A STRUCTURED ASSESSMENT SYSTEM FOR GROUPS ANALYZING AGILITY

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EXECUTIVE SUMMARY

This document presents a structured assessment system for use by groups of people who wish to analyze business and business components for Agility, describes examples and results of its usage, and discusses its evolution and testing. Discussion includes application guidelines and lessons learned in group events with people who have mixed or little prior experience at structured Agility analysis. This structured approach includes working forms and templates included here to assist at each stage of the assessment, and specifically analyzes for change proficiency of the targeted subject.

Three actual examples drawn from analytical case work conducted by Agility Forum industry groups in 1995 show diversity of application, and address information systems at Pratt & Whitney, manufacturing processes at Remmele Engineering, and business practices at Boeing Defense and Space. The assessment system is suitable for both private use by internal corporate reengineering teams as well as public use by visiting benchmarking groups. A specific feature of this structured approach is its separation of problem from solution, permitting an analysis of a strategic approach in the clear context of the total opportunity.

Figure 1: Important Definitions

1. Change Proficiency - the competency in which an adaptive transformation occurs.
2. Change Proficiency Metric - the performance item(s) to be measured in order to assign a comparative competency value to change-proficiency: Time, Cost, Robustness, and Scope.
3. Change Proficiency Issue - the item that the metric will be applied to (e.g. formation of partnership).
4. Change Proficiency Measure - Time is measured in units of time, cost in units of money, robustness in predictability and shortfall, and scope in lost opportunities and market innovations.

The assessment system is based on analytical exercises formulated in 1992 to help industry working groups at the Agility Forum explore and discuss the meaning and manifestations of change proficiency - the defining characteristic of Agility. These concepts were expanded and used in 1993 to assess manufacturing operations at a broad level as well as whole market sectors in specific industries, and reported at the 1993 Defense Manufacturing Conference [1]. The approach outlined a set of metrics and structural concepts for Agile business systems and practices based on eight types of change, four metrics for change proficiency, 12 business elements to be analyzed, and ten design principles for making something Agile. The next step after this initial structural understanding was to build assessment procedures that analyzed how a business element conformed to these structural hypotheses.

In 1994, 80 actual cases in six different business operational categories were subjected to this assessment process [2]. In that first year of broad application, ten project leaders guided approximately 150 people through these assessments. The eight change types formed the armature of the assessment process. These "change domains" provided a way to both broaden and deepen the probing and questioning to insure that an assessment group would understand as much as possible about the kinds of dynamic structure the business element was subjected to. Whenever a practice or process was found that intuitively appeared to be Agile, and demonstrated interesting change proficiencies, the assessment process identified and articulated evidence of the 10 design principles hypothesized as enablers for "Reconfigurable, Reusable, Scalable" architectures.

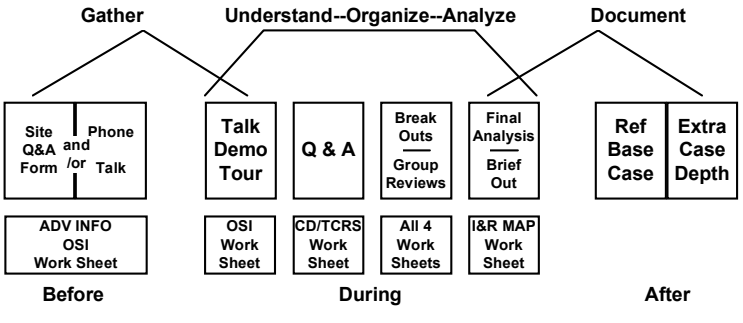
The results of that 1994 activity built a compendium of 80 cases, schooled the ten project leaders in a common process, enlightened 150 or so industry-group participants, tested a standard reporting format, and produced a first approach at structured analysis. Those 80 case reports represented the individual and early understandings of ten different project leaders exploring new territory, and exhibit some diversity of approach. It was evident in reviewing the 80 cases that real value accrued to those who had participated in the assessment experience, but less value was available to the after-the-fact reader.

A more formal process was tested in 1995 in order to insure that the post-analysis written report would capture more of the elements that actually contributed to a case's Agility. Perhaps more importantly, a strong focus was placed on understanding the nature of the change proficiency issues (opportunity/problem) independent of the actual solution being assessed. The "issues" are for the most part generic and can be found in any company with similar practices, the assessment then can gauge a specific solution approach against a general problem. Of course in these early times we are all still learning how to recognize the true nature of the problem. So the assessment process provides double value in that it defines problems as well as analyzing solutions. As might be expected, it is often the case that the problem definition phase discovers issues totally ignored by what was previously thought to be a comprehensive solution.

At this writing there have been over ten applications of this refined process by Agility Forum industry-groups, including assessments at AT&T, Boeing Defense and Space, Gateway 2000, Honeywell Avionics, Kodak, Mazak, Pratt & Whitney, Remmele Engineering, and others, some of whom wish to remain anonymous. Subsequent action by those who have been the subject of these assessments makes it evident that this structured, consistent approach resulted in much higher value to both participants and subjects, and to those that must be brought up to speed on the findings afterwards.

What follows is intended as a handbook for guiding assessment activities. Three case studies are included to show flexibility of application, discuss approaches, and provide a benchmark for case synopsis reports.

Figure 2: Three Phase Process



GROUP ASSESSMENT

The Structured Assessment System (SAS) described here has been effectively used by groups as small as five and as large as thirty. It is specifically targeted at groups of people who do not possess a great deal of prior experience in the assessment process. This system was developed for groups with mixed membership, and is appropriate for industry benchmarking teams composed of people from various companies, as well as internal corporate teams. Though this document constitutes an assessment handbook, an experienced assessment facilitator is required before an assessment team can expect to be effective and successful.

We are focused on change proficiency as a necessary and fundamental enabler for the Agile enterprise; and we recognize that an Agile enterprise can be as simple as a portfolio management company that constantly reshuffles the in-Agile resources it controls, or as complex as a vertically integrated organization concerned about the Agility of each of its constituent operating units, which in turn are concerned about the Agility of each of their key business systems and practices. As a result, the assessment system can be properly aimed at any element or sub-element of business, or even the entire business.

To show breadth of application as well as personalization of style, we include documentation from three actual assessment activities that were carried out in three different working groups at the Forum: Agile Business Practices, Agile Information Technology, and Agile Operations [7]. Other working groups conducted assessments that in some instances used close variants of this system, like Agile Accounting Practices [8] and Agile IPPD [10], and in other cases used something customized specifically for the focus of the group, like Agile People.

SAS is a generic approach to assessment regardless of the subject being investigated: it focuses attention solely on change proficiency issues, it requires that the change issues be defined, and it requires that the assessed practice or system be measured against the change issues. For sure there are other things to assess and monitor besides change proficiency, like emotional satisfaction of the employees, profitability of the business, market valuation of the company, customer quality perception and the like; even very focused measurements like cycle-times or utilization factors. But this is an assessment procedure focused solely on change proficiency. Note that we are most interested in timeless change proficiency, and not in specific approaches, like teaming, or empowerment, or partnering, or the many other things that appear to help change proficiency in today's environment but may not be the best approaches tomorrow.

There are other assessment approaches [3,11] and system-models [9] in earlier stages of development that will look beyond change proficiency to measure progress and static/dynamic properties.

For special situations the Agility Forum utilizes a variant of this SAS process specifically tailored for professionally facilitated private groups - where the members of the group share a common set of corporate goals and value the assessment process as one which will lead to actionable insight, strategic planning, and implementation.

A REVIEW OF NECESSARY FOUNDATIONS

The assessment system employs concepts about change proficiency that must be familiar to each participant in a group assessment activity - at least to the degree that they wish to participate as opposed to observe. These concepts are briefly covered in subsequent sections.

ASSESSMENT CASE REPORTS

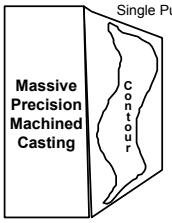
Whether you conduct a structured assessment with an internal group, or participate while hosting an external group, there are values that can be leveraged beyond the participant's learning experience.

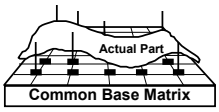
Figure 3: Partial Example of Assessment Report

Agile Practice

Modular Body-Panel Check Fixtures

	Hard Fixtures	Benefits	Pittsburgh Universal Holding Device
Create:	$70,000	Cost	$3,000
Create:	37 Weeks	Time	1 Week
Use:	4 Parts/Hr	Time	40 Parts/Hr, 3.5 Min. Set-Up
Create:	20% Rework	Robustness	1%Rework, Easy Modification
Use:	100% Accurate	Robustness	100% R&R Accuracy
	60% Predictable	Scope	100% Predictable
	Restricted Use	Scope	Innovative Uses
	Single Purpose	Scope	Opportunistic





Features

No	Reusable	Base, Retainers
No	Reconfigurable	Retainers, Details
No	Scalable	Details/Part, Parts/Facility

Patented by General Motors, contact Joe Pelan, 412-469-6571, GM Pittsburgh Metal Center.

The General Motors Pittsburgh stamping plant specializes in small-run, high-variety, service parts such as hoods, quarter panels, doors, and other stamped and welded metal fabrications. Small quantity orders stress traditional operating modes for profitability, while high variety stresses tool and die management and manual operations.

Body panel check fixtures presented a particular problem to this plant: 700 plus fixtures, with more coming, required a prohibitive amount of storage space. The financial climate did not permit a capital intensive high-technology solution but relief had to be found.

The plant invented a modular fixture scheme that utilized a common grid-work base plate with part-specific holding "details" that snapped into "retainers". Details could be machined in-house quickly and inexpensively, and then stored in a shelved shoe-box sized tray.

Unplanned, this space problem solution offers a variety of valuable Agile benefits for GM's traditional stamping and assembly plants.

(Explanation details would continue in a complete description.)

RRS System (Reusable, Reconfigurable, Scalable):	
Framework:	Common base plate with retainer grid.
Modules:	Retainers, Details.
Key Change Issues:	
Creation/ Deletion:	Make new checking fixture. Make duplicate checking fixture.
Expansion (Capacity):	Parts checked per hour.
Addition (Capability):	Both CMM and manual measurement alternatives. Check at point-of-production and point-of-assembly.
Reconfiguration:	Construct different fixture from common parts. Change facility storage location. Change plants.
Migration:	To laser CMM. To automated creation and set-up.
Variation (Performance):	Set-up for different part.
Augmentation (Improvement):	Reliability and repeatability.
Correction (Recovery):	Broken/bad/lost check fixture.

A structured assessment activity is a productive way to discover both mature and fledgling Agile practices within an organization. Assessment reports then provide a corporate diffusion mechanism and business case foundation for more of the same, heighten the general appreciation for RRS (reconfigurable, reusable, scalable) system values, standardize a digestible communication format, and illuminate the bottom line values of Agility. Of course exposing an Agile practice assessment report across a corporation also celebrates and encourages meritorious contributions.

Good places to find Agile production practices, for instance, are in stressed plants -- those with space constraints, variety and lot-size extremes, short lead-times, quick response requirements, etc. Another good hunting ground is in those plants that accomplish major change activities better than others - the ones that meet capacity fluctuation demands and carry out new model introduction, new product start-ups, and facility reconfigurations predictably.

Agile practices can be identified, evaluated, and communicated by applying the structured assessment system and producing a common-format report afterwards that summarizes the change proficiency issues and the related responses. The "Pittsburgh Universal Holding Device" in Figure 3 illustrates this concept.

The top of Figure 3 summarizes a comparison of before-and-after change-proficiency metrics. This comparison highlights the dramatic difference in cost and time to develop a new fixture, promising cost reductions across the corporation as well as shortened develop cycles and new innovative uses.

Scope is the metric that gauges breadth of potential applicability. Some of the innovations possible with this approach might include temporary fixturing, set tooling, match checking, and high frequency part verification. New opportunities are enabled for partial production checks, checking at production as well as assembly points, and duplicate fixtures at different locations.

At the bottom of Figure 3 is a table that summarizes the key change issues associated with the life cycle of a checking fixture. Importantly, the top of this table defines the specific system we are focused on in terms of its framework and modules. Experience has shown that this defining process helps to keep the change issues focused on the system in question and not on its environment.

