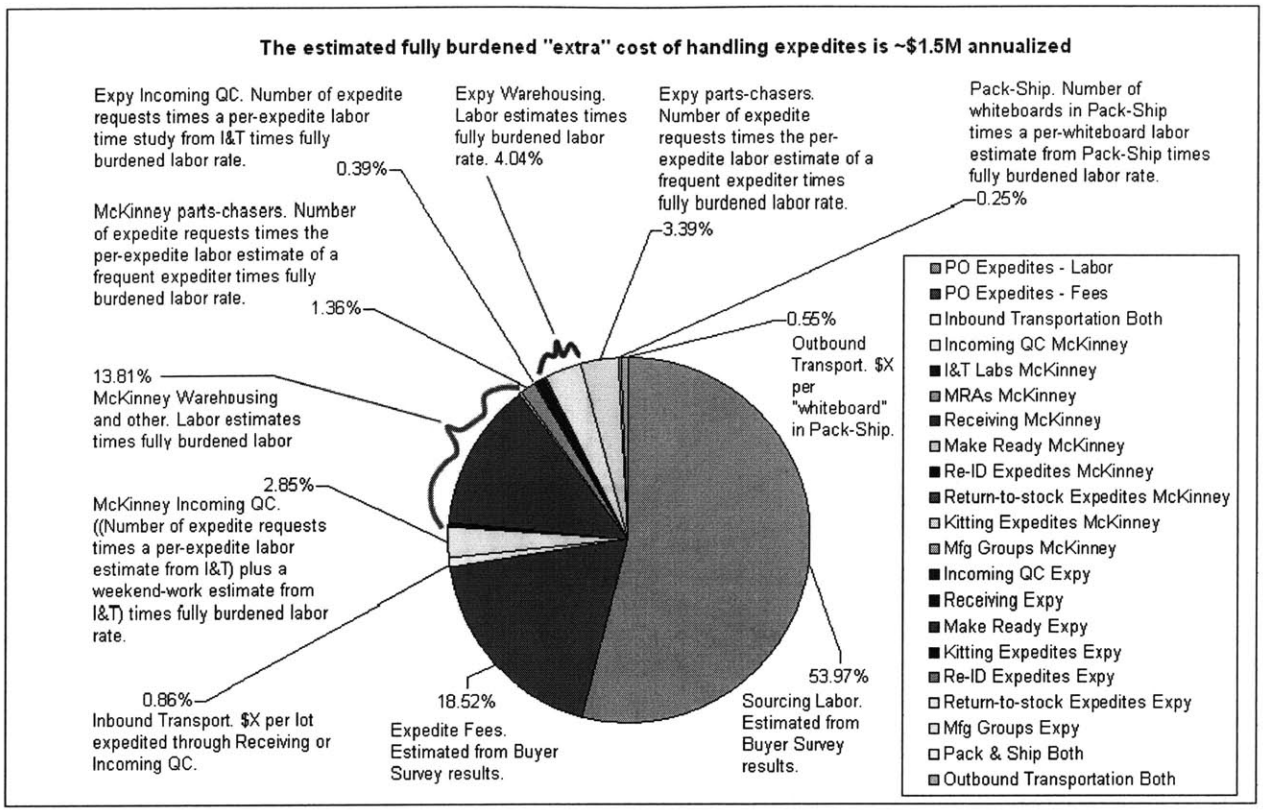




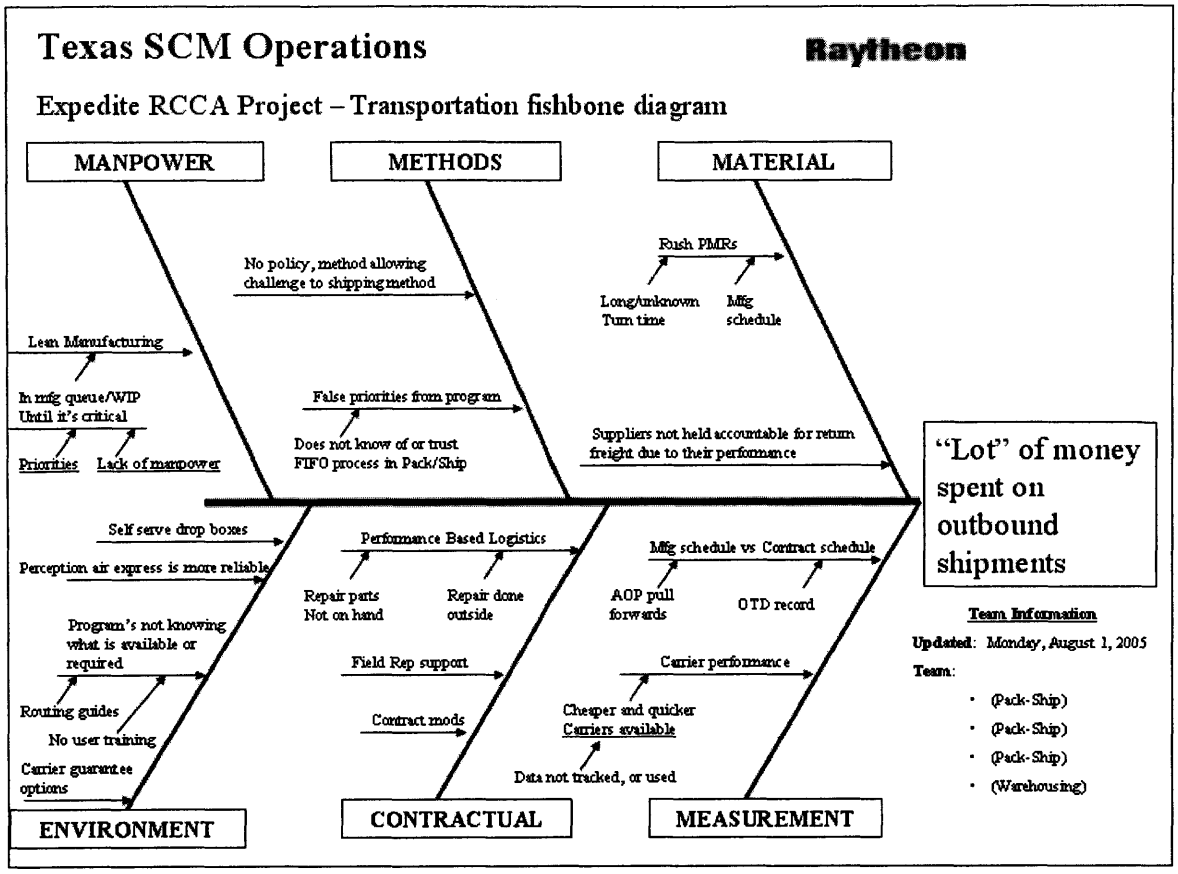
Appendix O: Initial Expedite Dollarization



