This is the original text-book manuscript material, with minor typos, misspellings, and sentence structure differences of no consequence

Preface

This book addresses the practical and physical aspects of *how* to become agile, and does not spend any real effort on the *why* question, or on the question of what to do with it once you have this *response ability*. Plenty of others are dealing with these unaddressed questions, while no-one as yet has addressed the *how* part. My observation is that people don't perceive a problem in any tangible, actionable form until they appreciate that a solution exists – and then they begin to define and understand the problem in terms of the solution. Here I will expose a solution.

In 1991 I co-led an industry/government project at Lehigh University to identify the competitive frontier in 2005. This project gave birth to the concept of the agile enterprise. Our predictions were based on observations that the business environment was becoming less stable, that the driving forces toward more uncertainty were and would continue to accelerate, and that current organizations were not equipped to operate under these conditions. Our intention was to illuminate an inevitable future, and motivate business organizations to begin preparing for it immediately and seriously.

Ours was an idea who's time had come. Which meant that others were thinking about the same inevitability, the consequences, and the strategies for both coping with increasing change and for turning this situation into advantage. Mass customization and organizational learning were two of the front runners then – one a prescription for marketing and manufacturing strategy, the other a prescription for cultural strategy. At about the same time tactical programs for change management and reengineering started sweeping through the business community, and lean manufacturing started removing the inertial fat.

As the decade of the nineties progressed, each year saw more books with new ideas on how to cope with, and take advantage of, increasing uncertainty and accelerating market cycles. By and large these books focused on strategies for specific aspects of business, such as business strategy, marketing strategy, manufacturing strategy, information technology, and knowledge management. Two books written by colleagues from the original agility project took a broader enterprise view, creating a call to arms, illuminating a cross section of agile micro strategies under test in various industries, and suggesting new priorities.

But still there was something missing. New and valuable ideas and strategies must be implemented. Implementation means changing some or all aspects of the organization; and the real underlying message was that these changes, however advantageous they might be when made, would have to be changed all too soon thereafter.

How do you design an organization, and all of its parts, so that it is naturally agile – able to transform itself with competence into whatever the new situation requires? My research since that 1991 call to arms has focused on just that question. This research employed collaborative industry teams analyzing hundreds of highly adaptable business structures over an eight year period, looking for common underlying fundamentals. We found them.

Being *able to respond* to proactive strategic direction, and being *able to respond* to reactive necessity, is what this book is about.

This book illustrates what it is that makes a business and any of its systems easy to change, and then demonstrates how to apply these principles to any system in a company, at any level. It shows you how to analyze opportunities and problems for their operational dynamics, and ways to use these tools to establish a solution strategy. It also demonstrates how to measure change proficiency, and then how to use this tool to profile a company and establish improvement strategies. It then focuses on the role played by culture, and how to establish and insert these new values and competencies compatibly into an established corporate culture, no matter what it may be.

This book answers the questions “What to do?”, “How to do it?” and “Where to start?”. It is first a book for doers who want to know how things work under the hood: for leaders, for strategists, for change agents, for operational managers, and for business planners who would be armed with knowledge, and the tools

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for imparting knowledge to others as a persuasive edge. In the hands of such people this book is also a supporting reference and tutorial for all others who will be part of the transformation.

■ TIMELINESS AND APPLICABILITY

When that 1991 investigation proclaimed accelerated and constant change as the coming business environment, it was an intellectual concept that had not yet materialized. There was no emotional understanding in the business community as yet. Since then the scramble towards eCommerce in 1999 brought near panic to most established companies in most established industries, as well as to the new fire flies who's five minutes of flame is extinguished by a newer batch. eCommerce is not the driving force behind this uncertainty and upheaval, it is only the first major wave coming from a deeper reality: the explosion and rapid application of new knowledge coupled with increasing connectivity and communication. True business complexity has arrived, and there is no going back.

eCommerce provides a good current backdrop. Everyone understands the need for an eCommerce strategy, but a company doesn't get an effective one without reengineering the organization considerably, and that's the hard part. An on-line order entry port is not what this is all about. eCommerce is so new its broader possibilities are not yet explored. If getting a first eCommerce strategy was a late wake-up call and cause for panic, getting another and another that is competitive will continue to be a panic for some time. New start-ups keep discovering new ways to redefine how eCommerce can change the rules. Welcome to the 21st century.

To take the focus away from eCommerce, look at the satellite communications network business. Many of us watched Iridium's multi billion dollar 1999 bust, and turned our attention to Teledesic. But right in the middle of the Teledesic startup comes a pronouncement[1] that manned aircraft on overlapping rotating schedules can provide sky-beamed communications services at considerably less cost than satellites. Whether that turns out to be pie in the sky or not, six months after that announcement comes one about a combination helicopter-rocket[2], which promises dramatic drops in satellite launch cost. New technology (knowledge) is threatening slightly-less-new technology with obsolescence even before it comes to market.

I will not talk much about eCommerce or communications networks; but I will deal with how an organization can be made *response able* when eCommerce requires a different organization, a different distribution logistics, a different production capability, a different innovation capability, a different set of resources, a different product design, a different service strategy, or a different approach to anything.

This book addresses the nuts and bolts and analytical side of organizational change proficiency. Its intent is to clear the haze surrounding the concepts of business agility and the agile enterprise by showing the fundamental principles which underlie an organization's ability to respond, and by showing how to apply these principles in real situations. It is the physics of the agile enterprise that is exposed here.

As a byproduct, this fundamental viewpoint provides a strategic context for lean operating practices, puts knowledge management and the learning organization in perspective, and offers a framework for incorporating today’s best advice on new business practices and strategic focus.

■ THE USER'S MANUAL

This book breaks many rules of traditional authorship. First, it attempts to speak both to enterprise leadership and to operational management – two audiences with different interests and different perspectives. Next, it speaks across the organization to various functional managers, each with a different viewpoint and strategic focus. The risk is that it will satisfy none. The reward is that leaders understand the concepts and know that there is an implementation plan, that implementers respect the strategic context that justifies and guides implementation, and that managers understand that they all have something very much in common. The style of the book, also unconventional, attempts to make it fruitful for all.

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The material in this book is both broad and deep. In some respects it is written to the mythical business engineer and architect. That person who would know something of all aspects of the enterprise, and take responsibility for enabling both leadership and viability under highly dynamic conditions. There may be times when this book doesn't speak to your experience base, when it gets too low in the organization or too high, when it gets too strategic or too tactical, or when it gets too social or too technical. If you don't skip over the unfamiliar terrain you will find a common theme throughout, and find a common language and perspective that binds them all. But skipping is enabled.

Reading this book may get your hands dirty. Many of the case examples are taken from the production floor, from product designs, and from information technology; and from the automotive, electronics, semiconductor, and aerospace industries. But there are also many examples dealing with other industries and service sectors, and dealing with organization design, supply chains, teaming, customer relationships, training tools, knowledge management strategies, knowledge worker relationships, and practically every other aspect of business.

As a learner I need answers to my questions as I have them, which is generally not in the order that teachers or authors think I should receive them. In theory, hyperlinked documents allow you to delve into detail, gloss over unnecessary explanation, or explore a relevant side issue to fit your own knowledge base; speeding up your introduction to new material and allowing you to control your own level of personal excitement. You (probably) have in your hands a bound collection of paper which doesn't have a point-and-click interface as yet – so it is linear by nature. But like all such books, it does have a big advantage over today's on-screen text, hyperlinked or not – you can quickly flip through it and have some sense of what you are bypassing as you do. This book has been crafted with that style in mind, and the understanding that we all learn differently.

I have always been intrigued with the way Scientific American illustrates their articles. For me, studying the pictures and their captions in many cases is sufficient. If you are a visual learner, as I am, you can get a pretty good overview from a cursory scan of the graphics in this book, and a reasonable amount of detail by reading the captions. Some readers may get a sufficiently complete story from only the pictures and tables and never investigate the back-up chapter text. Others will want to see the many different data points that create the final patterns.

Reading erratically is expected and encouraged. In the chapter text we generally discuss the nature of a problem before exploring our approach to a solution, often with anecdotes and metaphors, sometimes directly. If you already understand the problems as I do, don't get bored as I belabor the obvious, skip ahead. But if you do skip, and the solution doesn't make sense, step back and review the perspective on the problem. Unavoidably some information may be difficult to fully comprehend if other information isn't understood first. Nevertheless, after an overview scan, much of the book should be comprehensible when taken in random bites.

This book employs examples from many companies, but also leans heavily on four specific examples from four different companies. From these four specific examples you will see a pattern emerge that makes the material independent of any specific case. I will bombard you with examples from many different perspectives, some of which may be difficult to relate to if you haven't walked that mile in those shoes; but all are building a pattern, and there should be enough familiar examples here that the more obscure will bare their souls as the patterns emerge.

The books of the nineties chronicled the need to thrive under conditions of high speed uncertainty. I will not do that here. I assume that you know that, and now want to know how. I would like you to *know* it at a visceral level when you have finished with this book, and that is what has guided the style of presentation.

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■ NOTES

[1] Platt, C. (1999), "Ethernet at 60,000 Feet", *Wired*, June, pp 150-155, 208-209. "Already Proteus has made more than a dozen test flights in preparation for its ultimate mission: to cruise at 60,000 feet ...where it can do the kind of tasks routinely done by satellites...It could bring broadband wireless voice, interactive video, and data service to American consumers three or four years ahead of low Earth orbit satellite constellations such as Teledesic...A city can be served by a fleet of three Proteus airplanes, each carrying a 15-foot communications dish beneath its curved belly. One plane will circle for 8 hours, providing telecommunications for an area 50 to 75 miles in diameter. As it runs out of fuel, it hands off to the next plane, and so on, enabling uninterrupted 24-hour coverage." All of Teledesic's $9 billion system needs to be up and running before services can be provided, but Proteus can dominate a major market as soon as it puts three planes in the air – at a cost of $30 million; using revenues to finance additional major market coverage and leaving the sparse areas for Teledesic when it finally arrives.

[2] Port, O. (editor) (1999), "It's A Rocket! It's A Chopper? It's Both", *Business Week*, March 22, 1999, p 65. "It looks like a huge traffic cone that has sprouted a palm tree. But the 63-foot-tall Roton is a hybrid rocket-helicopter that Rotary Rocket Co. hopes will slash the cost of putting satellites into orbit – by as much as 90%...To make it happen he [founder Gary Hudson] has created a lightweight vehicle that will use whirling rockets to climb into orbit, then descend for a soft touchdown by unfolding helicopter blades. Roton's 72 rockets whirl like a fireworks wheel to create centrifugal force. That pushes fuel into the rockets and eliminates the need for the heavy and expensive turbo-pumps otherwise required."

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Part 1 – Agility, Response Ability, and Culture

Part one of this book lays in a foundation of concepts and leverage. Definitions attempt to clear up the slipperiness from the word agility when applied to business and enterprise. The roles of culture and knowledge management are discussed. And a common set of structural patterns is shown as the enabler for highly adaptable enterprise systems.

Chapter 1 - Putting Agility in its Place

Pre-read entire chapter for SDOE-678 Session 1

Agility is a very seductive word. One that finds immediate and personal definition for almost everyone touched by it. It can capture cycle-time reduction, with everything happening faster. It can encompass mass customization, with customer responsive product variation. It can embrace virtual enterprise, with streamlined supplier networks and opportunistic partnerships. It can echo reengineering, with a process and transformation focus. It can demand a learning organization, with systemic training and education. It can build on lean production - with high resource productivity. As a descriptive word agility can embrace almost any competitiveness interest with considerable intuitive appeal.

In this opening chapter we will establish some firm guidelines and definitions for examining agility and its enabling components.

■ BASIC CONCEPTS

Agility is not a brand new concept. Organizations have always existed in a changing environment and have always had to adapt, ever since the first humans banded together for purpose. Organizational adaptability is a core viability requirement, just like profitability (see Figure 1.1). In order to continue as a viable entity an organization must meet two conditions for existence: it must generate at least as much fuel as it consumes (profitability) and it must continuously adapt as necessary to changing environmental conditions. When either of these conditions is not met, the organization is threatened with extinction. In this sense an organization is just like an organism – both lead a transitory life in a hostile environment that requires the consumption of energy and constant vigilance, followed by either adaptation or extinction.

In the life metaphor we talk about evolution and mutation as ways to accommodate a changing environment, and we look for the enabling mechanisms in the genome of life. Equivalently for the organization, we will look to see how the organization is organized for change – both statically and dynamically. However, though there are organizational lessons in the life metaphor, we do not base the agile enterprise upon it: evolutionary life works on a much longer time frame than business does; evolutionary life does not possess willful consciousness and the ability for leadership directed mutation; and evolutionary life on the grand scale knows no sense of pain or loss from its failed experiments. We mention this only because there is now a growing voice for organizations based on self-organizing biological and ecological concepts[1] - which have much merit but often go too far in their infatuation with mindless evolution and adaptation.

Efficiency programs[2] like lean production, and transformation programs like process reengineering are all facilitated by an underlying proficiency at change. If the organization is “proficient” at change it can and will adapt to take advantage of unpredictable opportunity as well as counter the unpredictable threat.

Being agile means being proficient at change. It allows an organization to do anything it wants to do whenever it wants to – or has to. Thus, an agile organization can employ business process reengineering as a core competency when transformation is called for. It can hasten its conversion to lean production when greater efficiencies are useful. And importantly, it can continue to succeed when constant innovation becomes the dominate competitive strategy. Agility can be wielded overtly as a business strategy as well as inherently as a sustainable-existence competency.

Agility is a core fundamental requirement of all organizations. It was not a conscious interest when environmental change was relatively slow and predictable. Now there is virtually no choice in the matter

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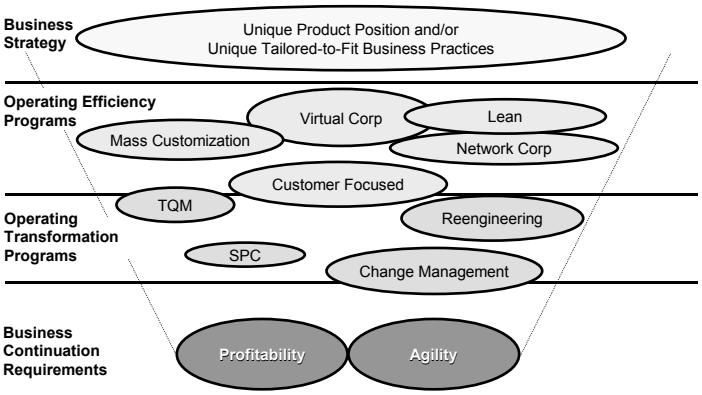
but to develop a conscious competency. Practically all enterprises now need some method to asses their agility and determine if it is sufficient or in need of improvement. This book introduces techniques for characterizing, measuring, and comparing agility in all aspects of business and among different businesses; it offers methodologies for sensitizing a corporate culture to the values and modes of agile activity and practice; and it suggests fundamental methods for increasing the agility of any business practice.

In the early '90s people wanted to know how agility differed from flexibility, or from the body of knowledge gathered under the lean rubric. These were (principally) manufacturing concepts, and agility carried with it

Figure 1.1

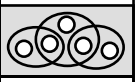
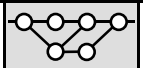
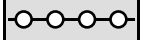


Agility Is An Objective, Not A Competitor, Of Operating Programs

When agility first emerged as a competitive concern it was confused by many as a repackaging of popular operating programs such as lean, TQM, mass customization, and virtual corporations. This confusion arose because the need was recognized before the means, and early attempts at describing supporting behavior borrowed operating modes and examples from existing programs. As a business continuation *requirement* agility is not a new concept. The widespread difficulty in keeping up with a changing business environment is. Though agility may also be wielded as a business strategy, that is an *option*.

Figure 1.2

A Manufacturing Metaphor for Agile Resource Relationships

Operating Architectures	Craft	Mass	Lean	Agile
Reconfigurable				
Flexible				
Specialized				
Comprehensive				

Agility initially carried with it a manufacturing focus - a result of its birth in response to the Japanese success with new manufacturing approaches in the 80s. In answer to early questions of how agility in manufacturing differed from flexibility and lean concepts agility was placed in the evolutionary continuum of manufacturing paradigms. This succeeded in helping many differentiate agility from older and more familiar ideas, and helped focus thought on the structural aspects of "response able" systems. But it also lodged agility too firmly in the manufacturing environment, and made it more difficult for some to visualize this concept in any and all aspects of enterprise organization. Worse yet, for some it cast agility as just one more operational paradigm - ignoring both the strategic and the fundamental places it timelessly occupies in the concept of enterprise.