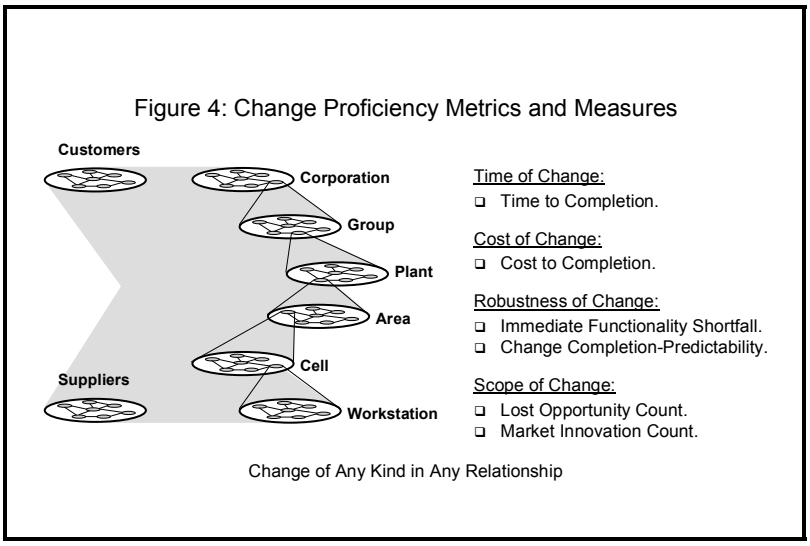
For instance, this particular table does creep outside the fixture architecture system and into the fixture's environment when it offers relocation of fixture and storage as reconfiguration issues, and when it offers multiple use points as a capability issue. These two are actually issues in a system where portable tools are the modules and plants, processes, and facilities are the frameworks. The issues are valid and well dispatched with this fixturing approach, but correctly belong in an analysis of a higher level system. We have included this confusion to illustrate a common (but generally inconsequential) mistake that arises with inexperienced analysis groups.

This example also illustrates an important feature of truly Agile practices: They can be introduced to the existing environment without disruption, and easily migrate to stronger and more pervasive forms over time. The Pittsburgh example is meritorious in that it requires no special expertise or new technology, nor does it require an investment and payoff period of any significance. When capital investment and sophistication are permitted, the concept can be extended with new technological solutions that automate the fixturing set-up and employ laser Coordinate Measuring Machines. Change proficiency must be taken in context: though check-fixturing with more sophisticated technology may offer more significant benefits in a high-volume environment, cost prohibits usage here.

CHANGE PROFICIENCY METRICS

Completing a change in a timely manner is the only effective way to respond at all in an environment of continuous and unrelenting change. The time of a change can be likened to the time-to-market of a new product: that time associated with product and process design and implementation that results in a deliverable cash transaction, including the formation and management of effective customer and supplier relationships. But the **time** of change alone does not provide a metric for agility.

If the cost of change is too much relative to a competitor's costs, there will be a steady erosion of working capital, or at least a higher tax on shareholder profits. Change at any cost is not viable. The **cost** of a change is the cost required for completion; or in our new product example, the cost-to-market for that first cash transaction.



Quick, economical change, however, is still not a sufficient profile for proficiency. If corners are cut in the process of changing in order to do it quickly and economically, the result is fragile. Continuing with the new product metaphor, though new products may be rolling off the line, neither the product nor the process design is rock solid in the early days of delivery. There is some rework and scrap beyond desired levels. During this early period there is a functionality shortfall, and generally poor quality-level predictability. **Robustness** measures the strength and competency (quality) of the change process. It can be measured in the same ways that product quality is measured: by customer satisfaction polls, by degree/amount of shortfall, etc. Robustness is a statement about the ability to predict the satisfactory completion of a change activity. How often is a change activity on time, on budget, on spec? Or at least within acceptable variances of original predictions.

Finally, something is considered Agile because it can thrive in the face of unpredictable change. Change is a transitional term that implies a starting point and some new ending point. How far away can the ending point be from the starting point? The dimension of **scope** addresses this question. Scope is an indication of how much latitude for change we can competently accommodate, and is indicated in the history of innovations and lost opportunities. It can be difficult to measure precisely, especially if there is no history. Lost opportunities are those events that arise which could provide some useful advantage but are declined - no matter the reason. An innovation, on the other hand, is a self-initiated change that provides some useful advantage.

Important definitions for metrics are summarized in Figure 1.

EIGHT TYPES OF CHANGE

In the early days of the Agility Forum, industry focus groups had trouble assessing the impact of change on business systems and practices: the concept was too large to get a focused discussion in a two-day workshop environment. What evolved from those early frustrations was a decomposition of the change concept into eight change domains that facilitated a bite-sized discussion with a specific focus.

The change domain approach was initiated as a structured way to guide a group of people through a thought process, a workshop tool to help focus people so that they could think in broad terms about many aspects of change. The approach helped expand working discussions by structuring the focus of questions, and evolved into a tool for structured assessment.

Figure 5 on the following page shows these eight change domains and gives examples of how they might be applied to identify supply-chain management issues. There are many more examples in the references and in subsequent sections.

Figure 5: Sample Change Issues for Supply-Chain Management

Change-Proficiency Metrics Identified as Time [T], Cost [C], Robustness [R], and Scope [S]

Change Type	Typical Issues
Creation/Deletion	Issues that involve the development of something new where nothing was before, or the dissolution of something fundamental. Prime metrics typically progress through time [T], cost [C], robustness [R], and scope [S] as an organization becomes more mature at change accommodation. Supply-chain examples include the development of a completely new network (perhaps upon entering a new market or securing a new major program contract), forming a new integrated development team with supplier representation, or reaching a new contractual agreement.
Addition/Subtraction (Capability)	Issues that involve unique modifications to something that already exists, either in the adding of something unlike anything already there or in the complete elimination of some unique portion. Typical supply-chain examples might include the addition of a few non-competing suppliers to an existing network, integrating a new uniquely-qualified participant into an existing IPD team, or eliminating troublesome clauses from an agreement.
Augmentation (Improvement)	Issues involved with continuous, incremental improvement of existing practices and relationships. Prime metrics tend to be robustness [R] and scope [S] in that important things too often cannot be improved without inappropriate risk, or "cannot" be improved at all (for whatever reason). For those things that are perceived as improveable, time [T] is generally the prime metric. Typical supply-chain issues are cost, quality, and speed of delivered product.
Migration	Issues that arise as new infrastructure of supporting processes and practices replace older ones. Prime metrics are often robustness [R] and scope [S]. Typical supply-chain examples today include the transition to new quality standards or programs (ISO-9000), upstream migration of design participation and responsibility, and electronic inter-enterprise integration.
Expansion/Contraction (Capacity)	Issues involved with quantity changes, when either more or less of something that already exists is more appropriate. Prime metrics are often time [T] and scope [S]. Typical supply-chain examples include the gaining or elimination of second-sources or the accommodation of a product demand surge.
Reconfiguration	Issues involved with re-ordering or re-relating a set of existing elements and their interactive relationships. Primary metrics are often time [T], cost [C], and robustness [R]. Supply-chain examples include re-assignments of first- and second-source roles, insource/outsource assignments, and tier re-assignments in a multi-tier chain.
Variation (Performance)	Issues among the normal course of operational performance that require unscheduled (or new schedule) accommodations from time to time. Prime metrics are generally time [T], cost [C], and scope [S]. The typical variation issue within established supply-chain relationships is the engineering change, but might also include such things as periodic blanket order releases, and varying order configurations.
Correction (Recovery)	Issues arising because something ceases to function as expected. Generally the prime metric is the time [T] it takes to correct the situation and recover. There are also cases where the cost [C] of recovery can be equally important. Typical recovery issues in supply chain situations include failure of a supplier or customer (for whatever reason) to live up to expectations and commitments, failure of a contracting document (for whatever reason) to serve the parties to the contract, and failure of a relationship to be useful under evolving circumstances.

RRS STRUCTURAL CONCEPTS

Whether we are assessing Agility in physical sub-systems, like those found in production, or in softer enterprise systems like knowledge management or innovation management, or assessing at the total enterprise level, we look for underlying system-design characteristics that enable change proficiency. Behind any system that is assessed are "business engineers" responsible for the system's design - whether these systems were designed consciously or unconsciously.

The adaptability of an enterprise system is determined by the nature of its design. The structured assessment system builds on prior work that has identified ten design principles, tabulated in Figure 7, that appear to promote adaptability, and encourages the assessment group to look for instances of these principles.

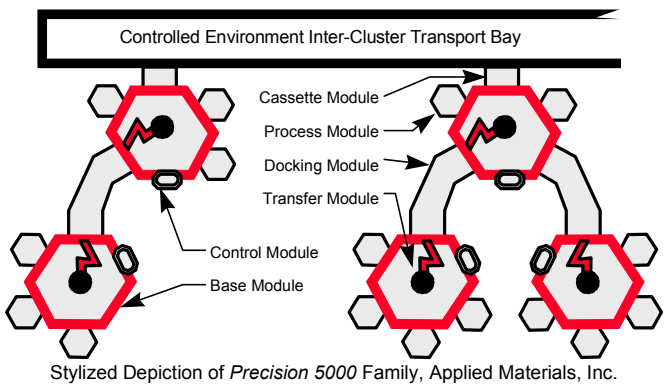
Figure 6 shows three highly adaptable systems at different levels in the production arena that all exhibit similar manifestation of these principles. The common principles employed in these three systems are discussed in some detail elsewhere [4], but are summarized in the Figure 7 table.

Adaptability (Agility) became a reasoned focus in the early '80s. Integrated software systems, whether in the accounting area, providing management decision support, or spread over countless factory computers, are the creation of a team of programmers and system integrators. These people also have responsibility for ongoing maintenance and upgrade during the life of the system. In short, the integrated software system is the product of intentional design, constant improvement, and eventual replacement with the cycle repeating.

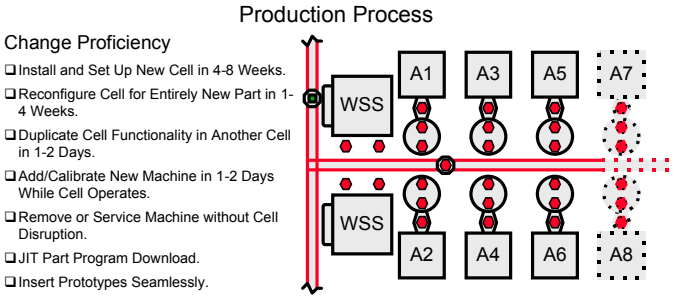
Few would disagree that information automation systems are critical infrastructure support for an Agile operating environment. But what will make the information system itself Agile, so that it can continue to support an Agile operating environment rather than guarantee its obsolescence? Are there fundamental characteristics that provide Agileness that we can look for in selecting information automation systems?

As engineering efforts, the design and implementation of these integrated software systems proceed according to an "architecture", whether planned or defacto. Over the

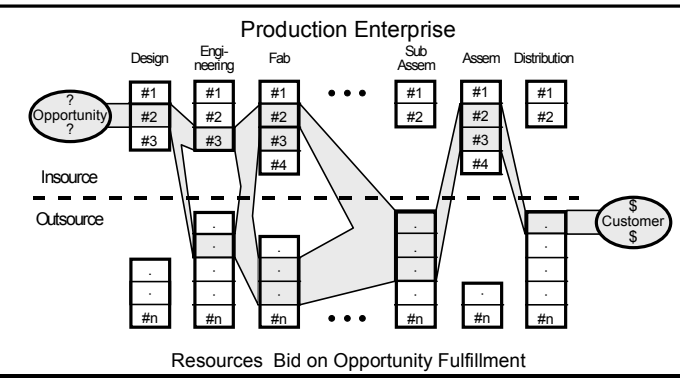
Figure 6: Production Examples of RRS Design Principles



Stylized Depiction of *Precision 5000* Family, Applied Materials, Inc.



Concept Based on LeBlond Makino A55 Cells at Kelsey-Hayes



Resources Bid on Opportunity Fulfillment

years the size and complexity of these systems grow to a point where traditional techniques are recognized as ineffective.

The problem stems from dynamics. Traditional techniques approach software design and implementation as if a system will remain static and have a long and stable life. New techniques, based on "object oriented" architectures, recognize that systems must constantly change, that improvements and repairs must be made without risk, that portions of the system must take advantage of new sub-systems when their advantages become compelling, and that interactions among subsystems must be partitioned to eliminate side-effects.

These new approaches have been matured over a decade now and are emerging most visibly into everyday employment under the name client-server architecture. Though there are significant differences between systems concepts called client-server and those called object-oriented, “encapsulated” modularity and independent functionality are important and shared key concepts. More to the point, information automation practitioners are now focusing a good deal of thought on the architectures of systems that accommodate change; providing a rich laboratory and experience base from which fundamental Agility principles are beginning to emerge.

The ten “RRS” (Reconfigurable, Reusable, Scalable) principles tabulated in Figure 7 are based on object-oriented concepts augmented with understandings from production and enterprise systems exhibiting high degrees of adaptability. A human resources director might feel more comfortable with "empowered work team" than with "encapsulated modules", though the two are similar architectural concepts. Similar concept translations need to be made for accounting, purchasing and other areas of business without engineering and computer jargon.

