PUTTING AGILITY IN PERSPECTIVE: A PROFILING TOOL

Rick Dove

A Working Definition for Agility

What precisely is agility? How do we measure it? How do we know when we have it? Is there a simple metric or index? These and other questions are currently being debated in the Agile Production Focus Group of the Agile Manufacturing Enterprise Forum. At the end of 1992, after our first six 2-day workshops, a picture of agility is beginning to emerge.

In our attempts to understand and communicate to others what agility looks like in the production environment, we started twice down paths that enumerated an ever increasing list of characteristics and relationships. Eventually we came to believe that too much detail was inappropriate at this early stage of understanding, and hardly useful in helping the uninitiated understand basic concepts.

Communicating basic concepts became our focus. Especially after we realized the depths of our own recurring confusion in defining this thing called agility. We experienced constant difficulty in separating agile from fast and agile from flexible. We found our companies preoccupied and committed to lean and TQM programs that seemed in competition with yet another perspective. And all too often we tried too hard to make agility answer all the competitiveness issues. Perhaps the exercise was both inevitable and necessary.

Falling back on first-things-first, we adopted this as our working definition of agility: the ability to thrive in an environment of continuous and unanticipated change.

The focal point here is "change" - the ability to initiate it, and the ability to respond to it. "Thrive" is a key word because it implies both long term success, as opposed to a lucky response, and because it implies wielding agility both as an offensive as well as a defensive capability. "Continuous and unanticipated" underscores the new long-term picture but, most importantly, distinguishes agility from mere flexibility, enabling successful change even when there is little advance notice and no prior expectation.

The Agility Profile Matrix

Though we are still in an early stage of understanding, one thing has become clear already: an agile enterprise has broad change capability that is in balance across multiple dimensions. We came to understand how important the "balance" part was when we tested candidate examples against extreme conditions.

Would you call it agile if a short-notice change was completed in the time required but at a cost that eventually bankrupted the company? Or if the changed environment thereafter required the special wizardry and constant attention of a specific employee to keep it operational? Is it agile if the change is virtually free and painless but out-of-synch with market opportunity timing? Is it agile if it can readily accommodate a broad category of change that is no longer needed, or too narrow for the latest requirements?

These questions helped us tease apart this thing called agility into four principal dimensions: cost, time, quality, and scope. To be agile, we feel there is a requirement to "score" well in all four dimensions. Scoring is not an area we have yet addressed in a quantitative manner. Here, you will find only a subjective approach sufficient for the aims of our initial exploration.

An operation may successfully accomplish many changes without all dimensions being above the agile threshold. These kinds of changes don't represent the full range required for thriving on the unanticipated, and can provide a very false sense of security. A few successes at narrow-band change can lull an operation into thinking they are agile even when all dimensions have not been stressed.

You can change virtually anything if money is no object. However, if your response to change costs too much relative to your competitor's costs, there will be a steady erosion of working capital, or at least a higher tax on shareholder profits. Change at any cost is not viable, else we need not restructure anything. We can simply throw out the old and buy a new capability, assuming, of course, that we can bring something new to the operational level quick enough.

But the cost of change alone does not provide a metric for agility. Responding to change in a timely manner is the only effective way to respond at all. Thus, speed of change becomes an equally important factor, especially in an environment characterized by continuous and unanticipated change.

Quick, economical change, however, is still not a sufficient profile for agility. The quality dimension is necessary in order to reflect the robustness of the change. If we cut corners in the process of changing in order to do it quickly and economically, we end up with a fragile, spit-and-bailing-wire result.

Finally, something is considered to be agile precisely because it is geared for change. But how much change? The dimension of scope addresses this question. Scope is the principal difference between flexibility and agility. Flexibility is that characteristic you fix at specification time. It is the planned response to anticipated contingencies. Agility, on the other hand, repostures the fundamental approach in order to minimize the inhibitions to change in any direction. Being agile is to recognize that change has accelerated to the point where contingency lists are outdated as soon as the ink drys. At the heart of scope is the architectural issue: rather than build something that anticipates a defined range of requirements, or ten or twelve contingencies, build it so it can be deconstructed and reconstructed as needed.

