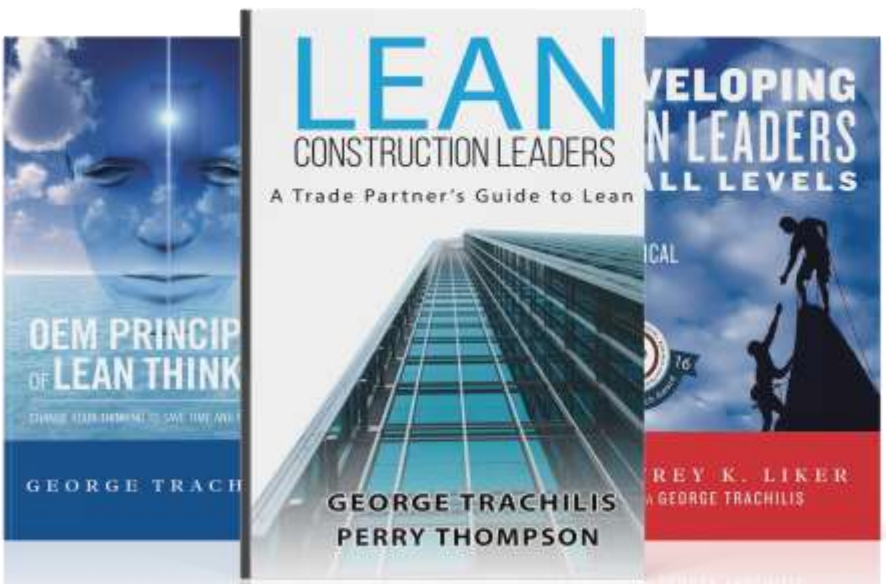
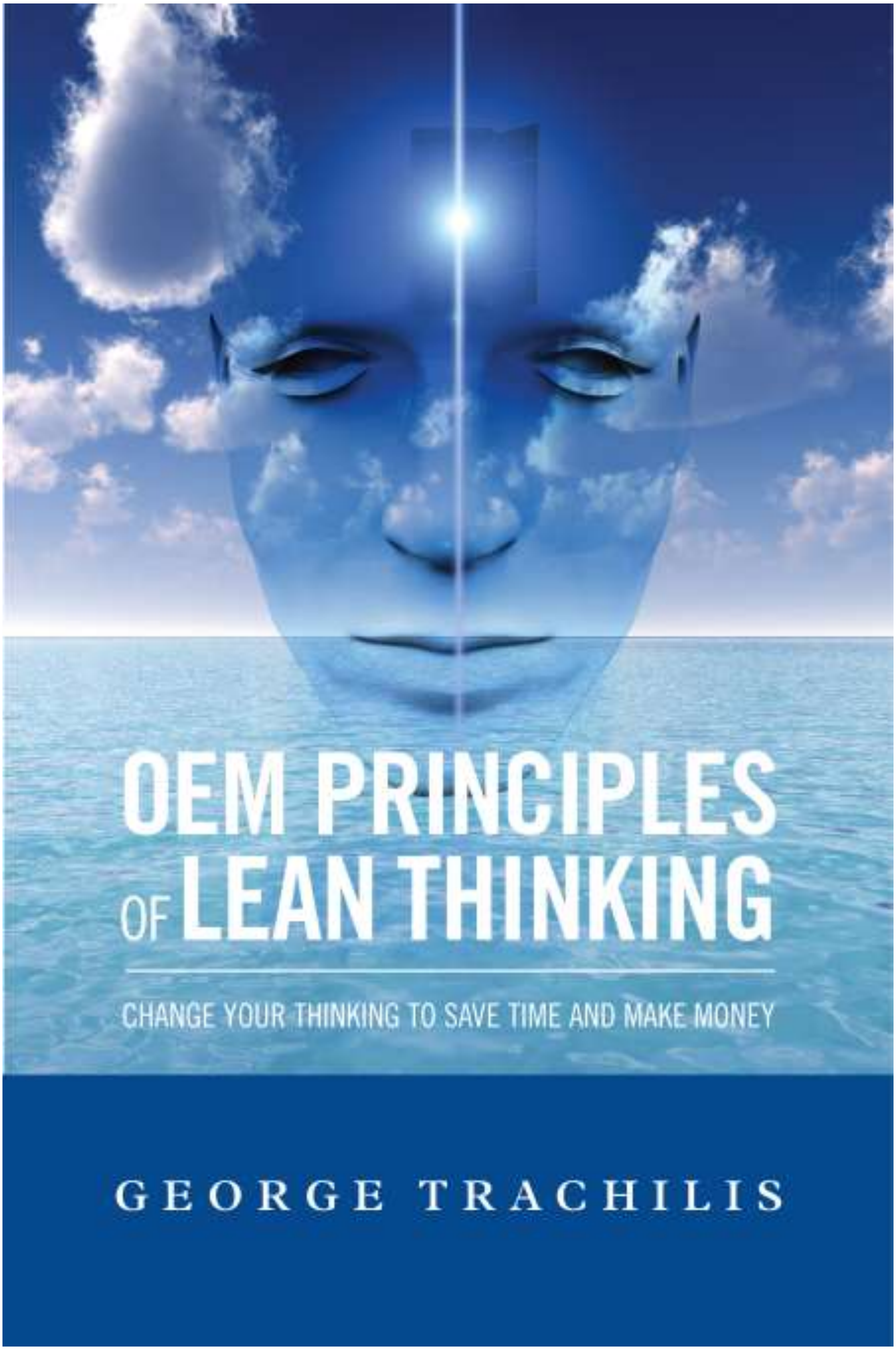

LEARN AND APPLY THESE TECHNIQUES TO MAXIMIZE PROFITS BY ADDING VALUE AND REDUCING COSTS
OEM PRINCIPLES OF LEAN THINKING
OEM PRINCIPLES
of LEAN THINKING
GEORGE TRACHILIS


LEAN
CONSTRUCTION LEADERS
A Trade Partner's Guide to Lean
GEORGE TRACHILIS
PERRY THOMPSON


OEM PRINCIPLES
OF LEAN THINKING
CHANGE YOUR THINKING TO SAVE TIME AND MAKE MONEY
GEORGE TRACHILIS

A Personal Message:

I truly hope you find inspiration from this book. For me there was such joy when I first experienced this Lean Lego Simulation. The competition was part of the allure. The learning was beyond what I expected. Finally, the education has helped me help hundreds of organizations start their Lean journey. Please take in the lessons page by page. If you are a veteran, please share this book with all that need to understand the concepts.

My latest goal is to create a follow-up to this book in an online course setting. When it is ready it will be launched from www.Lean101.ca - the home of the original from 2006.

My one mantra in all the years of striving for perfection is; Life is too short to think short term. I hope that you, too, make decisions based on the long-term benefits and place less weight on the short-term gains. Thinking long term has prompted me to be generous with everything I have. Striving to be humbler has driven me to listen much more than I speak. Finally, knowing the end is near has caused me to search for facts and truth, even in this crazy world that responds to chaos.

To share even more with you I have created a villain, *born from CHAOS*, called Mudaman. Please download posters, images and assets for free from my new website, www.CaptainLean.com .

Sincerely,

George Trachilis, P.Eng. Co-Founder, Lean Leadership Institute
Author, Publisher, Speaker, Online Course Developer and Lean Coach

Shingo Research Award Winner for Developing Lean Leaders at All Levels
OEM Principles of Lean Thinking, Lean Construction Leaders

Cell: +1-204-880-6363
george@GeorgeTrachilis.com
currently living the dream in...
Winnipeg | Canada -- Galveston | Texas -- Santorini | Greece
WEBSITES:

www.LeanLeadership.guru | www.GeorgeTrachilis.com
www.Lean101.ca | www.LeanConstructionLeaders.com
www.CaptainLean.com | www.SantoriniGeorge.com

OEM Principles of Lean Thinking

Global Principles to Save Time and Make Money

This book contains the contents of the

Principles of Lean Thinking Online Course

QR Code for http://Lean101.ca

"If you want small changes in life, work on your attitude. But if you want big and primary changes, work on your paradigm."

Stephen Covey

Lean Leadership Institute

Second Edition

ISBN-13: 978-1497333451

ISBN-10: 1497333451

Title ID: 4713803

Second Edition

Lean Leadership Institute Publications

www.LeanLeadership.guru

ACKNOWLEDGEMENTS

I would like to thank my father, Constantine Trachilis. He was my first coach, and taught me how to build, cook, and think. He died in 2002, and as I write this, making changes to the first edition, I think about how his death changed my life from that year on. I got to realizing how short life is!

