Capability Lifecycle Management:
Connecting Product Opportunities to Processing Capabilities

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Abstract

Capital intensive industries, with mature product portfolios face a daunting challenge in the age of global competitiveness. Does a company invest in the Capital to re-invent production capabilities to meet the needs of new product development? Does a company rely on out-performing competitors to be the 'last one standing'? How can a company leverage its existing investments in Automation, Information Technology, Quality Systems, etc. to meet the needs of mature and cost conscience customers?

These questions are not answered simply or quickly. A 'Capabilities Management' approach has been developed to balance the demands of cost focused customers with the need to transform the engineering infrastructure of a business to meet the demands of new product deployment. The processes involved are systematic and methodical and aligned with many of the systems required by FDA, ISO, OSHA/PSM and other regulatory bodies. The ability to manage and monitor capabilities within a plant fits into many of the cost containment solutions of our day (Six Sigma, Lean, etc.)

Recognizing the importance of managing a capability lifecycle versus an asset lifecycle or product lifecycle opens up plant floor integration to new product development and to further marketing / customer relationship management.

This discussion provides an overview of the relationships of Capabilities Management, how they affect the Engineering Community within a corporation and how they can be integrated into today's business enterprise.

Introduction

To start the discussion, we must be clear about the goals in front of us as an Engineering Community. Our organizations, with cultures, behaviors, organizational methods, systems and processes, are tasked with providing solutions to any combination of the following five problems:

1. How do we implement continuous improvements across similar opportunities faster and more consistently?
2. How do I systematically approach finding improvement opportunities?
3. How do I avoid repeat "mistakes" or predictable short-comings such as regulatory change?
4. How do I better leverage my current Capital investment to prevent "mistakes", or to implement improvements?
5. How do I ensure when new products, new processes, or new capital assets are deployed, I am operating at a high enough level to not be considered a "mistake"?

The resultant engineering organization is focused on Product Sustainability and Capability Management. The primary value expressed by this organization, is one of

Engineering Stewardship. The organization becomes the financial, quality, safety, environmental, energy, resource, and uptime custodian for production capabilities. The organization maintains the production capability by leading processes and technologies through a maturity process, managing the technology / process as part of a technology portfolio.

Vision of Connectivity

The first key element is to establish a framework for the solution. The Capabilities Lifecycle Model, included in Figure 1, provides the holistic overview of how the supporting cycles of a business enterprise maintain the cash work flow cycle for a business. The model is a very simplified picture of the complex interactions of an