When is an enterprise sufficiently agile to be called an agile enterprise? Perhaps when adequate agility exists in each and every one of the necessary enterprise system structures. Note that we are suggesting that "all" necessary structures must be agile in order for the enterprise to be agile.

We can have agile departments without having an agile company. In fact, we will undoubtedly begin the journey to agile on a department-by-department basis. In many cases, an agile department responding to a threat focused in that area will successfully defend the company, giving the illusion that the enterprise is agile. OK - as long as we don't take solace in the illusion and think the task is done.

With four dimensions in hand, we then set about building a profiling tool. Initially, we chose to look on the broad scale: at the agility of our people, our product, and our processes. This is not an attempt to be comprehensive - for we might also inquire into the agility of our strategies, or the agility of our business relationships, just to name two other categories. It is rather an attempt to profile and communicate the basic concepts of agility so that others might begin the inquiry in their own real production environments. It is worth noting that evaluating a product's agility is an exercise that can be applied to a piece of production equipment as well. After all, a piece of production equipment is a product bought for, and employed in, the manufacturing process.

Agility Profile Matrix: Four Balanced Dimensions - Three Arbitrary Categories

	Cost	Time	Quality	Scope
People	XXXX	XXXX	XXXX	XXXX
Product	XXXX	XXXX	XXXX	XXXX
Process	XXXX	XXXX	XXXX	XXXX

Relative Qualitative Metrics

A question heard often is how agility relates to other thrusts a company may be embracing as its next step in the change process. Let's explore the differences and similarities of Lean, TQM, Flexible, and Agile, and look at the distinguishing characteristics of cost, time, quality, and scope - the four dimensions of the agile profile.

Agility is the capability to respond when change is desired. It is different from flexibility. It is necessary for lean. It is a new dimension for TQM.

	Cost	Time	Quality	Scope	Re: Agile
Agile	Low	Quick	Self Healing	Limitless	---
Flexible	Low	Fast	Strong	Limited	Superseded
Lean	High	Slow	Fragile	Little	Complemented
TQM	---	---	---	---	Extended

Flexibility is a characteristic bounded by the purchasing specification. It is a fully anticipated and articulated need for variety. It is delivered in its full glory and will be responsive only so long as the batteries in the original crystal ball remain charged. It will be worse than useless when something outside the original specification is required because it will not be abandoned readily.

Lean takes all of the fat out of an operation and fine tunes it precisely for the job at hand. In its most successful traditional form it is rigid and fragile. Forcing a change on a lean environment is a slow process with high expense. On the other hand, stepping back from the definition of lean long enough to incorporate the need for agility can lead to highly successful results. Get skinny so you can dance!

TQM has not specifically addressed response-to-change as yet. In principle, however, total quality management means managing the quality of anything and everything that becomes important. With agility emerging as a principal competitive characteristic, TQM will encompass all that is agile. In this sense, TQM and agility are totally complementary, with agility viewed as an extension of the current TQM focus.

Using the Agility Profile Matrix

In our Focus Group workshops, we have used the Agility Profile Matrix to analyze a variety of production elements in different industries. The purpose of these exercises was to complete the tool by populating the empty matrix with pro-forma examples, and test the tool for its ability to clarify the understanding of agility.

The exercise was extremely illuminating, as the examples below will show. Even those of us who were actively exploring and debating the distinguishing characteristics of agility fell off the wagon repeatedly.

Some of the examples were individually submitted and some were developed in group workshop activities. Invariably, if someone did not act as critic, measuring the example constantly against the working definition of agility, and against the single-minded focus on change, the example wandered. Quality of change was often confused with the quality of the device or process under examination; and more often, with the quality of the product produced from the device or process. Evaluating new processes sometimes got confused between a focus on the process change itself and a focus on the resulting accommodation to product change. We will suggest some approaches later to help avoid these pitfalls.