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initially a manufacturing focus – a result of its birth in response to the Japanese success with new manufacturing approaches. In one of my own contributions to the confusion I responded to these questions head on, and placed agility in the evolutionary continuum of manufacturing paradigms: craft, mass, lean, agile (Figure 1.2). This characterization was a two-edged sword. It succeeded in helping many differentiate new agile concepts from older and more familiar ideas, and helped focus thought on the structural aspects of "response able" systems. But it also lodged agility too firmly in the manufacturing environment, and made it more difficult for some to visualize this concept in any and all aspects of enterprise organization. Worse yet, it cast agility as just one more transient operational paradigm, ignoring both the strategic and the fundamental places it timelessly occupies in the concept of enterprise.

■ AGILITY DOES NOT COME IN A CAN

Some ascribe to the belief that self organization and personal autonomy is required to navigate the turbulence of today's chaotic business environment, while others think that an organization can not be successful if it doesn't have strong leadership and strong management. Some believe that collaboration and team consensus is the only way to success for an organization, while others know that competency and excellence is compromised with consensus.

What people believe and know to be true is a product of their experience and environment, and quite likely is proven true daily if their experience and current environment are in alignment. You can not force autonomous operating concepts from complex adaptive systems (chaos) theory onto a polar opposite organization that lives and breaths a command and control culture; nor can you convince a culture that values unmitigated competency above all else that a committee consensus is the best way to make critical decisions. Conversely, a new manager bringing unquestionable procedural rules to a highly successful but independent and unpredictable creative team will either lose the team or be ignored; and the experienced team leader hired away from one company for his technical expertise may well fail miserably when he refuses to compromise ideals for the sake of team agreement in another company.

Bill Schneider, a clinical psychologist focused on organizations, suggests that corporate cultures fall into one of four core categories: control, competence, collaborative, and cultivative[3]. Figure 1.3 shows one of his characterization maps. He argues that reengineering works when the underlying principles of new management practices are translated into concepts compatible with the underlying culture – and doesn't work otherwise.

One of my most poignant learning moments in the early days of proselytizing the agile enterprise concepts occurred when I addressed a group of a hundred of so manufacturing managers and executives at Dupont. The Q&A session opened with: "It's nice to know that you have all that theory about agility but I need to know what to do. Tell me the five things to do! I've listened now for an hour and a half and it's been a waste of time for me. Tell me what to do!" I do not know how many people he spoke for with that sentiment, but it struck home deeply for me. Here I was sharing my most insightful thoughts about what had to be considered when you decided yourself what to do, only to find that I was talking to a person who did not want to make that decision. He did not even want to know what was behind the decision that someone else might make and hand to him. He wanted marching orders, and he wanted them quickly and simply. Production was what he lived for, and he kept it humming – at least as long as he was there and not off listening to some academic horse pucky.

Schneider allows as how a corporation may have a *core* culture of one type coexisting with other, even polar opposite, cultures in localized areas. My experience is that manufacturing is a functional area that tends to favor the command and control operational culture, regardless of what the core culture of the greater organization may be. Thus, what works with one part of the company may well not work in another, without some cultural translation of the underlying principles.

When this agile *characteristic* was identified in the 90s as a new and necessary competitive focus, there was immediate and impatient pressure in the manufacturing community to identify exactly how one

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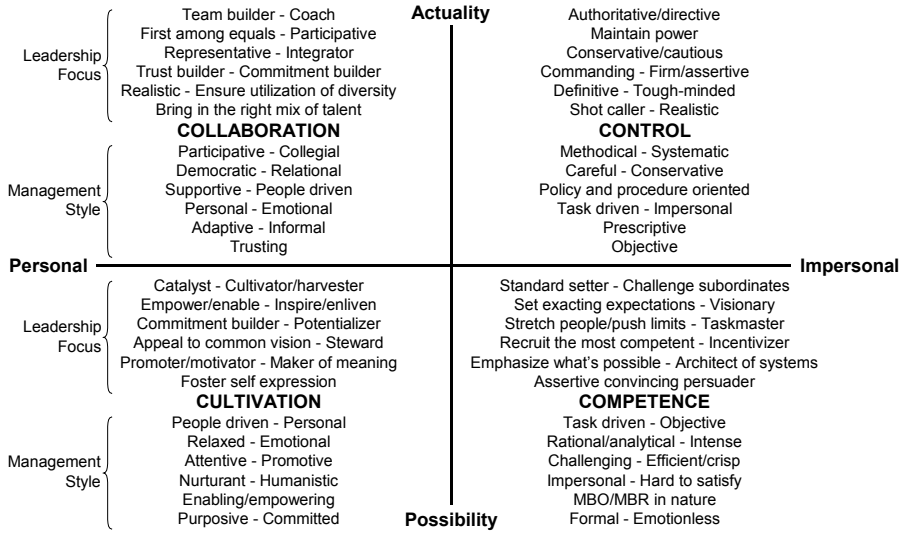
Figure 1.3



Core Cultures and The Leadership/Management Focus

From: *The Reengineering Alternative - A Plan for Making your Current Culture Work*, William E. Schneider, Ph.D. This is one of five tables characterizing the four core organizational cultures mapped by Schneider, a clinical psychologist who consults on organizational development and change. He argues that reengineering works when the underlying principles of new management practices are extracted and then translated into concepts compatible with the underlying culture. The vertical axis reflects what a culture pays attention to - the content - and ranges from *what is* to *what might be*. The horizontal axis reflects how a culture makes decisions and forms judgements - the process - and ranges from *impersonal analysis* to *personal/interpersonal involvement*.

Figure 1.4

Key Concept Relationships

KM + RA ⇒ A **Knowledge management + Response ability ⇒ Agility**
This expresses agility as derived from the ability to manage and apply knowledge effectively - providing the potential for an organization to thrive in a continuously changing, unpredictable business environment.

CP + RRS ⇒ RA **Change proficiency + Reusable/reconfigurable/scalable structural relationships ⇒ Response ability**
This expresses the dynamics and statics of agility; recognizing change proficiency (Cp) as a dynamic characteristic manifested during a change activity, and Rrs as a design discipline evident in the architectural structure of relationships among the things/people/resources involved in a change.

KPM + CLF ⇒ KM **Knowledge portfolio management + Collaborative learning facilitation ⇒ Knowledge management**
This expresses Km as having both a directed strategic component and a fostered grass roots component.

CP: **Change proficiency is a dynamic competency that facilitates change.**
Proficiency is a multidimensional assessment of competency measured on a five-stage maturity scale - characterized by the specific metric focus, nature of the working knowledge, and competency developed in four progressively difficult types of proactive and reactive change. (Part 2)

RRS: **Reusable/reconfigurable/scalable structural relationships are static principles that enable change.**
Analysis of business organizations, procedures, and systems shows an structure of reusable elements reconfigurable in a scalable framework as an effective way to enable high adaptability. (Part 3)

KPM : **Knowledge portfolio management.**
The directed identification, acquisition, diffusion, and renewal of knowledge that the organization requires strategically. (Part 4)

CLF: **Collaborative learning facilitation.**
The cultural and infrastructural support for creating and maintaining collaborative learning networks and collaborative learning events and activities. (Part 4)

For two of these terms I neither claim that they represent what others mean by them, nor carry some quality of superior correctness - both *agility* and *knowledge management* are terms carrying strong subjective meaning for many, and are also being applied to products and concepts with special interest champions. It should also be understood that agility is not viewed here as an all encompassing paradigm of organizational or business theory - only as one very necessary characteristic. For instance, the definitional span does not include the complimentary concept of leadership - yet it is obvious that wielding the characteristic of agility to superior competitive effect requires someone (or some process) to make superior decisions.

became agile. There are in fact many ways an organization may exhibit this characteristic. Agility is not a brand named management practice, business strategy, or manufacturing theory. Though one company may have *an* agile strategy, *an* agile practice, or *an* agile manufacturing capability, what it does to maintain this capability is likely to be very different than a similarly blessed competitor.

An American football team exhibits agility. There is a quarterback who tells everyone what the next play will be, and everyone knows exactly how that play is supposed to unfold. Independent ideas and play

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modifications are not tolerated. Once the ball is snapped, however, independent interpretation of what to do from one second to the next is expected. Fortunately everyone has a shared goal in mind and they all know where it is. Every single player knows what competency and excellence means in the role he is expected to play. Teams that do not simultaneously exhibit both high group discipline and opportunistic individual innovation are not among the best. Teams that are not agile enough to fluidly seize unexpected moments, recover from unanticipated setbacks, or modify their game plan to fit an uncooperative competitor are not winners. How a football team manifests agility, however, may not work at all in a fundamentally different environment.

Agility does not come in a can. One size does not fit all. There are no five common steps to achievement. And there is not a simple set of four variations to match the Schneider cultural map. Cultural models map an infinite continuum and mixture of style into a few black-and-white categories. Cultural maps are highly useful to help us understand and develop variation of approach; but they are not reality, just sketchy reflections.

This book will introduce fundamental principles and frameworks for examining your own needs for being agile, and for establishing the requirements of appropriate solutions. It offers methodologies for involving as much of the organization as is appropriate in developing these understandings and plans. It emphases that an understanding of the situation is necessary before solutions can be considered, evaluated, and selected, and provides methods for doing this. And it stresses the need and value of thinking and learning, rather than blind recipe following.

■ KEY CONCEPTS AND TERMS

Figure 1.4 defines key terms as I use them in this book, and is offered to eliminate ambiguity in the discussions, not to pretend some authoritative claim over their absolute meanings. I have arrived at these meanings after many years of trying them on in various ways – using them in working groups to describe concepts and build understanding – and have been guilty of using some of them interchangeably at different times as their evolution developed.

Here we will look at *agility* as deriving from both the physical ability to act (*response ability*) and the intellectual ability to find appropriate things to act upon (*knowledge management*). As we will expand upon later, this expresses agility as the ability to manage and apply knowledge effectively, providing the potential for an organization to thrive in a continuously changing, unpredictable business environment. Providing this potential is the focus in this book. How one exercises this potential strategically does not concern us here, for that, as Michael Porter points out[4], is where unique positioning is developed to differentiate one competitor from another. But first, the potential must exist.

Going a level deeper we look at *response ability*, the ability to act, as deriving from two sources: an organizational structure that enables change and an organizational culture the facilitates change. This term is featured throughout this book because its two components are where this book makes its principle contribution, though we will be looking at some important aspects of knowledge management as well.

The organizational structure we will discuss is based on *reusable* elements *reconfigurable* in a *scalable* framework (Rrs), and has been observed in our research at work in a wide variety of highly adaptable business systems, organizational structures, and processes. The phrases “organizational structure” and “system structure” are used interchangeably by me when referring to a collection of distinct resources (or elements) that are related as a group interacting together for some common purpose. A human resource director may not feel comfortable applying the term “system structure” to the structural relationship evident among a team of people. Similarly, a production foreman may not find “organizational structure” as the phrase that captures the structural relationships in a production process.

The organizational culture we will discuss is focused on *change proficiency* (Cp), and is a sub-culture of beliefs and values that co-exists compatibly with the corporate culture. Figure 1.5 depicts the principle tools we will discuss and apply when analyzing, comparing, and developing response able business practices.

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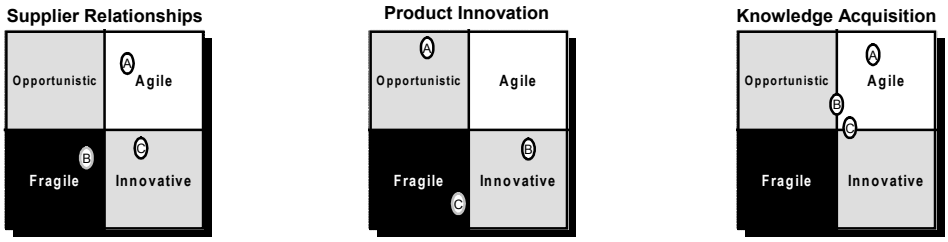
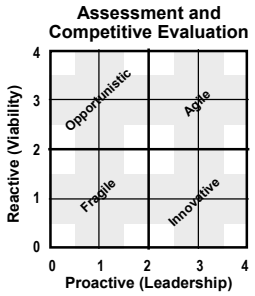
Figure 1.5



Change Proficiency Maturity Model

Maturity Stage	Metric Focus	Working Knowledge	Competency Development Reactive	Competency Development Proactive
0 Accidental	Pass/Fail	Examples	None	None
1 Repeatable	Time	Concepts	Creation	Correction
2 Defined	Cost	Metrics	Improvement	Variation
3 Managed	Qualitys	Rules	Migration	Expansion
4 Mastered	Scope	Principles	Modification	Reconfiguration



The five-stage maturity framework is used to assess existing corporate competency at change proficiency, as well as to prioritize and guide improvement strategies. Maturity progresses through five stages of working knowledge and metric focus, with separate competency tracks for both proactive and reactive proficiencies. A *Change Proficiency Maturity Profile* for an organization can be built from this framework across any selected critical set of business practices.

Knowledge management, response ability's companion in the agile enterprise, carries at least as many different popular, proprietary, and expert interpretations as agility does. Testament to both widespread interest in this concept as well as its relative newness as a focused enterprise factor. Here we will look at knowledge management as containing both a top-down and directed component called *knowledge portfolio management* (Kpm) and a bottom-up grass roots component called *collaborative learning facilitation* (Clf). For sure there are elements of knowledge management that don't involve collaboration in any form, but in the context of the agile enterprise this is our focus.

Someone at General Motors once asked what size had to do with agility, suspecting the two were inversely related. My answer was that the larger the corporation, the more knowledge it had access to, and the more leverage it could gain from effective mobilization. Agility has two components, and where a smaller company may be able to act quicker, a larger company may be able to know what to act upon sooner and more thoroughly.

Part one of this book provides a conceptual base. Part two provides a language for sensitizing the organization, and offers an analysis methodology. Part three looks closely at structural issues and ten enabling principles of reconfigurable organizations and systems, and offers a design methodology. Part four looks at culture, knowledge, and learning issues, and offers both a corporate assessment methodology and a cultural transformation methodology

■ GETTING A HANDLE ON THE ISSUES

Here, blame for the increased uncertainty in our business environment is laid on the increasing generation of new knowledge. To get a handle on the problem one must understand the root cause. Addressing the problem instead of the symptoms requires both some conscious management of knowledge and some competency to apply knowledge effectively – and it is argued that these two capabilities should be reasonable balanced, else there is wasted effort.

The explosion in knowledge actually causes change and disruption in the business environment through the instant and ubiquitous reach of modern communications: television, Internet, intranet, satellite, cable, fiber optics, and email connecting humans who make countless decisions each day about what to believe

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in, desire, wait for, and buy, and about what to turn against, shun, and throw away - both as personal consumers and as business employees. All of a sudden the world's people, the employees in the business, customers, suppliers, and the machines on the factory floor are connected in communities of interaction - trading and acting upon information.

This is complexity, and it is not going away. Dealing with complexity, however, can actually be simple; but only if we respond with a compatible approach.

■ KNOWLEDGE IS WHAT FUELS CHANGE

Agile enterprise, knowledge management, organizational learning, and collaboration concepts are all being explored by various groups of business managers, consultants, and academics. The general motivation for this interest is that organizations are finding it more difficult to stay in synch with the pace of change in their operational and competitive environments. Though many of these explorations are myopically focused on a single one of these issues, more and more are recognizing a convergence.

My personal interest in knowledge management came about through the back door - I was trying to understand how to design highly adaptable organizations. After an initial focus on systems engineering principles applied to the design of highly adaptable business practices and processes, I eventually came up against the fact that changing anything requires that somebody learn something, and that this learning process is every bit as big an obstacle as rigid inflexible system design.

This human thing we are distinguishes itself from other life by generating and applying knowledge. Our increasing population is building upon an increasing body of past knowledge, which increases the frequency of new knowledge generation and speeds the decay of old knowledge value, making the general business environment, which is built upon knowledge, more unstable and dynamic.