The first edition of this book was created to be a companion to the Principles of Lean Thinking online course (www.Lean101.ca). This second edition is dedicated to those who have not experienced the power that becoming a *Lean Thinker* can give them.

Since 2012, I have changed my focus from the two companies I started, OEM Consultants Inc., and Global OEM Solutions Inc., in pursuit of a much higher calling. I am now the Owner, President and CEO, of Lean Leadership Institute Inc. (founded by Dr. Jeffrey K. Liker and myself). My business has a clear mission to create lean leaders at all levels. This is accomplished by providing onsite and online consulting. In recent years, 2012 -2014, I have been fortunate enough to work with some of the most influential people in the “Lean Thinking” business. To name two of these giants, Norman Bodek, known by many as the godfather of Lean, and Jeffrey K. Liker, best-selling author of the book *The Toyota Way* and inductee into the Association of Manufacturing Excellence Hall of Fame.

I acknowledge all of the Lean Leadership Institute coaches that have supported my latest business model -- developing Lean Leaders over the internet. We reach more leaders via consulting over the internet then we previously thought possible.

I thank the Alberta Government in Canada for being forward thinking enough in 2007 to support my company (OEM Consultants Inc.) in delivering the training outlined in this book to over 300 client companies in Alberta, Canada. This initial success provided OEM Consultants with an exciting new revenue source and customers from 40 countries over the internet.

Thank you to Michael Deese for creating the Airplane Simulation – a Lego workshop - that allowed employees of OEM's customers to understand Lean by running a simple simulation using plastic interlocking blocks. What an eye-opening experience! The in-class training is very enjoyable, and the learning is instinctive.

Thank you Daniel Stanley, my publisher, who put a copy of my book in my hands from the online course material. This helped me visualize what the book would look like. In turn, I am inspired to end this project.

Finally, I would like to express my thanks to all of OEM's clients (now Lean Leadership Institutes clients), because without their support and loyalty, none of this would be possible.

"The Principles of Lean Thinking Online course (www.Lean101.ca) provided PTI a simple to manage on-line educational tool critical to establishing a base to move forward. The education helped our organization learn to talk the same language, gain a basic understanding of the tools of lean manufacturing to build from and understand the importance of continuous improvement. All in all, the training provided a great base to build a production improvement system."

Robert Maze
Senior Vice President, PTI Group Inc.

PREFACE

Life is too short to think short term.

My name is George Trachilis, Founder, President, and CEO of the Lean Leadership Institute. I currently work as an executive coach with clients globally, and most recently, I have added “public speaker” to my list of talents. I like to think of myself as a Guru focusing on eliminating the Waste of Miscommunication. Let us consider this the 10th waste, shall we. This will be my contribution to the world.

In this book, I describe the Five Principles of Lean Thinking, the first of which is to focus on your customer, and define value from your customer’s perspective. I suggest in this book that the best way to help you define the value is to first describe the wasteful activities. The activities that the customer does not care about – and stop doing them. We describe nine wastes in detail, and I will leave the 10th for another book.

I know it is difficult to work on strategic work (my next book as an example) versus tactical work in any business and it is no different for me. It's difficult to work on the future when the challenges of the day are keeping us busy for more than 8 hours, well, let’s just say it – even more hours than currently exist in a day. The time has come to become a long-term thinker and drive our daily priorities toward attaining long-term goals.

On December 24, 2011, I made a bold statement about where I want my life to start heading. I was determined to change my business model and in addition, I also changed how I did business. Then I decided to upload a video on YouTube describing what my dream job looks like.

What is your ideal state? (Take some time here and think about this question). Try to visualize what your ideal world should look like. Then see my video on YouTube, and see how I visualize my ideal world.

If you go to **http://youtube.com**, and search for “OEM Lean101 Online Course.m4v,” you will find my video, titled, *Make Your Dreams a Reality*. What I share is my ideal state.

http://youtu.be/0I6C8A6JgXM

This is what I want my life to look like. When I created this, I was **not** a well-known “global” consultant. However, I can tell you I have made great strides towards my ideal state since this video were posted -- since I made a commitment to my future.

There is a movie made some time ago called “City Slickers” where Billy Crystal’s character, Mitch, is receiving some serious advice from Curly, played by Jack Palance.

Curly: Do you know what the secret of life is?
[Holds up one finger] This!

Mitch: Your finger?

Curly: One thing. Just one thing. You stick to that and the rest do not mean s***.

Mitch: But, what is the "one thing?"

Curly: That is what you have to find out.

Well, I am here to tell you that I have figured out that “one thing” for myself. My YouTube video represents my visualization of the dream that I want for myself. This is the dream I share with others. By leveraging my strengths and servicing my passion, I created a great recipe for success. I will discuss more about how you can achieve your dream job.

In December 2011, I decided to give away some training in Lean Manufacturing to students through online social networking services. I created the OEM Lean101 – Principles of Lean Thinking course in 2006, and I wanted to see if there was global interest in this course so I could achieve my goal.

My Goal: To travel the world and consult over the internet.

Now I would normally say that a goal should have a deadline. However, if you cannot put a deadline to it – well… it may as well be the purpose of your existence. Instead of putting a deadline on my goal, I set a *target condition*. This simply means that there is a condition that I would strive for maintaining. My *target condition* is to be in Canada for 6 months plus 1 day each and every year. The remainder of my time is spent in other countries doing consulting work, speaking at events, or relaxing.

I was impressed with the interest that people showed in joining my online course. During the winter holiday season, I had over 100 students registering for my online course each day. There were students from over 40 countries that registered over the internet. But, what is next? I was giving the course away FREE. No wonder people registered. The interest was there, but were they willing to **pay** for the same training?

If Curly and Mitch had continued their conversation (from the movie), it most probably would have sounded like this:

Mitch: I know what my one thing is, now what?

Curly: Now you experiment, use the PDCA model.

Mitch: What is the PDCA model?

Curly: PDCA stands for Plan – Do – Check – Adjust. Create a Plan you think will get you closer to your goal, Do the plan, then Check to see if you are any closer to your goal, and finally adjust your plan based on what you learned, but remember, one step at a time.

Mitch: This sounds like a lot of work, I think I am going to need help, I think I need a coach.

Curly: Don't we all.

Ok, I realize I am stretching it a little bit. However, the "thing" is no good without a process of getting you to that "thing." This book gives you the base understanding everyone should have about Lean Thinking. So you know you are on the right track; perform a quick check with yourself.

Ask the questions:

1) Do I know the goal or target condition?
2) Do I know *exactly* how to get there?

If the answer is yes to both of these questions, then think again… your goal is most likely not challenging enough. What we can hope for in life is a good process. With a good process, it does not matter what our goal is, it matters that we have a direction so we are making our way toward that direction.

We are then able to start the journey towards getting there. The pathways to getting to our goals can be endless. Regardless of whether you are a student of Lean, an expert who has been applying Lean for many years, or have never heard of Lean before, you will be engaged on another level by reading this book and following the online course videos (**www.Lean101.ca**).

There are another two main contributors to this book. They are Dr. Jeffrey K. Liker, best-selling author of *The Toyota Way*, and Norman Bodek, known by many as the "Godfather of Lean."

The concepts outlined in this course apply to all industries, especially the ones that need a systematic process for making small strides towards breakthrough improvement. It is needed in healthcare and government as much as it is in manufacturing. I know that ***time*** is the valuable currency of tomorrow. Organizations poised to respond immediately to an increasingly competitive and demanding global marketplace will be successful.

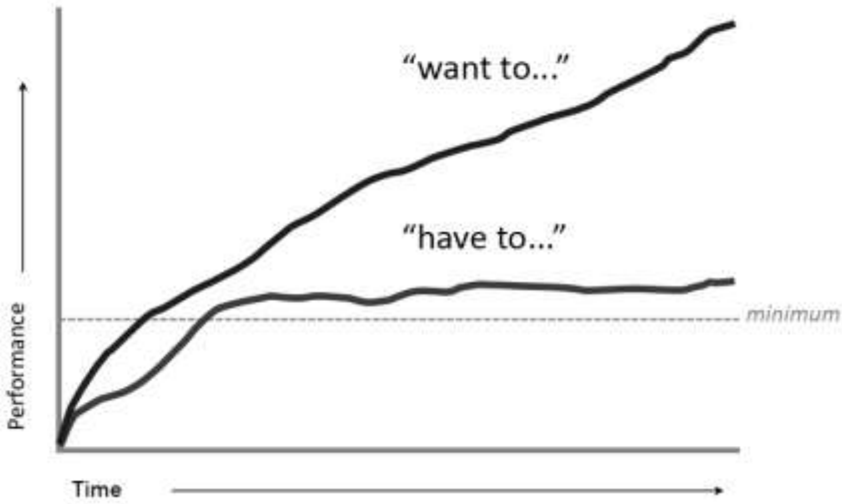
I would be pleased to help you on your journey toward excellence. It starts with the understanding shared in this book and in the online course.