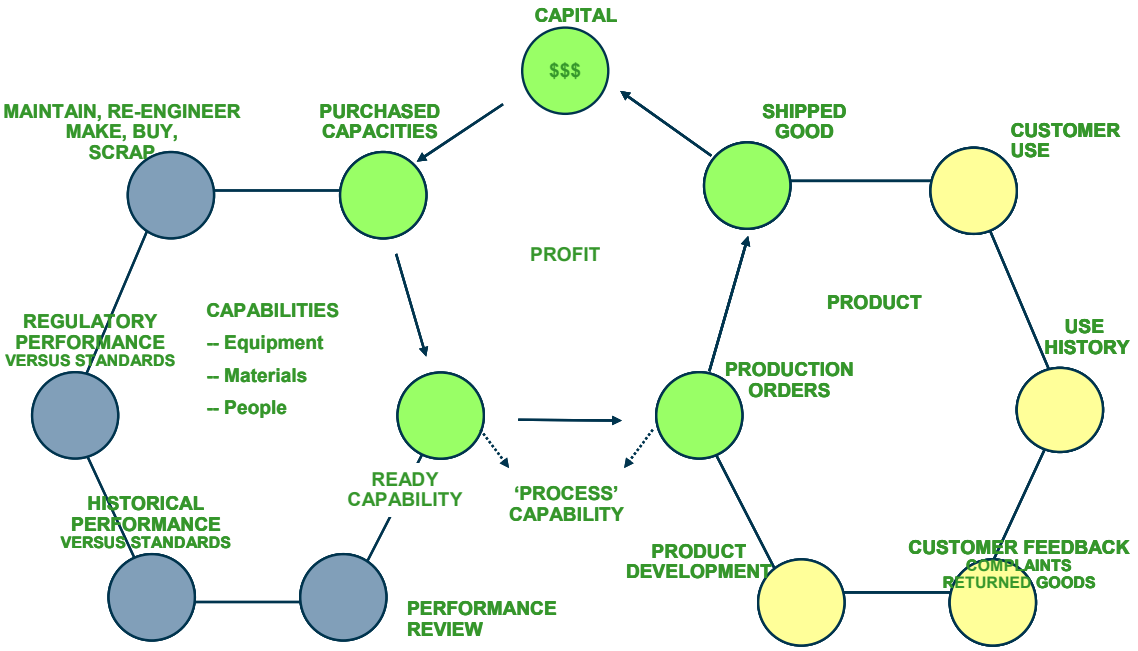

Figure 1: Capability Lifecycle Model

organization, but provides a critical vision of the connectivity of the many parts, in terms of work flow relationships.

There are four key elements within the model. The central element represents the basic work flow of capital within an organization, starting with investment capital and ending with profit from operating capital. Using Figure 2 as guide, we can break down the steps. All organizations start with an investment in Capital; we then must convert that Capital into a purchased capacity, then convert that purchase into a ready to use capability. That capability waits until a production order is issued, then the production order is converted to a shipped good, finally closing the loop by returning accounts recievable back to the capital pool. This is not a standardized accounting model. The intention is

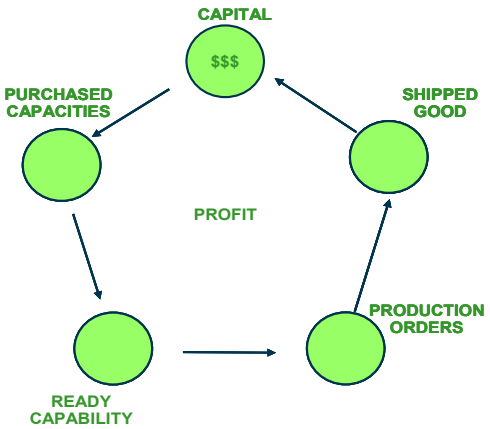

Figure 2: Cash Aspect of Model

to model the practical work of Capital as it relates to the engineering community.

The second major element within the model deals with the product workflows to turn product use into usable and actionable information. By reviewing Figure 3 we see that after a good is shipped we have customer use information which turns into a history and trend of customer use experiences. The customer use experience is the critical variable in a marketing campaign, where the company is trying to achieve a brand recognition for the product; in other words the mental history a customer has of the experience. The customer experience is returned to the organization through feedback, typically complaints or returned goods. Finally, that feedback is brought back into the operations organization through the product development process.

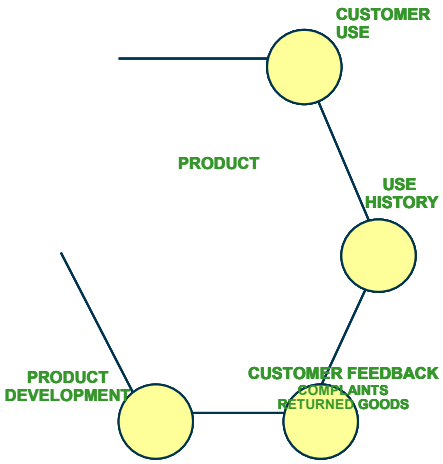

Figure 3: Product Aspect of Model

The final two aspects of the model are discussed together based upon Figure 4. The third item, is the process itself. The process is virtual. It does not exist as an entity but is the instanced manifestation of equipment, people and materials to produce a work element change. The fourth and final aspect of the model represents three distinct elements of the capabilities of the plant. The process capability is made up of equipment, materials and people. Each of these has their own unique workflow. Each cycle follows the pattern of first reviewing the performance against process performance requirements, then reviewing the performance historical information to observe trends against standards and process specifications. The process standards and specifications are reviewed against the regulatory requirements of the facility and a final decision on the retainage of the capability is made. Depending upon the retainage decision, the capability may require additional capital to ensure performance.