New knowledge demands to be applied. When one business applies new knowledge valuably, others have no choice but to follow, if they can. Knowledge does not express its value until it is applied. When new knowledge is applied it introduces a change into the environment which generates a value. Change that comes from the application of new knowledge is called innovation when the value is positive. Knowledge which cannot be applied has no value. Knowing about the canals on Mars is just as useless to an automotive assembly plant as knowing about a new assembly technology that cannot be implemented.

Knowledge management as one of two key enablers for agility. The other key enabler is *response ability* – the ability of an organization to apply knowledge effectively, whether it is knowledge of a market opportunity, a production process, a business practice, a product technology, a person's skills, a competitor's threat, whatever. As the millennium rolls over, my preferred working definition for agility is: *the ability to manage and apply knowledge effectively*, as it illuminates the current leverage points.

Agile is a word we associate with cats. When we say a cat is agile we observe that it is both physically adept at movement and also mentally adept at choosing useful movement appropriate for the situation. Agile carries with it the elements of timeliness and grace and purpose and benefit as well as nimbleness. A cat that simply has the ability to move quickly, but moves inappropriately and to no gain might be called reactionary, spastic, or confused, but never agile. Picture a cat on a hot tin roof. Conversely, a cat that knows what should be done but finds itself unable to move might be called afraid, catatonic, or paralyzed, but never agile. Like the cat that's got itself up a tree.

Prior to the 1991 study that kicked-off the interest in agility, my career was involved with start-up and turn-around management, where speed and urgency are important. First hand experience helped me appreciate the difference between developing a strategy and implementing it successfully. Knowing what to do was too often mismatched with the ability to do it. My engineering background started me looking for obstacles and solutions in the design aspect of organizational systems. Rather than go back to the entrepreneurial world, I began a series of collaborative learning events with industry, seeking to understand what makes some business practices and process highly adaptable while most are extremely difficult to change.

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Concurrently the concept of knowledge management and learning organizations were capturing increasing interest in other circles - for the same underlying reasons. In recent years our collaborative investigations have converged on the co-dependent relationships of change and learning. You cannot do one without the other. As to knowledge management, nothing happens unless and until somebody learns something.

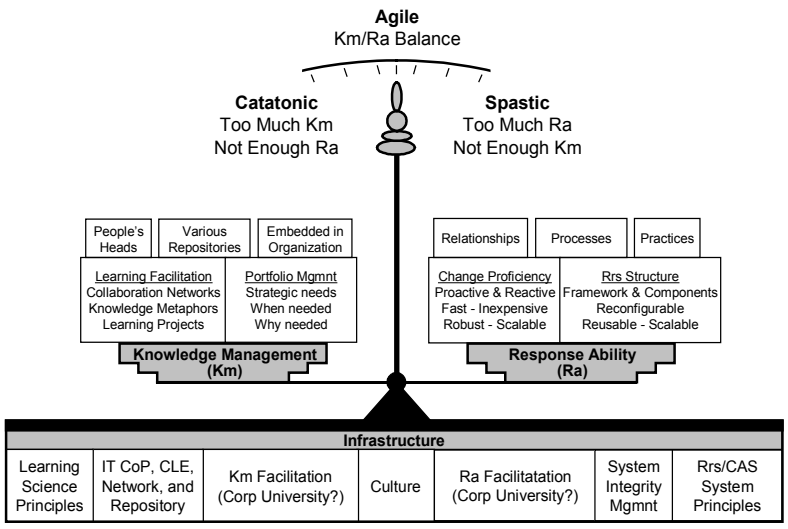
The concepts of knowledge management and response ability are not new. Organizations throughout time have practiced both successfully or they have ceased to exist. What is new is the need for more formal and conscious understandings of these practices, raising them to the level of a recognized competency – brought about by the quickening pace of knowledge development and knowledge-value decay. What used to be done unconsciously and in its good old time is no longer adequate in competitive enterprise.

Balancing these two competencies is important. A few years ago a Canadian auto plant decided to abandon the chain drive that moved all cars synchronously through the factory from work station to work station. They foresaw advantages in an asynchronous movement, and placed each car-in-process on its own automated guided vehicle (AGV), capable of independent movement and not in harness to the car in front. This promised more flexibility for adding mass customized features to individual cars without dragging all cars through stations where no work was performed. More importantly, if a workstation was shut down for any reason cars could be pool-buffered or rerouted to other stations first and then return - while the rest of the factory continued to operate.

Unfortunately when the plant went live the expected high throughput turned out to be considerable less then the traditional chain drive had provided. Under the old system a failed workstation shut down the entire production line and the silence was deafening - gaining immediate and total attention. With the highly fluid AGV flow, cars simply bypassed out-of-service stations and the comforting noise of industry continued. A classic architecture for increasing response ability that resulted in a major failure because it was unmatched with the knowledge management issues.

This shop-floor example may not appear to be what we currently call knowledge management. Perhaps because we do not yet have a general theory of knowledge management. Nevertheless, this situation occurred because of a disproportionate focus on response ability without a balancing knowledge base of

Figure 1.6



Agility - the Ability to Manage and Apply Knowledge Effectively

Abbreviations: CAS: Complex Adaptive Systems; CLE: Collaborative Learning Environment; CoP: Community of Practice; IT: Information Technology; Km: Knowledge Management; Ra: Response Ability; Rrs: Reusable, Reconfigurable, Scalable

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how and why to use it. Thus, we have a mismatch of both strategic knowledge as well as real-time operating knowledge.

As to a mismatched balance on the other side, revisit the classic story of Xerox and its Palo Alto Research Center. PARC was a collection of extremely innovative thinkers and learners, organized around active collaborative learning concepts[5]. A very progressive knowledge management organization in some respects, yet little was transferred and applied within the Xerox family.

■ ORGANIZING FOR CHANGE AND COMPLEXITY

In 1996 Peter Drucker suggested: "Big companies have no future....By and large there are no more advantages to big business. There are only disadvantages....In fact, today's big business is in such turbulence and crisis that it isn't even a model for business [let alone government]." After taking top management to task for "unconscionable greed" and outright "cruelty" in the downsizing process, he comments on global differences in business restructuring: "In this country, the restructuring has caused amazingly few social problems because our labor force is so mobile, so adaptable. Our disorder is a great advantage. The Germans and the Japanese are programmed for order - and it gets in their way." On the future of organizational structures, he offers: "The model for management we have right now is the opera....The soloists, the chorus, the ballet, the orchestra, all have to come together - but they have a common score. What we are increasingly talking about today are diversified groups that have to write the score while they perform. What you need now is a good jazz group." And the jazz group will make good music whether the bassist shows up or not, will continue to make good music when the saxophonist has to leave, and will still make good music even when the accordionist sits in. It is adaptable by nature.

Also in 1996 the University of Michigan's Karl Weick, Professor of Organizational Behavior and Psychology had a compatible view that arrived at a different conclusion: "... in a wired world of constant change, chaotic action is preferable to orderly inaction...there's no more middle management; and midsize organizations really don't exist anymore. More importantly, there'll be a lot of chronic ambiguity. For instance, many organizations have stopped publishing organizational charts because they become obsolete the day they get circulated....If you take chaos theory seriously, it asserts that the world is both unknowable and unpredictable. All you can do is engage in transient moments of sensemaking." He then relates a story about a labor strike in outer space. "Back in 1973, the third Skylab crew had a tight schedule of experiments to run. NASA kept leaning on them to take on more experiments. The crew got more behind, more overloaded, so it turned off the microphone for 24 hours and spent some time reading and looking out the window. This says something about how companies blend control and autonomy. People are better able to get complex assignments done when given more discretion within a framework of common values."

Whether it's Drucker seeing the demise of big business[6] or Weick seeing the end of midsize business[7], these and other wise man believe that the future of organizational structures is based on small, interacting, self-organizing, autonomous units, sharing a common framework that facilitates reconfiguration and adaptation. And it doesn't matter if we are talking about top-level corporate structure or looking inside at functional subdivisions, the concept of loosely coupled interacting *components* reconfigurable within a framework is the central design attribute that brings adaptability.

You can employ this reconfigurable framework/component concept just as fruitfully in the design of adaptable production processes, upgradeable products, responsive supply chains, flexible distribution logistics, high performance teams, evolving information systems, adaptable procedures, reconfigurable facilities, and any other aspect of business that must thrive in a constantly changing environment.

Though agility is a broad enterprise issue, looking at the production impact of product realization[8] will provide a tangible illustration and should provide some fundamental insight. Decreasing innovation cycles in all market sectors are increasing the product introduction frequency. The process of bringing new or improved products to market involves changes in the production process. Whether these changes are fairly small or quite sweeping, there is usually a transition period of adjustment and settling-in.

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During this transition period two principle sources of turmoil are at work: 1) as the changed portion of the process is put to the test of actual use some fine-tuning is required before it satisfies its purpose, and 2) the interaction of the changed portion with the unchanged portion of the process, its environment, has some undesirable side affects that need to be resolved. We speak of change here in the total production-environment sense. Thus, we do not limit a change to the modification of some process or piece of production equipment that exists, but include both the addition of something new and the elimination of something old as these too are changes in the total production environment.

Simply stated, after a change is designed, built, and installed, there is a transition period that must be dealt with before we have what we want, or decide to settle for what we get. Making this change incurs cost and takes time. Some of this cost and time is pure design, development, acquisition, and installation; and some is transition turmoil from integration and shakeout. In the agile ideal strived for this transition period takes no time, incurs no cost, is not prematurely terminated, and is not an inhibiting factor on the latitude of change that one is willing to consider.

Peeling the onion of turmoil one more layer, a new machine or production cell introduced into the production environment requires shakeout of the machine itself, integration of the machine into its interactive environment, operator training, maintenance training, and service training, to name the easy parts. Then we have the operational idiosyncrasies and failure modes that get learned the hard way with surprises and experience.

In the past such product changes occurred infrequently and the transition costs were easy to ignore. But product introduction frequency in all markets continues to rise, and in many markets already continued ignorance of transition cost and time is intolerable. The toll of the transition period is reflected in true product cost, product quality, and market responsiveness.

An obvious way to reduce the toll of transition is to reduce the quantity and complexity of things in transition. If we want to do this while accommodating more new product than ever before, we have to learn how to build new product with old proven process – reusable process, reconfigurable for a new purpose. Reusability and reconfigurability are construction concepts – they have to do with the way things are built, no matter whether these things are manufacturing cells, work procedures, production teams, or information automation systems.

To bring a new or improved product to market we want to introduce as little new process as possible. For instance, instead of designing and building a completely new welding cell (a collection of machines and/or people involved in a specific sub-assembly or sub-process – such as welding four or five individual metal stampings into an automotive door frame) we might duplicate and modify an existing well-understood cell. This cell will surely have some new elements in it to accommodate the variations of the new product, but a good bit of the cell will be time tested and familiar. It may not be as technically appealing as a completely new design, but it will be up and running a lot sooner and a lot cheaper, produce less scrap and rework, reuse prior service training and require less new training, and generally function more predictably.

This does not mean an end to capital investment or a continuous cannibalism of used equipment. It means an important new focus on the structure of the production elements which must be reconfigurable. And it is physical reconfigurability we need, not programmed reconfigurability. We need the ability to make unanticipated new things from reusable pieces, not simply select some predefined subset of flexible capability or imbedded options. Reconfigurable structures, whether they organize sub-units in a piece of equipment, equipment relationships in a cell, cell relationships in a production area, or production areas in a plant require some form of facilitated component reusability. For maximum benefit these structures must be scalable as well as reusable and reconfigurable. Scalability eliminates size restrictions imposed by the structure, allowing any number of reusable components to be included or omitted as desired.

Though we've been talking about production machinery, everything said applies to changes in any business area: new procedures, new business practices, new personnel, different personnel, introduction of teaming concepts, different suppliers, different customers, a change in work instructions - all incur a transition period of integration and fine-tuning before the turmoil is settled.

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Our business environment has become complex, and complexity compatible approaches must be employed to address it. The old ides of integration are dangerous, though still seductive to many. Just like lean tells us to remove all waste from the system while ignoring the loss of adaptability if we are highly successful, so integration tells us to couple ourselves intimately with everything else while ignoring the fact that single point failures can have broad and catastrophic reach. For sure, in a static environment, the integrated system will dance with efficient grace; but if one part breaks the whole mass becomes a whole mess. And forget about modifying or improving an integrated system, the unanticipated side effects will return you to the equivalent of a broken system.

If GM and Chrysler are locked into Ryder Trucking for delivering cars to market, all it takes is a teamsters strike against Ryder to stop the flow of product to the dealers.[9] Ford wasn't hurt noticeably by that 1995 Ryder strike; but in the same month they shut six plants down when one supplier couldn't deliver a power-steering-systems component.[10] High tech is just as vulnerable: When Apple Computer relied on sole sources for its sub-assemblies, all it took was a supplier problem to destroy what the 1995 Christmas buying season could have been.[11] Actually the problem in each of these cases wasn't single source really, it was the inability to replace that single source when it failed. It is a complex world we interact with now - you can't model your participation after a well-oiled integrated clockworks.

Lean designs and integrated design are neither forgiving nor malleable. There are still investments to be made in business for things we cannot afford to throw out too early - but neither can we afford to keep them when they become inadequate.

■ THE HANDLES OF UNDERSTANDING AND ACTION

In Figure 1.7 the four objects of customer, producer, competitor, and knowledge, and their relationship vectors, are not especially new; but the adjectives in the top three capture the inevitable behavior we see emerging today. New understandings in the relationship vectors are also worth exploring. We talk today about listening to the voice of the customer, about being customer responsive, about delighting the customer, and even exceeding the customer's expectations. It is politically incorrect to suggest otherwise, and these concepts are the fundamental platform for many corporate strategies.

In the late seventies the American machine tool industry made a point of asking the Detroit automakers, their biggest customers, what they should do next. They listened very well to the voice of their customer, and then watched as Detroit bought new innovations from Japan.[12] Vigilant competitor and opportunistic customer in action. In the eighties McDonald's asked their customers what they wanted next in fast food and the resounding answer in the USA was less fat. Customers backed up their voice by confirming their interests in a taste test. Then they turned their back on the concept when it was rolled out.[13] Listen to the voice of the customer, but do not trust it.

Customers cannot be expected to have the same command of new technology and its possibilities that a supplier's product development engineers have - a user's core competencies are purposely focused elsewhere.[14] Their voice can offer valuable improvements to what they already understand, and will probably be heard by the competition as well. Not listening to the voice of the customer creates an easy opportunity for the competition.

The voice of the customer, whether offered or sought, is a pointed demand for reaction made by the customer to the producer. If managed well the vigilant competitor cannot dislodge the current relationship, at least not under the current rules. Managing the opportunity from the competitor’s point of view means introducing a new set of rules - proactively bringing an innovation to the opportunistic customer. Successful opportunity management requires an active point on both ends of the communication vector between customer and producer. You can be sure that there is a two-way vector between customer and competitor – number two has to try harder and your customer wants to keep you honest.

At the heart of all of this is the engine room of ceaseless knowledge development. It is what makes innovations and improvements possible. Fairly independent of producer, customer and competitor,

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knowledge happens. New possibilities all of a sudden exist where *nothing* was before. What to do about this, how to foster it internally, and how to harness it effectively is the innovation management issue.

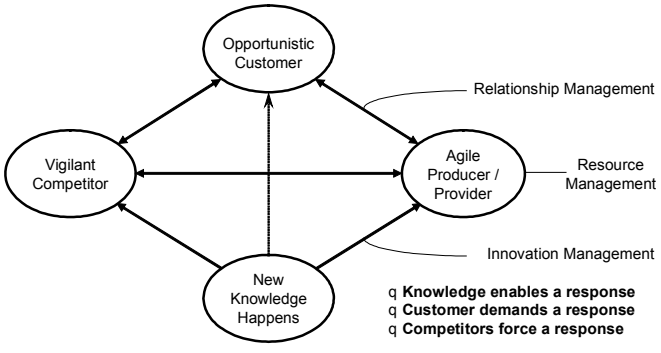
Being agile means being a master of change, and allows one to seize opportunity as well as initiate innovations. How agile your company or any of its constituent elements is, is a function of both opportunity management and innovation management - one brings robust viability and the other brings preemptive leadership. Having one without the other is not safe; having neither is a time bomb with a short fuse. How much of each is needed at any time is a relative question - relative to the dynamics of the competitive operating environment. Though it is only necessary to be as agile as the competition, it can be strategically advantageous to be more agile.