George Trachilis (front row) delivers training on-site for Dubai Customs in 2009. Dubai, UAE.

Why does this book exist?

This book seeks to give you the core information you need to increase the speed or elevate your thinking process. People and organizations need to reach new levels of understanding so that they can increase the ability to achieve. This book will give you an advantage as an entrepreneur, or as a practitioner of Lean in your company. It will show you how to apply the principles that are used by Lean organizations to stay ahead of their competition, and thereby are able to claim that they are a lean enterprise.

The concepts are simple and most companies and organization strive for this type of improvement. The secret to making this happen lies in understanding their people.

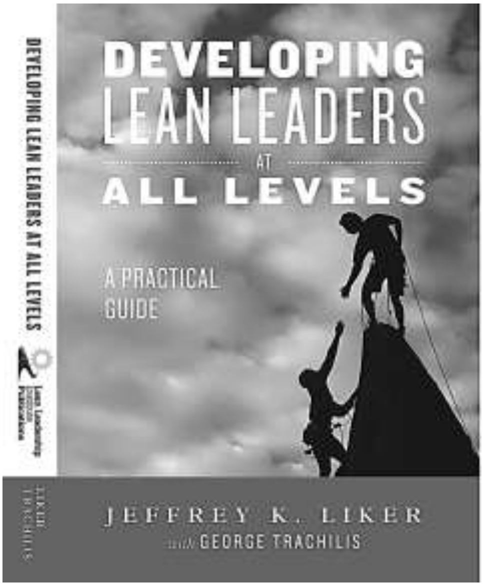


There is a huge difference between employees *wanting to* do something and *having to* do something. The above graph is a clear representation of the performance level I am experiencing by experimenting my way toward a vision that I created. It makes a huge difference when you "want to" do something versus "having to" do it.

Organizations have to realize that their only appreciating asset is people.

The above statement comes from Jeffrey K. Liker's newest book, Developing Lean Leaders at all Levels. I am thankful to be part of that publication.

http://leanleadership.guru/books.html



My way of doing business should inspire you to become the kind of leader that draws on the creativity and knowledge of others to boost your ability to create the right solutions for the right customers (or for yourself).

As a child of 5 years old, you may have wanted to be the astronaut, wanting to go to space. By today, those dreams have been sucked out of you from the people closest to you. People who knew no better way to educate you than to say, “No” or “Stop that” or any number of phrases that mean “No you cannot.” I call these people *dream takers*, as innocent as they may seem, they have done an injustice, and in the process – if you listened – you do yourself an injustice.

As an educated guess, 95% of the companies out there have done the exact same thing to the people who work for them. There is a ton of potential in so many organizations with absolutely no investment of money. This human capital must be harvested today to get the real productivity results that organizations are looking for. It is people, being brought together with common goals, who make things happen and make the difference.

Do you feel you have much more to accomplish in life?

It is time for me to encourage you to dream once again. Life is short. ***Life is too short to think short term.*** Do not waste another minute or second-guessing whether you can make money at what you love doing. Dare to dream and you might achieve what you never thought possible in the past. And why? Why did you think it Not Possible? The answer is shamefully simple… you were told it was not possible by those you trusted.

Dream the possible and become the best person, the best manager, the best innovator, and the best thinker you can be. Money is not the most important thing in life. Peace of mind is a lot better than money I cannot sit back and let life pass by without sharing these five simple principles that have allowed me to start my journey down the road of self-development by helping companies get organized.

The education provided in this book will be enough to inspire you to start your lean journey. In chapters 2 through 6, the principles of lean thinking are discussed exactly as they were presented in one of my workshops in 2006. In later chapters, I review some case studies of how Lean Thinking applies to all sorts of business businesses and personal improvement processes. I am positive this book will encourage you to start your lean journey, or get it back on track.

"What we have to learn to do, we learn by doing"

- *Aristotle*

A FORWARD by Michael Deese

My name is Michael Deese, the creator of the "Airplane Simulation" that is presented in Chapter 2. George and I entered into an agreement in 2007, where George added his expertise with training to enhance the simulation experience in his on-line course. This book describes what we both are very passionate about. SAVING TIME AND MAKING MONEY.

In the early 1990's I was converting my manufacturing company from a traditional to a cellular environment with teams. Today, this is well known as "Lean." Back then, I needed a tool to communicate, to everyone in my organization, what these changes meant to them. They needed to know the WHAT -was going to happen, and the HOW -things were going to happen. Because of our team environment approach, I knew that things were not going to happen to them, but with them, and with their direction. I also knew that our suppliers needed to understand our new business strategy as well; otherwise, they would be working against us, continually. For that reason, I created the simulation with interlocking blocks. In this book, George refers to my simulation as the best in the world. I trust that he is right.

Today, it is no different. Manufacturing companies that have not converted to this thinking have gone out of business, or, are about to go out of business. Some in management are waiting for the "silver bullet" to help them out of their crises; there is not one. There are only the five principles of Lean Thinking that George re-iterates. The way George explains it is brilliant! His examples are priceless, and that is what makes this book a "must have."

Originally, I made three sets of the simulation, kept one, and gave two to my business friends. As we talked with people, others wanted a set. I made another few sets, but the requests kept coming. I commercialized Lean Zone Production Methodologies in 1995, for the purpose of selling simulation kits to other companies that wanted to take away the fear of change from their employees. After marketing, copyrighting the materials, I built some inventory to keep up with demand.

I think what George is doing is great. Moreover, with over 28 countries now introduced to the ***live*** "Airplane Simulation," the demand for my kits is still growing.

I am writing this forward because George has put together a perfect mix of materials to guide you, through the confusion about how Lean Thinking is applied. Forget the fact that our backgrounds are in manufacturing, and be re-assured that this book would help you understand how to apply Lean Thinking Principles in any business, and any industry, and even in your personal life.

We should all be as passionate as George about our work. However, he continues to remind me that it is not work, when you love what you do. Great job George! I look forward to your next book.

TABLE of CONTENTS

CHAPTER 1

INTRODUCTION

This is the only book you'll ever need to understand the basics of what "Lean Thinking" is all about. Regardless of the country that you live in or the industry that you work in, Lean applies to you! You can apply it in your daily life and save time, each and every day.

Lean Thinking Origins

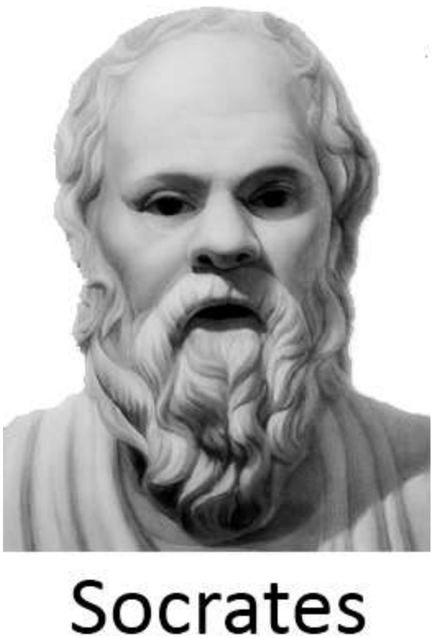


Figure 1-1: Socrates is best credited for asking questions to learn and teach

Socrates (see Figure 1-1) was a Greek philosopher who died in 399 B.C., and was credited as one of the founders of western philosophy. Philosophy in Greek (philosophia) means the love of wisdom. Another word for wisdom is knowledge. It is amazing that the man who was considered wisest of all the Greeks was quoted by his student Plato, as saying, “As for me, all I know is that I know nothing.” Socrates was masterful in the development of his student, Plato, who later became the founder of the Academy in Athens, the institution for higher learning.