Figure 7: Agile Reconfigurable-Reusable-Scalable (RRS) Design Principles

RRS	Design Principles	Production Equipment (Cluster Machines)	Production Process (Agile Machining Cell)	Production Enterprise (Enterprise Job Shop)
Reconfigurable	Encapsulated Unit Modularity: System of interacting units not intimately integrated. Internal workings unknown externally.	Wafer transfer module, various process modules, docking module, cassette transfer module, utility-base module.	Machines, work-setting stations, pallet changers, fixtures, rail-guided vehicles.	Design, engineering, fabication, sub-assembly, assembly, and distribution resource modules.
	Plug Compatibility: Units within the system share a standardized compatible interaction and interface framework.	Common human, mechanical, electrical, vacuum, and control system interfaces.	Common human, mechanical, electrical, and coolant system interfaces. Common inter-module mechanical interfaces.	Common info system and procedures among captured corporate resources, common interface in outsourcing contracts.
	Facilitated Unit Reusability: Standardized unit replication information, unit modification tools, unit capability catalogs.	Machine manufacturer extends/replicates module family for new capabilities. Fast module-swap maintenance is facilitated.	Machines do not require pits or special foundations, and are relatively light and easy to move.	Corporate outsourcing department maintains pre-qualified pool of potential outsources.
Reusable	Non-Hierarchical Interaction: Empowered self-directed units communicate, negotiate, and interact directly among themselves.	Processing modules decide how to meet part production objectives with closed-loop controls.	Complete autonomous part machining, direct machine-repository download negotiation.	Business unit resources free to bid on internal jobsand external jobs.
	Dynamic Late-Binding Relationships: All relationships are transient when possible; fixed binding occurs as late as possible.	Machine custom configured with processing modules at customer installation time.	Machines and material scheduled in real-time, downloaded part programs serve individual work requirements.	Individual business unit assigned to opportunity fulfillment at last possible moment.
	Distributed Control & Information: Units respond to objectives, decisions and data retained locally but accessible globally.	Intelligent process modules keep personal usage histories and evolving process characterization curves.	Part programs downloaded to machines, machine history kept in machine controller, machines ask for work when ready.	Enterprise integration information system queries data bases local to the busines unit.
	Self Organizing Relationships: Dynamic unit alliances and scheduling; open bidding; and other self-adapting behaviors.	Real-time control system makes use of processing units available at any given time, scheduling and re-routing as needed.	Cell control software dynamically changes work routing for status changes and new or removed machines on the fly.	Bid-based production-flow alliances.
Scalable	Scalable Size: Unrestricted unit populations that allows large increase and decrease in total units.	Machines can be interconnected into larger constant-vacuum macro-clusters.	Cell can accommodate any number of machines and up to four work-setting stations.	Outsourced resources can be easily added or deleted to increase the population of production modules with no size restrictions.
	Unit Redundancy: Duplicate unit types or capabilities that provide capacity fluctuation options and fault tolerance.	Machine utility bases are all identical, duplicate processing chambers can be mounted on same base or different bases.	Cells have multiples of each module, all cells made from same types of modules, machines have full work functionality.	Multiple duplicate production resources and second-outsources.
	Extensible Framework: Evolving, open system framework accommodates legacy, common, and completely new units.	Base framework becoming standard across vendors, and has accommodated processing technology across generations.	Utility services and vehicle tracks can be extended without restrictions imposed by a cell or its modules.	Enterprise integration Information system is open architecture, client-server based.

COMMON DIFFICULTIES TO WATCH FOR

All of these difficulties can be overcome by an experienced assessment leader easily enough. They are mentioned here to help hasten their demise. In general, mixed-group assessments include people who haven't spent the time to learn (or haven't been exposed to) what the concepts are really about in advance. The words used to describe many of the assessment concepts are common words that trigger pre-conceived meanings in the uninitiated. It is useful to conduct a brief discussion in advance about these difficulties, and it is useful to watch-for and discuss these difficulties when they manifest themselves later, as they generally do.

Difficulties stem from the fact that these assessments are learning experiences for people relatively inexperienced in the assessment process, and also from the fact that groups are frequently composed of people not from the same organization. This is compounded in workshop series that have some continuing membership but also accept new participants at random, resulting in a mixed experience level. Time spent explaining the assessment process and tools makes the old-timers impatient, and when done too quickly or not at all frustrates the new initiates.

The value of the assessment exercise to participants is directly related to their understanding of the methodology. These are 2-day assessments that will generally end on schedule no matter how long they take to get started. Experienced group leaders have found ways to "educate" new participants separate from activities involving the more experienced members, who want to maximize the time applied to discovery and assessment. Some have run education breakout sessions in parallel to analysis breakout sessions, bringing the group back together when the first review occurs on the first of the two-days. Others have had success with an indoctrination dinner meeting the night before.

Commonly, even with some experience, people forget that change proficiency metrics are targeted at measuring competency at change. Thus, the "cost" metric specifically applies to the cost of making a change and not the new improved cost of a product after a change has been made. Similar lapses occur with the other three proficiency metrics.

Even those with some experience too often take a quick and conventional meaning to the change domain words. For instance, "migration" has sometimes been interpreted as the moving of pieces of equipment around in a facility, when in fact it refers to fundamental paradigm shifts in operating procedures that can be anticipated. For instance, an organization might anticipate migrating toward team-based operating styles over many years, or anticipate the migration of the information system from mainframe architecture to client/server architecture. Other change types sometimes confuse the occasional user as well; but in general it is more important that the change issues get identified than that they be classified precisely in these mixed-group assessments.

Another common difficulty arises when an assessment team does not clearly demarcate the "system" under analysis. Many good issues may be collected in a single change proficiency table that in fact apply to multiple systems. Though the participants are all more sensitized to Agile issues as a result of the exercise, cause and effect relationships are not clear when this occurs.

Mixed-groups can sometimes be difficult to herd in a common direction, especially when strong willed people have a preconceived agenda for the site assessment. The assessment procedural structure can be used to keep them on track. Make sure the process reaches conclusion during the 2-day workshop no matter what, and make sure it touches each of the analysis steps. Anything short of this will leave the serious participants unfulfilled.

Figure 8: Refined General Agenda

Day One:		Day Two:	
1.5 Hr:	Intro and Present Goals/Tools/Process	1.0 Hr:	Short-List Issues Discussion (WS#2)
0.5 Hr:	Host: Overview Presentation	1.0 Hr:	Parallel Breakouts (WS#3)
2.0 Hr:	Host: Demo, Tour, Depth Presentation	1.0 Hr:	Group Review (Key Issues/Metrics)
		1.0 Hr:	Response Strategy Discussion (WS#3)
1.0 Hr:	(Lunch)		
		1.0 Hr:	(Lunch)
1.0 Hr:	Open Q&A (WS#1)		
1.0 Hr:	Initial Data Organization (WS#2)	1.0 Hr:	Parallel Breakouts (WS#3 & WS#4)
1.0 Hr:	Parallel Breakouts (WS#2)	1.0 Hr:	Structured Summary (WS#3 & WS#4)
1.0 Hr:	Group Review (All Issues Identified)	1.0 Hr:	Wrap-up & Process Improvement
	Group Dinner (Ad Hoc Discussion)		Week Later: Final Summary & Case Report

AGENDA PROFORMA

This is a proforma agenda meant as a guide for the two-day assessment, and can easily be varied to accommodate a wide variety of situations.

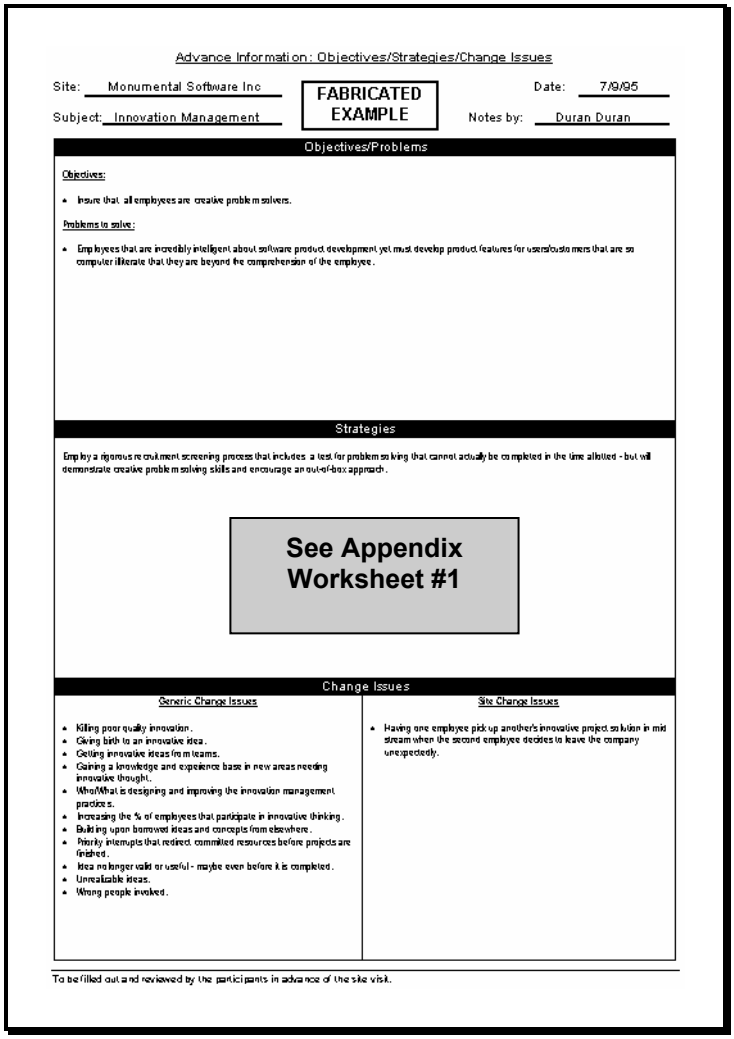
The primary concept to keep in mind is embodied in the four steps of phase two in the three-phase process diagrammed in Figure 2.

The first step corresponds to the morning agenda on the first day. It begins with an indoctrination presentation given by the assessment leader that overviews Agility (primarily for the host personnel but also for newcomers to the assessment team), introduces change-proficiency concepts that will be used in the assessment, discusses the assessment process, and reviews the Advance Information on Worksheet #1. This can generally be accomplished in the 1.5 hours if basic materials and the Advance Information have been previously sent to both host and assessment team participants. The remaining portion of the morning is then taken up with exposure to the subject for assessment. This exposure typically involves tours and demos and usually starts with an overview presentation. This period of exposure should be marked with few if any probing questions as they will tend to channel the information into focused areas and preclude a more comprehensive understanding in the allotted time. Clarification questions are appropriate if they cannot wait until step two.

The second step corresponds to the afternoon of the first day, and is best described as an interrogation, where the assessment team probes the host personnel for change proficiency issues using worksheet #1 for focus. The team then begins to organize the data as a group using worksheet #2, with the assessment leader projecting the worksheet while entering initial team thoughts. Breakouts are important in order to get everyone actively involved, and should happen on the first day - it's hard to hide in a small group, and 3-6 people seems to be the most useful range. A group review of the breakout work is a good way to end the day if time permits. In any event, the basic change issues should be identified on the first day.

Step three corresponds to the morning of the second day and is devoted to analysis breakouts and reviews that will narrow down the issues to the important ones, and identifies the separate and corresponding features of the item being assessed. Worksheets 2, 3, and 4 assist in these activities. This step ends with a group review that judges the fit of issues and responses.

Step four corresponds to the afternoon of the second day and is generally a clean up and summary activity that puts the findings in presentable fashion. Laptop computers can be well employed here to build a final summary from worksheet #3. Separate breakouts may also be updating worksheet #1 to reflect results and deeper understandings. Finally, a formal brief-out featuring a consolidated Issues and Responses Map (worksheet #3) is conducted, with all host personnel involved in any of the assessment activity encouraged to attend. Discussion should be in sufficient depth that anyone thereafter could use the Issues and Responses Map as a briefing guide for others who were not present at the assessment.



Advance Information: Objectives/Strategies/Change Issues

Site: Monumental Software Inc FABRICATED EXAMPLE Date: 7/9/95

Subject: Innovation Management Notes by: Duran Duran

Objectives/Problems

Objectives:

- Insure that all employees are creative problem solvers.

Problems to solve:

- Employees that are incredibly intelligent about software product development yet must develop product features for users/customers that are so computer illiterate that they are beyond the comprehension of the employee.

Strategies

Employ a rigorous recruitment screening process that includes a test for problem solving that cannot actually be completed in the time allotted - but will demonstrate creative problem solving skills and encourage an out-of-box approach.

See Appendix Worksheet #1

Change Issues

Generic Change Issues	Site Change Issues
• Killing poor quality innovation. • Giving birth to an innovative idea. • Getting innovative ideas from teams. • Gaining a knowledge and experience base in new areas needing innovative thought. • Who/What is designing and improving the innovation management practices. • Increasing the % of employees that participate in innovative thinking. • Building upon borrowed ideas and concepts from elsewhere. • Priority interrupts that redirect committed resources before projects are finished. • Idea no longer valid or useful - maybe even before it is completed. • Unrealizable ideas. • Wrong people involved.	• Having one employee pick up another's innovative project solution in mid stream when the second employee decides to leave the company unexpectedly.

To be filled out and reviewed by the participants in advance of the site visit.

WORKSHEET #1: ADVANCE INFORMATION

This worksheet is initially filled out by the assessment leader before the site visit occurs, and is subsequently augmented by team members during the assessment when additional and refined understandings come to light.