This talk about “how agile” and “more agile” implies we can quantify the concept, and compare similar elements for their degrees of agility. However, there is an open question about value tradeoffs between an increment of leadership and an increment of viability. Perhaps leadership wins if the leader always chooses the most optimal path to advance – but one false step allows a competitor to seize the advantage; putting the previous leader in reaction mode. A competitor with excellent viability can track the leader, waiting for that sure-to-come mistake. Poor viability may then keep the fallen-from-grace ex-leader spending scarce resources on catch-up thereafter.

Sun Microsystem's president, Scott McNealy, made an impression on me in the eighties when he announced that they would be sharing much of the innovative knowledge that they had developed, the kind that other's would typically hide with proprietary marks. His rational was that a would-be competitor would find a new set of innovations ascending by the time they could act upon this knowledge in any threatening way. In the meantime, Sun's leadership would gain support and followers. This was said when Sun was the leader to catch. His statement still has a lot of validity in my book - but he got blindsided by the rocket ascendancy and encroaching power of the personal computer - which grew to threaten the workstation market. Sun also suffered in the early nineties when their SuperSPARC microprocessor was two years late into production and took another two years before it reached its rated speed of 75-MHZ. "The lengthy delay allowed Sun's competitors to gain workstation market share at its expense."[15] Good proactively, not so good reactively - at least not in those heady days of leadership arrogance.

That Java eventually saw the light of day is a sign that Sun might be developing some reactive capability. Bill Joy, Sun's founding technologist, is credited for eventually seeing its innovative potential as an Internet

Figure 1.7
Agile Competition Model



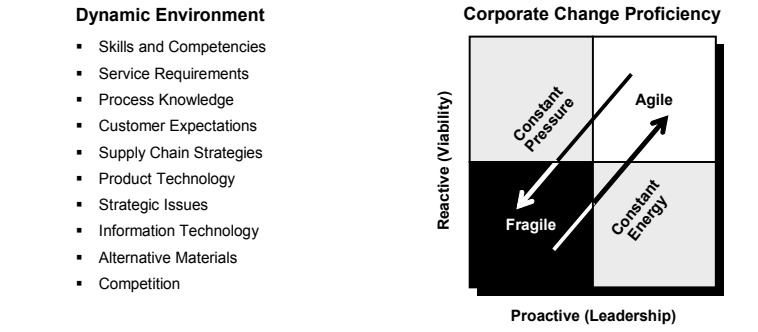
New knowledge happens independent of plans and forecasts, and brings both threat and opportunity to the conditions that bind producer to customer. Listening to the voice of the customer is necessary to maintain a relationship; but it is unlikely to be the source of innovation-producing knowledge. Competitors will encroach with new knowledge that change the rules. Response ability is both a proactive and reactive competency.

play. I know its hard not to look at Java as a proactive move, but it languished for years in the bowels of Sun, and though it may have sparked Joy's innovative juices, its backing by the company appears to be motivated more as an anti-Microsoft move. One sure way to success considered at Sun was licensing Java to Microsoft. Though this was purported to be an option should Bill Gates initiate the call, "Others

[Sun insiders] doubt whether McNealy could bring himself to consort with the enemy even if Gates showed up at the door. They believe that Sun's desire to beat Microsoft may be even stronger than its desire to see Java succeed."[16] In fact, McNealy's often quoted acerbicisms in the press throughout the nineties would make it easy to say that Sun is reactively fixated on Microsoft. Sun is an example of the relentless pressures that push seemingly agile companies out of the agile zone.

How about Intel? Andy Grove's now famous statement "Only the paranoid survive" would lead you to believe that this is a company that pays attention to reactive capability. On the other hand they haven't been put to the reactive test - they haven't really stumbled yet, and their leadership is clear in the microprocessor area. Dogging their heels, however, are two companies that appear to have mastered reactive capabilities: AMD (Advanced Micro Devices) and Cyrex. Against all odds these two companies have quickly brought to market lower priced compatible versions of the latest Intel processors and make a business of it. They aren't simply cloning Intel designs - they have to reverse engineer an Intel chip before they can do their own designs from scratch. As a result, while providing functional compatibility they also have the opportunity to provide customer-desired improvements. For example, AMD was quick to jump on the opportunity created when Intel introduced the Pentium Pro, a multichip processor.[17] AMD's K6 was functionally equivalent but packaged in a single chip, something that customer's valued. At the same time AMD was poised to offer a Pentium II equivalency that would plug into the same motherboards used in the

Figure 1.8
Amateurs in the Agility Arena Work Harder To Stay There
As Industries Develop Professional Agile Competencies With Time



Change proficiency is a competency that allows an organization to apply knowledge effectively - knowledge of a market opportunity, a production process, a service requirement, a product technology, a person's skills, a competitor's threat, whatever. Defensively it is wielded in reaction to events that occur independent of plan and schedule, and is necessary to maintain viability. Offensively it is wielded proactively to innovate, and develop unique advantage that defines and supports leadership. Until agility becomes an installed organizational competency across whole industries, however, it will be a relative, rather than an absolute, competency. There will be companies who are the paragons for a while, who will spur the contenders into deeper understandings, who will in turn replace last year's heroes and the cycle will spiral ever closer to the limit.

previous generation, while Intel's offering would require redesigned motherboards. This is good reactive and proactive strategy - backed up by some obvious ability to act on those strategies. AMD didn't overtake Intel and isn't likely to do so as long as Intel keeps running down the Pentium path in a reasonable fashion. Reach too far, however, and these companies will move in fast. They are stalking horses.

As to proactive capabilities, Grove has said that keeping the Intel freight train on the track is all consuming, and he is sure there is a brick wall somewhere down the road they will run smack into. That brick wall may well be the *systems-on-a-chip* approach. This concept packages an entire computer on a

single chip, not just the processor that Intel has focused on. The concept is not new – LSI Logic pioneered the concept in the early eighties, and has made a good market in this area since. To offer systems-on-a-chip requires technical capabilities, business strategies, and market relationships that Intel doesn't possess. Fast designs, custom designs, cheap production, and shorter product lives are some of the characteristics of this market for which Intel lacks experience. If the next intelligent-chip frontier shapes up as expected, small appliances, automotive gadgetry, light switches and plug sockets, cell phones and other personal accoutrements will create huge demands for low cost intelligent system chips. Fortune magazine's summery as 1998 began: "[Intel]...has no such products in development, nor does it have the [necessary] analog technology SGS, TI, and National have. But then, any world-class chipmaker with $10 billion in cash could move into this business fast - and Intel will, if systems-on-a-chip proliferate as much as their proponents expect."[18] Cash is not a substitute for proactive and reactive change capability - the best it can do is buy time while massive restructuring of business relationships, strategies, and cultures occur - and that only works if the competition is sluggish or shackled.

Intel looks to me, so far, like smart people who know how to run fast and leverage a front runner's position. They're damn good street fighters, the best in the neighborhood they grew up in – but they haven't left the neighborhood yet. Grove's admiration for what he lauds as strength is telling: "We could still turn on a dime. Our people still put the interests of the company ahead of their own interests and, when problems arose, employees from all different divisions would still rally around and *put in incredible hours* without anyone ordering them to do so [emphasis mine]." Being agile and response able is about not having to put in incredible hours. That is the brut force response pattern of a good street fighter, but not of a martial artist with deep insight and automatic moves built for the purpose. I am at a loss as to where I might place Intel in the four quadrants of the agile arena depicted in figure 1.8.

While we are dealing with icons of market leadership, we will take on Microsoft as well. Here is a company that has exhibited excellent reactive response ability – the browser about face triggered by Netscape required the redeployment of a sizable number of resources in very short order. Another reactive move, though not as onerous in resource reconfiguration, was the "...major about-face for Bill Gates. In August [1995] Microsoft Corp. launched a massive effort to catch up with America Online Inc. and CompuServe Inc. by offering Microsoft Network, a new proprietary online service accessible only through Windows 95 software. ... Then Gates abruptly decided he was fighting the wrong battle. In early December, Microsoft's chairman announced that next year, MSN would be available to all of the estimated 11 million users of the Internet. ... Gates' new vision for MSN is much more democratic. ... *The change in strategy leaves Microsoft with far less control over its product* [my emphasis]."[19] A decision that results in less control is different for them - and testament to their recognition that catching up is hindered with restrictions. I give them high points for reactive decisiveness and the ability to act well upon reactive decisions - at least in the business and product *strategy* areas. But overall I look at Microsoft much like Intel – brute force incarnate.

Microsoft has a reputation for hiring the best and the brightest. I know some of their superstars personally – having shared office space and development work with them in startup ventures of old – and they are everything the press cracks them up to be. But I can not figure out what effect they and all that the rest of that IQ has done for me as a customer. I've been a heavy and exclusive Microsoft user since the beginning, and have never seen any evidence of IQ at work in delivered product – in strategy yes, but not in product. Response able resource management would not have that problem. Response able product design would not either. No, I do not see Microsoft as an agile competitor in the *absolute* sense – they simply have better strategic moves and more assets to leverage then anyone else who has stepped into the ring. "We are very fortunate that every employee of Microsoft is today ten years older than they were ten years ago" jokes Mike Murray, Microsoft's head of human resources in a 1998 Fortune magazine article.[20] "Hopefully this aging process will make us more empathetic to customers and suppliers, help us listen better. I think we'll learn these lessons either from the marketplace or from 'other forces,' [the implication being the Justice department]". Right from the horses mouth - this is not an agile, response able company.

I have just called both Intel and Microsoft far less than agile companies. These are companies respected for their demonstrated abilities to thrive in fast changing unpredictable environments – the very core

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definition of agility. These are companies most other companies would gladly trade places with. If these two aren't agile, who needs it? They probably do, the most. They are very directly responsible for creating a much more agile set of contenders then we've ever seen before in the market. The likes of AMD and Cyrex are developing and honing strong reactive skills as a result of following Intel through the microprocessor market, and developing proactive capabilities at the same time. They aren't alone, just more obvious than LSI, TI, National, SGS and others who aren't addressing the clone market, but are poised for the next generation of intelligent chips. When these companies step out Intel will be in very unfamiliar territory.

I have taken these companies to task for their lack of agility on an *absolute* scale. That does not doom companies, it just shows how far they are from where they or their competitors could go, and will go without choice. Until agility becomes an installed organizational competency across whole industries, however, it will be a relative issue. There will be companies who are the paragons for a while, who will spur the contenders into deeper understandings, who will in turn replace last year's heroes and the cycle will spiral ever closer to the limit. Maybe by the time you are reading this book some metamorphosis will have already occurred in the companies I have taken to task. Perhaps they will have begun the pursuit of agility as a studied competency, but the lessons of history do not make that a good bet. Culture has everything to do with being response able, as we will see later when we look closely at one company example.

■ YOU ARE WHAT YOU EAT

Agility results in appropriate response to threats and opportunities, and may be present in any or all business practices and systems. Agility can be achieved in different ways. At the highest corporate level either an effective dictatorship or a ruthless resource portfolio management strategy can be quite agile. Small companies are often agile with these techniques. Start-ups are often agile with these techniques. We will not be concerned here with this type of agility, as it is not sustainable across dictators, and it is not scalable into the inanimate systems of the corporation: portfolio management techniques are easier to implement with people and business units than they are at the lower levels of business practices and processes – though you may replace a business practice overnight you cannot get your people to understand the replacement quickly. Here we will focus instead on systemic agility – you have to prepare people culturally for change, and you have to structure the systems they work with and in so that they are easily changed.

How innovative is your organization, relative to your competitive needs and environmental situation? How fast are the rules changing in your industry? Do you introduce a few changes of your own? If so, what fundamental capability allows you to do that? What do innovation and leadership mean in your organization? To whom? Does it have real meaning in every functional area of the organization? Do people speak of it in the purchasing department, in the accounting department, in manufacturing, and customer support?

What does organizational viability mean in your organization? Does it mean reliable employment, reliable dividends, reliable profits, reliable demand, reliable markets? Does it mean reliable anything, or does it mean sustainable something, or something else completely? Is this a universal meaning throughout the company? Who does it mean that to? What will be their response when it is threatened. What could threaten it? How much time will you have to deal with a serious threat to viability? Will a threat come alone or with a gang? Will weathering a serious threat be a temporary setback or a permanent position change? Are your business practices and processes as easily transformed into something different as a child's Lego creation?

■ MOVING ON

Somewhere in Zen Buddhist literature is the story of the Zen master so enlightened that he walks between the rain drops – or seems to. As a younger man I had difficulty with that story, not knowing if I was expected to see one real skinny, real fast Zen master, or think that he had already transcended this space-time continuum the rest of us inhabit. Older now in my perspectives I think dodging and weaving

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between the rain drops takes too much energy and is likely to miss a beat somewhere. Likewise, the quantum theory of transcendence is just too much to buy. So now I figure he's either controlling where the rain falls while walking where he pleases, knows where the rain will not fall next and steps accordingly, or he is part of the rain system – interacting with the rain drops in concert like the bodies in a complex adaptive system. Whatever, he's not getting wet and people continue to follow him – in awe at his agility.

■ NOTES

[1] Biological and ecological models of self organizing and adaptable business and economic models have been increasingly promoted as the investigations into complex adaptive systems (chaos theory) by the Santa Fe Institute gain exposure. Interesting and worthwhile books on the subject from various angles abound, and include: Kaufman's *At Home in the Universe*, Kelly's *Out of Control*, Morgan's *Images of Organization*, Postrel's *Enemies of the Future*, and Rothschild's *Bionomics*.

[2] Porter, 1996, What is Strategy. Michael Porter suggests that managers have forgotten what real strategy is in an attempt to regain ground lost to the Japanese - and are engaged in best practice benchmarking, outsourcing, developing core competencies, and other such programs to make them lean and nimble - mistaking these for strategies. He identifies them instead as operating efficiency programs, allows as how they have a definite benefit to offer, but reminds the reader that strategy is positioning a company uniquely in the market.

[3] Schneider, 1994, *The Reengineering Alternative*; and/or Schneider, 1998, Why Good Management Ideas Fail, for an excellent and succinct coverage of the material. www.cdg-corp.com.

[4] Porter, 1996, What is Strategy?

[5] Bennis (1997), *Organizing Genius - The Secrets of Creative Collaboration*, pp 22, 27, 76-78, 122, 212-213.

[6] August 1996 issue of *Wired* magazine, Peter Drucker interviewed by Peter Schwartz and Kevin Kelly as "The Relentless Contrarian", pp 116-120, 182-184.

[7] Wired magazine, April 1996, John Geirland interviews Karl Weick in "Complicate Yourself", p 137.

[8] The phrase *product realization* is used to encompass all activities from the initial conceptualization of a product through finished production and readiness to ship. It came into common use in the mid-eighties when the focus changed from separated and sequential activities of product development followed by production process development to an integrated product and process development (IPPD) or concurrent engineering (CE) approach - meaning that all planning, design, and development aspects occurred simultaneously in interactive collaboration - in the utopian model at least. Fine 1998 extends the concept of concurrent engineering in *Clockspeed* into what he calls 3-DCE (three dimensional concurrent engineering), where supply-chain development is added to the simultaneous activities of product and process development.

[9] Business Week, October 16, 1995, p 44, "Ryder's Rocky Road to the Bargaining Table". In 1995 Ryder had 60% of GM's hauling business and 40% of Chrysler's; and sales at both companies were impacted when the Teamsters struck Ryder in September.

[10] Business Week, October 2, 1995, p 70, "The Glitch That Shut Ford's Plants".

[11] Business Week, October 2, 1995, p 62, "Is Spindler A Survivor". This article noted that the part shortages plaguing all PC makers were hitting Apple the hardest because "many of its components are custom-designed and sourced from one supplier." Christmas demand was booming but remained unfilled because Apple lacked critical parts.

[12] Heated discussion at a national Center for Manufacturing Science's meeting in 1986, where representatives from the USA machine tool industry rebutted a simplistic "You should have listened to the voice of the customer" comment made by a representative from Detroit's auto makers. The essence of the rebuttal was that the machine tool industry had done extensive polling of the auto makers to find what they wanted, then did exactly that and got no reward. Instead, the auto makers began buying heavily from the Japanese machine tool makers who had developed superior control technology on their own initiative, something the automakers had not asked for but knew that had to have once they saw it.

[13] Martin (1995), "Ignore Your Customer", *Fortune*, May 1, pp 121-126.

[14] Hamel (1994), "Seeing the Future First", *Fortune*, September 5, pp 64-70.

