INDUSRY VISIONARIES

Whitepaper of Invensys Operations Management

Profitability-Based Operations Excellence

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Background

Attaining operations excellence has been a primary objective of leading industrial companies for decades. As with so many slogans in use today, most industrial professionals would not definitively identify an operationally excellent organization if they saw one. The reason is that "operations excellence" is not very well defined. Although most industrial companies strive to operations excellence, they find it to be very illusive.

Perhaps the best way to consider the true meaning of operations excellence is to establish the results that could be expected from an operationally excellent company. Many industrial professionals have suggested that a truly operationally excellent company can be determined by its high levels of operational efficiency. Although this certainly is reasonable, it may not go quite far enough, and it is difficult to establish a consistent measure of efficiency across various industrial operations. The reason most industrial operations exist is to create production value for their companies. The ultimate measure of production value is profitability. Profitability is fairly easy to measure and certainly reflective of healthy industrial operations. With this in mind, a strong and measurable working definition of operations excellence might be maximizing the profitability of an industrial operation through superior efficiency. This definition is simple, measurable and aligns with the primary objective of most industrial organizations and, as we will see, in today's technological industrial environment, it is also attainable.

A Traditional Operations Excellence Perspective

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Much of the research associated with operations excellence utilizes the classic three level model of Figure 1 to explain the scope of functionality involved in developing an operations excellence strategy. The genesis of this model is based on how industrial companies deployed automation based systems to help automate business functions under the guidance of the Information Technology departments. Over the decades the software of these systems evolved to today's Enterprise Resource Planning systems. On the plant floor automations technology, followed by computer-based automation systems, evolved into the control systems of today. Although the initial technologies used in automating business systems and plant floor systems were very different and distinct, with the advent of computer-based technologies, the IT and plant floor systems started to converge technologically. As computers were utilized for both IT and plant floor functionality, it became apparent that there were a number of desired functions that were not provided by either the business or the plant automation systems. A number of small software companies started to emerge providing software designed to perform these functions. The collection of software offerings comprising this middle layer became known as manufacturing execution systems, although there was not much about them that resembled a coordinated system. In fact, the software packages at the middle layer resembled confetti more than they resembled a system.

Figure 1
Enterprise Management Architectural Model

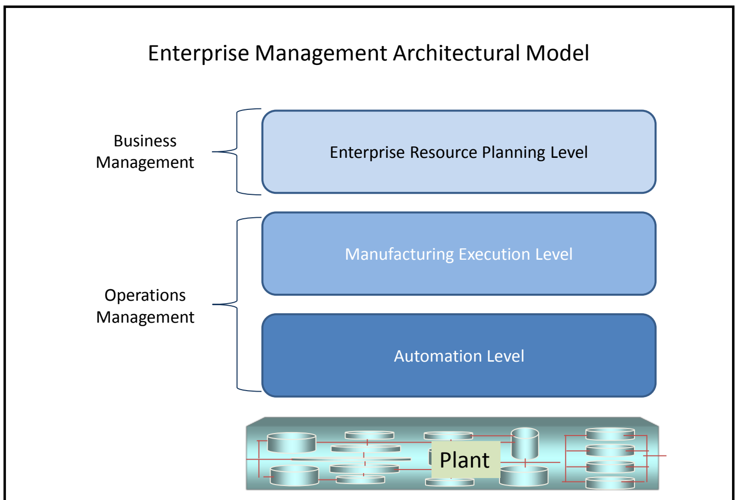


Figure 1

None-the-less these three layers of functionality emerged. Initially they were implemented as independent layers of functionality. This independence was perceived to be a weakness in moving to an efficiently run operation. Therefore, one of the initial aspects of operations excellence was developing technology and approaches to make these three levels of functionality interoperate more effectively. Considerable expense and effort was invested over the past two decades in developing interoperability, and interoperability standards between these three levels of functionality. Although almost nobody would argue that such interoperability does not add value, where interoperability has been achieved, the value has not been very evident. that interoperability by itself does not solve any business or operations problem. It merely overcomes technological barriers. Perhaps the time has come to reframe operations excellence from a business value perspective rather than technological interoperability.

