AN ANALYSIS OF INVENTORY REDUCTION PROGRAMS:
THE ROLE OF TECHNOLOGY, INFRASTRUCTURE AND CULTURE AS CHANGE AGENTS

Richard E. Crandall, CIS Department, Raley Hall, Appalachian State University, Boone, NC 28608
William "Rick" Crandall, School of Business Administration, University of North Carolina – Pembroke
Pembroke, NC 28372

ABSTRACT

Most business writers, both scholarly and practitioner, endorse efforts to reduce inventory or, better yet, eliminate it altogether. Businesses are ambivalent on this topic. They certainly want enough inventory so that shortages do not occur, but not so much as to raise holding costs. Accountants call inventory an asset; practitioners call it a liability. Consumers want variety but then complain because the choices become overwhelming. Marketing clamors for more; accountants demand less; and production managers just want long runs of whatever they make. Resolution of these disparate positions requires a careful blending of technology implementation, infrastructure adjustment and culture change.

INTRODUCTION

This article is about an endangered species – inventory. Most business writers, both scholarly and practitioner, make calls to reduce inventory or, better yet, eliminate it altogether. Businesses are ambivalent on this topic. They certainly want enough inventory so shortages do not occur, but not so much to raise holding costs. Accountants call inventory an asset; practitioners call it a liability. Consumers want variety but then complain because the choices become overwhelming. Marketing clamors for more; accountants demand less; and production managers just want long runs of whatever they make. Everyone has an opinion; yet nobody has a universal solution to the many facets of inventory management.

Efforts to reduce or eliminate physical inventories focus on three areas. The first focus area is the use of conventional programs to reduce the inventories used in making finished products for sale to consumers. The second is the implementation of programs to reduce indirect materials or supplies. The third area, and perhaps most revolutionary, is the conversion of physical goods to electronic formats. We will provide examples for each of the three s, identify their benefits, pose obstacles to their implementation, and offer observations about the change agents needed to achieve inventory reductions.

We are particularly interested in exploring the roles of technology, infrastructure and culture as change agents in these programs.

PHYSICAL INVENTORY REDUCTION

A number of programs focus on reducing the amount of inventory necessary to sustain the flow of goods from the producer to the consumer. These programs do not necessarily change the form of the inventory but they do reduce it. Trade publications promote and scholarly journals analyze in these areas. Some of them reside under the umbrellas of well-known improvement programs such as Lean manufacturing, supply chain management, or Six Sigma. Table 1 contains examples of these types of inventory reduction programs.

Table 1. Direct Reduction to Inventories. Programs that Cause a Reduction in Product Inventories

Transformation	Benefits	Obstacles
MTS to ATO to MTO	Reduced inventories	Increased response times
Physical inventory to cycle count	Accurate inventories	Increased analysis
Accurate perpetual records	Accountability	System maintenance
QRS to ECR to CPFR	Reduced inventory variation	Building relationships
Trace materials flow	Accountability	System cost
Product design – DFM,DFD	Reduced component variety	Design time; coordination
Mass production to mass customization	Increased customer satisfaction	Designing system
One big to many small facilities	Increased customer service	Investment cost
Reverse logistics	Improved product design	Added process complexity
Real to virtual inventory	Reduced inventories	System complexity
Flexible capacity	Smaller lots	Changeover and setup times
Inspection to process control	Reduced defects	Process variability
Shipping containers	Reduced theft	Coordinated system
Standardization	Reduced components	Coordinated system
Quality – TQM or SS	Reduced excess inventory	Program implementation

The main advantage of these types of inventory reduction programs is the reduction in inventory carrying costs. Indirectly, a program designed to reduce defects will lead to improved quality. A program designed to reduce response times and its corresponding in-transit inventory will improve customer service by more closely matching the items available to the items demanded.

The obstacles are in the need to design and implement programs that can achieve the inventory reduction without sacrificing customer service. It takes initial investment costs, initiative and persistence to achieve success with the programs listed in Table 1.

NON-PRODUCT INVENTORY REDUCTION

While product-related inventories represent a large portion of inventory dollars and administrative effort, there is a multitude of non-product inventories. Often, these inventories are included in overhead expense categories such as indirect materials or supplies. As a result, they may not get the attention they deserve.

However, there are expense inventories that are being addressed more closely these days, such as fuels and packing materials. As with product inventories, the form of the inventory does not change; however, the amount of inventory does. Table 2 contains examples of these types of inventory reduction programs.

Table 2. Indirect Reduction – A Reduction in Indirect Materials or Supplies.