Appendix P: Final Expedite Dollarization



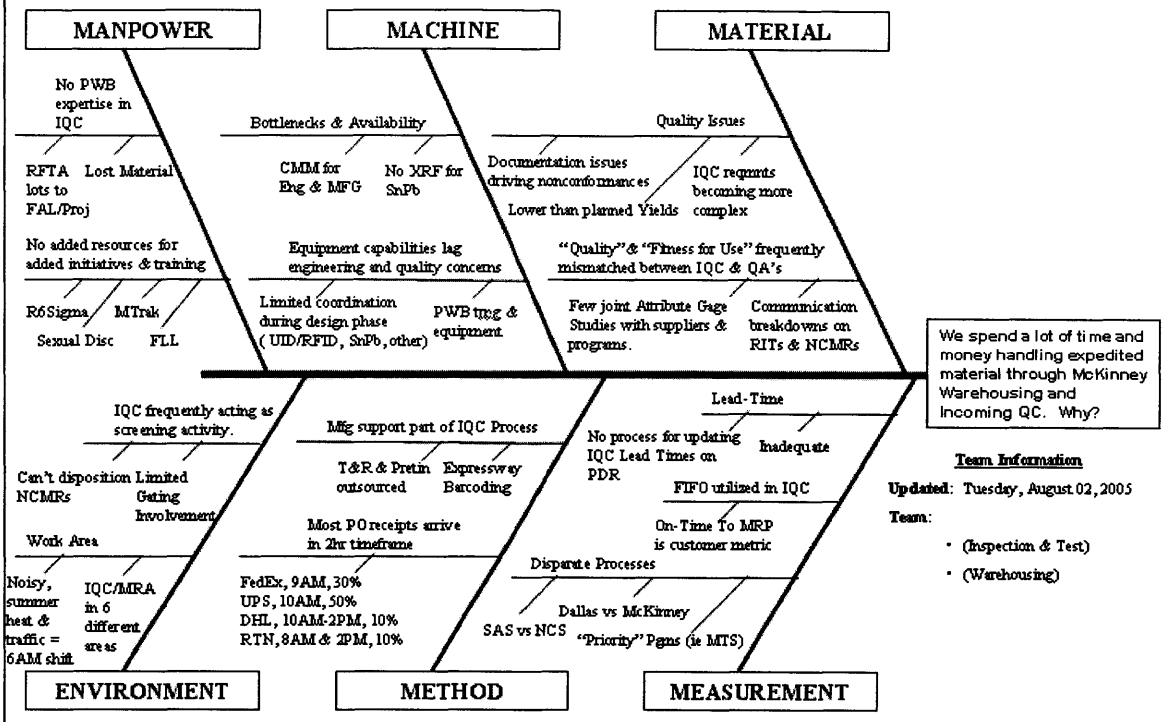
Appendix Q: Fishbone Diagrams



Texas SCM Operations

Raytheon

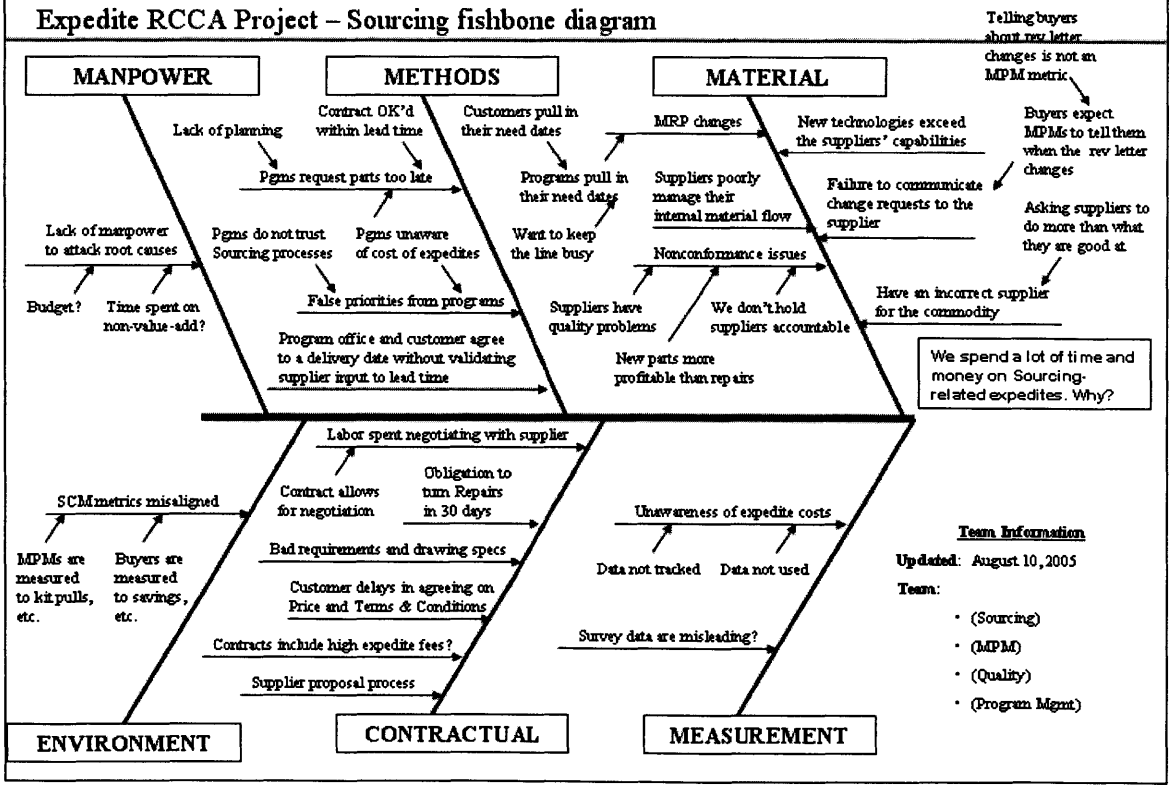
Expedite RCCA Project – Operations fishbone diagram