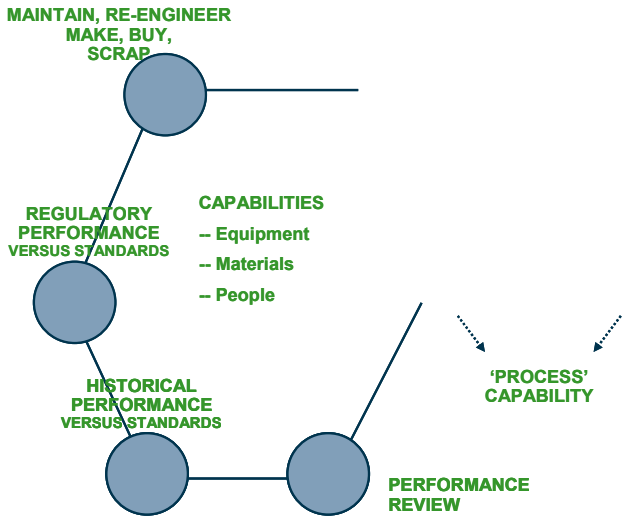

Figure 4: Capability and Process Aspect of Model

From this model we want to gain a few critical points:

- The interconnectivity of the Product, Process, and Capability Work Flows are critical to sustaining the overall fiscal position of an organization.
- The Quality Function (maintaining the perceived value received by the Customer) is fully integrated into this model, as is Sales and Marketing, Product Development, Operations, Logistics, Finance, etc. These functions are represented in the Product Work Flow aspect of the model.

- The Engineering Community, with New and Ongoing Process Development, Regulatory Compliance, Controls and Manufacturing IT, as well as Supplier Quality and Training, are all represented within the Capabilities Work Flow aspect of the model.
- The operational cost improvement programs relating to Lean , Design for Lean, Six Sigma, and Design for Six Sigma are provided for in the Cash Work Flow aspect, primarily between the Purchase Order and Ship to Customer work centers. This context highlights the importance of Design for Lean/Six Sigma in process development. As well, the tool sets of Six Sigma (DMAIC, PpK, etc.) are critical throughout the whole model.

The result of the model and facilitation of the workflows is that information and actions are aligned to support and sustain the maximized work potential of Capital, with the maximized flexibility to respond to ever changing product requirements and regulatory standards.

Product, Process and Organizational Maturity

Product Lifecycle (Concept, Commercialization, Retirement) and Product Maturity, separate from the Product Work Flow, are out of the scope of this paper. But let it be said that Product Maturity through innovation and management of Product Platforms using an innovation strategy, is the key to sustaining the Cash Work Flow over time. All Products will progress down a "commodity slide" of some proportion. Innovative Product Development is the response to this "commodity slide". The scope of Product Development, in simple terms for our discussion, will be reduced to two questions:

1. Am I required to change the fundamental design characteristics of the Product in order to sustain the profitable business of my customer? Or:
2. Am I required to change the manufacturing process and performance characteristics (Ppk, Cpk, OEE) of the process in order to sustain the profitability of the business of my customer?

Design Changes, as mentioned, are out of the scope of this paper. Process change, and the sustainable evolution of the process, is the essence of this paper.

All technologies and the engineering services that support them, evolve through a maturity process.[1] A common maturity model for process technology and engineering services is indicated in Figure 5. To address the five questions brought to light in the Introduction, we need to mature our process technology from relying solely on Ad Hoc methods to ensure quality and business goals, through reliance on structured release or final testing methods, through reliance on systems and

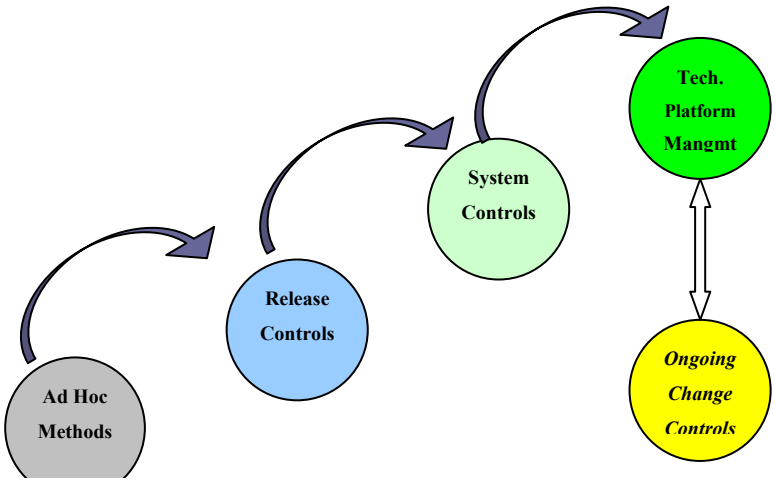

Figure 5: Process Maturity Model

standardized methods, to relying on a Platform Management of the process or technology.

