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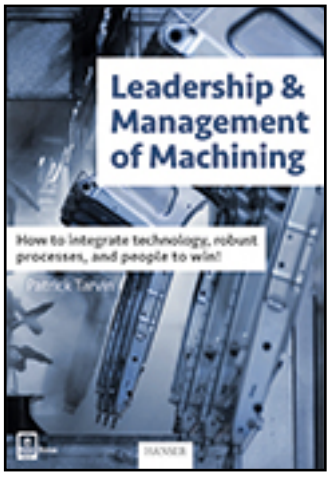

Patrick Tarvin

Leadership & Management of Machining

How to integrate technology, robust processes, and people to win!

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Dedicated to:

Donald and Patricia Tarvin
and
Nancy, Jessica, Joe, Robin, Zach

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ABOUT THE AUTHOR

With more than three decades of expertise in the business of machining, Patrick Tarvin constructs a blueprint for machining organizations of all types to achieve success and growth. He completed the machinist training program from one of the all-time great machine tool builders – Cincinnati Milacron. He financed his engineering education as a machinist and went on to earn an MBA and complete numerous Lean and Six Sigma programs. He has been a customer and supplier of machined components at both large and small organizations. He has led numerous acquisitions and turnarounds of machining facilities, and he has held every management and engineering position from machinist to plant manager. He is a machining industry expert who has proven experience integrating technology with lean processes and traditional machining fundamentals to create strong, agile, and winning organizations, a veteran of the aerospace, medical, automotive, and capital equipment industries. His exposure to nearly all types of machine processes, all levels of volume, push/pull, and five-ERP installations, provides the platform for Mr. Tarvin to bridge theoretical business practices with the real world problems faced by machining organizations in a hyper-competitive global economy. His passion is to help Western machining companies succeed and anchor a revitalized manufacturing sector based on innovation and technology.

INTRODUCTION

While some manufacturing processes simply disappear or glacially creep forward due to changing technology, machining has displayed more than a century of evolutionary and revolutionary progress. Just as manual machine tools gave way to NC machine tools, which led to CNC machine tools, the machining industry is now entering its next generation. Only this time, the technological advancements are as much outside the machine tool as within.

The intent of all technological advancements in the machining universe is to increase productivity and precision with less involvement of the endangered species known as the machinist. Connectivity, data, and digitization are providing opportunities for significant improvements in modeling, programming, simulation, machine/people productivity, and real-time decision making. Advances in chip technology and processing speeds yield more sophisticated controls. Software enhancements create advanced CAM systems, which interpret more complex models and produce higher precision programs.

This book demonstrates how to integrate these technological advancements with Lean /Six Sigma, CNC programming, quality, and machining best practices to create an agile machining organization, capable of winning against competition anywhere in the world. Technology by itself is not the answer. It is an enabler.

This book is not about cutting speeds or vibration analysis. It is about the business of machining and how to develop the infrastructure and people to provide not only profits and growth, but long-term sustainability.

Whether machining is just part of your business or “all” of your business, this book is for those at all levels of the company who must develop the machining strategy or execute the machining strategy.

While most publications are written for only executives, I have deliberately designed this publication for the entire organization. The role of everyone on the organizational chart or in the shop is discussed and reviewed. The premise of the book is that the demands of global competition on the modern machining organization are so great that success requires a foundation of leadership, people, equipment, quality, IT, robust processes, and all employees executing to yield excep-

tional quality, delivery, and profits. Since I examine the soft skills, hard skills, software, hardware, and all the business processes that winning machining organizations must integrate, I do not go a mile deep into any single topic. Other authors have created books for Lean, Six Sigma, supply chain, information technology, etc. I provide the reader with an overview of these topics and over how the varying types of machining companies should employ them to create the architecture and blueprint for high performance.