You may disagree with the ratings and comments on the chosen production elements. That's fine; they are currently qualitative assessments on very subjective scales known only to the people involved in the actual rating. The exercise of actually rating these elements for their agility, and developing a set of supporting comments, is the point. Those that engaged in the exercise came away with a much deeper understanding of what agility is and, especially, what is agile and what is not.

We are still in the process of refining this profiling tool and understanding how to use it. Perhaps we will be able to develop a universal quantitative measurement scale eventually. In the meantime, we find that the subjective scale is quite useful. We asked people to rate these elements for how agile they were in specific dimensions (cost, time, quality, scope) from zero to

one. Zero means they felt that the element in question was totally non-agile. One meant it could not be usefully more agile under any circumstances. Thus, these ratings are measured against a particular rater's desires, goals, needs, expectations, knowledge, and other equally personal factors. Surprisingly, most of the examples shown were done by groups of people numbering anywhere from five to fifteen, and represent a firm group consensus.

People Organization - Employee Core Augmented by Temporaries:

Cost - Providing a core group of employees with permanent employment and continual training can result in a highly knowledgeable, broad-skilled, and mobile workforce. Augmenting this core with outside temporaries to absorb fluctuating staff requirements and provide specialty skills protects the core group's employment and training investment. Though an apparent hourly premium is paid for temporaries, all hours are applied to production activity and none to training and skill broadening. Additionally, total training investments are reduced by reducing the loss of trained people who are eventually replaced by people in need of training when increases are required. Finally, when staff reductions are required they can be reflected immediately in payroll costs and do not incur additional severance costs.

Time - Staff increases and reductions can be made much quicker in the temporary ranks than in the permanent ranks. Specialty skills can be found almost immediately among organized labor pools, professional agencies, and independent consultants. The interview and hiring process goes much quicker because agencies keep a roster of qualified people and the penalties for mistakes are remedied easier.

Quality - Change in the organization here is focused on staff increases, staff reductions, team configuration, and team reconfiguration. After a reduction in staff size there is relatively no debilitating dip in moral since the permanent employee ranks are protected and the remaining temporaries have chosen this way of life. Increases in staff size with temporaries requires an initial shake-out period since the incoming people are never as trained and dedicated as permanent employees, but overall this activity is comparatively robust as "hiring" mistakes can be more quickly corrected and specialty skills can be more readily found. If the increase is going to be made in the permanent employee ranks because the business base-line has grown, hiring will be done from the pool of known temporaries on-site - a highly robust approach.

Configuring teams with skill-sets matched to tasks is facilitated by both the ongoing training investment in permanent employees and the option to augment the teams with highly specialized temporaries. Reconfiguring teams benefits from the same availability of broad skills, and also from a familiarity of dynamic interpersonal relationships that comes from mixing a permanent-temporary workforce.

Scope - The magnitude and variety of potential change in both size and skill-base of the total workforce is quite large. Keeping a core group of permanent employees allows a sizeable investment in continuous training - keeping these people current as well as making them broader. Augmenting the permanent workers with temporaries as needed, and bringing in specialty-skills whenever required, insures that large workforce capacity changes can be accommodated as well as a changing skill-mix requirement.