The two-day assessment process always ends on time, regardless of when it starts or how efficiently it focuses on the item(s) to be assessed. A useful assessment and learning experience cannot be done in this short time without some very crucial advance work.

It is too easy to arrange an assessment visit to a host company and find out when the group gets there that there is nothing of interest to assess, or that the interesting information is proprietary and cannot be disclosed, or that the people who really understand what's going on are not there that week, or that there are so many interesting things that the group never gets focused.

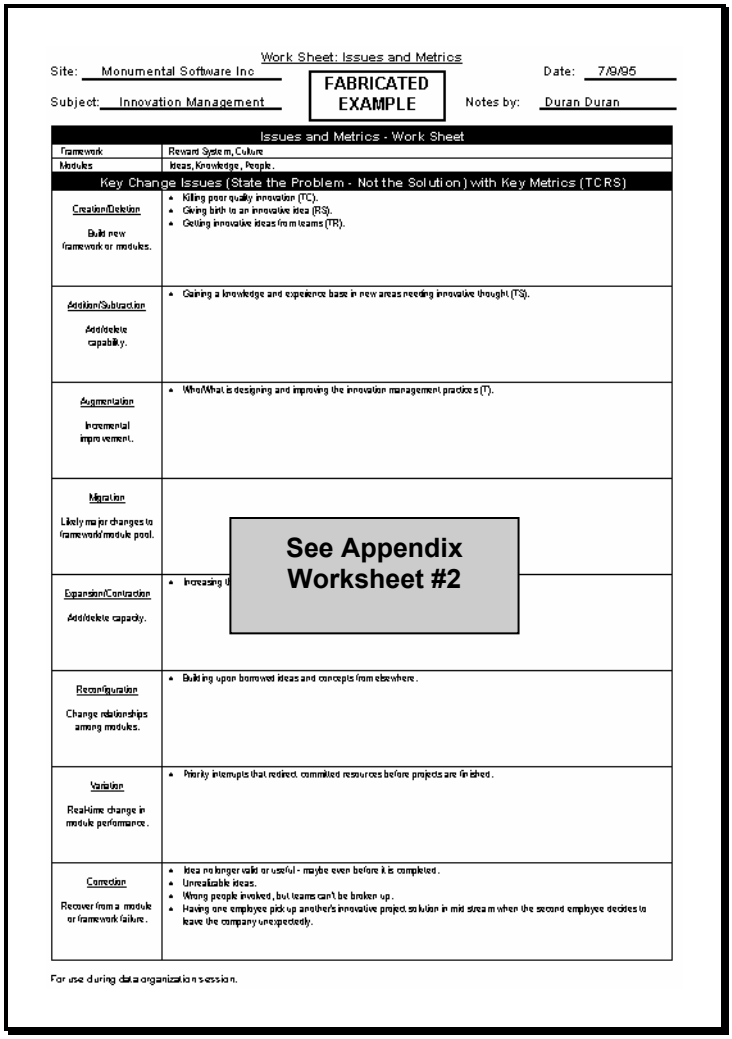
Worksheet #1 helps avoid these and other time wasting embarrassments, and also provides a valuable pre-briefing document for the group that focuses the assessment exercise and gets it started quickly. The process is improved even more when the host reviews and discusses the document in advance.

The "Subject" line states the context for the assessment, and triggers the inclusion or development of a set of generic change proficiency issues common to that element anywhere. Through telephone and/or written questions the assessment leader builds a profile of the specific situation to be assessed - whether it is an in-place practice (remarkably flexible machining), a problem that must be addressed (information system must be replaced), or a strategy under consideration (innovation management plans). This profile states the host's position on the objectives of the item to be assessed, the key strategy features employed to meet those objectives, and any site-specific change-proficiency issues that are obvious.

The dialog that occurs with the assessment host helps the host to understand the nature of the assessment focus - that it will be looking at change proficiency issues. This is generally a different way of looking at the assessment item and one that often has no readily available data. The dialog should tease out some anecdotes on change accommodation experiences and prepare the host for the type of probing the assessment group will do.

White space is good. Don't complete the assessment on this worksheet. Its purpose is to establish a foundation and context for the assessment.

The objectives and problems as stated by the host will often not include any form of change proficiency. The assessment is not evaluating the ability of the assessed item to satisfy the objectives, but rather to see how well the assessed item addresses the issues of change that it will or does confront. In many cases a good assessment exercise will cause the restatement of objectives by an assessment host.



Work Sheet: Issues and Metrics

Site: Monumental Software Inc | FABRICATED EXAMPLE | Date: 7/9/95

Subject: Innovation Management | Notes by: Duran Duran

Issues and Metrics - Work Sheet	
Framework	Reward System, Culture
Modules	Ideas, Knowledge, People.
Key Change Issues (State the Problem - Not the Solution) with Key Metrics (TCRS)	
Creation/Deletion Build new framework or modules.	• Killing poor quality innovation (TC). • Giving birth to an innovative idea (RS). • Getting innovative ideas from teams (TR).
Addition/Subtraction Add/delete capability.	• Gaining a knowledge and experience base in new areas needing innovative thought (TS).
Augmentation Incremental improvement.	• Who/What is designing and improving the innovation management practices (T).
Migration Likely major changes to framework/module pool.	
Expansion/Contraction Add/delete capacity.	• Increasing t
Reconfiguration Change relationships among modules.	• Building upon borrowed ideas and concepts from elsewhere.
Variation Real-time change in module performance.	• Priority interrupts that redirect committed resources before projects are finished.
Correction Recover from a module or framework failure.	• Idea no longer valid or useful - maybe even before it is completed. • Unrealizable ideas. • Wrong people involved, but teams can't be broken up. • Having one employee pick up another's innovative project solution in mid stream when the second employee decides to leave the company unexpectedly.

For use during data organization session.

See Appendix Worksheet #2

WORKSHEET #2: ISSUES and METRICS

This worksheet is the workhorse of the assessment exercise. Its purpose is to capture the different ways that change will confront the item being assessed, and to indicate for each of those ways the important metrics of proficiency. In this respect it serves as a "requirements" statement.

In its best form it will be an objective problem statement untainted by any biases for specific solutions.

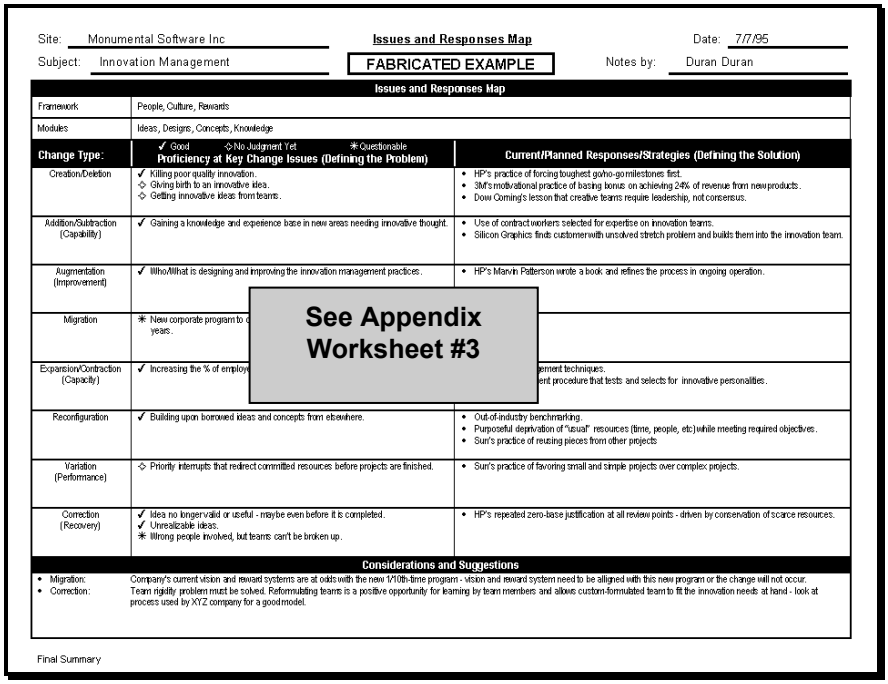
Because the information on this worksheet will shape the nature of acceptable solutions, caution must be observed to keep it objective. For instance, note in the "creation" category the issue "Getting innovative ideas from teams". It is an appropriate issue for an organization that has already implemented team structures and is now finding it difficult to get brilliant ideas out of a mandated consensus process (for instance). However, it would be incorrect to show "Instituting teams to generate new ideas", as this presupposes the solution to "Creating more new ideas" (the true issue) must be found in a team-based organization. We want to isolate the core issues so that we can later evaluate proposed or in-place solutions objectively. Though team interaction may be an excellent way to increase innovative idea generation, it is not the only way, and in many instances it will not be the best way either.

The worksheet is used as a note pad during presentations and demonstrations of the assessment item, as well as during the Q&A sessions. Projected on a screen, the assessment leader can use this worksheet to lead a discussion that amalgamates the team's collective understandings, sharpens the focus on pure issues, and identifies the key metrics as time[T], cost[C], robustness[R], and/or scope[S].

Listen as you have discussion and Q&A, and probe to find out where the important change areas are. Don't get overly hung-up on which change category should be assigned to an issue. Sometimes you will find a change can be reasonably classified in a number of different ways. It is more important that all of the changes be identified and listed than that a great consensus be reached on how to precisely categorize each change.

These eight classifications are used to help elicit comprehensive questioning and probing. They are the distinguishing feature of this assessment system that focuses analysis on change proficiency.

A central feature of the Structured Assessment System is its ability to identify objective requirements for change proficiency in the problem space, devoid of any bias on solutions. This builds a good requirement specification with which to evaluate a variety of solutions. The SAS process in its 2-day format is quite capable of identifying the important metric categories, but is rarely able to quantify them. Real numbers that can specify precise objectives, drive improvement goals, justify a business case, or simply document a benchmark, will be found later if motivation can be established with this assessment process.



Site: Monumental Software Inc — **Issues and Responses Map** — Date: 7/7/95

Subject: Innovation Management — FABRICATED EXAMPLE — Notes by: Duran Duran

Issues and Responses Map

Framework	People, Culture, Rewards
Modules	Ideas, Designs, Concepts, Knowledge

Change Type:	✓ Good ◇ No Judgment Yet ✳ Questionable Proficiency at Key Change Issues (Defining the Problem)	Current/Planned Responses/Strategies (Defining the Solution)
Creation/Deletion	✓ Killing poor quality innovation. ◇ Giving birth to an innovative idea. ◇ Getting innovative ideas from teams.	• HP's practice of forcing toughest go/no-go milestones first. • 3M's motivational practice of basing bonus on achieving 24% of revenue from new products. • Dow Corning's lesson that creative teams require leadership, not consensus.
Addition/Subtraction (Capability)	✓ Gaining a knowledge and experience base in new areas needing innovative thought.	• Use of contract workers selected for expertise on innovation teams. • Silicon Graphics finds customer with unsolved stretch problem and builds them into the innovation team.
Augmentation (Improvement)	✓ Who/What is designing and improving the innovation management practices.	• HP's Marvin Patterson wrote a book and refines the process in ongoing operation.
Migration	✳ New corporate program to c years.	
Expansion/Contraction (Capacity)	✓ Increasing the % of employ	ement techniques. ent procedure that tests and selects for innovative personalities.
Reconfiguration	✓ Building upon borrowed ideas and concepts from elsewhere.	• Out-of-industry benchmarking. • Purposeful deprivation of "usual" resources (time, people, etc) while meeting required objectives. • Sun's practice of reusing pieces from other projects
Variation (Performance)	◇ Priority interrupts that redirect committed resources before projects are finished.	• Sun's practice of favoring small and simple projects over complex projects.
Correction (Recovery)	✓ Idea no longer valid or useful - maybe even before it is completed. ✓ Unrealizable ideas. ✳ Wrong people involved, but teams can't be broken up.	• HP's repeated zero-base justification at all review points - driven by conservation of scarce resources.

See Appendix Worksheet #3

Considerations and Suggestions

• Migration:	Company's current vision and reward systems are at odds with the new 1/10th-time program - vision and reward system need to be aligned with this new program or the change will not occur.
• Correction:	Team rigidity problem must be solved. Reformulating teams is a positive opportunity for learning by team members and allows custom-formulated team to fit the innovation needs at hand - look at process used by XYZ company for a good model.

Final Summary

WORKSHEET #3: ISSUES AND RESPONSE MAP

This worksheet provides the principal discipline of the assessment as it is the objective of the exercise. Until it is completed the exercise is a workshop without conclusion, a workshop without a deliverable.

One value of this discipline is evident when multiple assessments are done by a team - either as an internal group looking at various things over time within the company, or as an external benchmarking group with consistent membership. The standard format builds a series of cases that are captured and presented alike, and especially provides value when similar things are assessed at different times or in different places.

Its main purposes are to drive the assessment team toward assessment conclusions, and to provide a recorded summary of those conclusions that can be used by participants and host personnel later in briefing non-participants.