Transformation	Benefits	Obstacles
Trace vehicle performance	Reduced fuel consumption	Investment cost
Videoconferencing	Reduced fuel consumption	Gaining acceptance
Virtual reality – travel	Reduced fuel consumption	Gaining acceptance
Environmental control – facilities	Reduced power consumption	Investment cost
Shipping containers	Reduced packing materials	Integrated system
E-commerce, B2B, EDI, IOS	Reduced forms and paper	Initial setup and cost
Outsourcing food service	Reduced food, equipment	Loss of convenience
Outsourcing deliveries	Reduced trucks and fuel	Loss of convenience
Make right turns in driving	Reduced fuel consumption	Retraining drivers
Remote medical diagnosis	Reduced fuel consumption	Initial setup and training
Reverse logistics	Reduced packaging	System design

The advantages of indirect inventory reduction are reduced costs and, to an increasing degree, a reduction in environmental pollution. Reducing fuel consumption is not only good business sense but also beneficial for the environment. For example, reduced packaging requirements limit the need for more, and larger, landfills.

The disadvantages are the need to set up a system for a type of inventory that is not usually the focal point of a company. These expense items receive the attention that product inventories do.

FROM PHYSICAL TO ELECTRONIC

The most extreme form of inventory reduction is to reduce a physical, three-dimensional product to an electronic format. The primary application is in the inventory of information. This format reduces the amount of space required for storage – multiple books can be stored on a DVD or flash drive. It also reduces the risk of damage or theft, assuming the electronic storage is adequately handled. It reduces the cost and time of transporting the information. Table 3 contains examples of this type of inventory reduction. Chris Anderson in his book *The Long Tail* (2006) provides a number of examples of this movement.

Table 3. Direct Substitution – Progression from Large Physical to Small Physical to Electronic

Transformation	Benefits	Obstacles
Cash to checks to EFT	Cost savings	Consumer acceptance
Day-Timer to PDF	Portability	Marginal; setup effort
Books to electronic	Cost + The Long Tail	Requires new way to read
Letters to e-mail	Time	Depersonalization
Patient files to electronic files	Retrieval time	Front-end setup; privacy concerns
Product drawings to CAD files	Preparation and storage costs	Conversion of existing files
Cameras – film to electronic	Per shot cost	Investment cost
Clay models to simulations	Increased versatility	Reduced demonstratability
Actual to simulated testing	Cost; increased testing	Gaining acceptance
Training manuals to LCD display	Availability; quality	Front-end setup
Doctor's office to patient's neck	Availability; consistency	Front-end setup
Easels to flash drives	Appearance; convenience	Projector availability
Cart to catalog to store to web	Convenience	Investment; acceptability
Metal license plate to sticker	Per vehicle cost	System design
78s to downloads	Portability; cost	Intellectual property rights
US Postal Service to EDI	Cost; speed	Infrastructure
Long forms to e-tax returns	Convenience; accuracy	Consumer acceptance

The advantages of this type of transition are in reduced costs and added convenience. It is much easier to research a topic by using ProQuest than it was to go to the library and hunt through volumes of reference publications, some of which were not available, in physical format.

The disadvantages rest primarily in the initial design and implementation of the system to make the conversion. In addition, some users are reluctant to make the change. Do any of you still go to a doctor or dentist with a wall full of patient records?

TANGIBLE BENEFITS

We have pointed out that inventory reduction results in lower purchase costs and lower inventory carrying costs. Programs to reduce inventories, such as JIT or Lean manufacturing, carry with it the requirement that the processes must change to improve product quality.

In addition to reducing direct costs, inventory reduction usually carries with it a reduction in equipment and facilities requirements – less space and less capacity requirements.

INTANGIBLE BENEFITS

Programs to reduce inventories also provide intangible benefits. These benefits are not necessarily primary objectives; however, they often result as a by-product of the programs implemented to reduce inventories. We will describe several of these benefits below.

Improved Customer Service

Often, companies view reduced inventories as a trade-off with the level of customer service. They believe that reducing inventories will also reduce customer service levels. Another way to view this issue is to pose this scenario.

> If we are going to be able to reduce inventories, we must know which inventories we really need and which are excess. If we learn this, we can reduce the excess inventories and retain those we really need. If we know which inventories we really need, we can make sure we have those inventories and thereby increase the level of customer service.

Taking this approach changes the situation to a win-win game, not a zero-sum game.