Socrates was one of the greatest educators who taught by asking questions. This process of asking questions draws out answers from his students. Everything we know about Socrates comes from his student, Plato.

The overall purpose of Socratic questioning is to challenge accuracy and completeness of thinking in a way that acts to move people towards their ultimate goal.

We need more teachers like Socrates in today's business world. In this way, we would be developing people faster than ever.

Socrates and the famous Socratic questioning process is used to describe a certain kind of questioning. This is where the original question is responded to by an answer, however this answer is not only in the form of a question, but the question assumes the person with the first question is correct. This forces the originator of the question, to dig a little deeper on his or her own theory.

If you were sparring in the martial arts, turning a question in on itself is like using your opponent's momentum against them. If you were playing racquetball or squash, it would be like playing with an opponent yet the opponent is the wall, but the wall never misses its' mark. Ask questions like this:

- What am I missing?
- What else might I ask?
- What does that mean?

To get your student to dig deeper into their own insight, ask these questions:

- How does this relate to what we have been talking about?
- What do we already know about this?
- Can you give me an example?
- Can you rephrase it so that I can understand?

To get your student to question their own beliefs, ask these questions:

- Is there anything else we could assume?
- How did you choose that assumption?
- Please explain why/how...?
- What would happen if...?

Rather than accepting the student's rationale, dig into their reasoning. Ask them these questions:

- Why is that happening?
- How do you know this?
- Can you give me an example of that?
- What do you think causes...?
- How can I be sure of what you are saying?
- What evidence is there to support what you are saying?

To show that there is more than one viewpoint; ask the student questions such as:

- Another way of looking at this is ..., does this seem reasonable?
- What alternative ways of looking at this are there?
- Who benefits from this?
- What is the difference between... and...?
- Why is it better than...?
- How could you look another way at this?

If a logical statement is made, and you think the consequences can be predicted to be either desirable or undesirable, then ask:

- Then what would happen?
- What are the consequences of that assumption?
- Why is that/this important?

Problem solving skills are desperately needed in most businesses. The 5-Why process, asking “why 5 times” is one of the most powerful skills someone can possess. The number five is arbitrary; it may be three or eight. It is asking specific questions that start with the word “why” that will get you to the root of an issue.

When you are the customer and others are overpowering your conversation ask, “Am I the customer here? (then wait for the response – and if “yes”), can I get my questions answered?”

Socrates was a master at working on developing his students and had a high respect for the communication process itself.

Developing people should be your first priority (of course you would end up continually developing yourself in the process) so that your people can improve your business or organizational processes. Driving excellence in people guarantees excellence in processes. One core skill in self-development is to ask questions to **learn** and ask questions to **teach**.

Figure 1-2: Henry Ford is best credited for the introduction of the assembly line.

Ford, 1863-1947 (see Figure 1-2) was credited for the development of the assembly line technique. As the owner of the Ford Motor Company, he became one of the richest and best-known people in the world. He was a genius of American industry, and ranked as the #1 most-influential businessmen of all time by Forbes.

As I learned more about Lean over the years, I realized that a pioneer in the Lean Thinking process was Henry Ford. He integrated an entire production process at Highland Park, MI, in 1913. This was a continuous moving assembly line. Parts were delivered to the workers by an assembly belt, and the timing was carefully orchestrated to ensure that the line moved smoothly. This concept revolutionized automobile production by reducing assembly time per vehicle, and lowering costs.

Ford managed to build a vehicle in record time. He turned iron ore into cash in 41 hours. Of this, 13 hours was transportation down the Rouge River in Michigan.

He was focused on both the people and the process, consistently using standardized work and conveyance to create what he called *flow production*. The general public saw this as a form of an assembly line, but Henry's manufacturing engineers knew that this went much deeper.

Henry Ford first started placing fabrication processes in sequence. He even had quality checks prior to moving the parts from one-step to the next. These checks were known as go/no-go gauges. In those days, it was truly revolutionary. He was able to turn inventory around in his company within a few days. At the time, there was one model going down the assembly line, and by 1926, there were five body styles, and features added. There was no need for changeovers (changing the setup of the line for mixed-model production), because this was one value stream or one product family.

By 1918, more than 50% of the vehicles on American roads were Ford's Model T. Ford was a master at working on processes and had a high respect for people. He took interest in the personal lives of every one of his employees.

Edward Deming (an American) was the biggest contributor to the rebirth of the Japanese economy after WWII due to his introduction of the PDSA (Plan, Do, Study, Act) cycle. Americans would not listen to him, so he went where they would, Japan.

The problem for Ford was that the world wanted variety in their automobiles. The opportunity for Japan (specifically Toyota) was that the world wanted variety. The Model T was limited to one color.

With Ford's domination, other manufacturers had to find a way to provide these customers with the variety they craved. The old adage of "you can't be everything to everybody" became apparent to Ford in the coming years.

Figure 1-3: Sakichi Toyoda is best credited for inventing the automatic loom with mistake proofing features.

Sakichi Toyoda, 1867-1930 (see Figure 1-3) was referred to as the "King of Japanese Inventors." His most famous invention was the automatic power loom, which was only possible through the principle of Jidoka. Jidoka (autonomous automation) meant that a machine stops itself when a problem occurs. The automatic loom that Sakichi invented stopped itself when a defect was detected. This prevented the production of any defective product. Sakichi Toyoda later sold his patent to a British firm for 150,000 British Pounds, which were used to help his son found a start-up business, Toyota. The descendants of Sakichi Toyoda have dominated the upper management of Toyota Motors ever since.

Sakichi also subscribed and further developed the concept of five Whys. When a problem occurred, he was able to ask the right questions, and trace them back to the source (the root cause) and in this way he improved the design, and was able to continually make improvements upon improvements to his inventions. Sakichi Toyoda was ranked #13 on Forbes Most Influential Businessmen of All Time.

Every business system today is best advised to have a “Jidoka” aspect to it. Many processes all connected together to deliver a product or service to the customer is considered a business system. The business system should stop producing when an error occurs thereby allowing the inventor/company to problem solve - fix the problem - and then start producing again. This is best described with a phrase, “*Stop production so that production does not have to stop.”*

As Kiichiro Toyoda (son of Sakichi) was later asked by his father to commit to do something for society, he chose the car. He became aware of the opportunity that Ford made available by not servicing all of its customer needs, and decided to capitalize by providing cars that had given the people what they were desperately asking for – variety. After World War II, Kiichiro enlisted Taiichi Ohno (a manufacturing genius) to take on the challenge of creating a Just-in-Time system and the invention called the Toyota Production System was invented.

The Toyota Production system is a way to describe the overall operational philosophy of Toyota. It was later described as a house with two pillars, one pillar of the system was called, Just-in-Time, and the other pillar was called Jidoka. There are many visuals that are used to describe the TPS system. In Japan, the Toyota Production System has been credited to Taiichi Ohno and Shigeo Shingo (an industrial engineer). Today, TPS comes down to two very simple concepts, excellence in product, and excellence in people.

Creating a visual that describes to the world (and your employees) how you do business is extremely powerful. It automatically identifies Do’s and Don’ts regarding how you go about doing business *YOUR WAY*.

The concept we refer to as “Lean Manufacturing” is described in the book *The Machine That Changed the World* (1990) by James P. Womack, Daniel Roos, and Daniel T. Jones. Later, in 1996, these Five Principles were described to be:

- Specify the value desired by the customer
- Identify the value stream for each product providing that value and challenge all of the wasted steps (generally nine out of ten) currently necessary to provide it
- Make the product flow continuously through the remaining value-added steps
- Introduce pull between all steps where continuous flow is possible
- Manage toward perfection so that the number of steps and the amount of time and information needed to serve the customer continually falls

From Lean Manufacturing to Lean Thinking

The application of lean manufacturing principles (see Figure 1-4) have been so successful in their use of eliminating waste (unnecessary activities) and adding value (to customers) in the manufacturing industry that the same principles now called Lean Thinking are being applied in many different industries with equal success.

Lean Thinking is about delivering value to the customer in the least wasteful way. This can be anything from providing a product, to providing a service, to providing information on time, on budget, and with no interruptions to the flow of that product, service, or information.

This illustration represents the steps in which to consider the endless delivery of value to the customer. The first question really does start with, “What does the customer consider of value?”