This is where issues and responses get matched and graded. Presumably the issues have been transferred here from earlier work, are objectively comprehensive, and have been short-listed to the important ones. By placing the assessed item's approach in juxtaposition with the issues it deals with we expose issues that are unaddressed and issues that are addressed poorly. It is also the case that some issue/response pairs cannot be evaluated for efficacy at the time of the assessment because there is not yet an experience base of information.

Each issue must be graded as well-dispatched, poorly or not dispatched, or unknown as yet. This is the essence of assessment - it is not sufficient to understand what the issues and responses are without venturing a value judgment. If an issue/response pair is judged to be poor or a singleton issue exists without a response, something should be said to elaborate on this judgment at the bottom to capture the reason and/or suggest a more fruitful approach.

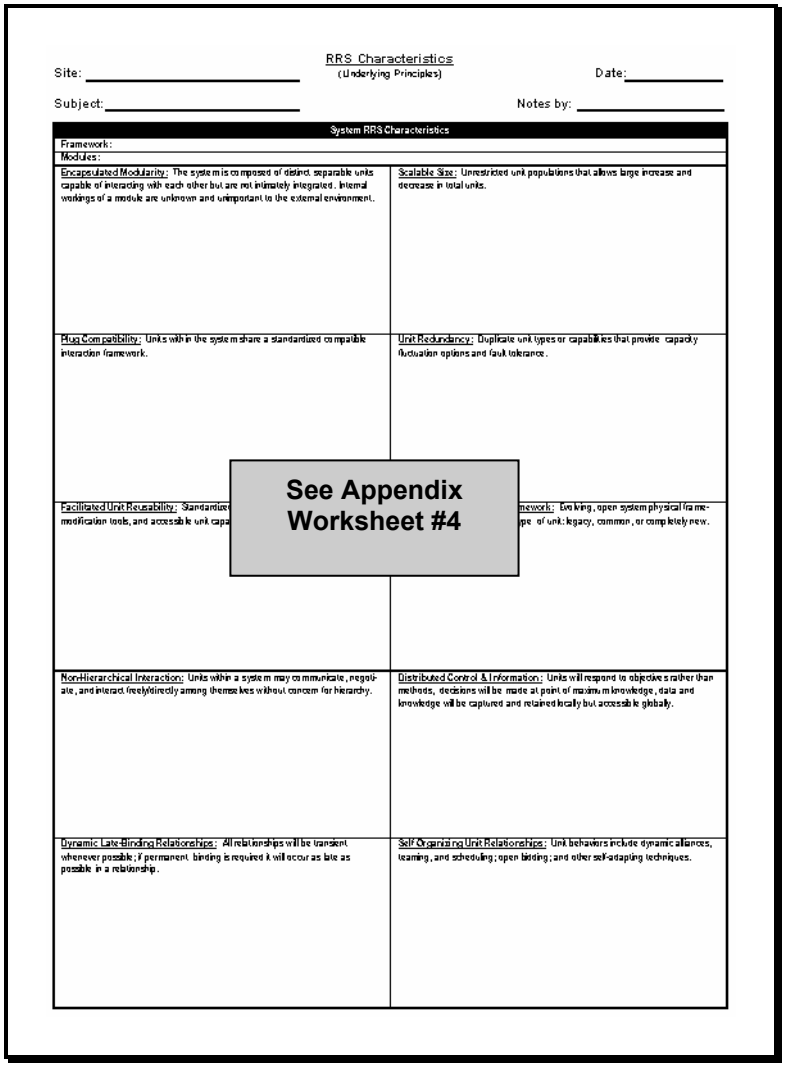
This summary is an ideal leave-behind when host personnel have either participated throughout the entire process or, as a minimum, have had a brief-out presentation and discussion at the conclusion of the assessment exercise. This summary can then be used by host personnel as a guide for briefing others in the company who were not exposed to the assessment activity.

This summary has equal value as a take-away for the participants, who spent two days away from their usual demanding activities and are about to return. The summary will keep the experience and the lessons fresh, and can be used as a guide for briefing others at their company on the lessons learned.

By itself this worksheet does not make a good stand-alone review of the assessment for readers who were not involved with the assessment process. It is a shorthand summary. It is, however, an excellent supporting companion to the 2-page case report that will be generated by the assessment leader with a larger audience in mind.

There are both portrait (vertical) and landscape (horizontal) versions of this worksheet. The landscape version has the advantage of placing issues and responses side-by-side for easy comparison.

Invariably, when the 2-page case report (discussed elsewhere) is written at a later time by a single, unhurried, focused mind, the information on this worksheet will be augmented and re-arranged.



RRS Characteristics
(Underlying Principles)

Site: _____ Date: _____

Subject: _____ Notes by: _____

System RRS Characteristics	
Framework:	
Modules:	
Encapsulated Modularity: The system is composed of distinct, separable units capable of interacting with each other but are not intimately integrated. Internal workings of a module are unknown and unimportant to the external environment.	Scalable Size: Unrestricted unit populations that allows large increase and decrease in total units.
Plug Compatibility: Units within the system share a standardized compatible interaction framework.	Unit Redundancy: Duplicate unit types or capabilities that provide capacity fluctuation options and fault tolerance.
Facilitated Unit Reusability: Standardized modification tools, and accessible unit capa	mework: Evolving, open system physical frame- pe of unit: legacy, common, or completely new.
Non-Hierarchical Interaction: Units within a system may communicate, negotiate, and interact freely/directly among themselves without concern for hierarchy.	Distributed Control & Information: Units will respond to objectives rather than methods, decisions will be made at point of maximum knowledge, data and knowledge will be captured and retained locally but accessible globally.
Dynamic Late-Binding Relationships: All relationships will be transient whenever possible; if permanent binding is required it will occur as late as possible in a relationship.	Self-Organizing Unit Relationships: Unit behaviors include dynamic alliances, teaming, and scheduling; open bidding; and other self-adapting techniques.

See Appendix Worksheet #4

WORKSHEET #4: RRS CHARACTERISTICS

This worksheet is useful for experienced teams who wish to go a step beyond the issues and response assessment; identifying underlying design principles that enable change proficiency.

A design strategy of reusable modules, reconfigurable within a scalable framework (RRS) can be responsible for the Agile capabilities of a wide variety of systems. Framework and module are two distinct key objects here, and reconfigurableness is the desirable characteristic.

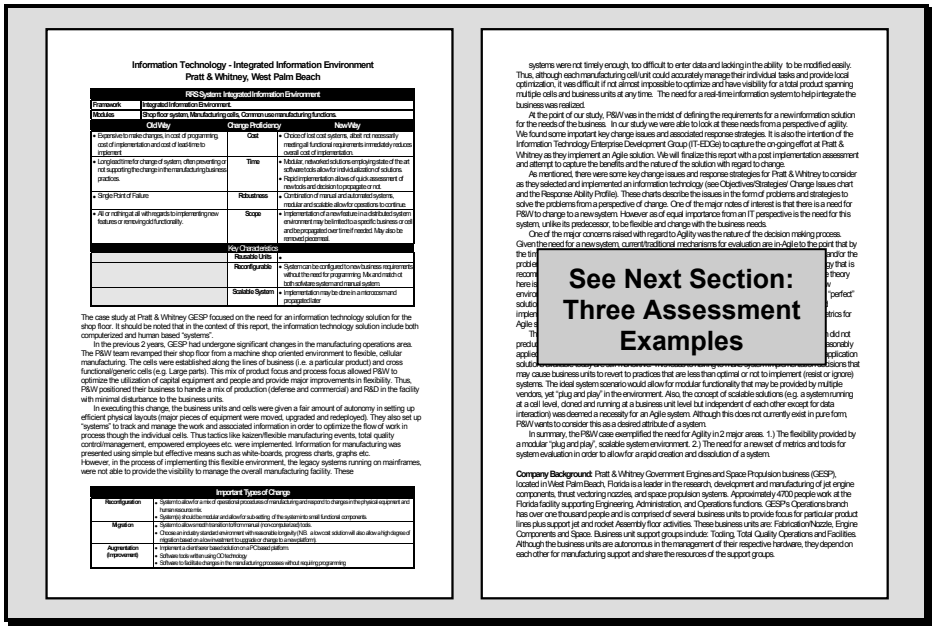
Use by experienced groups is recommended as the two-day agenda does not allow enough time for inexperienced groups to complete both the Issues and Response Map and the RRS analysis. Mixed groups, however, might devote a separate breakout session staffed with experienced assessors to an RRS analysis. The cause and effect relationships that get exposed in a subsequent group review can bring inexperienced team members up the learning curve faster.

RRS analysis is particularly recommended when an assessment team finds something that it considers especially proficient at change. When a good Agile practice is discovered there is more value to be gained if the team can learn what is responsible for this proficiency that might be applied elsewhere, either to a similar system somewhere else or abstracted as a principle that can be applied in a different system.

Designing Agile systems, whether they be entire enterprises or any of their critical elements like business practices, operating procedures, supply-chain strategies, and production processes, means designing a sustainable proficiency at change into the very nature of the system. With the business engineer's eye we are interested in discovering what impedes and what enables Agile systems in the underlying architecture. The ten design principles on the worksheet have emerged from observations of both natural and man-made systems that exhibit RRS characteristics

The worksheet can be used to record working notes during presentations and demonstrations, to structure discussion in a focused breakout session, or to lead a group review of key system design concepts.

In any event, the assessment leader is expected to understand the RRS concepts sufficiently well to identify the “framework” and the “modules” in any system to be assessed. Additionally, a key feature of the final 2-page reference case report is the identification of reusable, reconfigurable, scalable characteristics.



Information Technology - Integrated Information Environment
Pratt & Whitney, West Palm Beach

RRS System: Integrated Information Environment	
Framework	Integrated Information Environment.
Modules	Shop floor system, Manufacturing cells, Common use manufacturing functions.

Old Way	Change Proficiency	New Way
• Expensive to make changes, in cost of programming, cost of implementation and cost of lead time to implement.	Cost	• Choice of last cost systems, albeit not necessarily meeting all functional requirements immediately reduces overall cost of implementation.
• Long lead Time for change of system, often preventing or not supporting the change in the manufacturing business practices.	Time	• Modular, networked solutions employing state of the art software tools allow for individualization of solutions. • Rapid implementation allows of quick assessment of new tools and decision to propagate or not.
• Single Point of Failure	Robustness	• Combination of manual and automated systems, modular and scalable allow for operations to continue.
• All or nothing at all with regards to implementing new features or remaining dysfunctionally.	Scope	• Implementation of a new feature in a distributed system environment may be limited to a specific business or cell and be propagated over time if needed. May also be removed piecemeal.
	Key Characteristics	
	Reusable Units	•
	Reconfigurable	• System can be configured to new business requirements without the need for programming. Mix and match of both software system and manual system.
	Scalable System	• Implementation may be done in a microcosm and propagated later

The case study at Pratt & Whitney GESP focused on the need for an information technology solution for the shop floor. It should be noted that in the context of this report, the information technology solution include both computerized and human based "systems".

In the previous 2 years, GESP had undergone significant changes in the manufacturing operations area. The P&W team revamped their shop floor from a machine shop oriented environment to flexible, cellular manufacturing. The cells were established along the lines of business (i.e. a particular product) and cross functional/generic cells (e.g. Large parts). This mix of product focus and process focus allowed P&W to optimize the utilization of capital equipment and people and provide major improvements in flexibility. Thus, P&W positioned their business to handle a mix of production (defense and commercial) and R&D in the facility with minimal disturbance to the business units.

In executing this change, the business units and cells were given a fair amount of autonomy in setting up efficient physical layouts (major pieces of equipment were moved, upgraded and redeployed). They also set up "systems" to track and manage the work and associated information in order to optimize the flow of work in process though the individual cells. Thus tactics like kaizen/flexible manufacturing events, total quality control/management, empowered employees etc. were implemented. Information for manufacturing was presented using simple but effective means such as white-boards, progress charts, graphs etc. However, in the process of implementing this flexible environment, the legacy systems running on mainframes, were not able to provide the visibility to manage the overall manufacturing facility. These

Important Types of Change	
Reconfiguration	• System to allow for a mix of operational procedures of manufacturing and respond to changes in the physical equipment and human resources mix. • System(s) should be modular and allow for sub-setting of the system into small functional components.
Migration	• System to allow smooth transition to/from manual (non-computerized) tools. • Choose an industry standard environment with reasonable longevity (NIS. a low cost solution will also allow a high degree of migration based on a low investment to upgrade or change to a new platform).
Augmentation (Improvement)	• Implement a client/server based solution on a PC-based platform. • Software tools written using COM technology • Software to facilitate changes in the manufacturing processes without requiring programming

systems were not timely enough, too difficult to enter data and lacking in the ability to be modified easily. Thus, although each manufacturing cell/unit could accurately manage their individual tasks and provide local optimization, it was difficult if not almost impossible to optimize and have visibility for a total product spanning multiple cells and business units at any time. The need for a real-time information system to help integrate the business was realized.