Improved Customer Retention

Better customer service usually improves customer retention. Some studies indicate that increased customer retention can provide increased earnings. The premise is that it is more profitable to try to retain customers than to continually seek new customers. This approach sometimes requires a change in attitudes within the organization along with the need for sales and marketing employees to be more analytical than in the past days of seeking out new prospects. While it may be more interesting and challenging to find new customers, cultivating the current customers makes more economic sense.

Increased Knowledge Transfer

Increased knowledge is at the heart of every program listed in Tables 1-3. Without it, none of the programs would actually achieve reduced inventories. With increased knowledge, it is often possible to identify additional improvement opportunities. Customers may respond favorably to suggestions about new books that relate to books they have already purchased, a sales strategy used by Amazon.com. Analyzing product returns often leads to a new kind of product or service that business might otherwise overlook.

Increased Awareness

Closely related to increased knowledge is increased awareness. While increased knowledge may be specific, increased awareness is more general. Being more aware of customer buying habits may not always lead to a new product but it may provide insights into what future generations will purchase. Forecasting the rate of innovation acceptance is still more of an intriguing art than a refined science.

Although businesses may not know exactly when a new growth period will arrive, the concept of increased awareness helps businesses prepare for that growth surge when it does transpire.

CHANGE AGENTS

What are the change agents of a successful inventory reduction program? In a broad sense, they include technology, infrastructure and culture. Each of these terms are vague and need further clarification.

Technology

The APICS Dictionary defines technologies as the terms, concepts, philosophies, hardware, software, and other attributes used in a field, industrial sector, or business function. (Blackstone and Cox, 2005, APICS Dictionary 11E). This definition is so broad that we will have to look further.
Bessant and Francis offer this observation on technology:

> "Some technologies are 'hard', for example, cellular telephony, and railway signaling or electricity generation. However, 'soft' technologies also need to be transferred… There are significant debates about the meaning of the term 'technology'. Some, who we describe as the 'hardware school', define technology as the construction and use of machines, systems or engineering. Others, the 'socio-technologists', take a broader view and consider technology to be meaningful only when it becomes a social fact…. we adopt a socio-technological viewpoint and, simply put, we see technology as 'ways that people get complicated things done'". (Bessant and Francis 2005: pg. 96)

While technology is ambiguous, it is essential for the success of improvement programs.

Infrastructure

The term infrastructure may be even vaguer than technology. It is often associated with roads, bridges, and other public programs. It is also used in the military to designate support organizations such as parts depots and replenishment supply chains. We will consider infrastructure to be the inanimate guidelines of how things should be done. It includes the mission of a company outlining goals and programs, the organizational structure, policies, procedures and plans. The infrastructure of a business provides the framework within which technology helps employees get things done.

Culture

Culture, or the belief systems inherent in the organization, is another vague, but important, ingredient of successful inventory reduction programs. It includes the human side of the business and the vision of the company that sets out a philosophical approach to running the business as contrasted to the mission that portrays the tangible objectives of the business. The culture also includes the image of the company as perceived by persons within the company and those outside the company, whether customers or other types of stakeholders. Corporate cultures are formed by the history of the company – how it has operated over its lifetime, by the management styles of key executives and, most importantly, by the employees and their collective way of acting.

ATTRIBUTES OF THE CHANGE AGENTS

The change agents of technology, infrastructure and culture can assume a number of different roles during the implementation of an inventory reduction program. Ideally, they will work together in a coordinated

fashion for best results. Their roles, which we introduce as representative, can include any of the following and often more than one during the lifetime of an inventory reduction program.

Barrier. In this role, the change agents act to block any additional progress in the program's implementation. The program may reach the point where improved technology is required before continuing – for example, the need for lower prices on RFID tags. Infrastructure can be a barrier if there is a need for an agreement on profit sharing between two entities. A union contract can also be a barrier if proposed changes in inventory reduction can have an impact on the job security of the existing employees.

Restrictor. In this role, the change agents "drag their feet" in the improvement program. The EDI system works but has intermittent problems. The organization structure retains its vertical orientation and slows the need for horizontal communications. The employees are not able to spend enough time on the new program, either because of other required duties or because of reluctance to "buy in" to the new program.

Participant. All of the change agents are moving along rather well. The reverse logistics process is working with only minor hitches that can be resolved on a day-to-day basis. The policies and procedures align sufficiently to avoid conflict among internal and external entities. The differences between the "way we have always done it" and "this is the new way" have been reconciled so that the employees are able to do their jobs without undue interference.

Enabler. In this role, the change agents participate in a "more than expected" manner. On the technology side, the sales and operations planning system is providing benefits to both the demand and supply sides of the business. The matrix organization structure is enabling employees to work on the program without leaving a major gap in their regular assignments. As an enabler, the employees are compensating for the deficiencies in the IT system or the organization structure.