Controlling Plant Efficiency

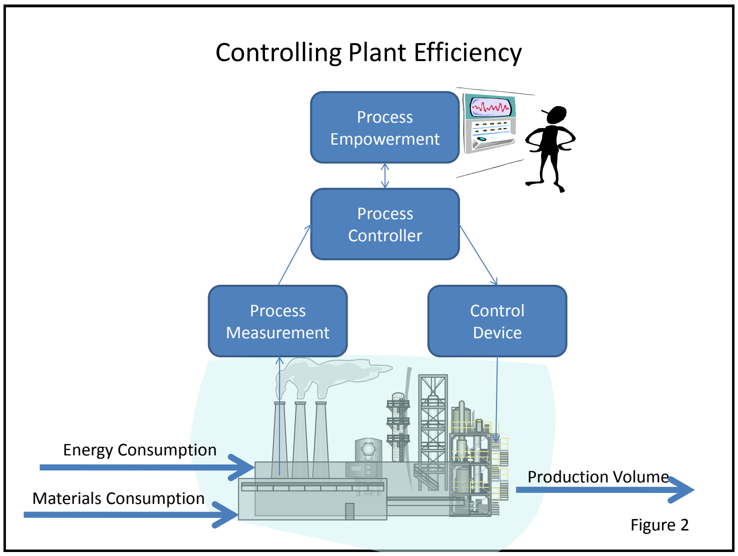
Controlling Plant Efficiency

One aspect of operations excellence that has been effectively implemented over the years is that of controlling plant efficiency. Considerable research and intellectual property investments have been made that have truly improved the state-of-the-art in plant efficiency over the last 50 years. Most of the important innovations have been developed within the basic framework of control theory. Control theory is a fundamental scientific discipline associated with how variables in the natural world can be controlled to predetermined desired values. Control theory permeates human activities within the natural world. Humans learn, teach, engineer, experiment, interact, persuade, debate, argue and innovate using control theory. The fundamental concept behind control theory is that if you can measure and convey the current value of a variable that can be modified, then you can take action to drive a change in the variable in the desired direction.

After a series of such actions the variable should be closer to the desired value than it had been. For example, a baby lying in a crib may want to reach out and touch a rattle hanging above them. The first time they reach they may miss, but the visual measurement taken by their eyes provides a measure of how close they may have been. They adjust their reach and try again. This is called feedback control. They may not hit the rattle the second time either, but will most likely be closer. After a number of tries the baby will hit the rattle. At that point they will somehow register the learning as some kind of model in their brain and will most likely be able to hit the rattle with far fewer tries the next time.

This is a classic example of feedback control theory in action. Feedback control is the most common type of control utilized in industrial operations. Figure 2 displays the basic elements of an industrial feedback control system. The first element is the industrial process to be controlled. This could be a simple process, such as a flow, level, temperature of pressure process, or it could be a more complex process unit often defined by a transformation of energy and materials into some desired product of intermediate. The second element is a device to measure the characteristic of the process to be controlled. The third element is a controller that will determine the direction and amount of change required to be made to the fourth element, which is a device to manipulate the process, such as a valve or variable speed pump. Process operators often oversee the performance of multiple control loops through a process empowerment approach realized through faceplates of CRT screens.