At the point of our study, P&W was in the midst of defining the requirements for a new information solution for the needs of the business. In our study we were able to look at these needs from a perspective of agility. We found some important key change issues and associated response strategies. It is also the intention of the Information Technology Enterprise Development Group (IT-EDGe) to capture the on-going effort at Pratt & Whitney as they implement an Agile solution. We will finalize this report with a post implementation assessment and attempt to capture the benefits and the nature of the solution with regard to change.

As mentioned, there were some key change issues and response strategies for Pratt & Whitney to consider as they selected and implemented an information technology (see Objectives/Strategies/ Change Issues chart and the Response /Ability Profile). These charts describe the issues in the form of problems and strategies to solve the problems from a perspective of change. One of the major notes of interest is that there is a need for P&W to change to a new system. However as of equal importance from an IT perspective is the need for this system, unlike its predecessor, to be flexible and change with the business needs.

One of the major concerns raised with regard to Agility was the nature of the decision making process. Given the need for a new system, current/traditional mechanisms for evaluation are in-Agile to the point that by the tim and/or the proble by that is recom theory here is envir "perfect" solutio metrics for Agile s did not precu sonably applie application solut sions that may cause business units to revert to practices that are less than optimal or not to implement (resist or ignore) systems. The ideal system scenario would allow for modular functionality that may be provided by multiple vendors, yet "plug and play" in the environment. Also, the concept of scalable solutions (e.g. a system running at a cell level, cloned and running at a business unit level but independent of each other except for data interaction) was deemed a necessity for an Agile system. Although this does not currently exist in pure form, P&W wants to consider this as a desired attribute of a system.

See Next Section: Three Assessment Examples

In summary, the P&W case exemplified the need for Agility in 2 major areas: 1.) The flexibility provided by a modular "plug and play", scalable system environment. 2.) The need for a new set of metrics and tools for system evaluation in order to allow for a rapid creation and dissolution of a system.

Company Background: Pratt & Whitney Government Engines and Space Propulsion business (GESP), located in West Palm Beach, Florida is a leader in the research, development and manufacturing of jet engine components, thrust vectoring nozzles, and space propulsion systems. Approximately 4700 people work at the Florida facility supporting Engineering, Administration, and Operations functions. GESP's Operations branch has over one thousand people and is comprised of several business units to provide focus for particular product lines plus support jet and rocket Assembly floor activities. These business units are: Fabrication/Nozzle, Engine Components and Space. Business unit support groups include: Tooling, Total Quality Operations and Facilities. Although the business units are autonomous in the management of their respective hardware, they depend on each other for manufacturing support and share the resources of the support groups.

REFERENCE CASE REPORT FORMAT

The writing of the Reference Case is an integral part of the assessment process. It sifts through all of the real-time workshop findings under calmer conditions, and is generally the responsibility of a single experienced mind.

The format is purposely standardized at two pages. If you can't write it in two pages you are probably not focused on the change proficiency issues. This constraint should encourage a crispness of reporting so that the principal features and benefits of an Agile practice or system will stand out, and thereby help promote an emergent understanding of what makes Agility occur. It will also discourage text devoted to broader issues that may be interesting and generally good practice but have nothing to do with change proficiency. Additionally, the brevity of a two-page write-up will entice more readership, and thereby mobilize knowledge about good practices.

The report summarizes the principal qualifications of each case in two ways:

1) On the top of the first page is a summary of the major change-proficiency features and benefits; preferably comparing an old (traditional) way with a new Agile way, though this is not always possible. For maximum effect the summary will also identify the Reconfigurable-Reusable-Scalable structural features, and specifically itemize the module types and the framework elements. This format has utility beyond the description on an Agile practice: it can establish objectives for a new system in comparison to the old, and it can summarize the key justification points for a business case proposal described in the text.
2) On the bottom of the first page, space permitting, is a tabled summary of the principal change issues. Usually there will not be entries for all eight change types as generally we are only interested in ones with sufficient impact to determine system success or failure. Two different approaches are common here depending upon the writer's point of view: one states pure issues as requirements demanding attention, the other states the nature of an effective response.

The text should support the summarized conclusions with sufficient detail that they can be understood. The text space available on these two pages will rarely describe a practice or system in sufficient detail that it can be duplicated elsewhere. The reader with a specific experience or application in mind, however, should learn enough from the text to know if the approach merits consideration.

The standardized two page format also lends itself to single sheet distribution, printed front and back, and facilitates the building of a library of reference cases that is easily reconfigured, updated, expanded/contracted, and assembled into custom collections for focused training or reference situations. In short, it follows the RRS design principles for reusable modules in a reconfigurable, scalable framework.

This two-page case summary can be usefully augmented with two of the worksheets used in the assessment process, if they have been subsequently edited and prepared for public consumption. Worksheets #1 and #3 are excellent supporting material and together lend themselves to a single sheet front-back packaging that now makes a case unit encompass two 8-1/2x11 sheets.

INTRODUCING THREE ASSESSMENT EXAMPLES

The final documentation from three assessments follows. These assessments address three completely different areas of business: knowledge management, information systems, and flexible manufacturing. They were conducted by three completely different assessment teams: Business Practices, Information Technology, and Operations. They were documented by three different assessment leaders: Rick Dove, Steve Benson, and Sue Hartman. They are included to show the diversity of approach possible within a consistently applied system.

The first two, addressing a knowledge management practice at Boeing Defense and Space and an integrated information system at Pratt & Whitney, include assessment worksheets with the final case write-up. The third, addressing flexible manufacturing at Remmele Engineering, is one of four case write-ups that resulted from a single multi-focused assessment [7].

The assessment at Boeing Defense and Space was the first application of the SAS to an intangible practice, and fed back some valuable lessons to the agenda proforma as a result. It is difficult to pass up a facility tour, especially at a first class aircraft manufacturer, even when it has no bearing on the assessment subject. Non-essential activities do limit the time available for the assessment, and these assessments need efficient use of most of the two days to explore a subject reasonably. Though the assessment activity was valued by the participants, more time would have allowed us to complete the evaluation on site and provide a brief-out and feed back for the hosts. Pressed for time, the assessment conclusions were integrated much later.

The Pratt & Whitney assessment was used to help formulate requirements and acquisition strategy for a new information system. Thus, the SAS process did not assess an in-place information system; but instead defined a set of issues that must be addressed by the next generation replacement. Interestingly, it also identified critical issues in the *requirements development* and *system evaluation* procedures that were immediately acted upon as a result. There was strong host participation in this assessment activity, which may be responsible for the ownership taken afterwards and the subsequent influence evident in the actions being taken. Angie Negron, Manager of the Space Products business, says: “The four people we had participating came away with a common base-line that had eluded them through six months of previous planning. The September assessment was responsible for short circuiting a process that normally takes years. By December a system had been selected and put on contract.”

The final assessment report addresses flexible manufacturing at Remmele Engineering, where a virtual gold mine of Agile practices was discovered. Vice President Bert Casper says of the assessment and report provided to them: “Our management group discussed the comments you made about Remmele, and we feel that you have identified most of our strengths, many of our weaknesses, and several of the opportunities we must pursue to continue our growth. Your group is very perceptive. We appreciate the information you provided, and look forward to your [final] report.”

Knowledge Management - Process Knowledge
Boeing Defense and Space

RRS System: Integrated Process-Based Knowledge Management	
Framework	Process integration architecture, Program Process Team, Boeing culture, and FAR/DFAR.
Modules	Process templates, knowledge-trained users, process owners.

Old Way	Change Proficiency	New Way
• Functional silos, poor inter-functional communication, lack of explicit process descriptions, computer-entrenched infrastructure, and government documentation and agency confusion made process change very expensive.	**Cost**	• Documented process templates kept in a central repository accessible by all users, owned by process managers, and taught in formal training classes make process-knowledge change and dissemination costs inconsequential.
• New people learned process knowledge on-the-job in approximately 18 months. • New and modified process templates take approximately 18 months to become SOP.	**Time**	• New people trained in 6 months. • New and modified templates "installed" in documentation and training in approximately 3 months.
• Process knowledge was learned on-the-job and spread by word -of-mouth only. • Lack of centralized explicit process descriptions made successful change a random event.	**Robustness**	• New and modified templates are documented, reviewed by "executive oversight team", kept in a central repository accessible by all users, and taught in formal training classes; providing highly predictable total conformance.
• Lack of process documentation repressed obvious needs and justifications for change. • Computer-entrenched functional infrastructure limited change potential to small areas only.	**Scope**	• Process visibility and ownership makes large changes possible and encourages process innovation.
Key Characteristics		
	Reusable Units	• Process templates applicable to multiple programs.
	Reconfigurable	• Cross-trained people can handle multiple templates, and apply templates on any program.
	Scalable System	• Process integration architecture is potentially non-restricting, but not put to the test as yet.

The process mapping activity at Boeing Defense and Space was motivated by a presidential vision and directive that process management (and knowledge) should become the structural theme to replace functional focus, and be elevated to the same importance as program and product management. As a result, the early '90s have been spent on introducing and driving a process driven strategy into an organization that currently manages some 85 or so aerospace defense programs in various implementation and maturity states.

Important Types of Change	
Creation/Deletion	• Knowing what you don't know, and must therefore discover. • Getting consensus on the need to change.
Addition/Subtraction (Capability)	• Application of new templates in program environment.
Augmentation (Improvement)	• How to identify what processes need to change.
Migration	• Templates will eventually have to be applied to legacy projects in some form, not just newly started projects. • Knowledge will eventually have to be driven all the way to the shop floor. • Processes knowledge will eventually be shared and common between commercial and defense businesses.
Expansion/Contraction (Capacity)	• Educating more employees on standard processes.
Reconfiguration	• Infusion of best practices and other discoveries into the standard templates.
Variation (Performance)	• Real-time variation of the process templates when special situations warrant.
Correction (Recovery)	• "Lessons learned" in process template applications that have difficulty need a feed-back mechanism.

An early key finding was that the existing computing services infrastructure was defining the business processes rather than supporting them - and maintained an impregnable set of functional and departmental silos that had little if any information representations in common. Getting from the entrenched functional-based structure to a process-based operating mode required a considerable and uncomfortable cultural change among a large number of people in a company that was obviously quite successful - thus, had no pressure to justify the upheaval of change.

A working "Process Oversight Team" composed of the President and Vice Presidents was established. People were enlisted from each of the functional stovepipes into process mapping teams. 101 key processes were eventually established as the focus. Individual process owners were selected from top management to review a team's ongoing effort and the planned investments in "to-be" transformations.

It became clear that each of the 85 current programs was in a different stage of maturity that would find disruptive change activity difficult or impossible to justify - so phasing in new approaches had to accommodate the "legacy" commitments and not impose sweeping change mandates precipitously.

As the magnitude of the undertaking became appreciated the group began to look at formal programs for process management. A wall chart showing all 101 processes compared to functional areas was created showing where each functional group was spending money.

The Process Oversight Team is obligated to analyze the emerging process knowledge in frequent reviews. This insured that insight was created and owned by top management - the very people required to cause any subsequent change action. Boeing recognizes that culture change occurs a step at a time with awareness dawning gradually; and that the power structure of the company must be involved in the culture change. As real process knowledge emerged it was captured in the wall charts and mobilized in the analysis process.

Processes were grouped into three different categories: regulatory, execution, and support processes. It was found that improvement of a process occurred differently between these three types of processes. The metric put on a regulatory process for example, is different than one put on an execution process. Core competency at Boeing is believed to reside within the execution process group.

The process knowledge that has been captured (and restructured) is now deployed by "integrated product teams" - a mix of people with complimentary expertise in process knowledge and functional expertise are teamed to produce a program execution plan.

Importantly, a Program Process Team, consisting of functional managers and program managers, has responsibility for overseeing the ongoing management of the process knowledge base: maintaining a validated set of program process templates, maintaining program guides for implementing those templates, providing requirements for process template improvement from a program perspective, and recommending the sustaining framework for managing and adapting the process knowledge over time. Additionally, a dedicated organizational support group has responsibility for training people in process mapping and template application.

In summary, they are capturing process knowledge in modular, reusable templates, that can be assembled into collections customized for different programs as appropriate. These templates are formal concepts that are trained into people responsible for their application, who are assigned to programs accordingly. They have also built an infrastructure framework for managing continuous capture, deployment, improvement, and replacement of this knowledge; though at the time of assessment there was little experience in this area as yet. Rather than look at the process-knowledge capture-and-restructure activity as a one-time what's-going-on-here event, Boeing recognizes that this is now a continuing activity that requires a formal business-system structure with ongoing management.

Worth noting: Boeing personnel observed that the capturing of this process knowledge has not been straight forward or easy. The activity which has spanned many years, however, has apparently contributed heavily to an awareness of "change", and is expected to make any future effort of similar magnitude much easier. It is viewed as a valuable corporate and cultural learning experience that has made the group more Agile.