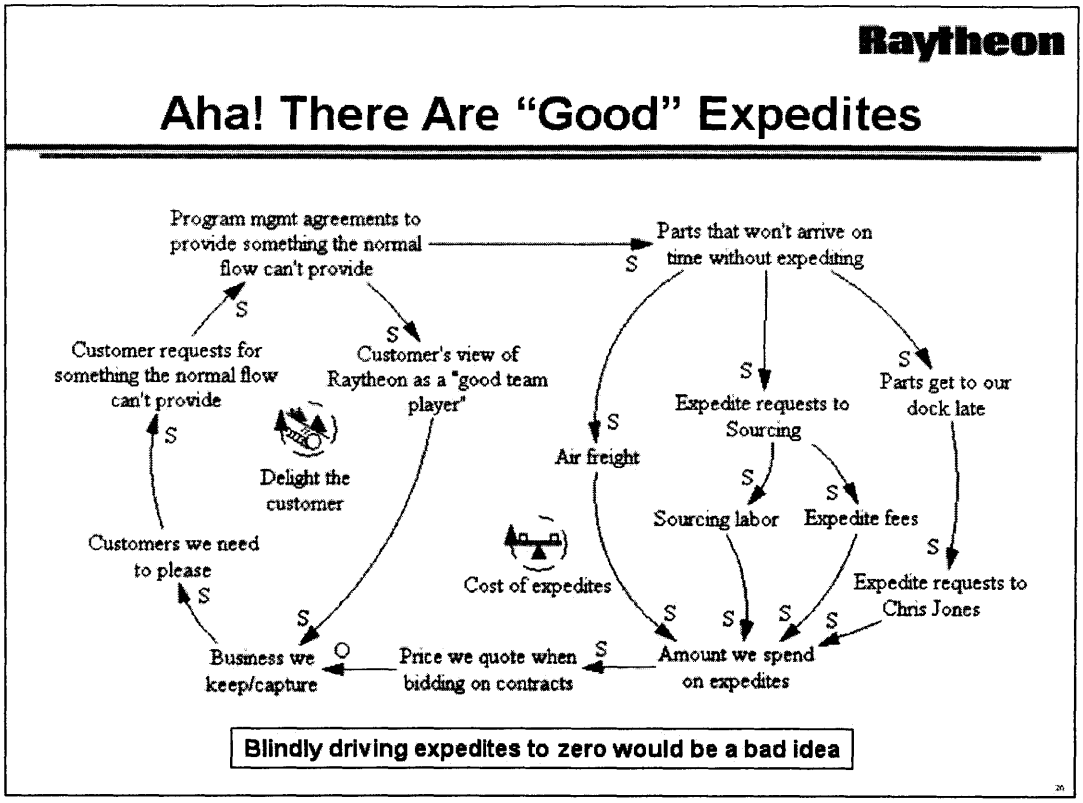
Texas SCM Operations

Raytheon

Expedite RCCA Project – Sourcing fishbone diagram



Appendix R: Causal Loop Diagrams