There are experts in every field that I discuss who possess extreme knowledge in their specific area of focus. There are companies, mostly large organizations with extensive resources, which already successfully apply some or many of my recommendations. Most experts ignore or minimize other functional areas of the machining organization outside of their niche. What I present is a holistic approach to real world machining problems, gained from decades of servicing the most demanding customers in multiple industries. There is no replacement for remaining in a leadership position for five-plus years at a machining facility and living through the successes and failures that result from the decisions you made. I have had this opportunity on four occasions in four different industries: capital equipment, tool and die, medical, and aerospace. Leaders hire, develop, and mentor technical teams. They lead teams that acquire and install complex equipment, processes, and software, and they answer to unhappy customers, suppliers, and employees. It is easy for consultants and academia to preach zero inventory, but when the supply chain falters, it is the plant manager who is responsible for enacting recovery plans, it is the plant manager who is responsible for fixing the problem, it is the plant manager who forces overtime, it is the plant manager on daily calls with the customer, and the plant manager is responsible for poor P&L due to expediting costs and schedule disruptions. These experiences develop the wisdom to decide when to carry inventory, whom to hire, how to develop teams, how to motivate people, when to create lean cells, how to improve CPk, how to manage a supply chain, and how to focus on customers.

Human learning, technology, and productivity have surged throughout history, as new forms of communication have been introduced: writing, printing, photography, radio, TV, and the internet. Will connectivity through the Internet of Things (IoT) and Industry 4.0 be the next catalyst? Through these mediums and with our personal experiences we all stand on the shoulders of those who came before us. I am no exception. For all those listed in my bibliography and all my peers throughout my career, who will recognize many of the topics and solutions I discuss—thank you!

If you are in the machining business, you are running two races at the same time. You are running the 100-meter sprint at this very moment to deliver to your customer this week, and you are running a marathon to develop the people, software, and processes your customers will require in the coming years. Let us get started.

1 PYRAMID

I believe that machining is the most challenging type of manufacturing process from a technical and managerial perspective. Contributing to this is a lengthy era of rapid change, constant pressure to innovate in order to reduce cost, and erratic global markets. From a technical perspective, the high number of input variables that must be controlled to produce complex geometries, precision tolerances, and flawless surface finishes exceeds the demands from other manufacturing processes. A die or mold will produce thousands and possibly millions of components with no appreciable wear. Assembly processes, by nature, have no wear and little variation other than the variation driven by the lower-level components. Conversely, during machining the cutting tools begin to wear on the first part, and there may be dozens of cutting tools on any given operation. Developing economies consistently begin with assembly, fabrication, and continuous process industries (chemical, food) because of these facts. Only later do they begin repetitive machining of high-volume components with simple geometry and open tolerances. Low-volume or batch-volume machining of medium to high complexity is still the domain of advanced economies in Western Europe, North America, and Japan. Often overlooked are the infrastructure requirements to produce critical aerospace, medical, and energy-related products. In low-cost regions, the integrity of the raw materials, heat treat, and chemical coatings is a grave concern.

Manufacturing has evolved in Western developed economies. We started with craft production, moved to the replaceable components of Eli Whitney, through the assembly lines of Henry Ford, and finally onto the Toyota Production System, and now, mass customization. Over the last two decades, machining, or more accurately, Computer Numerical Controlled (CNC) machining and its family of support technologies, have further evolved to the level that we need a new approach to management and technology implementation.

The ability to collect and share real-time data, store and retrieve mass amounts of process documentation, and advances in CAD/CAM accompanied by game-changing metrology and machine tool developments have created a data-connected factory far surpassing productivity and quality potential of past years. Gone are the

days of problems building undetected and, once detected, waiting for a team to be assigned until the problem could generate a large enough savings to justify resolving. The new model is people, equipment, and data to create robust processes on day one and the breadth of talent and detection to sustain and continuously improve processes 24/7. I call this management system for modern machining organizations the machining pyramid (see Figure 1.1).