Company Background: Boeing Defense and Space Systems Group is part of the Boeing Corporation. In 1994 Defense and Space Systems had revenues of $1.4 billion, and employed 25,700 people at approximately 20 USA facilities. The company supports approximately 85 programs ranging from the recent Space Station to the more mature Avenger program. The company provides products to the US military, NASA, special projects, and international customers.

Site: Boeing Defense and Space **Issues and Responses Map** Date: 8/22/95

Subject: Knowledge Management **Work Sheet #3** Notes by: ABP group

Issues and Responses Map		
Framework	Process integration architecture, Program Process Team, Boeing culture, and FAR/DFAR.	
Modules	Process templates, knowledge-trained users, process owners.	
Change Type:	G-Good N-No Judgment Yet Q-Questionable **Proficiency at Key Change Issues (Defining the Problem)**	**Current/Planned Responses/Strategies (Defining the Solution)**
Creation/Deletion	G - Getting consensus on the need to change. N - Knowing what you don't know.	• Building a process team. • Wall chart exercise.
Addition/Subtraction (Capability)	G - Application of templates on/in program environment.	• Customer Involved.
Augmentation (Improvement)	G - How to identify what processes need to change.	• President made change a top priority vision. • Building a virtual Model, Building a process team. • Cross division to have one division verify equipment for the other.
Migration	G - Use templates on existing projects. G - Driving information to the shop floor. G - Migration of processes between commercial and Defense.	• Beginning to have joint process interaction and integration.
Expansion/Contraction (Capacity)	G - Educating employees on standard processes.	• Formal educational process.
Reconfiguration	G - Infusion of best practices and other discoveries to our standard processes.	• Broad based benchmarking on industry standards. • Core competency benchmarking on defense industry standards. • Company-wide benchmarking.
Variation (Performance)	G - Real time variation of the templates (standard processes).	• Bring the customer into the process strategy.
Correction (Recovery)	Q - Use lessons learned.	• Using a post-mortem survey on each project (Sustaining framework).
Considerations and Suggestions		
• Correction be in place	The sustaining framework is not fully operational as yet - but feedback mechanisms from actual implementation and application experiences do not appear to to function on a real-time bases, but rather on an annualized periodic review basis.	
• Other:	Other suggestions are reserved for verbal discussion as the assessment activity ended with many open questions.	

Advance Information: Objectives/Strategies/Change Issues

Site: Boeing Defense and Space Date: 8/22/95

Work Sheet #1

Subject: Knowledge Management Notes by: ABP Group

Objectives/Problems

Objectives:

- Switch from a departmental/functional silo operating orientation to an integrated process/team orientation.
- Elevate process management and design to the same importance as product/program management and design.
- The goal is to create a barrier-free integration of processes: meaning smooth, immediate work flow unhindered by incompatible practices, technology or bureaucracy - which in turn means compatible and linked-processes, paperwork, computing, costing and oversight.
  1. Barrier free between sites.
  2. Barrier free between organizations.
  3. Barrier free between Boeing and its customers, suppliers and partners.

Problems to solve:

- Learn what the actual processes are.
- Separate the pervasive information infrastructure from the actual process requirements.
- Get people to buy-in to this different operating approach.
- Develop and implement an ongoing process management process.

Strategies

- Set up working Oversight Committee of top executives
- Involve large numbers of people from all functional areas to get buy-in and knowledge deployment
- Establish process owners among management
- Drive program as a Presidential priority
- Utilize wall charts for broad and accessible visibility
- Take as long as it takes to get it right
- Set up active maintenance and continuous improvement responsibilities among program and functional managers

Change Issues

Generic Change Issues

- Identify/recognize important knowledge to have/find.
- Develop new knowledge.
- Capture existing knowledge.
- Gain new knowledge from elsewhere.
- Mobilize knowledge, Impart knowledge to others.
- Reuse knowledge in new ways.
- Adapt knowledge to fit new circumstances.
- Combine knowledge from different areas.
- Evolve knowledge continuously.
- Expunge/replace incorrect/obsolete knowledge.

Site Change Issues

- Get people interested in knowledge-capture participation.
- Develop process-knowledge framework.
- Get buy-in and ownership.
- Remove impediments to process improvement and change.

Information Technology - Integrated Information Environment
Pratt & Whitney, West Palm Beach

RRS System: Integrated Information Environment		
Framework	**Integrated Information Environment.**	
Modules	**Shop floor system, Manufacturing cells, Common use manufacturing functions.**	
Old Way	**Change Proficiency**	**New Way**
• Expensive to make changes to mainframe-based system in both programming cost and lack-of-benefit costs during long implementation lead-time.	**Cost**	• Choice of low cost relatively-simple client-server systems meeting most functional requirements immediately reduces overall cost of implementation and operation, and enables affordable incremental additions.
• Long lead time for change of system, often preventing or not supporting the change in the manufacturing business practices.	**Time**	• Modular, networked solutions with state of the art software tools allow for rapid individualization. • Rapid implementation allows quick assessment and decision to propagate further or not.
• Single point of failure (mainframe).	**Robustness**	• Combination of manual and automated systems, modular and scalable, allow operations to continue.
• All or nothing with regards to implementing new features or removing old functionality no custom modifications.	**Scope**	• Implementation of a new feature in a distributed system environment may be limited to a specific business or cell and be propagated over time if needed. May also be removed piecemeal.
Key Characteristics		
	Reusable Units	• Modular server applications.
	Reconfigurable	• System can be configured to new business requirements without the need for programming. Mix and match of both software system and manual system.
	Scalable System	• Implementation may be done in a microcosm and propagated throughout the organization later

The case study at Pratt & Whitney GESP focused on the need for an information technology solution for the shop floor. It should be noted that in the context of this report, the information technology solution include both computerized and human based “systems”.

In the previous 2 years, GESP had undergone significant changes in the manufacturing operations area. The P&W team revamped their shop floor from a machine shop oriented environment to flexible, cellular manufacturing. The cells were established either along the lines-of-business (i.e. dedicated to a particular product) or as cross-line generic cells (e.g. focused on large parts). This mix of product focus and process focus allowed P&W to optimize the utilization of capital equipment and people, and provide major improvements in flexibility. In this way P&W had positioned their business to handle a mix of defense production, commercial production, and R&D in the same facility with minimal disturbance to individual business units.

In executing this change, the business units and cells were given a fair amount of autonomy in setting up efficient physical layouts (major pieces of equipment were moved, upgraded and redeployed). They adopted current concepts including kaizen, flexible manufacturing, total quality control/management, and empowerment. They set up “systems” to track and manage the work and associated information in order to optimize the flow of work-in-process though the individual cells. Manufacturing information was presented using simple but effective means such as white-boards, progress charts, graphs, etc.

Important Types of Change	
Reconfiguration	• System to allow for a mix of operational procedures of manufacturing and respond to changes in the physical equipment and human resource mix. • System(s) should be modular and allow for sub-setting of the system into small functional components.
Migration	• System to allow smooth transition to/from manual (non-computerized) tools. • Choose an industry standard environment with reasonable longevity (N.B. a low cost solution will also allow a high degree of migration based on a low investment to upgrade or change to a new platform).
Augmentation (Improvement)	• Implement a client/server based solution on a PC based platform. • Software tools written using OO technology • Software to facilitate changes in the manufacturing processes without requiring programming

In the process of implementing this flexible environment, however, it became evident that the legacy mainframe systems were not able to provide the necessary management visibility. These systems were not timely enough, data entry was difficult, and they couldn't be modified easily. Consequently, though each manufacturing cell/unit could accurately manage its individual tasks and provide local optimization, it was virtually impossible to optimize at the global level: visibility for a total product spanning multiple cells and business units at any time was unavailable. The need for a new real-time information system to help integrate the business was evident, and had become a high priority.

P&W was in the midst of defining the requirements for this new information system when this assessment exercise was conducted.

A major issue that surfaced was the cumbersome traditional decision-making and system-selection process. Given the pressing need for a new system, current mechanisms for evaluating alternative solutions and justifying a selection take so long that the original problems are unlikely to remain in original form: either the problem will have been solved with some quick-fix means or the problem will have shifted to where the new solution is no longer valuable to the business. The assessment discussion suggested immediate as well as long term values in a strategy that sought low cost, simple solutions that could be implemented quickly, rather than define a large scale solution that misses the moving target of need when it is finally implemented. Though this strategy does not necessarily evaluate all potential features and functions of a new system, the expeditious move to a new environment that solves important problems will impact the business immediately, and generally more beneficially in the long run, than a time-consuming, highly researched "perfect" solution. This issue appears to be wide-spread in industry, and indicates the need for a new set of evaluation and implementation tools and procedures.

The assessment team is recommending the development of a set of tools, methods, and metrics for establishing system requirements and subsequent system selection.

The other set of issues in this case study centered around the need for a system framework which did not preclude the integration of multi-vendor solutions. Although the concept of open systems has been reasonably applied in the area of infrastructural software (e.g. Networks, databases and operating systems), the application solutions available today are still monolithic. This leads to having to make system implementation decisions that may cause business units to revert to practices that are less than optimal or not to implement (resist or ignore) systems. The ideal system scenario would allow for modular functionality that may be provided by multiple vendors, yet "plug and play" in the environment. Also, the concept of scalable solutions (e.g. a system running at a cell level, cloned and running at a business unit level but independent of each other except for data interaction) was deemed a necessity for an Agile system. Although this does not currently exist in pure form, P&W wants to consider this as a desired attribute of a system.

There are many change issues and response strategies for Pratt & Whitney to consider as they select and implement an information technology (see accompanying worksheets: #1-Issues and Responses Map and #3-Objectives/Strategies/Change Issues). These assessment worksheets identify a broader set of change proficiency issues than this review has focused on, and suggest response strategies that address the broader set of issues. Major benefits of the assessment exercise included:

1) The conclusion, with supporting arguments, that a compelling need existed for changing to a new system quickly.
2) The requirement that the new system, unlike its predecessor, be flexibly reconfigurable and scalable in order to support continuously changing business needs.
3) The identification of the wide-spread need for a new set of metrics and tools for establishing system requirements and conducting subsequent system evaluation and selection.

Company Background: Pratt & Whitney Government Engines and Space Propulsion business (GESP), located in West Palm Beach, Florida is a leader in the research, development and manufacturing of jet engine components, thrust vectoring nozzles, and space propulsion systems. Approximately 4700 people work at the Florida facility supporting Engineering, Administration, and Operations functions. GESP's Operations branch has over one thousand people and is comprised of several business units to provide focus for particular product lines plus support jet and rocket assembly floor activities. These business units are: Fabrication/Nozzle, Engine Components and Space. Business unit support groups include: Tooling, Total Quality Operations and Facilities. Although the business units are autonomous in the management of their respective hardware, they depend on each other for manufacturing support and share the resources of the support groups.

Work Sheet #3

Subject: Shop Floor Information Tech. Notes by: AIT Group Composite

Issues and Responses Map	
Framework	Integrated Information Environment
Modules	Shop Floor Systems, Cellular Manufacturing, Common Use Mfg. Functions
Key Change Issues (Defining the Problem)	
Change Proficiency:	G - Good N - No Judgment Yet Q - Questionable
Creation/Deletion	Q - Visibility of new orders coming into a hybrid "push/pull" environment. Q - Potentially long lead time to decide on a system solution based on old evaluation methods. Q - Event driven release signals to alert the shop of new demand.
Addition/Subtraction (Capability)	Q - Partial releases (partial work instructions) gives limited visibility to business requirements. Q - Short-term solutions required to complete customer order -- (reactive instead of proactive). Q - Need the ability to do a "what-if?" analysis.
Augmentation (Improvement)	G - Cellular units use manual white boards to show status of orders. Q - Mainframe information system is old, unwieldy and difficult to adapt to hybrid environment.
Migration	Q - Old technology mainframe will migrate to more current technologies. Q - Resistance to change (i.e. use of technology to enhance newer manual systems). Q - Workforce flexibility/adaptability is upcoming - Centralized system is inflexible.
Expansion/Contraction (Capacity)	Q - In order to keep current system accurate, it's an "all or nothing at all" environment with no capacity latitude. Q - In a crisis/surge, systems are not compatible with the business plan.
Reconfiguration	Q - Current IS system is rigid -- not flexible or modular. Q - Re-planning is untimely. G - People and equipment are positioned for reconfiguration and reallocation.
Variation (Performance)	Q - Estimates vs. actuals are polarized (standards and accuracy vary across processes). Baselines are not accurate. Q - No effective standards, systems do not react to changes in the process.
Correction (Recovery)	Q - No learning curve metric when only making one piece. G - Manual systems in place to recover (often in spite of the information systems).
Current/Planned Responses/Strategies (Defining the Solution)	
Creation/Deletion	• Interactive planning/scheduling system tied to the actual events on the shop floor. As new requirements enter the process or completed ones leave or are canceled the effects to the overall manufacturing operation is understood. • Put a solution in quickly, evaluate in situ and consider changes or replacement.
Addition/Subtraction (Capability)	• System will accept partially defined "orders" and incorporate the manufacturing requirements into the pipeline of products.
Augmentation (Improvement)	• Implement a client/serer based solution on a PC based platform. • Software tools written using OO technology • Software to facilitate changes in the manufacturing processes without requiring programming
Migration	• System to allow smooth transition to/from manual (non-computerized) tools. • Choose an industry standard environment with reasonable longevity (N.B. a low cost solution will also allow a high degree of migration based on a low investment to upgrade or change to a new platform).
Expansion/Contraction (Capacity)	• The technology solution should allow for limited utilization with little or no overhead imposed by other features (e.g. if system supports labor cost tracking, if not needed, no extra data/transactions should be required of operators or other users, conversely should labor tracking be required at a later date, no major changes to system should be required).
Reconfiguration	• System to allow for a mix of operational procedures of manufacturing and respond to changes in the physical equipment and human resource mix. • System(s) should be modular and allow for sub-setting of the system into small functional components.
Variation (Performance)	• System(s) are to interact with actual data and adjust accordingly. This implies a highly interactive solution.
Correction (Recovery)	• System needs to allow for one-off manufacturing and account for "learning curve" or one-time requirements • No single point of failure. The current plan of a distributed PC based solution should allow for an amount of autonomous operation when a component fails and allow for uninterrupted operation upon recovery.
Considerations and Suggestions	
This evaluation is based on an environment in which the IT in current use is considered obsolete and an Agile solution is being sought. Suggestions:	• Traditional mechanisms for evaluating software solutions will take too long. The problems may change before or during the implementation. A quick, low cost test implementation of a non-optimized solution may yield quicker/better results. • Given the mixed manufacturing style environment, a single solution may not be appropriate. Rather a mix of low cost solutions may yield better results for the individual units, but should be tied into an oversight system for visibility to the whole .