Driver. In this role, a change agent is the leading force in moving the improvement program along, often in spite of other parties being in a restrictor or barrier role. The automated point-of-sale system offers so many benefits that it creates tremendous pressure on the infrastructure or the culture to "get with it." When the infrastructure assumes this role, it means that the conditions have been arranged so that the technology (when it is done) and the culture (when they buy in) will move without interference. The culture can act as a driver when there is a consensus among the employees to "do it."

PHASES IN INVENTORY REDUCTION PROGRAMS

Continuous improvement programs, such as an inventory reduction program, pass through several phases in its journey to success. For a more comprehensive discussion of program life cycles, see Abrahmason (1999) and Crandall and Crandall (2006). For this paper, we will consider those phases to be:

- Discovery
- Design
- Implementation
- Adaptation
- Assimilation
- Consolidation

Discovery. This phase marks the beginning stage of the inventory reduction program. It is the equivalent of the birth stage in the product life cycle. The discovery process can result from either of two situations. The company finds it "must" do something or fall into financial difficulties, or it "can" do something because of a new idea that they have discovered. In the first scenario, the company is aware that

inventory problems impact the bottom line. In the second scenario, an inventory reduction may look attractive because other successful companies are implementing it in their organizations. At any rate, the threat or opportunity ranks high enough in management to get their attention.

Design. Once there is a decision to do something, a task force takes on the job of designing the program. At this stage, they consider the available technology (high level of emphasis), the changes needed in the infrastructure (some consideration), and the possibilities of culture change (often only a brief look and a "we'll get back to that"). Ironically, often the culture stage can make or break the success of a program. Firm resistance can cause programs to derail, even if there is some apparent good in the program implementation. Consequently, any program introduction should include a subsequent intervention in changing the culture of the organization. Often, it is a matter of reminding employees that change is necessary, even though it may be painful in the short-run.

Implementation. At this stage, the fanfare and expectations of the program may begin to wane as the reality of the hard work ahead settles into the minds of organizational members. Nonetheless, management should gear itself for this loss of enthusiasm, and expect it as a normal part of the change process. Changing the culture of the organization so that employees will be more future oriented is necessary.

Adaptation. In this phase, it may become necessary to make mid-course adaptations of the inventory reduction program to the specific needs of the organization. Such changes may not have been anticipated originally, but now, must be considered if the program is to succeed. Again, affected employees need to be reminded that such mid-course changes are a normal and necessary phase of the implementation process.

Assimilation. Most programs will have a finite life. At some point, the elements of the program that succeeded will be assimilated into the normal way of conducting business. When a program reaches this stage, most of the rough edges have been smoothed and everyone involved appreciates its benefits and limitations.

Consolidation. After the main elements of a program are assimilated into the normal operations of a business, there is a need for a period in which the company operates in a stable and effective way. However, such periods of equilibrium are usually only temporary. In fact, with all of the change that organizations must endure, the normal course of events is to see organizations move in and out of equilibrium. Some note that organizations seeking to operate at a comfortable equilibrium may actually be in danger of failing in the long run (Pascale, 1999; Singh & Singh, 2002). Ready or not, managers and employees must begin to prepare for the next new idea.

ALIGNMENT OF CHANGE AGENTS

Change agents can play several roles. Improvement programs go through several stages. What roles do change agents' play during these program phases? This is at the heart of our research. At this point, we propose a possible scenario such as shown in Figure 1. We hope to validate, or refute, these propositions during our future research.

Proposition 1. Technology is the driver of most improvement programs. It initiates the idea, enables the program to be implemented, becomes a restrictor as the need for modified or improved technology becomes necessary, and finally becomes a participant at the end of the program's life.

Proposition 2. Infrastructure is rarely a driver of change. It is somewhat of a restrictor in the early program stages, becomes a participant early and perhaps even an enabler when it gets ahead of the program needs, then settles back into a comfortable role as participant at the end of the program.

Proposition 3. The culture is usually a barrier, or at least a restrictor, in the early stages of an improvement program. People are the heart of a company's culture and people resist change. Over time, the people can adapt, the culture can change and become a participant in the program. In fact, under good conditions, the culture may play a key role in assimilating the improvement program into the normal practices of the business.

Proposition 4. A continuous improvement program will have only limited success until all of the change agents are aligned as participants in the implementation process.