The Machining Pyramid that I am going to discuss is a holistic approach to organizational success for a manufacturing company, with specific emphasis on machining. It is an integration of many business and technical practices combined with my 30 years of success in diverse machining facilities. Many organizations fail to achieve expected results despite management changes, consultants, lean implementation, capital investments and other initiatives. Understanding the Machining Pyramid will display the management system and infrastructure that must be in position to optimize and connect upstream and downstream machining activities.

We learned about pyramids as children. We drew pyramids, we saw them on TV and in cartoons, and most of us have made human pyramids at one time. We certainly still see them today formed by cheerleaders at basketball games. More importantly, we know that the ancient Egyptian pyramids remain well preserved and standing strong after several thousand years.

What you have never seen at the basketball game is the top cheerleader placed in position prior to all the base layers. It is highly probable that when drawing a pyramid you will draw the base layer first. It only seems to be in business that we seek to build the pyramid from the top. In manufacturing, especially machining, we need to build from the bottom and not the top. How many times has someone in your organization stated, “we need to improve our on-time shipments”, or “we need to reduce scrap”, or the ultimate construction-from-the-top-of-the-pyramid pronouncement, “we need to increase profit margins”. The simple reason that these wishes (scrap, on-time deliveries, profits) are upside-down construction is that they are not actions that any given employee or group of employees can perform. They are, in reality, percentages.

Each one is a metric with a numerator and a denominator that represents thousands of outcomes and is influenced by dozens of variables. They are, in fact, by-products of performing other tasks. They are not themselves tasks which can be performed. If you seek improved cost of quality, delivery, or profit, you must perform all the tasks better that aggregate into the numerator or denominator.

For example, profit margin for a given month is an average of the profit for each product shipped during the month. This can be hundreds or thousands of unique components, assemblies, fabrications, etc. The profit on any one item is influenced by the sale price (or for some organizations an internal transfer price) and the total

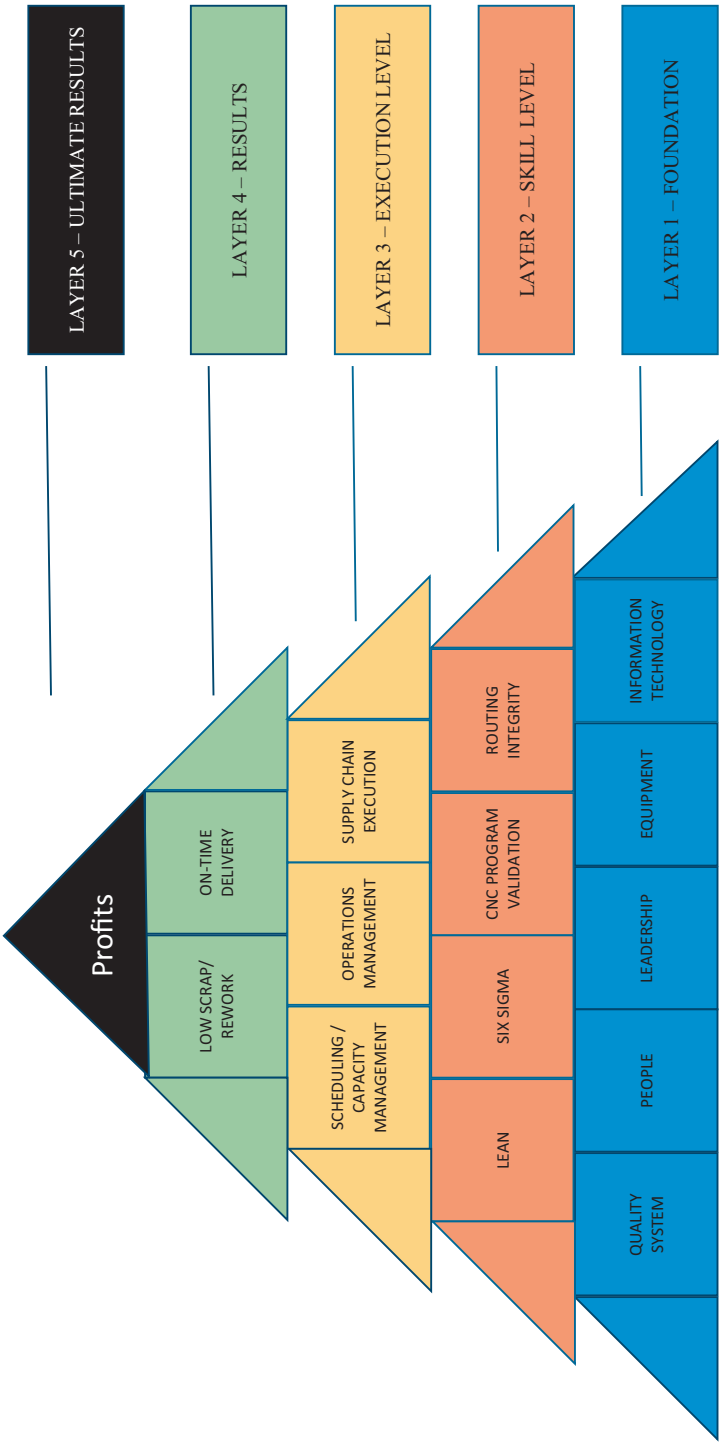
LAYER 5 – ULTIMATE RESULTS
LAYER 4 – RESULTS
LAYER 3 – EXECUTION LEVEL
LAYER 2 – SKILL LEVEL
LAYER 1 – FOUNDATION
Profits
ON-TIME DELIVERY
LOW SCRAP/ REWORK
SUPPLY CHAIN EXECUTION
OPERATIONS MANAGEMENT
SCHEDULING / CAPACITY MANAGEMENT
ROUTING INTEGRITY
CNC PROGRAM VALIDATION
SIX SIGMA
LEAN
INFORMATION TECHNOLOGY
EQUIPMENT
LEADERSHIP
PEOPLE
QUALITY SYSTEM