Advance Information: Objectives/Strategies/Change Issues

Site: Pratt & Whitney, WPB Date: 14-15, Sep-95

Work Sheet #1

Subject: Shop Floor Information Tech. Notes by: AIT Group Composite

Objectives/Problems

Objectives:

1) Evaluate and recommend an Agile Information Technology solution to plan, execute and provide visibility of manufacturing execution.
2) Solution(s) should be modular, scaleable, distributed and flexible systems.
3) Support for concurrent engineering and manufacturing processes.
4) Business style - Built a non-value added environment over the years from what was originally a "skunk works". Lead-times protracted as more formalities and bureaucracy grew. Mix of production and R&D in-process at any time. Organization "stovepipes" that worked independently and/or at cross purpose with each other. Business units are grouped but not well integrated (both horizontally and vertically) from an operational and Information System perspective. Squeaky wheel prioritization.
5) Trying to move to an Agile environment, systems are not in place to do so.
6) Visibility to understand the total business requirements and impact of change is missing.

Problems to solve:

1) Complex manufacturing environment make it difficult if not impossible to predictably produce products according to schedule/plan.
2) Empowered work teams need visibility to information in order to make decisions and have those decisions and the ramification of the decision rapidly disseminated across the organization.
3) Visibility from external applications (e.g. MAPS) to/from the Execution environment is needed.
4) An integrated information view of the total manufacturing environment is needed without jeopardizing the individual manufacturing unit's autonomy and local optimization.

Strategies

1) Quickly implement an information system that is responsive to the needs of the shop and provides visibility to the changes in the process, work in process and demand by the customer.
2) Require no more or possibly less resources to use/implement.
3) Manage by exception to the state rather than manage a state where everything appears as an exception.
4) Business style - go back to the "skunk works" R&D type business without throwing out the mandated (customer/regulatory) requirements.

Change Issues

Generic Change Issues

- So busy fire fighting today's problems, there is little time to implement a solution.
- Discipline required to make the system valuable needs to be instituted.
- Solutions do not come for free, they require change to both the business and the information technology.

Site Change Issues

- The existing system is perceived as a solution by some of the organization, but may not meet the needs of the entire organization (issues of scalability, robustness and reconfiguration).
- General support areas may resist a new system without seeing clear benefits.
- Inability to solve problems of manufacturing (and engineering) in a timely (real time, event driven) fashion.
- Does such a system require finite or infinite scheduling.
- Different planning needs (and possibly execution needs) for various business units based on type of manufacturing.
- Impact on customer satisfaction.
- Impact to the operation
- Problems seem to be 20% technology driven versus 80% culture driven.

Operations - Production Process
Remmele Engineering, Inc.

Change Proficiency	Flexible Machining Systems
Cost	• Significant utilization of multi-purpose, flexible equipment reduces operating costs and capital investment costs • Lowered facilities cost due to facilitated moves, expansions and reductions of work cells.
Time	• Enables rapid modification to the process when customer initiates engineering changes. • Shortened time to tool up for a job because of flexible CNC equipment, fixtures and tooling.
Robustness	• Changes are made to the part and/or to the volume with minor impact to the overall operation.
Scope	• Can encompass major variations in part type, material, customer and volume.
Key Characteristics	
Reusable Units	• Each machinist is trained in the operation of all of the various machine tools enabling smooth movement within a plant. • The machine tools are programmable, multi-use capable and totally movable.
Reconfigurable	• Work cells are reconfigurable to meet varying demand and new part requirements
Scaleable System	• Work cells are setup to allow the addition of complementary machine tools adding capacity or capability.

Remmele Engineering has gained a reputation for agile performance in its ability to reconfigure its manufacturing process through the unique simultaneous implementation of flexible machines, flexible processes, flexible employees and flexible facilities.

An example of a flexible machining system at Remmele is the FMS (Flexible Machining System) manufactured by Yamazaki Mazak Corporation. The FMS concept is a multitask machining center with automatic part and tool loading and unloading for a hands free operation. These systems can be configured to handle a wide variety of part configurations and requirements. The FMS versatility and broad functionality allow Remmele to accept a wide variety of jobs, materials and performance specifications from its customers.

At Remmele, machining centers are sometimes ganged in a work cell environment; providing redundancy in the event of a machining center failure and the ability to meet demand variability and expand capacity**.** An important concept at Remmele Engineering is that the equipment is not permanently dedicated to a particular modular work cell or specific customer's job. The equipment is mounted on "I" beam structures so that the machining units can be temporarily clamped to a position on the floor, but moved from job to job as customer requisites are modified or brought to completion.

Tooling is purchased with multiple use and versatility in mind. Most of the machine tools are CNC variants; supporting easy programmability and modification when an engineering change is requested by a customer, or the machine is set up for a new customer's job. This enables Remmele to offer a form of mass customization to its customers without cost penalties. The company provides an excellent example of a major paradigm shift from the old dedicated tooling concept fostered in the industry to the new, flexible, multi-use tooling concept.

Whenever possible, "custom" fixtures are designed and built with consideration to future applications, enabling **migration** to other applications and opportunities. Remmele's strategy is to purchase technologically advanced equipment, such as the FMS equipment, learn how best to utilize it, and then find customers for this capability. This proactive approach is backed up by intensive benchmarking analyses to ensure that the right capabilities are added to the company's product and process portfolio.

Because of the increased utilization of the equipment, machine uptime becomes a critical component of Remmele's flexible machining strategy. A rigorous preventative maintenance program for all equipment helps to ensure that maximum uptime is obtained.

To facilitate this flexible machining strategy, it is important to have plant facilities that can be quickly and economically adapted to work cell creation, reconfiguration and ultimate deletion. At Remmele, plants are configured so that utilities such as electrical power and air are distributed throughout the facility allowing quick, flexible installation of a wide complement of CNC machine tools and automation equipment.

Each machinist/operator, enabled by extensive in-house training, can readily move between various types of machining and CNC equipment. The training, along with the flexible facilities, enables Remmele Engineering to maximize the performance of each piece of equipment with the least amount of non-productive time. When all of these elements are combined, Remmele Engineering exhibits agility through an integrated flexible manufacturing concept encompassing machines, process, people and facilities.

	Important Types of Change
Creation/Deletion	• The plants can create and dissolve customer focused work cells as needed through the utilization of flexible machines and a reconfigurable plant-utility infrastructure.
Addition/Subtraction (Capability)	• A strong in-house apprenticeship program and an imbedded learning culture facilitate the addition of new skills. • Standardized I-beam mountings and plant-utility infrastructures facilitate the addition and subtraction of unique capabilities on-demand from customer-focused cells.
Augmentation (Improvement)	• An ingrained learning culture, flexible facilities, and flexible equipment enable continuous improvement.
Migration	• A process leadership strategy constantly evaluates, benchmarks, and installs the best new process technology in anticipation of emerging market opportunities and requirements.
Expansion/Contraction (Capacity)	• Machine tool utilization-potential is maximized; machines are moved from cell-to-cell and used wherever they're needed.
Reconfiguration	• Machine tools and machinists are totally reconfigurable.
Variation (Performance)	• Highly flexible CNC machining allows part-by-part download for customization and real-time work-in-process part-to-part job variation.
Correction (Recovery)	• Equipment redundancy is built into the modular machining cells to allow for unexpected failure to occur on one machine tool and still allow parts and/or assemblies to be manufactured from the others. • In-depth preventative maintenance affords the maximum up time during production.

Company Background: Remmele Engineering is a modern contract machining, assembly and automation equipment manufacturing company located in the St. Paul, MN area. With over 450 employees and sales in excess of $90 million dollars per year, Remmele takes pride in a large customer base spanning the aerospace, aircraft, defense, power generation, industrial machinery, automotive, medical, computer and construction equipment industries. Founded in 1949, they have steadily grown and now occupy five separate facilities totaling 457,000 square feet of space. Remmele Engineering consists of four focused divisions:

- General Machining Division - Precision machining of large parts
- Repetitive Batch Division - Batch production approach for parts up to 2 cubic feet in volume
- Production Division - High volume precision machining of parts up to 2 cubic feet in volume
- Automation Division - Custom design and fabrication of special automated fabrication, assembly and test equipment for other equipment manufacturers.

Each facility is focused on different market segments, running as autonomous profit centers. Finance, Human Resources and Information Systems are centralized. Remmele Engineering intends to grow their business by 10% or more every year through a strategy of long term vision, investment in resources and technology and a focus on customer satisfaction.

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APPENDIX

A. Worksheet #1
B. Worksheet #2
C. Worksheet #3
D. Worksheet #4

Advance Information: Objectives/Strategies/Change Issues

Site: Date:

Work Sheet #1

Subject: Notes by:

Objectives/Problems
Objectives: Problems to solve:
Strategies
Change Issues
Generic Change Issues | **Site Change Issues**

Issues and Metrics

Site: Date:

Worksheet #2

Subject: Notes by:

Issues and Metrics - Work Sheet	
Framework	
Modules	
Key Change Issues (State the Problem - Not the Solution) with Key Metrics (TCRS)	
Creation/Deletion Build new framework or modules.	
Addition/Subtraction Add/delete capability.	
Augmentation Incremental improvement.	
Migration Likely major changes to framework/module pool.	
Expansion/Contraction Add/delete capacity.	
Reconfiguration Change relationships among modules.	
Variation Real-time change in module performance.	
Correction Recover from a module or framework failure.	

Site: **Issues and Responses Map** Date:

Subject: **Worksheet #3** Notes by:

Issues and Responses Map		
Framework		
Modules		
Change Type:	✔ Good ✧ No Judgment Yet ✳ Questionable **Proficiency at Key Change Issues (Defining the Problem)**	**Current/Planned Responses/Strategies (Defining the Solution)**
Creation/Deletion		
Addition/Subtraction (Capability)		
Augmentation (Improvement)		
Migration		
Expansion/Contraction (Capacity)		
Reconfiguration		
Variation (Performance)		
Correction (Recovery)		
Considerations and Suggestions		

RRS Characteristics

Site: Date:

Worksheet #4

Subject: Notes by:

System RRS Characteristics	
Framework:	
Modules:	
Encapsulated Modularity: The system is composed of distinct separable units capable of interacting with each other but are not intimately integrated. Internal workings of a module are unknown and unimportant to the external environment.	**Scalable Size:** Unrestricted unit populations that allows large increase and decrease in total units.
Plug Compatibility: Units within the system share a standardized compatible interaction framework.	**Unit Redundancy:** Duplicate unit types or capabilities that provide capacity fluctuation options and fault tolerance.
Facilitated Unit Reusability: Standardized unit replication information, unit modification tools, and accessible unit capability catalogs.	**Evolving Extensible Unit Framework:** Evolving, open system physical frame-work that accommodates any type of unit: legacy, common, or completely new.
Non-Hierarchical Interaction: Units within a system may communicate, negotiate, and interact freely/directly among themselves without concern for hierarchy.	**Distributed Control & Information:** Units will respond to objectives rather than methods, decisions will be made at point of maximum knowledge, data and knowledge will be captured and retained locally but accessible globally.
Dynamic Late-Binding Relationships: All relationships will be transient whenever possible; if permanent binding is required it will occur as late as possible in a relationship.	**Self Organizing Unit Relationships:** Unit behaviors include dynamic alliances, teaming, and scheduling; open bidding; and other self-adapting techniques.