[15] "Business Trends", *Electronic Business Today*, Cahners, July 1996, p 23.

[16] Bank. D. (1995), "The Java Saga", *Wired Magazine*, December, p 245.

[17] Alsop, S. (1997), *Fortune*, April 14, pp 169-171.

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[18] Kirkpatrick, D. (1997), "Three Promising (Non-Intel) Chipmakers", *Fortune*, December 8, pp 211-212.
[19] Eng, P. et al. (1995), "Microsoft Plays the Net", *Business Week*, December, p 41.
[20] Schlender, B. (1998), "Gates' Crusade", *Fortune*, June 22, pp 30-32.

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Pre-read up to ADAPTABLE CULTURE section for SDOE-678 Session 2

Chapter 2 – Change-Enabling Structure and Culture

This chapter provides tangible examples of adaptable manufacturing enterprise environments of four kinds: product, process, practice, and people. The fundamental common pattern shared by these examples – reusable components reconfigurable in a scalable framework – is offered as a structural template for guiding improvement strategies.

If you are in a manufacturing business and responsible for management, strategy, or planning you will see a common set of concepts applied across a full range of system design, from a machine on the production floor all the way up to an organizational structure of multiple divisions and plants. If you are responsible for operations or production you will find very specific models of response able production here, models that should either offer reasonable templates or readily adaptable concepts for implementation.

If you are in another part of the business, like HR or IT or product development, or in a completely different business, perhaps in a process industry or the service sector, the fundamentals of adaptable organization and system structure are plainly illustrated here ready for adoption into your environment. A little more thought will be required on your part, and you'll be the wiser for it...recipes don't turn a line cook into a chef.

■ ADAPTABLE STRUCTURE

Remember the child's round-peg, square-hole hammer toy? It had a wooden framework with 6 or 8 uniquely shaped holes and a set of individually shaped wooden pegs. The trick was to plug each of the pegs into its uniquely compatible hole. These toys taught us valuable lessons about compatibility. A more valuable lesson might have been about incompatibility, however. The framework had a fixed number of holes that demanded filling. A missing peg rendered the system incomplete. Spare pegs could not be bought separately, and trying to replace a lost peg with one from a friend's set generally found a different peg geometry.

Contrast that with the Lego brand system that younger generations are growing up with. The framework has a simple repetition of identical sockets on a standard grid pattern, and can be extended indefinitely by simply attaching additional framework sheets together. The components come in various simple forms, all with an identical socket structure. Macro-components can be assembled from basic pieces and replicated as often as needed to build or expand complex systems quickly. Losing a few pieces is hardly noticeable. The framework is so simple that compatible components from competitors are readily available with special characteristics and pricing advantages. And the observed useful lifetime of the reconfigurable Lego set far exceeds the peg-pounder. Lego even eclipsed Erector Set. Though you could build almost anything with an Erector Set, without a framework every project was a custom construction effort that consumed too much time in piece-interfacing activity.

An Rrs design strategy of reusable components, reconfigurable within a scalable framework can engineer adaptability into a wide variety of systems. When we define a system as any group of units that work together to achieve a common purpose, we include such business systems as a collection of machines in a manufacturing process, a procedure in an assembly process, an integrated chain of suppliers, a contract full of clauses, a gaggle of partners, a team of people, an organization of departments, and so forth.

It should come as no surprise that we can find examples of adaptable operating techniques in the fast-change industries of electronics and software. We will in fact draw heavily upon two different aspects of semiconductor manufacturing in the detailed examples that follow. We will also, however, use an equally instructive example from an automotive brake manufacturing operation. We chose the three following examples not because they are unique, but rather because they illustrate both adaptability and the application of Rrs concepts clearly, and at progressively higher levels of production: the machine level, the process level, and the organization level.

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■ ADAPTABLE PRODUCTS

The U.S. lost the semiconductor market to Japan in the '70s, and hopes for regaining leadership were hampered by a non-competitive process equipment industry – the builders of the "machine tools" for semiconductor fabrication. In this high paced industry, production technology advances significantly every three years or so, with each new generation of processing equipment cramming significantly more transistors into the same space.

With each new generation of equipment semiconductor manufacturers build a completely new plant, investing $250 million or more in equipment from various vendors, and twice that for environmentally conditioning the building to control micro-contaminates.

For equipment vendors, each new generation of process equipment presses the understandings of applied physics and chemistry. Million dollar machines are developed to deposit thinner layers of atoms, etch narrower channels, imprint denser patterns, test higher complexities, and sculpt materials at new accuracies and precessions. Generally each machine carries out its work in a reaction chamber under high vacuum, and sports a sizable supporting cast of controls, valves, pipes, plumbing, material handling, and whatnot.

New equipment development is actually new invention, frequently taking longer than the three-year prime-time of its life. And because the technology utilized in each generation is so unique, market success with one generation of equipment has little to do with the next or the last generation. The industry's history is littered with small vendors that brought a single product-generation to market.

Single purpose, short lived, complex machines. Long equipment development cycles. Repeatability and reliability problems. All targeted for a high volume, highly competitive production environment serving impatient, unforgiving markets. And every new generation requires a new plant with more stringent environmental conditioning to house the new machines. The learning curve in this industry is dominated by touchy equipment that takes half its product life to reveal its operating characteristics. Forget about rework here, and get used to scrap rates way above 50% in the early periods of production. Heavy industry may scoff at the low scrap cost, but scrap here means lost deliverables with devastating loss of critical short-lived-market penetration. Equipment budgets routinely factor high outage expectations into extra million dollar machines.

Getting product out the door is so critical, and mastering the process so tough, that no one has time to question the craziness. This is the way of semiconductors. Or rather, it was until something occurred in 1987: Applied Materials, Incorporated, a California-based company, brought a new machine structure to market based on reusable, reconfigurable, scalable concepts.

Depicted in Figure 2.1.a, the AMI Precision 5000 machines decoupled the plumbing and utility infrastructure from the vacuum chamber physics, and introduced a multichamber structural concept. Instead of one dedicated processing chamber, these machines contained up to four independent processing modules serviced by a shared programmed robotic arm. Attached like outboard motors, process modules are mixed and matched for custom configured process requirements. A centralized chamber under partial vacuum houses a robotic arm for moving work-in-process wafers among the various workstations. The arm also services the transfer of wafer cassettes in and out of the machine's external material interface.

A single machine can integrate four sequential steps in semiconductor fabrication, decreasing the scrap caused by contamination during inter-machine material transfer. Yield rate is everything in the competitive race down the learning curve; but this integrated modular approach pays other big dividends too.

Applied Materials shortened equipment development time and cost significantly by separating the utility platform from the processing technology. Development resources are focused now on process technology, reusing a utility base common across technology generations, which accounts for 60% of the machine. This eliminates a significant design effort for each additional process capability Applied brings to

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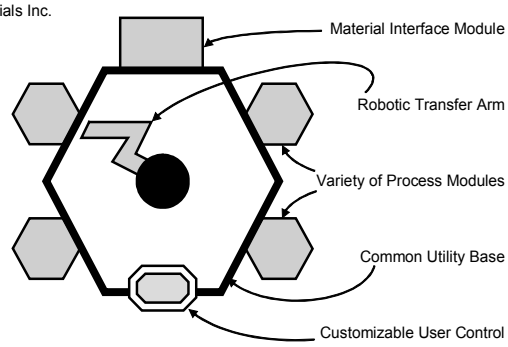
Figure 2.1.a Semi-Conductor Wafer-Processing "Cluster" Machine

Depiction of *Precision 5000* Family from Applied Materials Inc.

Reusable
- o Material interfaces, transfer robots, process modules, utility bases, docking modules, and user controls are independent units.
- o Common human, mechanical, electrical, gas, and hydraulic framework.
- o A growing variety of processing modules may be mixed or matched within a cluster.

Reconfigurable
- o Wafer path determined in real-time by availability of appropriate process modules.
- o New process modules may be added when new capability is required, and not before.
- o Clusters may begin as 4 sequential processes and evolve to a single 4-unit process as product demand grows.
- o Process-specific control is contained within the process module, and travels with it when redeployed.
- o User control modules are custom configurable for proprietary processing.

Scalable
- o Within a cluster 1 to 4 process modules may be installed.
- o Clusters may be interconnected into larger super-clusters using docking modules in place of process modules.
- o Clusters and super-clusters can be interconnected without limit by transport-bay or sealed cassette transfer.

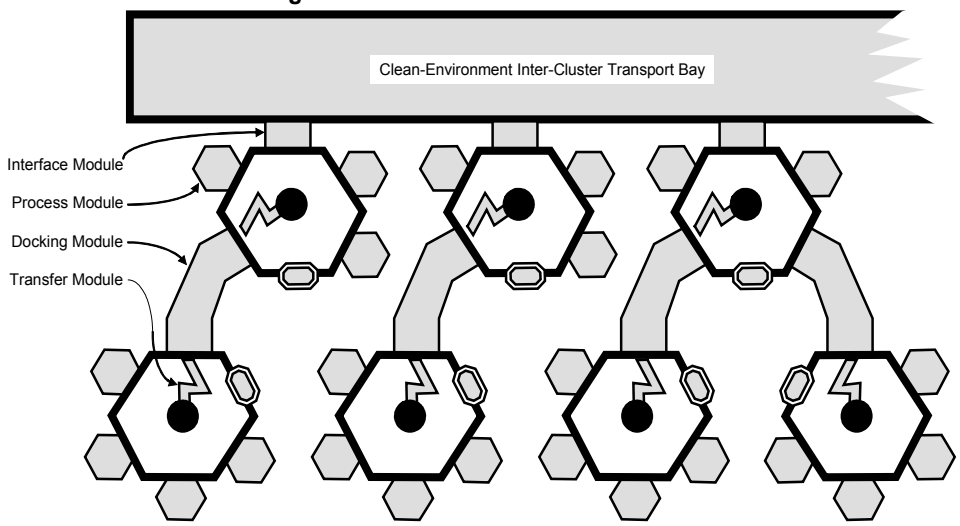


Response Ability
- o Test and Introduce new process modules incrementally.
- o Custom process individual wafers and prototype runs.
- o Repair/replace faulty process module while cluster operates.
- o Add process modules and machine clusters as/when needed.
- o Reconfigure clusters and redeploy process modules as product-line demand cycle changes.
- o Create super-clusters as contaminant sensitivity requires.

market, and shrinks the complexity and time of shakeout and debug in prototyping stages. More importantly, perhaps, is the increased reliability that Applied's customers enjoy with a mature and stable machine foundation.

In process sequences with disparate time differences among the steps, a configuration might double-up on two of the modules to optimize the work flow through a three-step process. A malfunction in a process module is isolated to that module alone. It can be taken off-line and repaired while the remaining modules stay in service. The structure also facilitates rapid and affordable swap-out and replacement servicing if

Figure 2.1.b Scalable Machine Clusters



Using standardized docking modules to replace a process module allows multiple cluster machines to be assembled into larger, constant vacuum, clusters. This has particular value when a process sequence is sensitive to contamination, which is most likely to occur when wafers make the transition between the vacuum environment of the cluster machines and the atmospheric pressure of the inter-cluster transport bay. Process modules may be mixed or matched within a cluster.

repair time impacts production schedules.

Semiconductor manufacturing is barraged with prototype run requests from product engineering. New products typically require new process setups and often require new process capability. When needed, redundant process modules can be dedicated to prototyping for the period of test-analyze-adjust iterations it takes to get process parameters understood. And if a new capability is required, a single new “outboard motor” is delivered quicker and at a lot less cost then a fully equipped and dedicated machine.

Cluster structure also brings a very major savings in both time and cost for creating new fabrication facilities. The ultra-clean environment needed for work-in-process can be reduced to controlled hallways rather than the entire building. People can attend and service the machines without elaborate decontamination procedures and special body suits.

Work-in-process is most vulnerable to contamination when it is brought in and out of high vacuum. The cluster machine structure reduces these occurrences by integrating multiple process steps in one machine. Using a docking module, as depicted in Figure 2.1.b, these machines can be directly interconnected to increase the scale of integration.

In 1989 the Modular Equipment Standards Committee of SEMI (Semiconductor Equipment and Materials International) started work on standards for mechanical, utility, and communications interfaces[1]. What started as a proprietary idea at Applied Materials is moving toward an industry open architecture, promising compatible modular process units from a variety of venders.

Applied Materials revolutionized the semiconductor industry. Their cluster machines propelled them into global leadership as the largest semiconductor equipment supplier in the world. Leadership is defined by followers, and today, every major equipment supplier in the world has a “cluster” tool strategy.

Here we've looked at a machine structure that is sufficiently adaptable to enable a response able production environment. Next we will look at an equally adaptable metal-cutting production operation, but one that contains machines which are not themselves adaptable.

■ ADAPTABLE PROCESSES

Manufacturing cells in general and flexible machining cells specifically are not especially new concepts, though their use and deployment is still in an early stage. Machining centers are not inexpensive machine tools, and the economics of building cells from multiples of these machines is still beyond the vision and justification procedures for many. It is typical to expect benefits from these flexible machining cells in production operations with a high part variety and low volume runs. When justification and benefit values are based on flexible configurations and objectives this is understandable.

Recently, however, innovators are finding important values in quick market response: rapid new product introduction, accommodation to unpredictable demand, fast prototype turnaround, non-premium-priced pre-production runs, efficient engineering-change-order incorporation, longer equipment applicability, and the latitude to accept (or insource) atypical production contracts to improve facility utilization.

These new response able system values now challenge applications where transfer lines and dedicated machinery have traditionally reigned, and their applicability is based upon concepts that push beyond the traditional flexible values. After examining these values Kelsey-Hayes decided to build two entirely cellular plants for the production of ABS (automatic braking systems) and other braking systems. “We want to achieve a strategic advantage on product cost and delivery” was the vision voiced by Richard Allen, president of their Foundation Brake Operations[2].

We are not talking mass customization here, with custom configured products. We are talking about fundamental change in the value structure of the high-volume-car / high-volume-brake markets. Technological advances in ABS systems have cut each succeeding product generation’s life-time in half.

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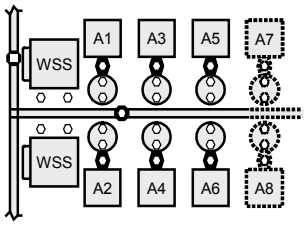
Figure 2.2.a Adaptable Machining Cell

Reusable
- Machines, work setting stations, pallet changers, fixtures are all standard, independent units.
- Common human, mechanical, electrical, and coolant framework.
- Machines do not require excavated pits or special foundations, and are relatively light and easy to move from one cell to another.

Reconfigurable
- Cell control software dynamically changes work routing to accommodate unit status changes and new or removed units, on the fly.
- Complete autonomous part machining, non-sequential.
- Machines and material transfers are scheduled by cell control software in real time according to current cell status.
- Part programs downloaded to accommodate work requirements when needed.
- A machine's life history stays with the machine as part of its controller.
- Machines ask for appropriate work when they are ready.

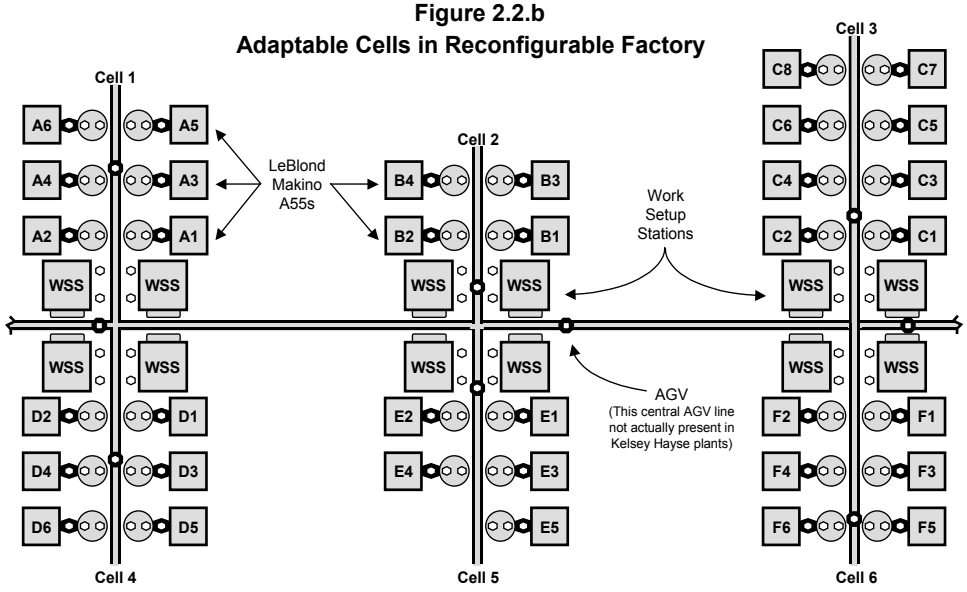
Scalable
- A cell may contain any number of machines and up to four work setting stations.
- Cells may have multiple instances of each unit in operation.
- Machines are capable of duplicate work functionality.
- Utility services and vehicle tracks can be extended without restrictions imposed by the cell or its units.