With a mature process, managed as a technology platform, we can rely on the technology and the engineering support required, functioning as required, when we need it, where we need it. In order to support the requirements of Product Development (question #2), we establish the engineering community support and management controls to mature the process, the derivative capability technologies, and the engineering services required to manage the lot as a technology platform.

The engineering community must account then for the following organizational functions, supporting these 'Macro Business Processes' within the Capability Lifecycle Model, and in our desire to have a highly matured and evolved business process.

Table 1: Organizational functions required to support Macro Business Processes,

New Product Development	Ongoing Product Development
New Process Development	Ongoing Process Development
New Equipment Development	Ongoing Equipment Development
New Materials Development	Ongoing Materials Development
New Training Development	Ongoing Training Development
Engineering Management Controls, including: • Project Management • Annual Product Review • Periodic Process Technology Review • Periodic Equipment Capability Review • Periodic Material Capability Review • Periodic Training Capability Review	

The Development processes ensure that appropriate standards and specifications are created, and are maintained to meet the current purposes. The Management Controls ensure that we are not sacrificing a capability in one area to maximize a short term operating capital gain; thus resulting in capital investment to re-attain the capability when needed in the future.

By *expanding* the role of Engineering Management to include maintaining and actively reviewing an inventory of technology processes, the overall ability to meet our demands increases. Expanding the role of Project Management to include a feedback loop within the close out phase, to update inventory information (reference information, cost performance information, and physical inventory information), we reduce the front end investigation work required. Also if we include a monitor phase of Project Management, we can audit our performance as an implementation organization, ensuring customer (a.k.a. our bosses) satisfaction.

Justification to Expand the Engineering Work Scope

We offer two primary sources of justification for taking on more responsibility within an organization, as the engineering community. The point of the justification is simple*: If we do these things, we, as an engineering community, will be able to better manage the "issues" in our organizations, allowing more time to focus on the "opportunities"*.

First, consider the splitting of the engineering community to more narrowly focused roles and responsibilities, aligned with niche needs and skills, over the past number of years. In the book, *The Origin of Brands*,[2] the authors argue (in paraphrase) that the survival of a product line hinges on its ability to differentiate and serve a niche need. The product must serve a new category, or create a category that serves a new purpose in order to survive and thrive. The implications of this concept for product development are significant, the opportunities for social development are vast, but the impact on the engineering community, we argue, has been detrimental.

The engineering community has created new categories within itself, and each new category is providing a niche service that has explicit value. The engineering community, has created niche services such as Safety Engineering, Quality Engineering, Environmental Engineering, Six Sigma Engineering, Project Engineering, Process Engineering, Controls Engineering, and IT Engineering, to name a few. All of these services add value. And, in agreement with the authors, it would be foolish to think the solution is convergence of these separate niches. But the absence of oversight and holistic capabilities management is an issue. Where there is absence, there can be creation.[3] The first thing we must do is to create the functions of engineering capability management to provide the niche service of holistic oversight, where the success of the function is the assured flow of information and work to support the Cash Work Flow.

Secondly, the probability of any improvement idea succeeding, sustaining the improvement across other opportunities, is a function of the inter-connectivity of an organization. In the book, *The Tipping Point*,[4] [5]the author argues that for an idea to sustain (as an epidemic of thought) there must be a few individuals who can translate an idea from an innovation, into a concept tolerable to early adopters. Subsequently the idea must be wildly attractive for early and later adopters as well as laggards. The author argues further, in the afterword, that there is a critical absence of the subject matter experts who can take an idea and understand its business context as a primary challenge.

Additionally we need to translate and twist an idea across the engineer / manager chasm, as well as the chasm between the different niche engineering functions.

This is not solely a soft and 'feel-good' exercise. We can take the well known graphical representation of Geoffrey Moore's work and superimpose the cost structure of an idea to represent the fiscal impact of idea roll out (see Figure 6).