Profiling Three Pro-Forma Examples: People, Product, Process

	Cost	Time	Quality	Scope
Category: People Organization **Type:** Employee Core Augmented by Temporaries.	**0.9** - Temps incur no training investment & no severance costs, & optimize employee training cost.	**0.9** - Agencies maintain rosters of qualified people, hiring risks minimized, immediate reductions.	**0.9** - Highly robust changes in staff size and team configuration, good morale, right skills.	**0.9** - Broad internal skills, temporary specialty skills, large temporary pools available.
Category: Product Configuration **Type:** PCMCIA Laptop Computer Standard	**0.9** - Eliminates shop service costs, trade-in losses, and down-time due to imperfect third-party interfaces.	**0.8** - Simple customer installation, but dependent on unstandardized case access.	**0.9** - Industry-wide standard assures that future upgrades will work, even with mixed vendors.	**0.7** - Reasonably broad but does not address display, keyboard, power, or case upgrades.
Category: Product Production Equip. **Type:** Batch Reactor Vessel.	**0.7** - Low cost changeover relative to per-day production revenue.	**0.2** - Registration and certification procedures for EPA and others is very slow.	**0.9** - Rock-solid after reactor vessel is re-plumbed, re-gauged, re-controled, and re-certified.	**0.6** - Limitations due to tank linings, shapes and sizes matched to the chemical reaction.
Category: Process Equipment **Type:** General Purpose Board Tester	**0.3** - Test software costs too much to develop for each new board to be tested.	**0.4** - It takes too long for software and fixture development for each new board to be tested.	**0.8** - Solid operation on all boards set-up for test. Problems with one set-up don't affect others	**0.7** - Accommodates a reasonable range of board sizes and types, but is not universal.

Product Configuration - PCMCIA Laptop Computer Standard:

Cost - With the advent of the Personal Computer Memory Card International Association (PCMCIA) standard, the cost of changing laptop capabilities takes on a whole new dimension. Until now, if you wanted an upgrade or new features on the internals of your laptop, you basically threw the old one away and bought a new one. However PCMCIA provides a standard slot for solid state devices.

This means that changes or additions to your laptop will not require a huge investment as a consumer. This has many other ramifications as well. Formerly, upgrades and add-ons if they were even possible were proprietary to the vendor of the original unit. Third party products (modems, 3.5 volt devices, solid state disks etc.) which were not available will join the marketplace. This will drive the cost of new capabilities down and reduce the cost of modification to the product. Thus, the laptop with PCMCIA is a far more agile product to its predecessor from a cost of change and rate of cost change perspective.

Time - If you think the best is yet to come in portables, you're right. The perfect machine yesterday is today's markdown and demand is for tomorrow's product. Timing of introduction of these product is absolutely critical. Manufacturers have a limited window of opportunity before the competition forces minimal recoup of engineering and manufacturing costs.

The speed at which product developers and manufacturers must operate in order to meet the ever changing product dimensions is getting faster and faster. The agility metric for time on the laptop with PCMCIA is going to be measured by how much faster a new technology can go from conception to installation than was previously possible.

From the consumers perspective, the time factor will be most evident in how long an upgrade will take to install. Where this has been either impossible or required a field return to the manufacturer, PCMCIA will allow upgrades in minutes by the customer.

Quality - Operational quality of a product is a given in today's marketplace. However, the Agile Product will require a new plane of quality definition. PCMCIA introduces agility to the product in its ability to allow for change of the laptop with no adverse effects to the end user.

In the past, third party upgrades and/or original vendor add-ons did not have agreed-upon specifications. Therefore end users were at risk whenever they bought into an upgrade or change. One advantage of the PCMCIA standard is

that add-ons can be tested for compliancy, providing a robust change capability. An upgrade from 1 meg to 4 meg memory, for example, will be painless and perform as specified. In addition, new or hybrid components (accelerators, graphics, network etc.) can be added without creating installation and use problems.

Scope - PCMCIA will allow for upgrades that in the past have not been possible. The mentality of buying a machine now and having it superseded in a few months may no longer be a problem. Furthermore the entire scope of the product changes. The lifespan and usage can grow, whereas the current generation of products is hamstrung by "hardwired" configurations.

An additional scope metric lies in how much more rapid the product can grow in functional capabilities. The 20mb and 40mb solid state drives that fit into the PCMCIA slots will go quickly to much higher capacity cards. These cards will then be installed by the laptop owner and produce an even more powerful machine at very little time and cost penalty.