Figure 2
Controlling Plant Efficiency

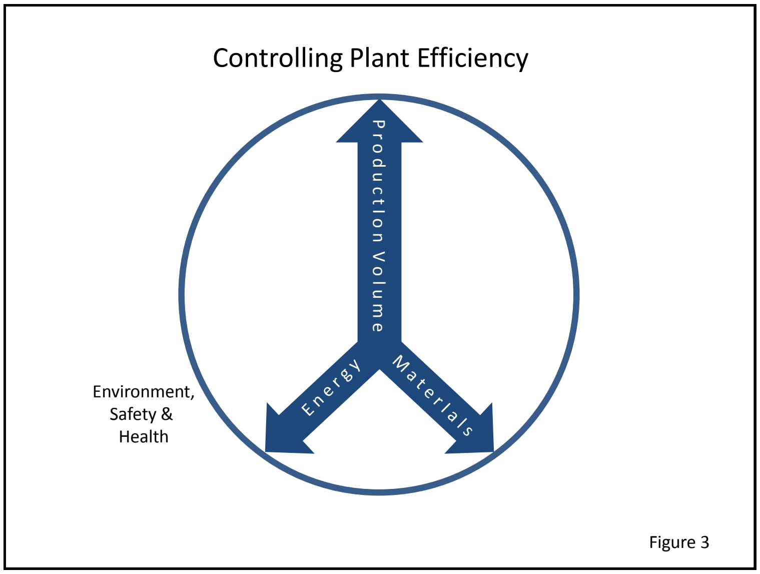


The basic concepts behind industrial control have been consistent for decades, but the technology for realizing high levels of control has continually improved. In the early phases of the industrial revolution, human operators performed the task of the process controllers. Gauges were inserted into the processes that would measure the variable of interest (flow, level, temperature, pressure, speed, etc.). The faceplate of the gauge might be a circular dial with a needle that would convey the value of the measurement to the operator and often let the operator know where the measurement should be by having a green sector on the faceplate in the desired area. The operator would evaluate where the needle was relative to the green sector and turn a hand valve in the direction that would cause the variable to move in the desired direction. Initially hundreds of operators would control thousands of control variables in this manner resulting in a pretty good level of operational efficiency. In its day these manual control systems may have been seen as the state-of-the-art of operational excellence.

Over time, as the cost of human labor increased, manual control schemes were replaced by automatic controllers. These automatic controllers evolved from pneumatic, to electronic analog, and finally to digital electronic, but in any case they perform the basic feedback control, functions quite well. Fewer operators were required as industrial operations transitioned to automatic control and the role of the operator changed significantly from that of a direct controller of process variables to an overall coordinator of major sections of plants. In this new role, operators developed a level of experiential learning of how the plant works greater than was ever previously available. Unfortunately, for the most part, even with this new level of knowledge the operators continued to be viewed as laborers and as a result, their domains of responsibility and authority were severely limited by management and engineering.

None-the-less, most plants focused on managing the efficiency of the plants, and the plant operators were charged with this task with support from engineering. Automatic control technologies improved over the years, with model-based control approaches proving to offer better control, and requiring a much higher level of expertise. Controlling efficiency involved material consumption within the constraints of safety and environmental concerns (Figure 3).