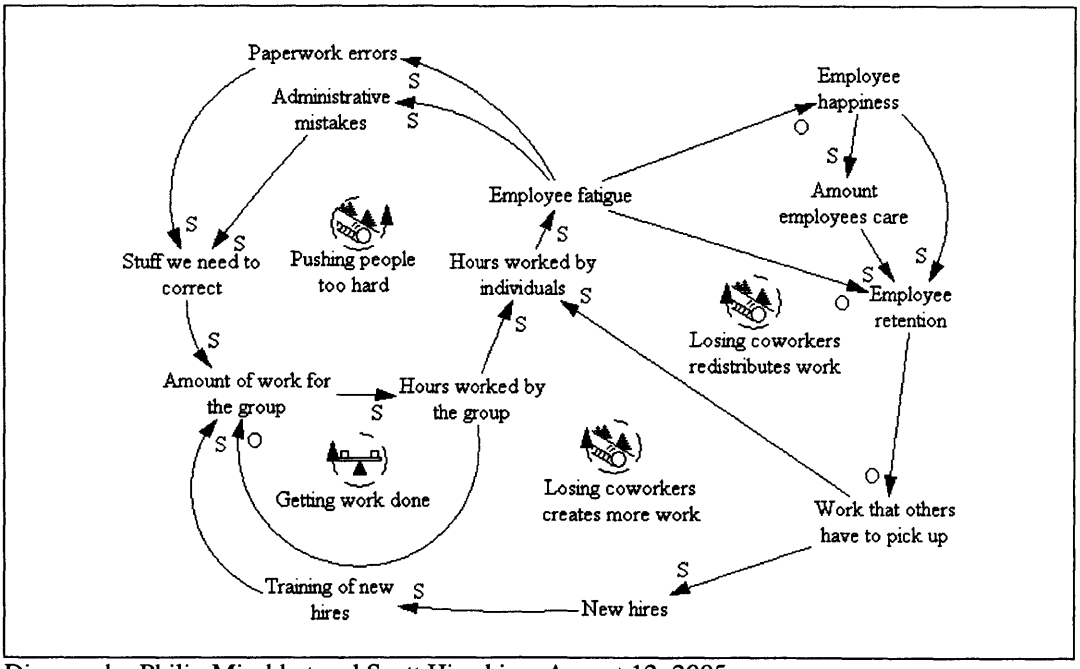
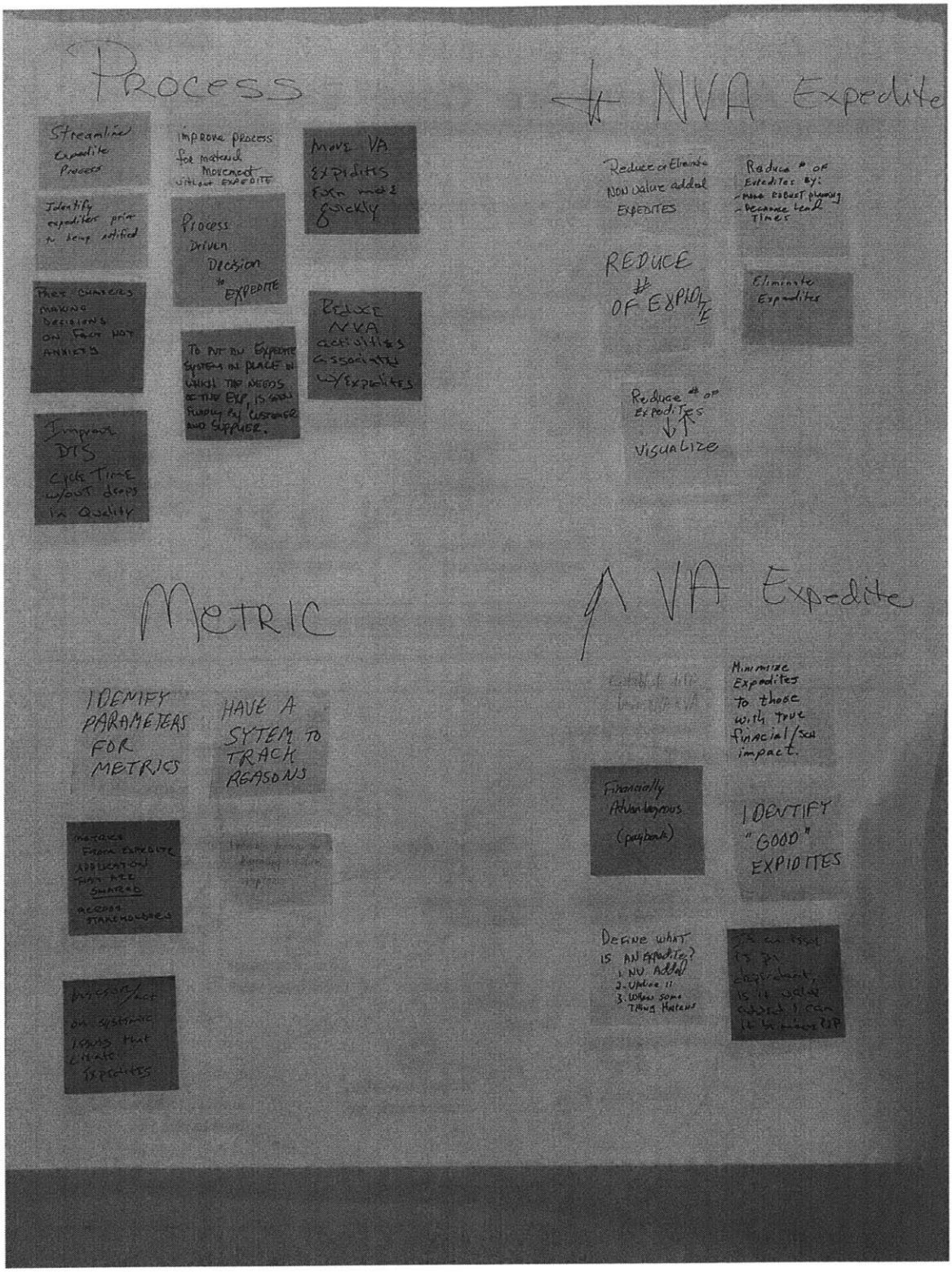


Diagram by Philip Mischkot and Scott Hiroshige, August 12, 2005.