Product Production Equipment - Batch Reactor:

Cost - Though batch reactors are considered to be general purpose equipment, switching the product to which it is assigned, say from polyglycol for the polyurethane seat cushion market to paper coatings for the stationary market, is not to be taken lightly. Reactor vessels are generally installed into a matrix of input and output delivery system components, such as pipes and transport mechanisms, that need to be rebuilt for a different product. The EPA and local regulatory agencies also impose requirements on registration and certification for the new use the reactor will be put to. Though costly, by comparison to the value of the production it is negligible. Gauges, controls, and control software will also need to be constructed for the new production activity. All in all, when compared to the revenue generated by the new production unit these costs are negligible, often less than one day's output.

Time - This is the biggest stumbling block to agility. Changing controls, control software, gauges, piping and transport mechanisms really only requires a few weeks from start to full compliance product output. The major time consumption is in the regulatory approval process. If gases are to be vented and then incinerated, for example, the EPA gets involved. Generally, the local fire department will also require registration and inspection. Experience shows that it is difficult to accomplish these regulatory procedures in less than six months even under extremely urgent priority conditions.

Quality - Once a reactor is switched over to a different product it is a solid operation. Replumbed, recontroled, regauged, and recertified, it is once again a dedicated and reliable production resource.

Scope - General purpose always has its limitations. With reactor vessels it is seen in the linings and the hardware configuration. Chemical reactions must be matched to tank linings in order for a reactor vessel to be a production candidate. These linings are generally permanent and not something that can be changed once the vessel is built. Hardware configurations also play a role when shape and size are important to the reaction under consideration.

Process Equipment - General Purpose Board Tester:

Cost - Though a general purpose electronic board tester is a highly flexible piece of production equipment, the cost to introduce another board to the suite of boards that can be tested on the device is quite high. These costs are incurred in programming the test software and designing and building the board test fixtures. Some of these costs are due directly to the general purpose nature of the tester, making programming and fixturing more complex.

Time - Cost and time go hand-in-hand here since the costs are caused by both software and hardware engineering time. Both time and cost would be greatly improved if test programs and fixture designs were generated automatically from the engineering design documentation.

Quality - Once a new board test suite and fixturing is completed, the general purpose tester is quite robust in processing the new board.

Scope - The general purpose nature of these testers allows a fairly wide range of board sizes and types, though there are always some restrictions, particularly in mixed analogue/digital production environments.

Avoiding Pitfalls

Experience shows us that it is very easy to get side-tracked and confused in these Agility Profile Matrix evaluations. Partly, because there is a tendency to confuse speed and flexibility with agility. Partly, because it is sometimes difficult to separate a production element from its environment. Partly, because we know the production element very intimately, and have a strong model of its strengths and weaknesses in our minds.

We have found that we must be precise about what we are measuring and rating. For instance, a general purpose board tester is highly flexible, perhaps even agile, within the bounds of the boards it is already set-up to test. However, when a new board is introduced we find this highly flexible piece of equipment to be very non-agile, as it is non-trivial to introduce a new board into the system. The key point here is that we have focused on the "introduction of a new board" into the production environment, rather than just the ability to handle a lot of different boards.

Note that the board tester was evaluated for its ability to handle the "unexpected" - a board that was not current in its test suite. Evaluating it on its ability to handle what it is already fully prepared for is not a test of agility, but rather of flexibility.

Getting It Right

- q Be precise on what is being evaluated.
- q Focus on the response to the "unexpected".
- q Focus on a single architectural level.
- q Use uninvolved critic to review for the above.

If we are in an agile enterprise, with an agile factory, that has an agile process, that utilizes an agile piece of production equipment to produces an agile product, we must be very careful about which "architectural level" we are examining. Even if some or none of these are agile, it is easy to shift the point-of-view in the examination, especially when we move from one dimension to another.

For instance, we might evaluate a process for producing custom-colored, custom-formulated caulking compounds. When looking at the cost dimension we could rate it highly agile because changing from one formulation to another is instant with no waste. When we get to the quality dimension we could rate it high here as well, because the color match for each customer requirement is precise. However, what we have done is mix an evaluation of the process change cost with an evaluation of the resultant product quality. If the quality issue had focused perhaps on the lack of cross-contaminates when the change was made, we would be evaluating the process.