Figure 3
Controlling Plant Efficiency



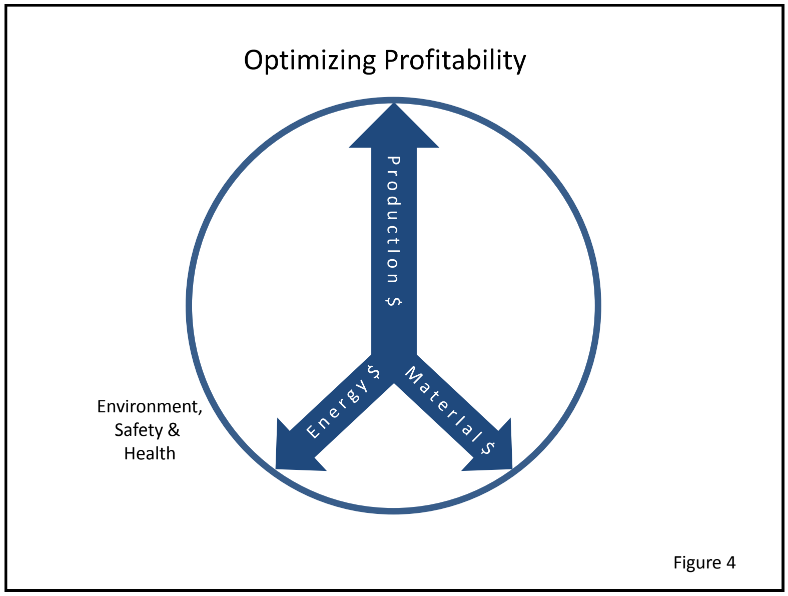
Efficiency and Profitability

Efficiency and Profitability

Industrial companies are in business to produce a profit. Traditionally maximizing the efficiency primary business variables impacting the performance of plants were essentially constants over prolonged time periods. For example, a decade ago it was not unusual for industrial plants to have contracts with their power suppliers that relegated the price they were paying for electricity to a constant value for as long as a year. With a constant energy price, the component of profitability associated with energy could be controlled by controlling the consumption of energy in the plant. The same is true for materials and products produced. The variability of the key business variables was so small that controlling plant efficiency would control plant profitability. This all started to shift with the opening of the power grids throughout the world. As the competition on the power grids became more intense the volatility of the price of power increased. Today in many parts of the world it is not unusual for the price of electricity to change forty eight times daily. As the price of electricity became more volatile it had a domino effect on energy intensive materials as well as the products the plants produced. In a matter of five years the primary business variables impacting industrial profitability transitioned from constants over extended periods of time to real time variability.

Today, although industrial operations still strive to control efficiency, controlling efficiency is not good enough for insuring maximum profitability. For example, plant operators may actually work to minimize the overall consumption of energy over a day, but may consume more energy in higher price periods than in lower price periods resulting in an increase in the overall price of energy to the plant. The same may be true for materials and production. Therefore, controlling profitability in industrial plants requires that the efficiency of the plant is well controlled, but also that the critical business variables that may have real time volatility are also well controlled. Those critical real time business variables are production value, energy cost and material costs, and like similar to the efficiency variables they are also constrained by safety and environmental concerns (Figure 4). Optimizing the profitability of an industrial plant involves the effective balancing of the three real time profitability variables of production value, energy costs, and material costs, with the two real time constraint variables of environment and safety.

Figure 4
Optimizing Profitability



Controlling Plant Profitability

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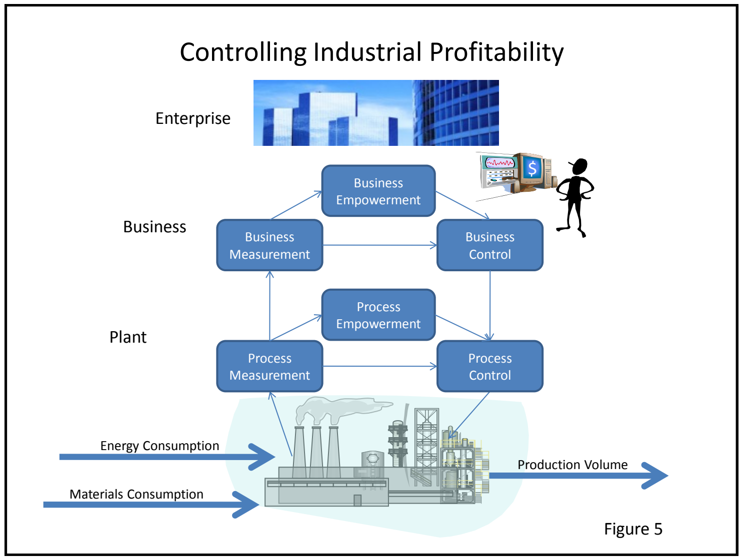
New approaches are required in this real time industrial environment to bring the profitability of industrial operations under control. Controlling the efficiency of plants is absolutely necessary, but not sufficient for controlling profitability any more. The good news is that the expertise and capabilities professionals in the industrial community have developed over the past century, the effective control of process variables, can be expanded upon for the control of business variables (Figure 5). Control theory works off of fundamentally simple concepts. First the variables to be controlled must be measured in a time frame equivalent to their variability characteristics. In the case of the critical real time business variables, the time frame must be in real time. Second, the measurements must be passed to a controlling mechanism which will determine if they are at the desired value and, if not, adjust a control device to bring them back toward the desired value. In the early industrial revolution people served the function of controllers. Today, with the real time business variables, it makes sense for people to serve this function as well, at least until an understanding of the dynamics of the business variables is well enough understood to develop general purpose business automatic controllers. The good news is that the plant operators who have developed significant experiential knowledge of the operations of the manufacturing processes are the ideal candidates for controlling the business variables given effective visualization tools. Operators are used to dealing with real time variability, have a broad perspective of the experiential operations of the plants, and have proven capability to learn from experiential data. For variables that vary too quickly for effective human response, a custom designed automatic controller can be developed either through modeling techniques for real time workflow triggers.