Appendix S: Brainstorming→Affinity Diagrams



Appendix T: New Web App Data Enables RCCA

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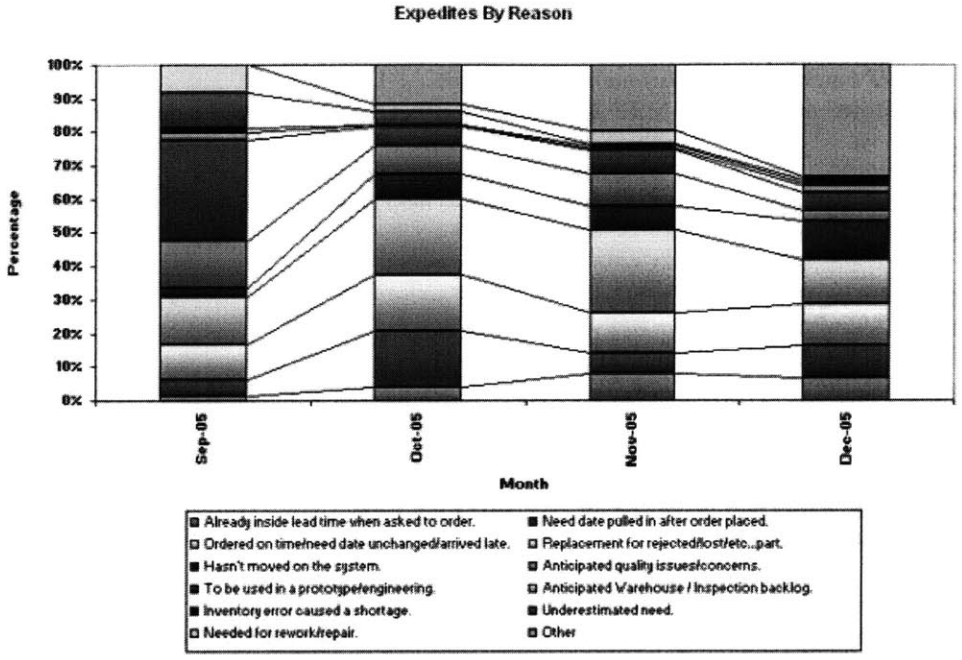
Additional Data Enables Future RCCA



Appendix U: Early Process for Determining "Start By" Dates

Normal Receipts:

1. Go to Operations Data Warehouse logon page.
2. Log on with Directory Services employee number.
3. Click "Acquisition System" (ACQ).
4. Enter Requisition Number from RTD.
5. Click "Search" button.
6. Locate "Proc Code" (Procurement Code).
7. Go to Part Data Record Report.
8. Enter part number/dash number.
9. Click "Search" button.
10. Find "Move" number for that part number/Proc Code.
11. Subtract "Move" number from MRP REQD DATE using the M Calendar to determine MRP "Start By" date.
12. If MRP "Start By" date is within the next ten workdays, then use it as the GDT "Start By" date.
13. If MRP "Start By" date is greater than ten workdays, then add ten workdays to the Receipt Date and use that as the GDT "Start By" date.

Receipts with MRP REQD DATE 99/99/99

1. Open ESN Mainframe.
2. Open MENU screen.
3. Select RSGIMSP
4. Log on.
5. From a clear screen type (/for MRP 316).
6. Input part number and enter.
7. Tab to first purchased part identified by P/P under PRT TYP.
8. Select "s" and hit [F5] key.
9. Find "Move" number under MOV column.
10. Find MRP REQD DATE by checking across the N row for the date with the first requirement. If the first requirement is under PDUE then use the Receipt Date as the MRP REQD DATE.
11. Subtract "Move" number from MRP REQD DATE using the M Calendar to determine MRP "Start By" date.
12. If MRP "Start By" date is within the next ten workdays, then use it as the GDT "Start By" date.
13. If MRP "Start By" date is greater than ten workdays, then add ten workdays to the Receipt Date and use that as the GDT "Start By" date.

Receipts with INV DEPT 47

- Add 10 to the Receipt Date using the M Calendar to determine the GDT "Start By" date.

Links:

http://opsdw.rsc.raytheon.com/logon.asp (Operations Data Warehouse) logon page.

http://opsdw.rsc.raytheon.com/PDR.asp (Part Data Record Report).

The M Calendar can be found from Internet Explorer using this link: \\pclt117\mppopen\2005 M Day Calendar.doc .

Source: "Steps for determining GDT 'Start By' Date.doc," Expedite RCCA Team, September 16, 2005.