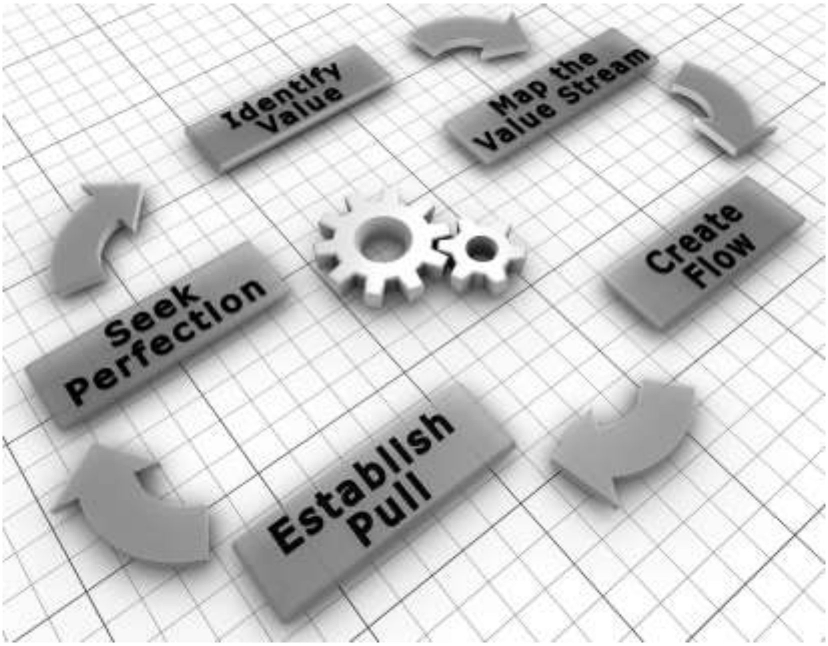


Figure 1-4: Lean Manufacturing principles summarized.

The visual above shows the process of Lean Thinking as an endless cycle of going from Identifying Value to Seeking Perfection. The real question is, "Does this apply to every business, to every process, to every person on the planet?" I suggest it does, but not in this order.

I had a very enlightening conversation with Jeff Liker one day, we were discussing my book and the online course, and I suggested that anyone in business should start, **FIRST**, with Identifying Value from their customers' perspective and make their way along the process as described. I also suggested the most important of these Principles is the first one, *Identify Value from the Customer's Perspective*. He disagreed.

Today, I have come to realize that Seeking Perfection is a very powerful way to stay driven toward your goal. By focusing on the ideal, you no longer need any motivation. You are motivated to continue the journey, to find solace in the fact that you will *never* get to this ideal state but rather that you will be making progress. This takes a lot of commitment and understanding on your part.

Why start something you cannot finish?

Well, it is about the journey. So one of the greatest gifts you can give yourself and others is to freely **ask**, and without judgment **answer** the question, “What should it be like?” Regardless of the country, industry, business, or demographic that you find yourself in, this question applies and should be your starting point.

Norman Bodek and I agree that everything between your current condition, the circumstances in which you find yourself today, and your future-perfect desired condition, is considered waste. Imagine considering every obstacle in your life just another obstacle that you must eliminate as you make your way to your ideal state. Norman is very spiritual, and it shows in his discussions and in the wisdom that he imparts to those who will listen.

Over the past couple of years, I have come to appreciate the knowledge and wisdom imparted to me by these great leaders. I would be remiss in suggesting that the five Principles of Lean Thinking is the only way to look at the world. As a matter of fact, Jeff Liker and I have a new book out on the market called, *Developing Lean Leaders at All Levels: A Practical Guide*, which focuses on exactly that – developing leaders to coach and develop others to become Lean Thinkers and Leaders.

Lean Thinking is the accepting of the Five Principles as your paradigm – as the way you will see the world from this point forward. There was a book already published called *Principles of Lean Thinking*, by Jim Womack and Dan Jones. I am not redefining these principles, however, I do make it clear that the starting point is to Strive for Perfection, and show how these basic principles can be applied to your daily life as much as in your business.

Lean Principles apply to service-based businesses just as much as they do to Toyota, where they originated. This is the reason this book, OEM Principles of Lean Thinking, exists and I make a very clear statement that the way to unlock all of this human potential in yourself and in others is to start with the fifth principle first.

The Five Principles of Lean Thinking are:

1. Strive for Perfection (an ideal state).
2. Specify the value from the customer's perspective.
3. Identify the value stream(s).
4. Make the product/service flow without interruption.
5. Introduce pull where flow is not currently possible.

Repeat this cycle endlessly until you reach your goal. Then set a more challenging one, and start over again.

Are you a leader or are you a learner?

The more I learn about the complexities of implementing Lean (Lean Thinking) in different industries and with very different approaches, the more I can make the following statement and expect that we will all agree.

Applying Lean Thinking should drive results.

There is one thing that limits Lean Thinking from doing exactly this, and it is constancy of purpose. If we were able to stay consistent, and focus continually with eyes on the goal then we would get there with the right process.

Mike Rother, author of *Toyota Kata*, described this process as an individual having an improvement Kata (IK) and a coaching Kata (CK). It implies, correctly, that we need a coach. The question is, "Why do we need a coach?" Mike suggests that the right process is one where the coach teaches the learner how to make their way through the "unclear territory" towards the "next Target Condition" (see figure 1-5). It would follow then that as you achieve your many target conditions on the way toward the challenge that you would eventually get there, with the right process.

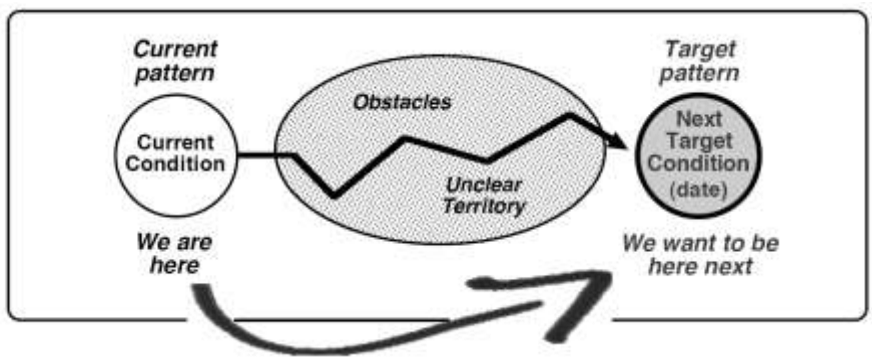


Figure 1-5: Setting the Next Target Condition

Why do we need a coach? Just like Socrates coached Plato in the techniques he created, we need coaches to help us close the gaps in our current understanding of process that we have chosen to learn for the purpose of getting us the results we desire.

For Socrates, as a leader, he did not use a coach (or did he?). At some point in his life, as the expert – as the guru, he gained followers of his teachings and then he decided to coach and develop others. This may very well be the highest calling we have in this world. To coach and develop others in the craft that we have created, or learned.

For your name or company to outlive you there must be some significant contribution that you make. For Socrates it was his creation of the world of philosophy, for Henry Ford it was the assembly line, for Sakichi it was Jidoka, and for Kichiiro Toyoda, it was the car. We all have the ability to be great, now the question becomes, “what is your contribution to society?”

Before you get started in answering this question, let us look at the direction we would like our lives to start heading. Every good coach that I have personally used in the past started me off the same way, and generally with the same question, “What are you trying to accomplish, what is your vision?”

As we make our way towards providing an answer for this question, it is worth saying, "**first, you must learn about lean thinking"**. Your next step is to read Chapters 2 through 6, and absorb all of the information. These five chapters will give you all of the basics and more about Lean thinking and more, and the remaining chapters will help you make the connection as an individual, as a manager, or as an owner of a company of what your next steps should be.

Enjoy the following chapters, and know that real learning cannot happen unless you are doing something with the knowledge. Please find a project, or think of a situation, and start applying these five principles in your daily life… start now! Then, we will further develop our understanding of how to create the ideal world that we are able to visualize.

To received PowerPoint presentations of the following materials join the Online Office at www.LeanLeadership.guru/community.html.

"Without continual growth and progress, such words as improvement, achievement, and success have no meaning"

- Benjamin Franklin

CHAPTER 2

DEFINING VALUE FROM THE CUSTOMER'S PERSPECTIVE

Lean Thinking

As our associates and professionals in the industry are talking about Lean, they are getting very excited about it. All of them realize they can apply it in the workplace, at home, or any place where processes are used, which is **everywhere**.