One technique we have found to be useful and almost always necessary, is to employ a procedures critic - someone who has neither participated in the evaluation nor has an involvement with the item being evaluated. With experience the need for the critic diminishes, but people new to the evaluation process almost always bring some passion to the act that clouds the results.

The Next Step

We believe that agility is rooted in architectural issues: the integration structure of production control and information systems, the organizational structure for employees, the equipment hardware modularity, business practices and procedures, individual practices and procedures, and other structural realities that determine how things work together over time. We need next to identify the fundamental architectural issues that determine agility in all four dimensions, and use these architectural issues as the framework for our profiling and scoring exercises.

For instance: if we are evaluating a piece of production equipment, we want to know if it can be extended or reconfigured to accommodate something different than originally anticipated. If it is a robot, can we add another axis of motion or must we get another robot. If it is a wave solder machine, can we upgrade it for yet-to-be-defined EPA requirements or must it be replaced.

Work in this direction has already begun. Concurrent with the development of this Agile Profile Matrix tool, the Focus Group produced another tool that profiled a preliminary framework for agile software systems. This framework suggested principles and attributes that enable agility in large integrated software systems, and then provided examples of these same attributes in other "system" areas such as organization, machines, processes, supply-chain relationships, and product design. Though these tools were developed simultaneously, and shared many of the same minds, they had not come into sufficient focus to cross-pollinate each other before publication.

Currently we expect to explore and develop agility audit and evaluation procedures as part of our Agile Production Focus Group agenda for 1993. Both of these preliminary tools developed in 1992 will provide the foundation for this activity, and be refined and integrated in the process.

Acknowledgements

Author:

Rick Dove Paradigm Shift International, 510-652-7528

PCMCIA Example Written By:

Steve Benson FACT, Inc., 508-470-0852

Principal Collaborators:

Steve Benson FACT, Inc., 508-470-0852
Curt Holmes Martin Marietta Energy Systems, 615-574-3247
Joe Kann Allen-Bradley, 414-382-2252
John Kohls Institute of Advanced Manufacturing Sciences, 513-948-2111
Richard Neal Martin Marietta Energy Systems, 615-574-1862
John Oleson Dow Corning Corporation, 517-496-4516
Deborah Reich Department of Labor, 202-219-5769
Frank Reynolds Eastman Kodak, 716-477-6187
Sal Scaringella United Technologies, Norden Systems, 203-852-5179
Raja Seshadri Honeywell, 612-785-4050

Reviewers, Contributors, and Focus Group Members:

Clint Ackerman Digital Equipment Corp, 508-635-7758
Len Allgaier General Motors, 313-947-0686
Karl Burr Electronic Data Systems, 313-524-8371
Mike D'Orlando United Technologies, Norden Systems, 203-852-7871
Patrick Eicker Sandia Laboratories, 505-844-5827
Mike Griesmeyer Sandia Laboratories, 505-844-0282
Robin Hale Rockwell International, Rocketdyne, 818-710-4345
Al Hrncir Texas Instruments, 214-956-6469
Keith Jessen Rockwell International, Collins, 319-395-5544
Vernon Lott Texas Instruments, 214-956-6843
Ray Patterson Department of Defense, Army, 803-760-4344
Frank Plonka Chrysler, 313-577-484
Gilbert Staffend Allied Signal Automotive, 313-827-5012
Dave Standen Chrysler, 313-956-7478
Stephanie Swirsky Department of Labor, 202-219-5769
Orapong Thien-Ngern Lehigh University - Iacocca Institute, 215-758-5517
Jerry Tuschner Martin Marietta Missile Systems, 407-356-3973
Gary Vasilash Gardner Publications, Production Magazine, 313-473-0800
Bill Wadsworth Wadsworth Consulting, 215-356-3361

Mike Wald	Alcatel Network Systems, 214-996-5293
Curt Ward	Raychem, 510-795-8997
Robert Woelfling	Hershey Chocolate, 717-534-6400