Figure 1.1

actual cost to produce the item. The sales price can frequently vary and is particularly subject to swings at contract shops and design/build organizations. Total actual cost will vary due to the cost of the material, expediting outside processes, any scrap or rework incurred, and the amount of direct labor at each operation. If your company shipped 100 unique items during the month, and each item required an average of six manufacturing steps (also called operations), then you performed six hundred operations during the month. Each operation was an opportunity to scrap the items or to significantly overrun the expected labor. Each operation also required some level of setup, first piece inspection, tooling changes, and possibly a handoff between shifts. You may have been successful on 575 operations, but the other 25 operations generated enough scrap/rework or additional labor to reduce the profit margin.

Let us look a little deeper at the "tasks" that have to go right to be successful on "each" of the six hundred machining operations performed each month. The machine tool needs to be available and capable of holding the tolerance on the print; the cutting tools, fixtures, and inspection devices need to be located, accurate, and set up correctly; the machinist needs to be properly trained and must not commit errors or spend excess time; the CNC program needs to be accurate and provide enough documentation for the machinist to understand how to set up holders, tooling and fixtures without creating scrap or using excess time; the parts have to be correct from each preceding operation, and in general the overall process created by your engineering or processing group needs to be lean and statistically capable of producing parts within tolerance. All this is challenging when you are machining the same or similar product each month—sometimes referred to as high volume/low mix. For organizations that are producing new components, that have varying quantities and little visibility to customer demand—sometimes called low volume/high mix—managing these tasks is extremely challenging.

As a result, to improve the profit margin you not only need to improve the underlying tasks discussed above, but the tasks must be executed on all shifts, for all operations, on new or old parts, and with experienced or new machinists.

On-time shipments and scrap/rework have completely other sets of tasks which must be executed for each operation, each shift, each day, and each month. These "tasks" are the execution level of building blocks on our Machining Pyramid.