My personal background has been in manufacturing business. My experiences have centered on production, scheduling, and plant management. Usually, when we want to make improvements it is to a department or a process – not overall. It is when we start focusing on the overall that we see that large improvements can be made for a company? At some point, we started realizing that we were spending money in the wrong places. We should have been eliminating potential bottlenecks in the manufacturing process. Lean Thinking allowed us to focus on the overall; it also provided a methodology for people to get training and to see things differently.

The principles of Lean Thinking have been around for a number of years and will be around in the foreseeable future. It is hard to disagree with the degree of productivity improvements gained from applying them.

Many have gone to investigate why and how Toyota Motor Co. became the most successful company in the world. In 1996, Jim Womack and Dan Jones authored the book, *Lean Thinking*. It provided us with the 5 Principles of Lean Thinking. The principles of Lean are very simple to learn and extremely effective. Nonetheless, a large number of companies and organization in the world have yet to adopt them.

Historically, if you visited any Emergency Room, you would notice that the wait time was usually outrageous – regardless of the urgency. People got very frustrated with emergency room waiting rooms because they ended up waiting for hours in the process. The central reason for this was a lack of information.

At one point, hospitals put in a light system allowing patients to see where they stood in line – i.e. relative to others regarding priority. If a person came in with a severe condition, no one got frustrated because of this system. They could see that this person was on their deathbed. As a result, all hospitals adopted this technique. Today other technologies are being used as well.

A former colleague of mine, Bob Kerr, went deep-sea fishing in the middle of the Atlantic Ocean. To help them improve the fishing company's process, he proposed to implement Lean Thinking. Initially, the fishing company thought it would not work in their industry.

Bob drew a map of their process. What he found was that their fishing capacity had nothing to do with the size of their net, or any other obvious factor for that matter. It just had to do with the motor on the boat. Every time they had a big load, the motor would give out. As they strived to collect more fish, a motor that could not handle the load limited them. By mapping everything out, Bob figured out the weak link in this system. When he pointed this out, they reserved to bring in less fish more frequently. At the end of the day, they brought in more fish overall. Lean Thinking applies to all sorts of industries.

Defining Value

There are five principles to Lean Thinking. The first one, *Define Value from the Customer's Perspective,* is actually the most important. When we say ‘define value’, we really mean the activities that the customer cares about. Bring your external customer into your facility and ask them, “What activity would you be willing to pay for?” Right away, you will get to know what a value-added activity is to the customer. Alternately, non-value added activities are the ones that the customer is not willing to pay for.

A customer can be external, somebody buying a product or a service, or an internal within an organization. Additionally, anybody helping you put that product together further downstream of the process is also a customer – i.e. an internal customer.

Any activity that the customer cares about is a value-added activity. In contrast, a non-value added activity is one that the customer does not care about. For instance, it may not be done right the first time and therefore the customer is not willing to pay for it. However, there are non-value added activities that are necessary – this is the third criterion that business activities fall into. These non-value, yet critical activities at this point, are necessary but also wasteful. We know we cannot eliminate them so what do we do? The answer is we can reduce the time they take. Nonetheless, non-value added activities are targeted for elimination – ideally, they are not just to be minimized but completely eliminated.

We have stated that if a customer is willing to pay for something this is an indicator that there is value associated with it. When I was working with PAL (Princess Auto Limited) Manufacturing, I asked a group of employees if they had ever done a rework. What do you think they answered? Yes, of course. However, is the customer willing to pay for the rework? No. Nevertheless, the customer ends up paying for the rework because it is built into the cost.

No matter what the customer’s perspective is on the subject of rework, you have a company to run and your costs are built into it. You charge the customer the lowest price you can and try to stay competitive. At the end of the day, you still have to absorb those costs.

We want to identify and define value from the customer perspective. Three criteria identify and define value. All three must exist in order to establish that something is “value added” to the customer.

- The first criterion is that the customer cares about it.
- The second criterion declares that the customer wants it to be done right the first time. If you are doing it the second time around, you are not adding value. It could have been done right the first time around.
- The third criterion states that it has to change the item while going through the process.

These three criteria must be met in order for an activity to be considered valuable by the customer.

Is payroll a value added or non-value added activity? Payroll is non-value added but necessary. That means we have to minimize the amount of waste in such an activity but we cannot eliminate it. In this case, we deem the activity necessary.

In all other cases, activities are non-value added and unnecessary. These have to be completely eliminated from the organization.

Percentage of Waste

In this next section, we are going to be talking about the percentage of waste during the entire process. As we go through each of the steps, we will break them down into smaller fragments and analyze them. Then we will think of each fragment as a ‘verb’ starting that process.

For example, ‘wait’ is a verb that starts the process. We might say, “Wait for the material.” ‘Cut’ would start a process by saying, “Cut the raw material.” As you break down each of these pieces, you define whether they are value or non-value added to the customer. You are then able to answer questions from a customer’s perspective. For example, customers might ask themselves, “Am I willing to pay somebody to wait for material?” The answer is very clear.

At PAL Manufacturing, the value added is found in the cylinders that they make. Accordingly, we asked the question, “What is the customer willing to pay for?” A cylinder consists of a shaft, a tube, and seals. What does the raw material look like? In this case, raw material is twenty-foot length of metal. This has to be cut by someone. When it is cut, value is being added. The same goes with the welding operation, the drilling operation, etc. All these add value because you can see that the item is changing.

Can you guess the percentage of activities that add value to a typical non-lean manufacturing shop floor?

The answer is *only 5%*!

This is sad considering how high manufacturing costs are. This means 95% of the activities are non-value added from the customer’s perspective. When we start a company, we get used to doing things in a way that makes sense at the time. Then years go by and we get comfortable. We do not want to change. Inevitably, we end up building up waste from the customer’s perspective and we do not know how to change it. Actually, over time, we become incapable of seeing the waste in the process. Ultimately, this translates to higher costs to the customer.

We mentioned earlier that only 5% of manufacturing activities add value. What about in a typical office environment?

It is only 1%!

Seven Forms of Waste

Sometimes, finding value in a process is almost like finding a needle in a haystack. What if, instead of trying to find the needle, we look at the haystack to see what it is made up of? The key is putting our focus on the haystack. By shifting our view and defining waste as being the haystack, we come up with seven forms of waste that we need to eliminate in our process of looking for the needle. These are…

1. Overproduction
2. Waiting
3. Transportation
4. Inappropriate Processing
5. Unnecessary Inventory
6. Unnecessary Motion
7. Defects.

#1 - The Waste of Overproduction

Strategically, we start with the first waste: overproduction (see Figure 2-1). This prevalent symptom is found in manufacturing and office environments. As soon as we spot the waste of overproduction, we see a ton of inventory as its visual representation. Notably, overproduction is the waste that contributes to every other waste. For that reason, it is the first of the wastes that we review.

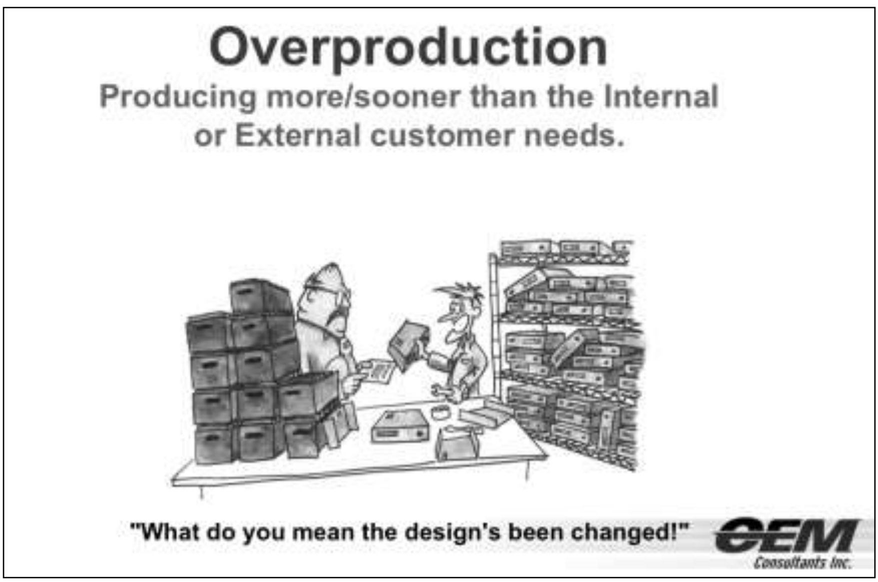


Figure 2-1: Definition of "The Waste of Overproduction"

In the 1980's, Michael Dell wanted to establish the best and largest supplier of computers in the world. He revolutionized the computer industry by cutting out the middleman and selling directly to the customer. The result? He had to produce a lot of computers to meet the demand and to fulfill his strategic goal – i.e. his dream to be the biggest supplier.