Appendix V: Final Process for Determining "Start By" Dates

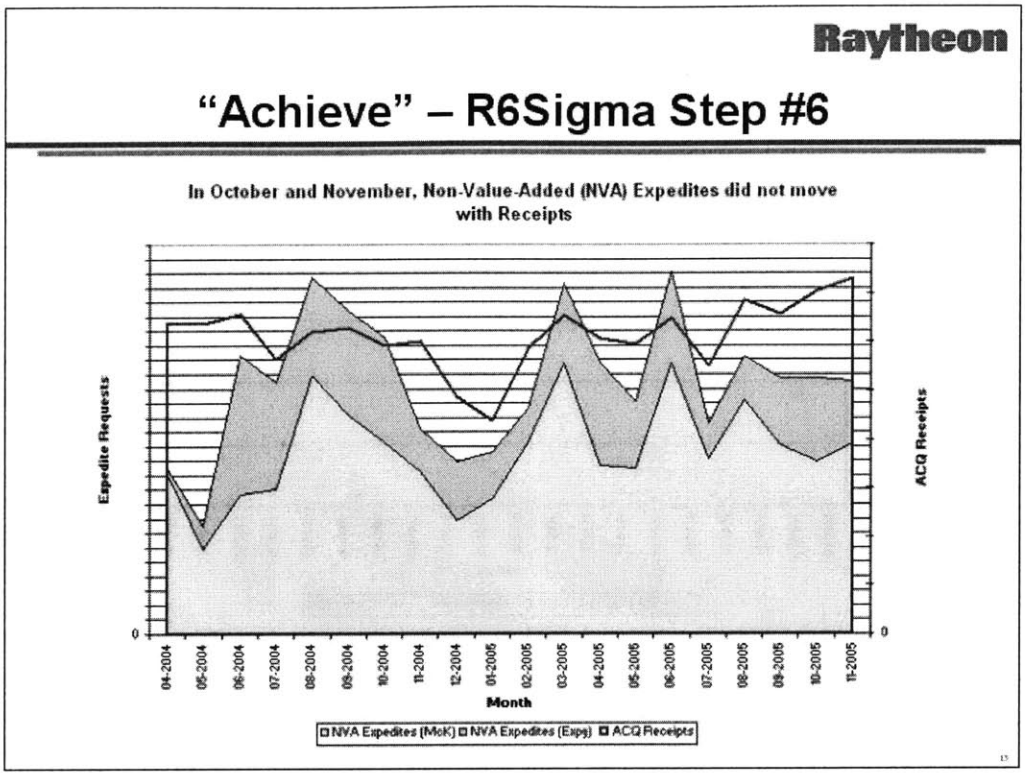
1. If the "Req No" ends in 'R' or 'H' (as opposed to '0'), then write Today's Date on the box.
2. If the MRP REQD DATE is '99/99/99', write Today + 5 Working Days on the box.
3. Look up the Move Days. (Use PDR and ACQ.)
4. Calculate the MRP REQD DATE minus Move Days.
5. Write a date on the box.
   - If MRP REQD DATE minus Move Days is too BIG, write Today + 5 Working Days.
   - Otherwise, write MRP REQD DATE minus Move Days.

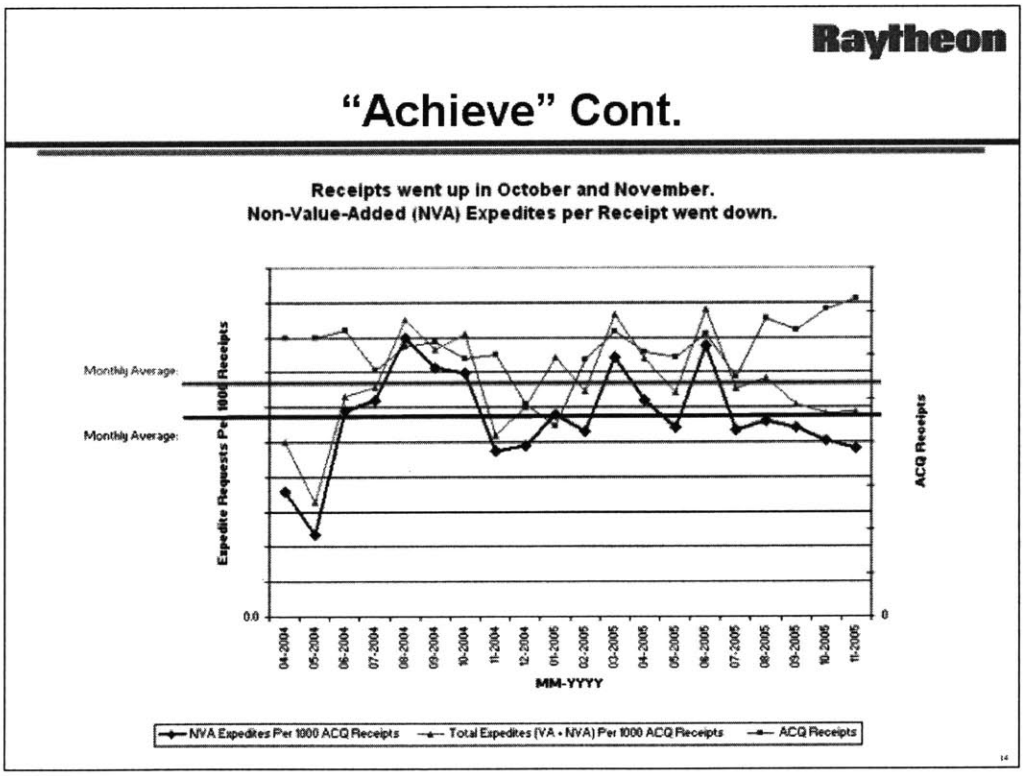
Appendix W: Thoughts behind the IQC Prioritization