Concept Based on LeBlond Makino A55 Cells at Kelsey-Hayes

Response Ability
- Install and set up a new cell in 4-8 weeks.
- Reconfigure a cell for an entirely new part in 1-4 weeks.
- Duplicate cell functionality in another cell in 1-2 days.
- Add/calibrate new machine in 1-2 days while cell operates.
- Remove or service machine without cell disruption.
- JIT part program download.
- Insert prototypes seamlessly.

Figure 2.2.b
Adaptable Cells in Reconfigurable Factory



These horizontal machining centers do not require that pits be dug underneath the machines for delivery of cooling fluids and removal of scrap, or that special rigid foundations be constructed, so they are readily movable. A cell can increase or decrease its machining capacity in the space of a day. This is facilitated by a plant infrastructure that provides common utility, coolant, mechanical, and human interfaces that provide a framework for reconfiguring components easily.

The trend to higher automotive-system integration and more technology promises even more change. Car companies want leadership in functionality and feature, and faster times to market; and can't afford to feature obsolete systems when competitors innovate. Kelsey-Hayes sees opportunity in this faster paced, less predictable market. To put the problem in perspective and provide a basis for evaluating the depicted solutions, we will look at some change issues first.

It is common in high-volume manufacturing to custom design and build an automated process that basically functions like one big multi-stage machine. Called transfer lines, these machines typically

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advance every part-in-process simultaneously through the sequence of workstations that comprise the process. There is a high up-front investment in these single purpose machines, justified by the high speeds and low unit costs this automated approach can deliver when producing standard parts in large quantities over time. The auto industry, for instance, has and still makes extensive use of this approach for large machined items like engine blocks as well as for smaller machined and assembled components like automotive braking systems.

Product life-cycle for ABS dropped from ten years to three years over three generations of product, and continues to decline – so taking 4-6 months to retool a custom built, single-product, dedicated transfer line became a significant part of the production life – not good. As auto makers mine new niche markets and increase total systems integration in standard models the frequency of ABS model-change increases. Within this shortened life of any model is the increasing frequency of modifications to add feature advantages and necessities. Of course all of these modifications and new models don't spring to life from pure design, they each need prototypes and small pre-production runs.

Auto makers, like most everyone else, have never been able to forecast demand accurately, and it's only getting worse. Coupled with new just-in-time material arrival requirements and reduced finished goods inventories the auto makers attempt to throttle production in concert with demand on a week-by-week basis. Suppliers must either be proficient at capacity variation or face increased costs in higher finished goods inventories and higher scrap at end-of-life obsolescence.

Previously we looked at an example of an adaptable semiconductor-production machine structure, and how those machines might (and do) support a response able production operation. Now we look at an adaptable cell structure (system of separate machines/processes) and how it supports a response able production operation. Both the cell (Figure 2.2.a) and the production environment (Figure 2.2.b) make use of capabilities and configurations possible with the LeBlond Makino A55 machining centers, and are substantially similar to actual installations. Other vendors can provide similar capabilities[3].

The depiction of the machining cell in Figure 2.2.a includes a synopsis of some of the response abilities possible with the configuration. Flexible machining cells have been implemented in many places, but the response able configuration here brings additional values. The configuration and the specific components were chosen to increase the responsiveness to identified types of change. The LeBlond Makino A55 horizontal machining centers do not require that pits be dug underneath the machines for delivery of cooling fluids and removal of scrap, or that special rigid foundations be constructed, so they are (relatively speaking) readily movable. A cell can increase or decrease its machining capacity in the space of a day and never miss a lick in the process. This is facilitated by a plant infrastructure that provides common utility, coolant, mechanical, and human interfaces that provide a framework for reconfiguring components easily. These and other Reusable-reconfigurable-scalable concepts are detailed in the depiction.

It is accepted knowledge that replacement or massive retooling of a rigid production component is more expensive than transformation of a flexible production component. Now we see where response able system configurations can further change the economics to overcome an initial investment that has been higher. "Has been" should be stressed. The price/performance ratios of modular production units are becoming better as increased demand increases their production quantities.

Don't let the examples so far lead you to a wrong conclusion. Response able production requires neither response able nor flexible machines – for the response ability is a function of how the components of production are permitted to interact. A response able system must be readily reconfigurable, and may gain this characteristic by simply having a very large variety of compatible but inconsistently or infrequently utilized production units.

The toy industry is an example where this is a common approach. Not knowing from year to year what toys will be the hot items until a few months before volume deliveries are required, toy manufacturers are either highly vertically integrated (with poor resource utilization) or broadly leveraged on outsourced manufacturing potential. Agility is a relative issue, and the toy industry has few alternatives to either outsourcing or just-in-case vertical integration. The just-in-case alternative does not have to be as onerous

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as it sounds if these practitioners become proficient at insourcing other company's needs, to cover the costs of their insurance base.

From the organizational viewpoint a response able production capability can be built quite effectively from a seamless and reconfigurable network of outsources, which is what we look at next.

■ ADAPTABLE PRACTICES

LSI Logic was founded in 1981 as a "fabless" semiconductor company, meaning that they had no internal fabrication (manufacturing) capability. Though they were one of the first fabless suppliers they are not unique in this respect: there were over 200 such companies in 1998.

The highly-competitive, volatile, and cyclical semiconductor market often finds some manufacturers without enough capacity to meet demand while others have excess capacity. Initial speed to market, as well as speed-to-volume, are major factors in developing market share for products that may only have an 18 month, 12 months, or even a single Christmas season prime-time.

LSI initially made a market in consolidating, managing, and delivering the industry's excess capacity to other semi-conductor companies in need; coupling this resource management capability with unique specialized services that featured faster initial speed to market. LSI has always been a leader in this area with front-runner process technology for semi-custom ASICs (application specific integrated circuits), and a proprietary circuit-design tool called CoreWare[4], which reduced new ASIC design time dramatically by re-using previously developed and tested sub-circuits. Reusable sub-circuitry also cut total time-to-volume dramatically with "right-first-time" product.

One example: At one time Nintendo had a lock on the game-hardware market. They heavily promoted their next generation offering for the 1996 Christmas season, but then couldn't meet the demand. Meanwhile Sony had taken their new entry, the PlayStation, to LSI, which finished the design and took it to production in a mere 8 months rather than the traditional 18 months. Sony filled the demand that Nintendo created that season and was catapulted overnight into a major market position. So much for brand loyalty: people went to the store looking for Nintendo and bought what was there – availability is what counted.

LSI is no longer a fabless operation, having added significant fabrication capability of their own over the years. They used the fabless strategy as a way to enter the market without the immense up front capital requirements. The majority of companies in the fabless category specialize in proprietary chips, typically for specialty markets like communications, video, or military applications. LSI, on the other hand, provides manufacturing and design services for other semi-conductor manufacturers that principally sell direct, like Intel and the traditional fabless operations with proprietary designs; as well as other major semi-conductor users that also have significant internal manufacturing capability, like Sony and Motorola. Consequently, LSI competes with the in-house capability of its customers as well as with other out-source options its customers have with companies such as Texas Instruments, Toshiba, Fujitsu and Hyundai.

Though instructive in its own right, we won't discuss the structure of LSI's CoreWare design tool; but focus instead on their overall product realization services. To their customers they are an outsource that incorporates other outsources into their resource pool.

The principally different feature that LSI introduces is a set of practices designed specifically to nurture and manage a loosely coupled mixture of in- and outsources as a coherent entity. Since its founding in 1981 the corporate operational center is a management group in Hong Kong, which builds and maintains this pool of outsources, and assigns and schedules both in- and outsources for specific customer orders.

The resource assignation process is notable in that potential resources bid on specific jobs, offering both price and availability. A production resource path is then assembled from the best bids. Bids from a given resource are likely to change with each job, whether in- or outsource, depending upon their available capacity and loading at the time required, as well as their facility, process and labor costs. Insources are not given any preferred status over outsources – the ability to deliver low cost on time is what produces a

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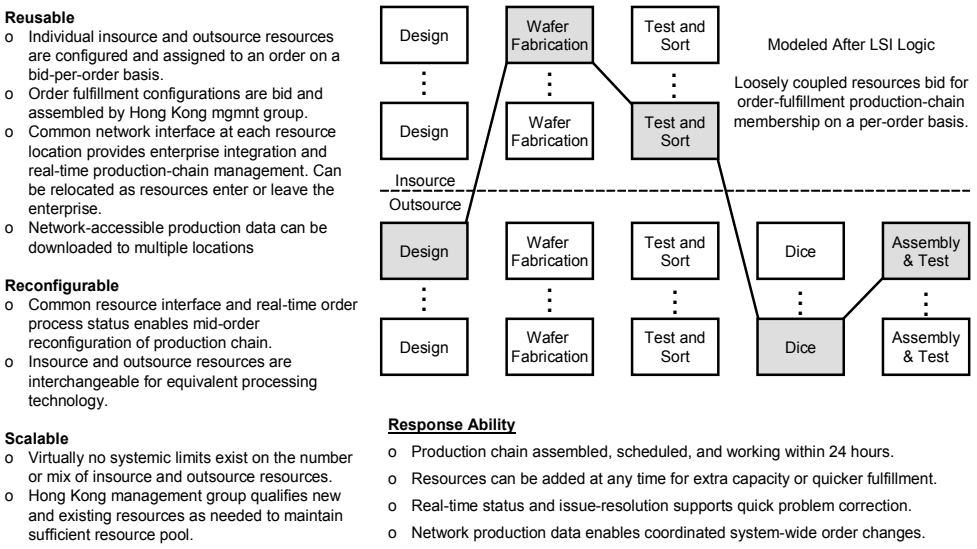
Figure 2.3 Adaptable Organization



repeatable profit stream. If an inside resource is unable to compete with outsource alternatives it is a candidate for upgrade investment, divestiture, or retirement.

LSI's purpose for adding insourced fabrication capability was not motivated by an expected cost advantage as much as by guaranteed capacity at the leading edge of process technology. Their addition of wafer testing/sorting capability was also motivated by technology issues, and began with a program to test and refine new technology and then export it with training to their outsources. One benefit of this approach is now a common on-line interface that allows them to monitor the test results in real-time at both in- and outsource locations. They continue to test and refine other critical "backend" production technologies as a prelude to helping their outsources adopt these leading capabilities.

A key element in the effective management of a loosely coupled resource pool is the standardization of the inter-resource interface. LSI has been evolving a system they call the Subcontractor Technical Network (STN) to accomplish this. In popular terms STN is pioneering combined features of an inter-enterprise integration system and a real-time electronic supply chain management system. STN comes packaged as a common hardware/software port for each of their principle production resources, with LSI providing installation, support, training, and upgrade services.

In addition to inter-resource communication protocol and transaction standards, STN provides design and manufacturing data and report transfer standards, a common set of data bases accessible to all, real-time progress monitoring, some real-time process monitoring as in the example of test and sort, and importantly, an issue resolution capability.

LSI sells quick concept-to-design, speed of market entry, short time-to-volume production, and variable production capacity to its customers. It also sells leading edge process technology as well as leading edge design complexity, pioneering the system-on-a-chip concept. Sometimes it does the design work for its customer, sometimes it collaborates on the design with its customer, and sometimes it is handed a design by its customer. In this highly competitive first-to-market environment it is not uncommon for a design effort to continue even after initially release to production. These are some of the principle change issues that LSI's organizational structure is designed to service.

The concept is similar to what Peter Drucker called the *flotilla* structure[5], which he contrasted to the traditional factory as a battleship. The flotilla is a collection of components, each with its own command

and control but each also under an overall fleet-level command and control. Drucker likened each component to a ship, able to maneuver to another location in the process chain, and able to develop new relationship with others in the flotilla. The organization provides a common set of operating standards for each component while giving greater flexibility to the total process. When the article appeared in 1990 he was suggesting the application of this flotilla concept to the sub-processes within an integral factory, and allowed as how no such organizations existed as yet. Drucker drops some understated insight when he suggests that standardization and flexibility are no longer in opposition but tightly related, though in a different balance in these organizational structures. Though beyond the scope of this current discussion, experience shows the line between standardization and autonomy to be the central design issue for response able systems.

■ RRS STRUCTURE

This discussion has focused on structures of response able production systems, and even portions of the enterprise systems that encompass them; suggesting that response ability is a characteristic enabled by design. Behind each of these systems are design engineers responsible for the system's design – consciously or unconsciously, as the case may be. The discussion now turns to the origins of the Rrs concepts specifically for those interested in the business engineering aspects; offering some references into earlier, similar, and advanced concepts that should assist in the interpretation.

Structures for adaptable systems became a major focus with the advent of object-oriented software interests in the early '80s. The progress of software technology and deployment of large integrated software systems has provided an interesting laboratory for the study of complex interacting systems in all parts of enterprise. The integrated software system, whether it's in the accounting area, providing management decision support, or spread over countless factory computers and programmable logic controllers, is the creation of a team of programmers and system integrators with ongoing responsibility for maintenance and upgrade during the life of the system. Thus, the integrated software system is the product of intentional design, constant improvement, and eventual replacement with the cycle repeating.

As engineering efforts, the design and implementation of these integrated software systems proceeds according to an "architecture", whether planned or defacto. By the early eighties the size and complexity of these systems grew to a point where traditional techniques were recognized as ineffective. This awareness came from experience: from waiting in line for years to get necessary changes to the corporate accounting system; from living with the bugs in the production control system rather than risk the uncertainty of a software change; and from watching budgets, schedules, and design specifications have little or no impact on actual system integration efforts.

Software design and implementation techniques typically approached the activity as if a system would remain static and have a long and stable life. New techniques, based on "object oriented" structures, 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 maturing for two decades now, and have emerged most visibly into everyday employment under the name client-server structure. Though there are significant differences between systems concepts called client-server and those called object-oriented, modularity and independent module functionality are important and shared key concepts. More to the point, information automation practitioners are now focusing a good deal of thought on the structures of systems that accommodate change.

Though there is a lot more depth to the Rrs concepts then we have presented so far, the examples and abstractions shown do convey the fundamental ideas. The theory and application of Rrs design concepts are explored in much more depth in later chapters.

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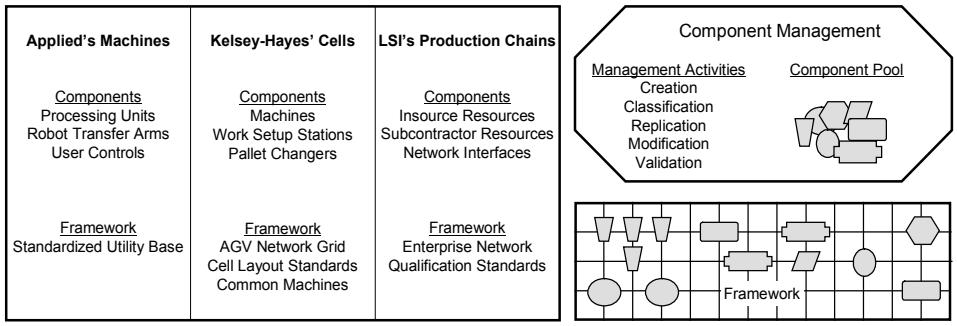
Figure 2.4 RRS Design Strategy

Reusable Components Reconfigurable within a Scalable Framework



The framework and component structure is central to the Rrs design strategy and the maximization of change proficiency. The framework is a set of slowly-evolving standards that establishes the limits on size and complexity of system configurations, as well as the speed with which components can be assembled into systems. The standards chosen for the framework define the system boundaries: too much standardization reduces size and complexity, not enough increases component incompatibility - both conditions restrict system configuration and reconfiguration potential below the optimal. Finding the right point is the designer's art form.