Figure 5
Controlling Industrial Profitability



Controlling the profitability of industrial plants involves developing a cascade control system in which the outputs of the business controllers are cascaded to the set points of the process controllers. In the case of the manual business control systems through empowered operators, the operators can view real time performance information for each critical business variable in a simple prioritized and contextualized dashboard. This will enable the operators to perform their normal functions with an understanding of the business impact of each action. For example, operators have been changing process set points for many years, but without any understanding of how the new set points impact the profitability of the operation. With the performance dashboards, as soon as they change a set point they can watch how the performance of the operation as it changes. Over time they earn how to operate the plant to maximize profitability.

Profitability Based Operations Excellence

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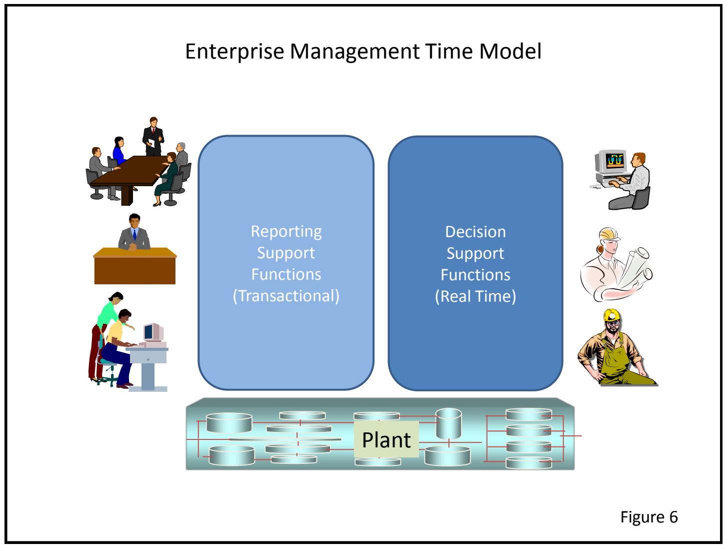
With all of this in mind it is time that industry changes its perspective of operations excellence to that of profitability based operations excellence. It makes no sense for any operations excellence approach to have any other primary objective than maximizing profitability. The idea of merely interconnecting the various system and software components along the traditional three layers of the industrial architectural model (Figure 1) is simply archaic and not effective, unless, by providing the interconnection, a company is actually executing real time profitability control. It is a shame how many operations excellence initiatives have not resulted in the improved profitability that they could or should have. As an industry we seem to have become so intrigued about making technology interoperate that we have overlooked the fundamental objectives and goals that the technology was supposed to support.

One of the myths associated with the traditional three layer architectural model that has to be put aside is that of the role and position of the real time automation systems versus the transactional business systems. The implication is that all real time functions should operate in the plant environment and that all functions at the business level could be transactional. This may have been close to the case before the critical real time business variables started to transition to real time variability, although I believe that even then it was a gross over simplification. But today's operationally excellent companies have to recognize that there are real time information requirements for effective decision support at all levels of industrial organizations, just as there are reporting functions that require transactional information at all levels (Figure 6).