The following is the prioritization that the process outlined in Appendix V produces. This list is in priority order, with smaller number receiving higher priority.

1. Material that is holding up the line. Downed lines waste money.
2. Material that should have been started in the past—these will become #1's if we can't make up the lost days.
3. Material that should be started today—these will become #2's tomorrow.
4. 'H' (Engineering use) parts – Since prototyping occurs upstream, saving Engineering a day saves everyone a day.
5. 'R' (Returns) – Some programs are contractually obligated to turn repairs in 30 days.
6. Material that does not have to be started until tomorrow or later. IQC self-imposes that material arriving very early should be started five working days from Receipt.
7. Material that nobody will ever need. (e.g., extra parts bought because of Minimum Buy agreements.) Currently IQC treats these like #6's.

Appendix X: Project Impact

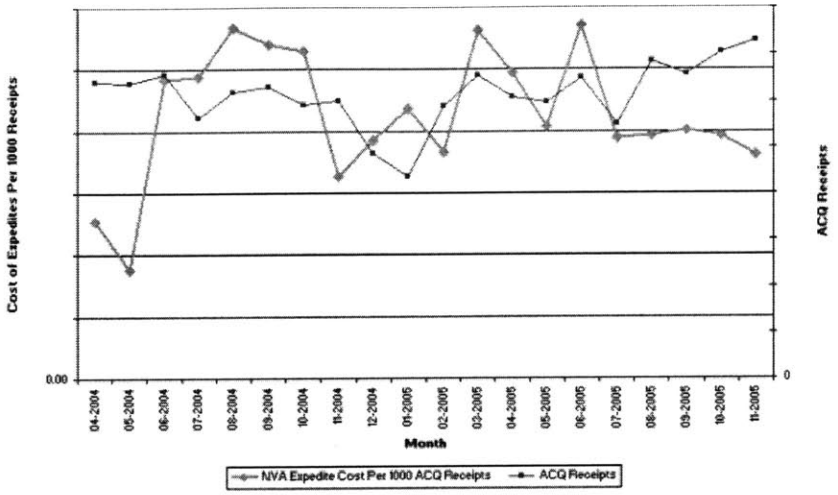




Raytheon

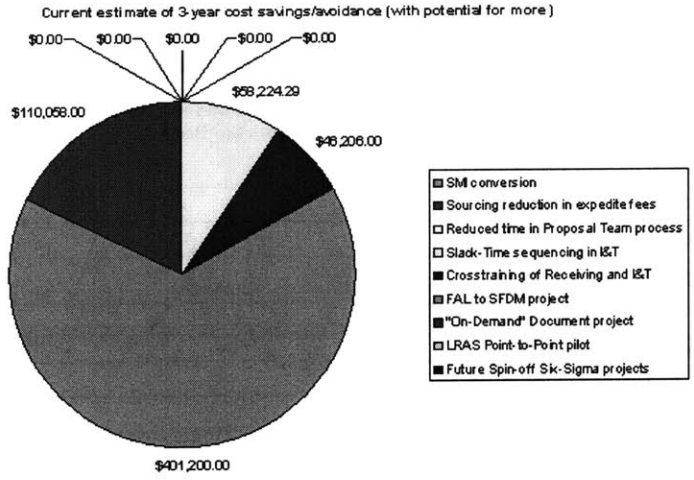
"Achieve" Cont.

Receipts went up in October and November.
Cost of Non-Value-Added (NVA) Expedites per Receipt went down.



Raytheon

Estimated impact: $615,688.29 over 3 years



 2382.32