While success was in sight, the issue that Dell faced was that of overproduction. As technology advanced at a very fast pace, the overstock could not be sold for the same price. As a result, the components ended up costing him more than what he could sell them for. He started losing money – big money!

Overproduction almost cost Michael Dell his company in the early eighties. This was because Dell computers were made to order and according to the customer's wish list. This resulted in the component inventory increasing like crazy. Inventory costs money. In the financial books, inventory may show up as an asset. However, storage costs (including rent, heating/cooling, electricity, etc.) all cost money.

How do you think Dell computers are produced today? They are still made to order and Dell is still a major manufacturer of computers. In fact, production is higher than it originally was. The company is satisfying more customers than ever with inventory levels reduced down to 72 hours' worth. How? Production is done according to the customer demand.

By producing on demand, which completely differs from the initial strategy, Michael Dell has become much more successful. The lower your inventory is, the better your customer service is; as long as you are doing it right and thinking Lean.

#2 - The Waste of Waiting

A lot of people spend a lot of time on quality. Of course, this makes good sense: the better quality product you deliver, the happier a customer is. In the past, you would *try* to get quality by doing things right the first time. That made a lot of sense too. Nowadays, a lot of company's effort to get it right the *first time*.

When you remove time out of a given process, you are doing the right thing. Waiting is one of the biggest factors around removing time out of a process (see Figure 2-2). Finding out why you are waiting and then doing something about it.

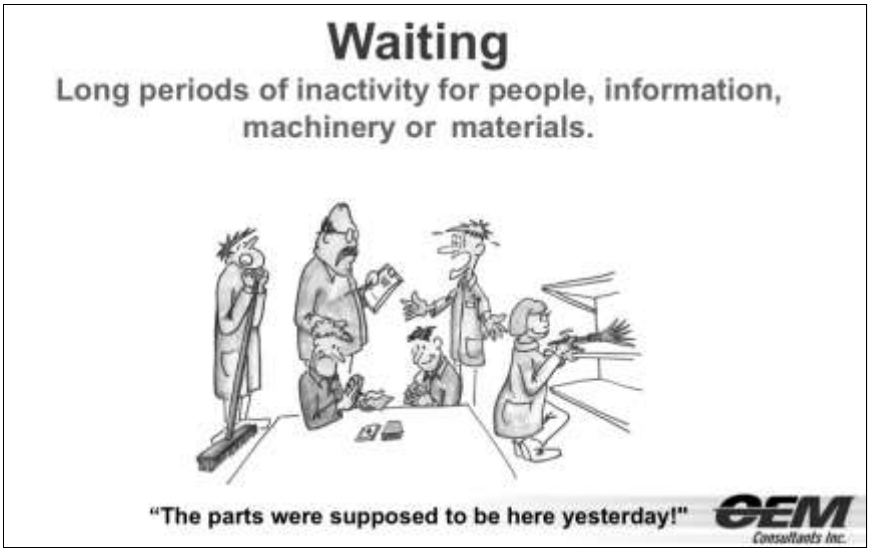


Figure 2-2: Definition of "The Waste of Waiting"

Our focus is to open up our eyes to waste. Waiting is just another waste that we have to identify and eliminate completely.

If we look at retail, an obvious example is waiting to get the stock on to the shelf. What happens when a customer is looking for an item but cannot find it? An employee has to look for it on the computer if they have an inventory management system. They may try looking for it directly in the retail area. If they cannot find it there then they go into the back of the store to check their inventory. Think of what the customer could be doing instead of waiting while the employee looks for the item. If we eliminate the waiting, we actually increase the ability for the customer to shop for more. This adds value to both the customer and the store.

In manufacturing, if a machine goes down, we have to wait for the machine to become operational again (or, for a backup). At a former client's plant, a CNC machine was down for two or three months! It held up production for an unacceptable amount of time and the related costs were very high. Obviously, this could have been prevented. When there is no backup, the process must be done right. Whether we have a backup or not, we always get operators to work very closely with their machines; as if they were married to them. They are tasked to do regular maintenance checks and take pride in the condition of their equipment.

Our workspaces are inundated with situations where we are waiting for machinery, people, and processes. For this reason, we have to eradicate this waste as quickly as possible!

#3 - The Waste of Transportation

Of all the wastes, I personally enjoy eliminating the waste of transportation the most (see Figure 2-3).

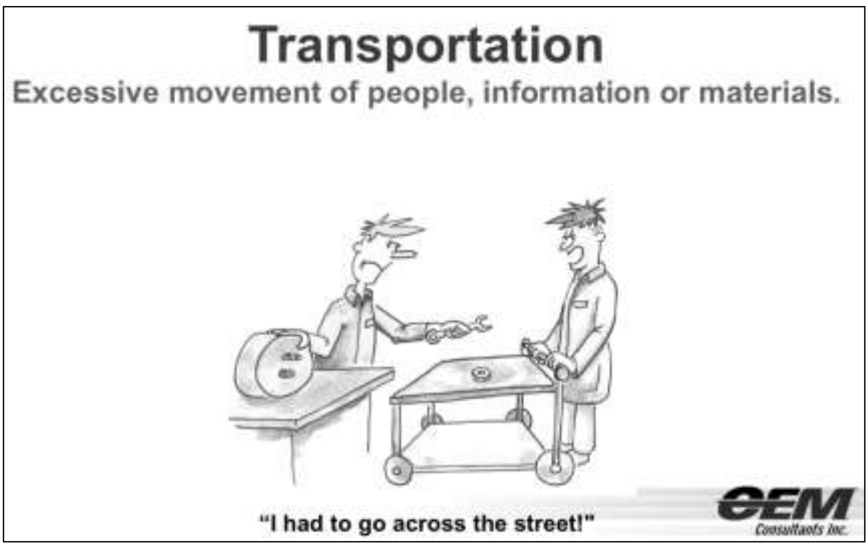


Figure 2-3: Definition of "The Waste of Transportation"

Transportation waste is usually large and can be identified visually. When we talk about transportation, we are talking about the transportation of material and information; or, even people from one place to another so that they can do their jobs.

The waste in transportation can be mapped out using a system. This system has been around for a long time: i.e. the Spaghetti Diagram. Here is how it works. We draw a diagram as we follow a person, product, or information from place to place. We track where it comes from, where it goes and how many times it crosses back and forth. It is basically a map of every step we take as we follow our target. We draw lines, from one place to another, allowing us to calculate distances traveled. This humorous example illustrates the point (see Figure 2-4).

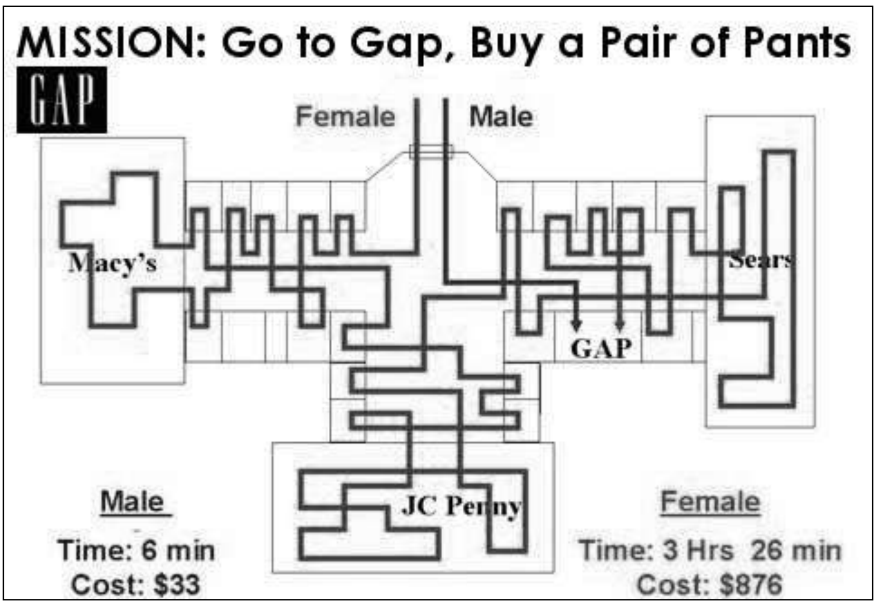


Figure 2-4: Spaghetti Diagram

Some time ago, I was a plant manager. One day, our team decided to follow the journey of an order starting from the moment a customer placed it. From the sales person it went into our order entry system. A printout landed on my desk, which then made it to engineering. Then purchasing got it, and it later came back to engineering. Why do you think that happened? The information was not recorded right. We continued to follow the order and we were astonished. By the time it had gone through all of the required steps, it had traveled 3 kilometers!