Figure 6
Enterprise Management Time Model



The artificial concepts introduced to industrial systems through the three level architectural model have to be put behind us, and a new perspective needs to be adopted to move forward to true profitability based operations excellence. Operators on the plant floor require transactional reports to summarize various aspects of the operations, and executives, right up to the CEO and perhaps even the Board of Directors, may benefit and become more effective if they get information critical to the operations of their business in real time. The result will be better and timelier decisions, better reporting, and better results to report.

Conclusion

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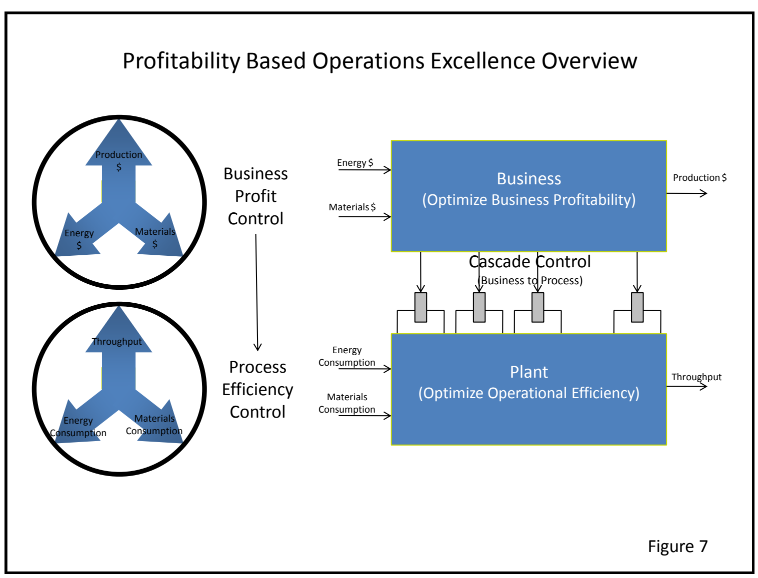
Operations excellence is a noble objective for any industrial organization. But it will be ineffective if the net result of driving towards operations excellence is not a significant improvement in the profitability of the operation. Traditional approaches to operations excellence that involve the mere interconnection of systems and software from the plant floor through the enterprise have proven to be largely ineffective. They are overly technology focused and not enough business focused. Industry must converge on a new definition for operations excellence based on maximizing the profitability of the operation in real time. The recent transition of business variables from highly transactional to real time variability necessitates a new and different approach – profitability based operations excellence (Figure 7).

Figure 7
Profitability Based Operations Excellence Overview



The challenges associated with profitability-based operations excellence may, at first look, appear to be daunting and unattainable. But a closer analysis shows that many of the skills and talents developed in industrial operations over the past century are exactly the talents required to meet this challenge. The high volatility of business variables merely presents a new control challenge – a business control challenge. Industrial operations have been built on control theory and control theory is well understood across the industry. Applying control theory to this new profitability control problem requires an evolutionary increase in the skills and talents which have been developing across the industry for years. Profitability based operations excellence is no longer a wish – it is reality!

About the author

Dr. Peter G. Martin has been a member of the MC&A Hall of Fame since 2018. He is VP of Innovation and Marketing and an Edison Master at Schneider Electric. He has worked in industrial automation for over 40 years in training, engineering, product planning, marketing, and strategic planning. Peter holds multiple patents for dynamic performance measures; real-time activity-based costing; closed-loop business control; and asset and resource modeling. He is a published author, was named one of Fortune magazine's "Hero of U.S. Manufacturing" and one of InTech magazine's 50 most influential innovators of all time in instrumentation and controls. He is an ISA Life Achievement Award recipient, an ISA Fellow, member of the Process Automation Hall of Fame, recognized for his work in integrating financial and production measures that improve the profitability and performance of industrial process plants. Peter has a bachelor's and a master's degree in mathematics, a master's degree in administration and management, a Master of Biblical Studies degree, a doctorate in industrial engineering, and doctorates in biblical studies.