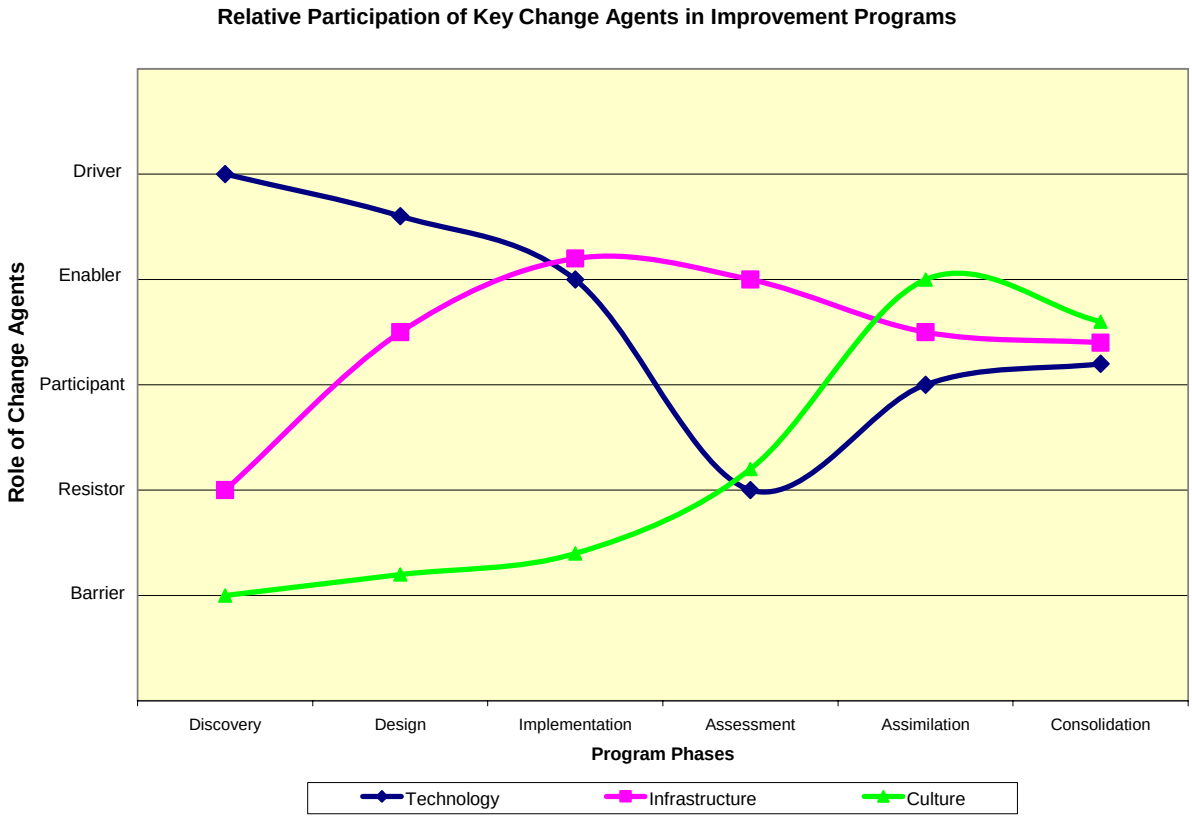

Figure 1. Alignment of Change Agents

CONCLUSION

Most companies find they need to have a successful inventory reduction program, either because they have to or because they are able to. For the program to achieve their objectives, the company must align their principal change agents of technology, infrastructure and culture.

References

1. Abrahmason, E., & G. Fairchild, (1999). Management fashion: Lifecycles, triggers, and collective learning processes. *Administrative Science Quarterly*, 44, 708-740.

2. Anderson, Chris, *The Long Tail: Why the Future of Business is Selling Less of More*, Hyperion, New York, 2006.

3. Bessant, J. and Francis, D., (2005), Transferring soft technologies: exploring adaptive theory, *The International Journal of Technology Management & Sustainable Development*, 4, (2), 93-112.

4. Blackstone, J. H., Jr. and Cox, James F., APICS Dictionary 11E, APICS, Alexandria, VA, 2005.

5. Crandall, William "Rick", Richard E. Crandall and Mohammad Ashraf, (2006). The perilous world of management fashion: An examination of their life cycles and the problem of scholarly lags. *Academy of Management Proceedings*, Atlanta, GA.

6. Pascale, R. (1999). Surfing the edge of chaos. *Sloan Management Review*, 40(3), 83-94.

7. Singh, H., & A. Singh, (2002). Principles of complexity and chaos theory in project execution: A new approach to management. *Cost Engineering*, 44(12), 23-33.