There is a pattern emerging here that can be observed in the adaptable processes in your environment. By the same token, this pattern can be used as a guide to improve the areas you feel are in need. We've focused on hard, tangible examples of system/organization structures here to illustrate important static design concepts that facilitate the implementation of change; but these structural concepts don't cause change – knowledge and people do that.

Not necessary to pre-read beyond this point for SDOE-678 Session 2

■ ADAPTABLE CULTURE

Isaac Asimov's robotic laws of science fiction fame employed three rules* to govern all robotic interaction with humans:

1) A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2) A robot must obey orders given it by human beings except where such orders would conflict with the First Law.
3) A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

Asimov's many books repeatedly show how these three simple rules result in the best possible response to all possible interactions. Interesting that he didn't, instead, hand each of his thinking robots a policies and procedures manual at birth; but maybe understandable: he would have never finished this manual sufficiently to christen the first robot. Nor could that robot, no mater how wonderful its *positronic* brain, ever finish integrating the apparent but necessary contradictions. The brain would either loop among contradictory procedures or infinitely recurs into catatonia.

Another robotisist, Rodney Brooks, built autonomous robots at MIT's Artificial Intelligence Laboratory. One famous six-legger graced many magazine covers in the early-90s, uncannily exhibiting behaviors of insect life when faced with obstacles and problems in the real world. What set the Brooks approach[6] apart from others was its lack of any overall world-view or hierarchical control - the behavior emerged from the

* "Three Laws of Robotics," from *I, ROBOT*, by Isaac Asimov. Copyright 1950 by Isaac Azimov. Used by permission of Doubleday, a division of Random House, Inc.

combined interactions of many independent, simple-ruled decision mechanisms. There was no master control that understood how to coordinate six legs into forward motion, how to climb over or circumnavigate an obstacle, or how to right itself after being turned upside down. There were instead independent controls for joints and other decision actuators, each with a set of goals, each with a set of very simple rules, and each with the ability to sense their environment, including the actions of other controllers. Eventually this collection of independent decision makers learn which cooperative responses result in goal attainment. Again, simple rules capable of complex behaviors and novel responses to unanticipated events.

A belief Brooks eventually expressed[7] was that the emergent behavior could not easily be determined in advance. That is, humans that designed the rule systems for the myriad of autonomous control units could not predict the collective results. That makes it difficult if you're trying to design such a system to a precise behavior specification. On the other hand, it makes it possible for the system to cope with unanticipated situations, and in fact to be innovative and come up with novel solutions.

We have examples all around us that say we can design useful emergent systems purposefully. A free market economy is one, the stock market another. In the business world we see experiments with empowerment, teaming, listening to the voice of the customer, organizational learning, and other concepts as movements toward self organization - though not necessarily with that end in mind.

Fractal math has gained general exposure recently, and the *Mandelbrot[8] set* is the most famous fractal graphic. Named after the inventor of fractal geometry, the infinite complexity of the Mandelbrot graphic (Figure 2.1) is obtained from a simple equation with only three terms. Overlaid on that graphic is a quotation from *Built to Last*, by Collins and Porras[9], that identifies a strong corporate ideology as the secret to long term corporate viability. In their research comparing numerous well known companies they showed how those with a strong ideology consistently outperformed those without; and they suggested that having a clear corporate ideology is so overwhelmingly powerful that its specific content is not important. Basically they see the ideology as the core values that guide the decisions of all employees, creating an organizational result that emerges from collective action.

Collins and Porras show that any ideology is better then none. But the content of an ideology does make a difference, and some ideologies are better than others. This is evident in the *Agile Enterprise Reference*

Figure 2.5

Infinite Response from a Small Set of Rules

"Companies seeking an "empowered" or decentralized work environment should first and foremost impose a tight ideology, screen and indoctrinate people into that ideology, eject viruses, and give those who remain the tremendous sense of responsibility that comes with membership in an elite organization. It means getting the right actors on the stage, putting them in the right frame of mind, and then giving them the freedom to ad lib as they see fit. It means, in short, that cult-like tightness around an ideology actually *enables* a company to turn people loose to experiment, change, adapt, and – above all – to *act*."

Collins and Porras
***Built to Last*, pg. 139.**

Fractals are one of the aspects of chaos math that have gained general exposure, and the *Mandelbrot set* is the most famous fractal graphic. Named after the inventor of fractal geometry, the infinite complexity of the Mandelbrot graphic is obtained from a simple equation with three terms. Overlaid on that graphic is a quotation from *Built to Last* that identifies a strong corporate ideology as the secret to long term corporate viability. From a few simple "rules" in a corporate ideology emerges a pattern of corporate behavior infinite in its complexity.

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Model and Case Study of Remmele Engineering[10] , which examined twenty-four critical business practices for response ability. Remmele was chosen for this case study because they exhibited broad-based maturity at dealing with change.

The more practices analyzed at Remmele, the more it became apparent that they all owed their adaptability to a very few common ideological beliefs plainly stated in the corporate Guiding Principles. Among those principles are the beliefs in constant change and continuous learning. These two, as well as a few others, form the generating function for the organizational entity called Remmele Engineering. Like Asimov's robotic laws and Brooks's distributed control, a simple set of ideological beliefs generates a highly successful response capability to unanticipated change. And like the Mandelbrot set, infinite complexity emerges from a few simple terms.

■ REMMELE ENGINEERING - ENGINEERED FOR RESPONSE ABILITY

Remmele Engineering is in the machined-metal parts and custom-automation business, operating in Minnesota at a little over $100 million in 1999, growing at a sustained and comfortable 12% per year on average. They are abnormal in a market populated mainly by slow or no-growth family-owned regional-businesses in the $5 to $25 million range.

They offer several advantages as a case study: they are small enough to analyze in deep and comprehensive detail, yet large enough to exhibit some complexity; their history spans enough decades to claim sustainability, yet not so many that the path is forgotten; their industry is not undergoing explosive growth that drags everyone along and masks true competency, yet it does exhibit major changes in technology, markets, and skills; and the lessons they offer are readily transportable to companies of any size in other industry and service sectors.

Metal-parts machining may not be a high growth market, but it is far from stable. Technology is having its way here as most everywhere. Programmed controls and robots introduced an abstract and indirect relationship between the skilled machinist and the part, and continue to shift more of the hands-on direct control into the abstract and procedural realm each year. On top of that these control and robotic technologies continue to evolve with new capabilities and new service problems with each generation. CAD/CAM systems are changing the way parts are represented and the way they are introduced to the machining processes. Sophisticated process analysis is increasingly necessary as machine speeds and feeds increase, as materials become more exotic, and as parts are put into critical high tech medical, aerospace, and defense applications. Accurate cost accounting is shifting as flexible automation changes the underlying traditional economics. Computers and the Internet are rapidly changing the relationships between customer and supplier both upstream and downstream - with electronic drawing transmission, remote video real-time product/process design conferencing, remote quality-assurance buy-off, and the latest trend toward on-line real-time supply-chain status monitoring. And, there are major human resource problems: increasing knowledge requirements and decreasing general interest in a manufacturing career conspire in tandem to reduce the potential work force.

Management at Remmele has embraced change as both a comfortable business reality, and as a corporate strategy, and engineered the organization for response ability. Rather than examine Remmele as an example of Rrs structural design, as we did the earlier examples in this chapter, we will focus only on their cultural enablers, looking at their ideology as formed by their mission and strategic policies.

Adaptable People

They know what their competitors do, they know what their customers think, they know what technology has to offer, and they know what their capabilities are. They know. The reasons they know are because they listen and because they continuously probe for the latest developments in all of these areas, because they are genuinely curious and committed learners, and because they have a culture of communication, collaboration, and knowledge sharing. But you don't hear them talk about knowledge management. It isn't a phrase used in the company. They just do it.

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Remmele Mission Statement

Our Goal - Our goal is to be the BEST company in our industry.
Who We Are - We are a company which specializes in high quality, difficult and complex work requiring innovative technologically advanced processes in the areas of: (1) contract fabricating, machining, and assembly; (2) designing and building of tooling; and (3) designing and building custom equipment for automating a variety of manufacturing processes.

Contract machining services are primarily directed toward high value-added machining of complex, close tolerance parts. These services encompass small lot non-repetitive machining, repetitive-batch machining, and high volume continuous-run machining. Customers for our services consist primarily of manufacturing industries throughout the world.

Why We Want To Be The Best - We want the satisfaction and pride of achievement associated with being important, highly skilled members of an organization that is constantly working toward being the BEST in its industry and, with our families, to share the material rewards that this success brings.

When We Will Be The Best - To be the BEST in our industry, we will have a consistently growing number of loyal customers who recognize us as the leader in providing customer satisfaction. Our employees will demonstrate a high level of satisfaction with our company and their jobs. We will be recognized as a good corporate citizen by our employees and those people we impact in our communities, and our vendors will recognize us as an ethical and valuable customer. We will be at or among the top companies in our industry both in terms of sales and profitability, and we will maintain a record of consistent growth. As an aid in measuring our performance, we will compare ourselves annually to a select number of the top performing companies in our industry, and to the industry data available through our trade associations.

The company goal is to “Be the BEST,” the company T-shirt says “Pride in Quality,” and the company people know how they stand in the industry. There is a pervasive sense of self confidence everywhere; but one which is constantly earned and reaffirmed, not blindly taken for granted. This self confidence stems from a shared ideology, the totally involved pursuit of objectives, and the active and open discourse that takes place among tightly aligned and highly competent teams - not from a sense of superiority. There is no arrogance here.

The goal is clearly and honestly stated. More importantly, the metrics for achievement are defined and tracked. In the machining industry gross revenue and net profit percentage tend to move in opposite directions, so being the BEST for Remmele means being among the highest in both simultaneously. It is also noteworthy to see how they put meaningfulness into "meeting and exceeding customer expectations" without employing that trite and lazy phrase. Their mission statement doesn't sound like Madison Avenue wrote it; nor does it sound like it was the outcome of a consultant's project. It is their truth in their words. They live and breath it. It is their culture.

"Pride in Quality" is on the company T-shirt. In the mission statement it says: "we will have a consistently growing number of loyal customers who recognize us as the leader in providing customer satisfaction." That's the result and the measurement of producing a quality product, providing a quality service, and maintaining a quality relationship. Remmele turns away work, even when it's hungry, if the job demands a compromise on quality. This is not an issue of policy as much as the fact that nobody there will work on a job that requires a compromise on quality. That's how they feel. That's one of the reasons they are there.

The "why" part in the mission statement is important. It relates the company mission to each and every individual in the organization. It defines the common mental attitude of the Remmele employee. And it is a large part of the entrance attitude-exam for prospective employees.

In 1976 Remmele grossed $8 million in sales. At that point it broke with tradition in its industry and set up a national sales rep organization. Within six years in 1982 revenues exceeded $26 million, making it one of the few at the top end of its industry. It continued investing in equipment and people, typically committing to a promising technology before finding the business to support it - believing that they should first understand and master the technology before seeking customers. In 1989 sales exceeded $60

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million. By 1996 Remmele Engineering had more than 475 employees and annual revenues of approximately $90 million. Its customer base includes computer companies, automotive manufacturers, medical device manufacturers, heavy equipment manufacturers, the aircraft/defense/space industry, as well as others. In 1996 Remmele Engineering had grown to five plants grouped into four divisions - each serving a different type of market, each operating in a mode compatible to that market and different from the other divisions. It added a sixth plant in 1998.

Remmele's guiding principles are both straight forward and fairly comprehensive:

Remmele Strategic Policy: A – Guiding Principles

We at Remmele Engineering believe that conducting our business with the following principles in mind will ensure the accomplishment of our goals and provide job security for all. Success in following these principles will result in an ever increasing number of satisfied customers, the retention and growth of our people, and increasing profitability to be shared with all employees.

1. *Customer Satisfaction*
   a) *By aspiring to excellence in quality, delivery, and productivity, which will assure competitive prices.*
   b) *By committing to continuous improvement in every service or product we provide a customer.*
   c) *By treating everyone with courtesy, integrity, and friendliness.*
2. *Employee Satisfaction*
   a) *By making Remmele an economically secure and personally rewarding place to work.*
   b) *By providing an atmosphere of trust and open communication where people can continue to grow in knowledge, skill, responsibility, and compensation.*
   c) *By maintaining high standards of concern for the needs of the individual and the community.*
   d) *By involving everyone in our organization to ensure we accomplish our goals.*
   e) *By maintaining a clean, orderly, well lighted, and safe working environment.*
3. *Growth*
   a) *By attracting and further training outstanding people who are intelligent, honest, hard-working, skilled, and self-motivated to excel.*
   b) *By maintaining an innovative environment through challenging the status quo, embracing change, and encouraging informed risk taking.*
   c) *By regularly investing in the best tools, systems, and equipment available to be effective and competitive.*
   d) *By following a strong, well planned, effective marketing program.*
   e) *By formulating detailed, specific action plans to aid in accomplishing our goals.*
4. *Community Service*
   a) *By being a good corporate citizen, protecting our environment and supporting worthwhile community activities.*
5. *Profits*
   a) *Sufficient to accomplish these goals and provide a fair return to our stockholders.*

As with the mission statement, Remmele does not stop with a simple list of objectives, but follows through on these guidelines with a set of strategic policies that detail how these guidelines are employed in the operational pursuit of business. These are living, evolving statements that are reviewed and refined annually to reflect changes in the business environment and deeper understandings of core values and beliefs.

They plan and follow through on their plans constantly - not just at annually triggered events, but throughout the year. Everybody involved in implementing a plan is involved in the formulation or critical review of that plan. Critical review is a continuous process in this open communications environment, where the biggest sin appears to be making decisions without doing defensible homework. No one is penalized for decisions that turn out to be wrong as long as the decision is based on a diligent effort to assemble and interpret the available knowledge. *Informed risk taking* is a phrase repeated often at Remmele, and a concept that everybody in the company understands.

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Though descendents of Fred Remmele, the original family founder, still hold all shares and a few board positions including the chair, there are no family members involved in company management. Profit targets, and distribution are first concerned with the strategic needs for continued investment in technology, human resources, and knowledge development - the sustainability of the business. Dividends paid to shareholders are considered after the investment decisions are made.

Underneath it all they recognize that their continued success is based on the people they can attract and keep in the company. They have a very strong and directed recruitment and screening program that continuously trolls for thinking, curious people. And they maintain an environment required and sought by these kinds of people: honest communications, continuous learning and new knowledge application, a voice in the company decision making dialogs, loyalty, and respect. That doesn't mean they have management by consensus, and it doesn't mean they have abdicated responsibility at the top. They practice accountable empowerment at all levels, with clear and differentiated responsibilities as well. The responsibility expected of top management, after honestly listening to all who wish to be heard, are the strategic objectives and investment decisions; but not the requirements on how these must be achieved or carried out. And the decisions of top management come under the same open critical review and questioning as decisions made by any other employees.

Customer Satisfaction

Remmele next focuses on its customers:

Remmele Strategic Policy: B – Customer Satisfaction

1. *Meeting customer expectations results in customer satisfaction. Customer satisfaction goes far beyond the products we manufacture and encompasses the total business relationship between our customers and all our people and activities within our company. Leadership in the marketplace can only be sustained by constantly meeting or exceeding the expectations of our customers and anticipating their future needs through continuous improvement of our products and services.*
2. *Consistent with our Guiding Principles, we will accomplish this through teamwork and employee involvement; by regularly investing in the best equipment, tools and systems available; and by investing in the ongoing training and development of our people to enable each of us to perform in a manner that meets or exceeds the expectations of our customers.*

Ok there it is: "meeting or exceeding the expectations of our customers" - that vacuous phrase that all too often substitutes for actionable substance in many company mission statements. Notice that this is not the mission statement, and it is not offered here as the objective. Meeting expectations is offered as a means to customer satisfaction, and exceeding expectations is offered as a means to market leadership. And all of this is followed by specific guidelines on means for achievement, ultimately laid at the doorstep of continuous investment in process capability and knowledge development.