The conclusion from this graph follows that to maximize impact of an idea, we should be minimizing the time to "chross the chasm". Our innovations should be mature enough, through systematic review of needs and capabilities, to allow our organizations to not have early adopter / early majority resistance. The impact is a quicker realization of profit. The reason for quicker realization is because we are connecting the people within the organization, through facilitating the Work Flows in the Capability Lifecycle Model, to implement ideas to the right requirement.

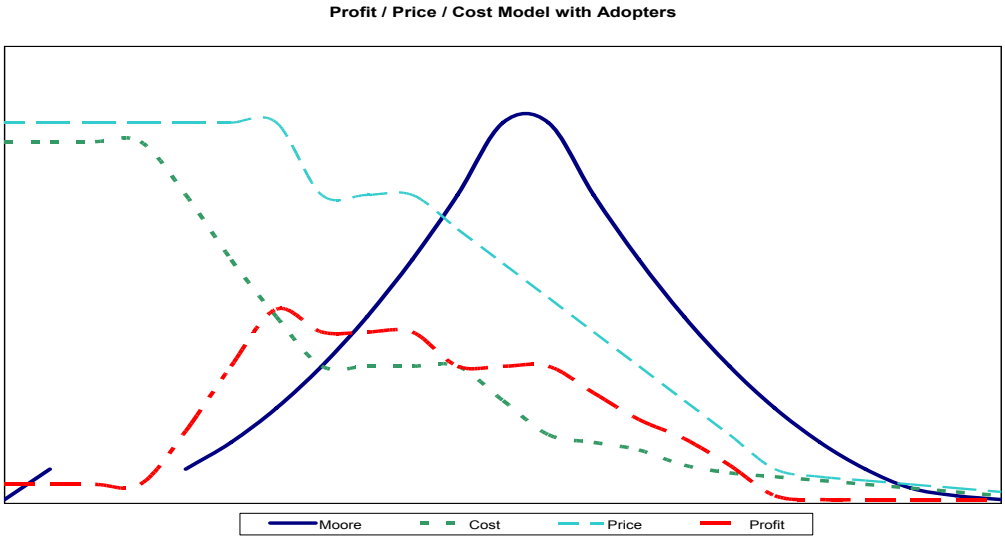

Figure 6: Moore's Adopter's Cycle superimposed with Profit / Cost / Price

Final Comments – Implementation Tools

The tools to implement these concepts are as simple as a list of product inventories, process technologies, equipment, materials and training that your organization is required to manage.[6] The management team must review the lists on a periodic basis, and act accordingly. The engineering professional must develop standards and specifications required, to periodically review. Product development and Process engineering must use tools like Quality Function Deployment (QFD) to link the "Whys" (Product Features) with the "Hows" (Processing Steps). Good engineering practice can relate Process information from a PFD to equipment information on a P&ID. Project Management techniques and Stage-Gate methods can be used to facilitate the update and closure of the inventory lists. Preventative Maintenance and Calibration systems can be leveraged to facilitate the inventory. Information can be tracked and identified from the existing systems, and be delivered in a way that can be used; ISA standards like S95.01 can be utilized to assist. There are challenges within an organization, but broken down into manageable pieces, all of this can be handled.

Closure

The implementation, as an Engineering Management or Operations Management method, of a Capabilities Lifecycle approach, will assist organizations in tying together the variety of demands facing them. With the approach in place, the organization can be free to manage other improvement initiatives including Lean or Six Sigma. The end result for the organization is sustainable economic progress, due to continual development of products, processes and capabilities.

References and Endnotes

[1] Diana Mekelburg, "Sustaining Best Practices: How Real-World Software Organizations Improve Quality Processes," *Software Quality Professional* (2005), vol. 7, No. 3, pp. 4- 13.

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[3] Sarah Jane Gilbert, "The Accidental Innovator: Q&A with Robert D. Austin", *Harvard Business School – Working Knowledge (Web Page: hbswk.hbs.edu/item/5441.html)*, Published July 5, 2006.

[4] Malcom Gladwell, *The Tipping Point* (New York: Little, Brown and Company, 2002).

[5] Geoffrey Moore, *Crossing the Chasm* (New York: HarperCollins, 1991) pp 9 – 14. Reference through Gladwell and other professional experience.

[6] David Allen, *Getting Things Done* (New York: Penguin Group, 2003)