Lean Manufacturing and Six Sigma are an important part of our Machining Pyramid. Your product mix, volume, and overall business model will determine the degree to which you can employ these tools to manage your operations. I believe there exists a separate foundation to your business that, if strong, will allow you to develop and optimize lean tools and Six Sigma tools.

So, our Machining Pyramid begins with a bottom layer that I call the foundation layer (see Figure 1.1). This consists of five strong blocks that, when properly estab-

lished, will support all organizational activities in good times and in bad times. We are building our pyramid to last for decades. We are building our pyramid to survive earthquakes, storms, and time. Our layers are not just blocks sitting on top of each other. We are building a Machining Pyramid with three-dimensional interlocking blocks. The foundation layer consists of people, equipment, information technology, quality system, and leadership.

There are many ups and downs to owning and operating any business. Manufacturing organizations encounter additional challenges. In addition to the typical economic cycle of boom and bust, the ordinary manufacturing enterprise will periodically lose a key customer, key personnel, or perhaps a key supplier. The manufacturer also periodically must reinvent their products or services, face recalls or serious quality escapes, and other man-made or natural catastrophes. Through it all, a properly instituted foundation layer will provide the strength, wisdom, depth, and breadth essential to negotiate troubles with minimal disruption and stress.

Resting above and interlocked with the foundation layer is the skill layer. These are the tools that will be employed to create processes superior to your competitors, innovative processes that yield better quality and productivity, processes that are easier to manage, simpler, and more reliable. This layer consists of CNC program validation, routing integrity, lean manufacturing, and Six Sigma. In the machining industry, it is not enough to have robust processes that are innovative. All methods and steps must be documented, controlled, and repeatable, so that months or years later the same results can be achieved without additional setup, debug, or scrap. According to the SIC data, there are more than 35,000 organizations performing machining in the U.S. alone. These companies employ diverse business models to satisfy their customer requirements and compete within their niche. I explain how to tailor lean manufacturing and Six Sigma to the various types of machining organizations: original equipment manufacturers, contract machine shops, machining job shops, and high-volume machining.

Now that our foundation layer has provided the human and material elements and the skill layer has created our robust processes, we are ready to manufacture our parts every shift, month, and year. Hence, the next layer is our execution layer. It consists of scheduling and capacity management, operations management, and the supply chain. The execution layer is where we convert the raw material into finished products.

The fourth and fifth layers of our Machining Pyramid are the result layers. If we have been successful on our lower levels, our results will yield low scrap/rework, on-time deliveries, and profits. I will review how to create appropriate metrics to drive improvement further, interpret trends and the relationship of the three result layer blocks.

There will be a chapter devoted to each building block. We will discuss why each of these building blocks is essential, examine the nuances of each, and determine how to measure and optimize for your organization.

A successful company establishes the base layer of their Machining Pyramid as the foundation for success. By executing the functions on the middle layers of the Machining Pyramid your team is positively influencing the individual data points that aggregate into success on the upper layers—low scrap, better on-time delivery, and higher profits.

There are no shortcuts to success in the competitive machining world. You may have some of the building blocks in position, but without your entire Machining Pyramid in place you will limit your growth and profits. The Machining Pyramid is an architectural structure that incorporates hierarchical requirements. A building will not stand with missing columns or missing floors. Your machining operation is the same. Good machine tools without the corresponding metrology equipment or adequate CNC programming will not perform to expectations. People and technology will be thwarted by a lack of scheduling and capacity management capabilities. You cannot be strong in some areas and weak in others—it just does not work in machining.

If our chosen profession was the restaurant industry, we could purchase a franchise and would be provided with a menu, building architecture, dining layout, kitchen equipment, advertising, daily raw-material deliveries as well as training programs, and we would have every business function planned and standardized. There are no franchises in manufacturing, but for machining organizations the Machining Pyramid provides a customizable framework that delivers as close to a franchise as feasible.

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