Organization

At Remmele, organization is a critical aspect of company policy:

Remmele Strategic Policy: C – Organization

1. *To better serve our customers we will utilize small (200 people or less) focused plants to ensure good communication, maximize the involvement and commitment of our people, and ensure responsiveness.*
2. *In the interest of enhancing the psychological ownership of our business by all employees we will continue to (1) involve people in the process of making decisions which affect them, (2) provide for decision making and problem solving at the most appropriate level, (3) encourage risk taking, and (4)*

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empower employees with the freedom and authority to make the decisions necessary for effective job performance.
3. *Emphasize communication at all levels within the company so all our people will understand (1) what is going on in the business, (2) the issues the company is facing, and (3) how they can help.*
4. *During times when sufficient work is not available, we will implement a series of responses to try to cause additional business to happen while simultaneously reducing working hours to match the available workload. Recognizing that our people are our most valuable resource, we view layoffs as the last resort to be undertaken only during a sustained severe business downturn when the survival of the company may be at stake.*

Remmele believes real and effective communication is important for profitable growth; and that letting employment at any one plant get above 200 people makes this difficult. They feel this helps maintain close working relationships with customers as well as with all employees; it allows them to maintain a nurturing environment; and it gives employees the opportunity for recognition and a sense of contribution. Notice that their size criteria is based on relationship management and the employee's view rather than the more typical management span of control arguments.

Keeping the plant small enables customers to know everyone involved in their job, and helps the employees feel a sense of "ownership." For instance, when a prospective customer visited one of Remmele's plants unannounced, without hesitation he was handed over to the group supervisor and machine operator that were involved in the proposed work as management was otherwise engaged. The operator showed the prospect how he would approach the proposed project, and showed his thought preparation with a software analysis of the tool path he had worked out. The prospect became a customer, impressed that Remmele's operators knew exactly what they were going to do from a technical perspective during the estimation and proposal stage.

When a plant grows too large, Remmele spins off one or a few of its capabilities into an independent operating unit. They do this to help maintain an entrepreneurial atmosphere, sense of excitement, and team spirit within the company. Employees said that a common question among them is: "When are we going to split off and become our own plant or division?"

Management

The central importance of communication, along with the themes of learning and interpersonal respect, underscores management policy:

Remmele Strategic Policy: D – Management

1. *We will continue to develop a supervisory team that successfully plans and leads in reaching objectives that benefit our company and all of those associated with it.*
2. *We will continue to encourage all members of the supervisory team through various forms of education, to increase their managerial skills, such as:*
   a) *Enhancement of our interpersonal skills so that:*
      (1) *Our communications are candid and open;*
      (2) *We develop the trust of our peers and subordinates;*
      (3) *We constructively manage conflict;*
      (4) *We are aware of our use of, and do not abuse, power;*
      (5) *We develop competence through delegation;*
      (6) *We accept and support the need for change.*
   b) *Improvement of our group process skills so that:*
      (1) *Our communications are candid and open;*
      (2) *We accept the ideas and communications of others;*
      (3) *We are supportive and cooperative;*
      (4) *Our focus is on team building;*
      (5) *We have more productive meetings;*
      (6) *We accept and support the need for change.*

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c) Increase our verbal and written communication skills so that:
(1) We eliminate "jargon" when talking with customers and others in the company;
(2) Our written communications are clear and concise;
(3) All of our communications reflect care and competence.

3. *We will continue to encourage all members of the supervisory team to increase their technical skills through various forms of education; i.e., college courses, seminars, in-house training, etc. In addition, we must develop a structured program of continuous technical training for each managerial and technical field, i.e., design engineer, designer, project manager, plant manager, etc.*
4. *We will continue to manage with honesty, thoughtfulness, compassion, humility, courage, and enthusiasm. We will demand of ourselves, and encourage from those with whom we work, the highest standards of performance, emotional stability and maturity, consulting supervision and leadership.*
5. *Continuous improvement of quality and productivity are an integral part of our management philosophy.*

Item 2.a.6, "We accept and support the need for change," is a recurring theme that appears to be an underlying driver for much of what is articulated. In reading through these strategic principles one develops the sense that they have chosen their words thoughtfully. It is revealing that they included "the need for" in this statement, rather than omitting these three words and simply acknowledging that change happens, and that people should make their peace with it. These three words transform an otherwise reactive approach into a proactive strategy.

Lists are just lists in many places, but at Remmele these strategic policies are a mission realization roadmap that is the evolving product of an annual review - a collaborative process involving a large percentage of the company. To know Remmele is to believe that theses statements are their attempt to capture explicitly their implicit beliefs and values, and not a wish for what they ought to be, or a desire for how others should perceive them.

A large investment in maintaining and developing skill and knowledge resources was evident to our team as we conducted the Remmele analysis. Though their four-plus year apprenticeship program is an obvious major investment estimated at $100,000 for new employees, many other instances abound. A majority of the company's machinists, for instance, are regularly sent to the annual machine tool show for a number of days each year - an heretical concept in an industry where income is generated by someone working at a machine, not off at a show. We asked president Tom Moore how he budgeted and measured this investment: as a percentage of payroll, as a percentage of gross revenue, as an annually decided target, what? He responded with words to the effect that he wanted no explicit performance measures of training and education for fear that they would become managed numbers rather than necessary and integral parts of the operating activity. Some things are obvious and easy to dig out of the books if you wanted to, like the amount spent on employee tuition subsidies; but they are not reported as separate performance metrics. Tuition, by the way, is covered 100% and paid up front by the company - not reimbursed partially or contingent on grades or other performance criteria; and studies toward any skill needed anywhere in the company are eligible without restricting a specific employee within their current or anticipated job function. You hear a committed philosophy at work here the deeper you dig.

They do not mention the maintenance and evolution of a common culture in the list of centralized functions as this is not recognized as a direct product or responsibility of any particular function. Under the centralization of human resource activities, however, are the management of the corporate-wide apprenticeship program and the recruitment process, two activities that do have a pronounced impact on the corporate culture.

During the recruitment and interviewing activities lots of talk happens up-front to fit people with the culture and weed out the wrong ones. Common screening procedures test for like-minded people who expect serious work, a sense of family, and constant learning Though the recruitment screening is formal and specific, the qualifications are for broad values and ethics rather than dogma and background. The company actively seeks self motivated innovative problem-solvers that think for themselves. The Director of HR described the process as: "We discuss continuous learning as the job, commitment to continuous improvement, empowerment and the responsibility it brings, that getting ahead is attached to skill and

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ability, that people come to own their work very overtly, about access to information, about challenging people, and that the Remmele reputation is to solve tough manufacturing problems, so we need the best and the brightest." Recruitment efforts target top talent and gifted personnel with a mind of their own; screening machinist apprentice candidates for breadth of interest and world consciousness, as well as for values and value systems—rather then for specific beliefs.

The specific nature of Remmele's ideology and its consistency among employees has resulted in a decentralized self-organizing system. When three shop employees were asked: "What if somebody gets past the screening process and turns out to be on the lazy or less prideful side?" the individual answers were a progression of practice - 1) "It wouldn't happen," 2) "We'd talk to them and help them get up to speed, and 3) "Eventually they'd see that they didn't fit and leave voluntarily; but if all else failed the supervisor would invite them to leave." These sentiments were echoed closely in another division, where the focused-factory cell teams made their own decisions about who would join the team, and then worked among themselves to develop the necessary complement of skills and responsibilities: "Nobody really hasn't fit in, but if all else fails, the pressure is raised on that person and eventually the supervisor will help if they don't move on voluntarily."

Remmele has an excellent and active internal collaborative network. Within plants the family/team culture fosters this activity. Across plants there are common-function forums convened for purchasing, accounting, technology, and marketing which provide collaborative learning events and channels. Both marketing and technology, for instance, conduct frequent and periodic cross-divisional meetings to look for potential innovations and new opportunities. Both groups engage in continuous and deep knowledge development: Red Heitkamp, director of advanced manufacturing-engineering, spearheads a dedicated world-search for technologies, engaging other personnel when promising process or equipment is discovered; and Bert Casper, director of marketing, spearheads classic research activities into markets targeted for investigation by the cross-divisional team and the management team. These knowledge development activities are continuous, structured, scheduled activities.

Learning is not insular at Remmele. Though they are not totally immune to hidden bias, their ability to embrace foreign concepts and their propensity to expose themselves to foreign ideas creates a broad pool of fresh ideas. They bet first on people and their passions to pursue a reasoned idea - rather than first choosing a direction and then finding a person willing to follow it. Examples of strategies they employ that are uncommon in their industry include the use of manufacturers representatives, a predominately outside board of directors, significant growth as a goal, a major commitment to knowledge and skill development, autonomous empowerment, finite shop scheduling, and activity-based costing for job estimation. An excellent example of a strategic principle adopted from another industry is the concept of "informed risk," which president Tom Moore credits to Intel's mission statement from the early '90s.

■ STRUCTURE AND CULTURE IN PERSPECTIVE

In this chapter we have looked closely at structures that enable change - examining static system structures that make change possible, and examining a dynamic organizational culture that makes change probable. Both the static and the dynamic parts are important.

Static structural views are very comfortable for many as they are technological, hard-edged concepts that lend themselves well to factual examination and direct control. They are impersonal. The cultural side of change proficiency is another matter. It is about people, their beliefs, and their values. It is the soft side of the business that has contradictions, equivocations, and indirect control. It is personal.

Two different styles of system control are exhibited here. One employs a physical structural design that is easily changeable, and then puts a change master in charge of it. The other creates a set of boundary conditions and objectives and turns everyone loose. As stand-alone approaches, in these early days of agile competition, either path can make almost any company a lot more adaptable than its competitors - in the land of the blind the one-eyed is king. Real competitive potential, however, is not realized until a company is strong in both the possible (more range) and the probable (more likely to act) dimensions.

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Harvard's David Upton wanted to understand why it was so difficult for companies to become more flexible, even when they saw it as a competitive advantage[11]. To accomplish this he studied 61 factories that make fine papers in North America, and compared the ways in which each employed automation and computers in the factory. His answers showed little correlation between flexibility and the employment of technologies intended to make factories more flexible. Indeed, many common assumptions were proven incorrect, including no relationship found between size of plant and flexibility, and no relationship found between work-force experience and flexibility. Instead, the flexibility of these plants was primarily determined by the people, and their personal interests and concerns for flexible operation. "Plants whose managers had not made flexibility a clearly understood goal were much less flexible than those whose managers had."

The corporate culture provides alignment among the employees and between the individual and the organization. Culture is a framework. It can promote or inhibit the reusableness and reconfigurableness of human resources. You can have a culture that does not promote agility, so simply having one is not enough. The culture at Remmele embraces continuous learning and the continuous application of new learning. People expect the nature of their jobs to change frequently. They look forward to personal growth and development. They anticipate the opportunity to help develop a new business and join it in a newly created plant. They know their markets have ups and downs, and expect to contribute however necessary during the downs and work the overtime during the surges. If things didn't change they would be disappointed.

But embracing change alone is not enough. The culture also provides a common set of standards for interaction, relationships, participation, and values. These standards facilitate the mobility of people within the organizations because they provide a common language, common objectives, and open communications that permits someone to enter into new relationships effectively.

The static-design examples we looked at earlier were focused on specific well-bounded physical systems. Here in the dynamic cultural environment, where the "systems" that get built and reconfigured are the corporate operational strategies, and the "components" in those systems are the corporate resources, the cultural framework has a pervasive effect. In all cases we wish to quickly and effectively assemble appropriate resources into a purposeful system.

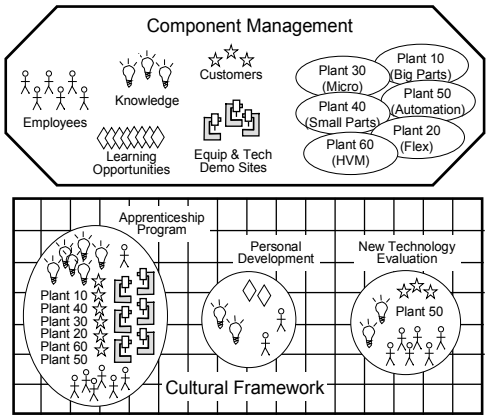
Figure 2.6

Remmele's Corporate Culture Provides the Framework for Highly Response Able Competency Development

Reusable
- Common core knowledge and culture make people internally mobile.
- Continuous employee development keeps skills current and meaningful.
- Continuous search for new solutions to problems matches knowledge to opportunity.
- Common business-unit interface shields internal business-unit differences.

Reconfigurable
- Collaborative organizational learning is self organizing.
- Knowledge and competency control, not rank.
- Apprentices do not select, or get assigned, to a home plant until after their multi-year apprenticeship is completed.
- Employees empowered to seek learning opportunities, plants empowered to educate and train w/o budget cap.

Scalable
- Employees screened for curiosity, rather than similar thinking.
- Common interest and competency at learning provides large capacity for massive and rapid knowledge diffusion needed .
- Cultural framework continues to evolve.



Response Ability
- Maintain healthy margins and growth in a no-growth industry.
- Meet continuous growth needs in staff size and knowledge-base in an industry that isn't a major draw for graduates.
- Maintain continuous leadership in new technology introduction.
- Re-orient plants and divisions when markets disappear.
- Absorb demand fluctuations without loosing resources.
- Continuously identify, create, and enter new markets.

Depicted here are three competency development "system" types that get constructed and reconfigured regularly at Remmele. All share a common framework defined by the corporate culture. The cultural framework at Remmele enables change especially well because it specifically embraces continuous learning and the continuous application of new learning as the expectation of all employees, as well as providing trust, respect, and opportunity factors to support a sense of family.

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In the static examples, this system assembly and reconfiguration process is very personally managed: someone (or some group) is specifically responsible for reconfiguring a machine or a process or a production/supply chain to meet a need. Within the cultural framework, however, the human resources often play a direct role in self-organized system assembly and reconfiguration. Some degree of self-organization occurs in every peopled organization, whether or not the cultural framework is designed to constrain and enable this process effectively to meet organizational goals. When a cultural framework does not recognize and address self-organization beneficially it guarantees built-in productivity conflicts.

Remmele has an effective culture for dealing with their changing business environment. There are other ways perhaps more suited to other organizations in other industrial or service sectors. The important concept here is the need for a culture that can service as an effective framework for assembling the necessary response systems. And these response systems must be capable of dealing effectively with the nature of change in a specific operating environment. It is this nature of change that we will look at next.

■ NOTES:

[1] SEMI (1989), *Cluster Tool Module Interface and Wafer Transport Standard.*
[2] Vasilash (1995), "On Cells at Kelsey-Hayes", p 59.
[3] "Transfer Lines Get Flexible" was the cover story in the January 1999 issue of Manufacturing Engineering magazine, pp 42-50. This article offers an overview of approaches offered from a variety of machine tool manufacturers that have modularized what they used to offer as stand alone machining units, so that the individual reusable components can be reconfigured into customized "flexible" transfer lines. Transfer lines built this way have downloadable product flexibility not present in prior generations. The structural concept provides the machine tool manufacturers with an agile machine assembly capability. Some of the machine manufacturers were looking at mechanical component standards that would move some of this reconfiguration agility into the machine owner's domain. None were yet promoting the response ability that a Lego-like, reconfigure-on-site, structure would offer the user; but that is only a short move from where they are.
[4] LSI Logic's proprietary CoreWare tool is a classic example of Rrs structural concepts. The tool contains a library of popular and commonly needed sub-circuits - some of which LSI has purchased rights to and some of which they have developed themselves - and assists the designer in stitching these into a total system-on-a-chip along with any new circuitry that is required. It is credited with a dramatic shortening of time in new chip development - typically one-third the time it would take to develop a total circuit from scratch. The concept is a mirror of the sub-contractor management concept reviewed in this chapter: there is a pool of circuit resources, there are people who obtain and standardize the circuits that enter the pool, there are people who access the pool and stitch together resources into a total solution, and there are people responsible for establishing and evolving the plug-compatibility framework standards that govern the compatibility of resource components. More can be learned about CoreWare at the LSI Logic web site: www.lsilogic.com/.
[5] Drucker (1990), "The Emerging Theory of Manufacturing", p 94.
[6] Dewdney (1991), "Insectoids Invade a Field of Robots"; and Brooks (1990), "Elephants Don't Play Chess".
[7] During a visit to the Santa Fe Institute in 1995 Chris Langton related this to the author.
[8] Cambel (1993), p184.
[9] Collins (1994), *Built to Last*.
[10] Dove (1996), *An Agile Enterprise Reference Model with a Case Study of Remmele Engineering*. Sue Hartman, a colleague in this research along with Steve Benson, had been to Remmele Engineering earlier for a single-practice analysis, and suggested that they would be an excellent candidate for a corporate-wide analysis.
[11] Upton (1995), "What Really Makes Factories Flexible?", *Harvard Business Review*, July/August 1995, pp. 74-84.

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