Many people’s hands had touched this sales order. Would you consider this activity value added? Not at all.

The waste of transportation did not end there either. The order finally got out to the shop floor. First, it went into a saw. After which, the item was placed onto a rack. From the rack, it went into tube drilling. Once the drilling was performed, the item was taken to the rack again. As the product went through three other value-added steps, it had to be placed on a rack between each operation! As it arrived to the inspection area, the whole floor was covered with inventory. Then the item passed by quality control. Then it then went into yet another rack. From there, it finally went into assembly where they actually started putting the product together. You get the picture.

#4 - The Waste of Inappropriate Processing

Throughout this book, I talk about hidden wastes. Appropriately named because we cannot see them. Many of the wastes, such as inappropriate processing, are hidden from the people who are executing the tasks (see Figure 2-5).

Figure 2-5: Definition of “The Waste of Inappropriate Processing”

As we find ourselves in situations where the same things are done repeatedly, no one can imagine doing them differently. When new people come in, their ‘fresh eyes’ perspective allows them to see things we maybe shouldn’t be doing. You could even call it a customer’s perspective. At this point, we really should be asking the obvious questions. These obvious questions are great! Do not be afraid to ask them. Such questions help us uncover the inappropriate processing that goes on. Otherwise, we remain blind to it.

Let us go back to our PAL Manufacturing cylinder example from earlier in this chapter. Recall they had a big pile of inventory. Raw material was received in 16-foot lengths. They actually needed 15 ½ feet. Consequently, the welder had to get a hold of the material and saw off 6 inches – before even performing his own task. As a result, welding was considered a bottleneck at this company.

I asked the following question. “Why are we purchasing material from a vendor at 16 feet when we could be bringing it in at the right length?” What do you think the answer was when I asked the owner of the company? “We brought it in at the right length. What are you taking about George? Who told you this? And who’s cutting that material?” He seemed bewildered. We ended up looking for the enemy within; which is the wrong way to go.

If, and when, you uncover waste, everyone should celebrate that the problem was found. We should not be trying to find out who caused it. When we adjusted our thinking as a company, we were able to identify all of the wastes in the process. It has nothing to do with people – it is the process we should be after.

Let continue with our example of waste over at PAL Manufacturing. Cylinders come in different lengths and have variables such as stroke, bore, etc. How many different part numbers do you think we had for the cylinders? There were 625 part numbers. Each had its own bill of material. It became obvious that they were not using their software correctly. When we looked at the variables – and created proper bills of material – we managed to organize and combine the part numbers. The result was a reduction in the bill of materials (BOM) count. They were down to 25 part numbers.

What a difference this made. They were managing 625 BOMs when they could have been managing 25. This serves as a perfect example of inappropriate processing.

#5 - The Waste of Unnecessary Inventory

Of all the wastes, inventory is the one practitioners’ talk the most about (see Figure 2-6).

Figure 2-6: Definition of "The Waste of Unnecessary Inventory"

You need a strategic amount of inventory in your company. Everything above and beyond that amount is unnecessary inventory. On the balance sheet of a non-Lean company, inventory is usually sitting in the column called 'Assets'. When we look at it from a Lean perspective, we quickly realize how flawed this kind of thinking is.

We truly need to think of excess inventory as being very wasteful. Otherwise, we run the risk of never getting rid of that asset from our balance sheet.

As we discuss inventory, I encourage you to start looking at how it impacts a business. Think about inventory even in your own home. It collects; it takes over the environment and becomes an obstacle to productivity. Worst of all, it results in a great deal of cost.

The more you hold on to inventory, the more it collects. There are many reasons why companies have gone bankrupt in manufacturing. You can bet one of those reasons is excess inventory. It really ties up cash.

Let us look at a positive example. Today, the Dell Company has inventory in their system. They understand that a strategic amount of inventory is needed. Anything above that strategic amount is unnecessary inventory. It suffices to say, Dell manages their inventory with great precision.

Would you say the strategic amount of inventory for a given company is high or low? The answer is it can be high on some items and low on others.

What does inventory cost us today? Way too much! Ideally, we really need to know exactly how much inventory costs us in order to help reduce it and to save money. I provide more detail on this later in the book.

For now, the most important thing to remember about inventory is that it is a symptom of the real problem. You can reduce the inventory but, to keep it reduced, you must eliminate the cause of the problem creating the inventory.

#6 - The Waste of Unnecessary Motion

The waste of unnecessary motion gives you a lot of opportunity to get creative. Companies usually go through and identify things that are dumb, dirty, and dangerous and eliminate them (see Figure 2-7). Generally, they achieve this by decreasing human labor and automating with a robot in their place.

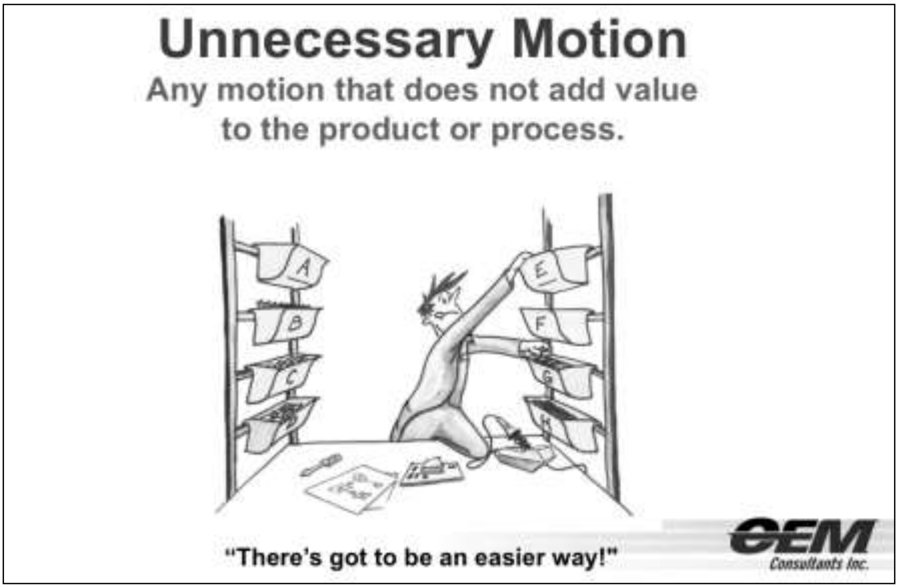


Figure 2-7: Definition of "The Waste of Unnecessary Motion"

These are situations where you have someone leaning over to get tools, reaching up to get supplies or unnecessarily moving materials/machinery. Creative methods are found to eliminate such unnecessary motions out of the entire process. Companies implement systems like 5S (see Figure 2-8 further on in this chapter). The operator gets involved – first of all by seeing it – and is tasked to eliminate it. He or she eliminates all unnecessary motion by using a few guidelines.

Let us focus on 5S for a while. As a tool, 5S is the most popular of all the Lean strategies applied by companies. This is because of its ability to effectively address many of the wastes. In fact, it is considered a foundational tool. This is why I wish to spend some time here describing it. 5S is a popular counter measure used by most companies applying a tool-based approach to Lean.

Let us consider a shop floor in manufacturing as the simulation environment to help understand this next part.

With 5S, we have a 45-degree rule. If materials and tools are not within 45 degrees in front of you, either way, they are in the wrong spot. This 90-degree zone ensures that you do not have to turn your head. We also utilize a strike zone. If it is not between your knees and your shoulders, then it is too low or too high. We get very strategic about where the tools need to be for everyone to do their job. Additionally, think about how this improves the health and wellbeing of the operator. As a workplace organization system, the 5S approach is an all-around win-win.

A respected consultant and partner in my group, Othmar Furer, worked in Singapore as a supplier to Yokogawa in 1985. Toyota would not let his company become a supplier unless it implemented 5S as one of the foundations of their system. What do you think his company did? To this day, they have never regretted adopting the 5S system into their processes.

5S comes from five Japanese words that start with the letter “S.” I am sharing the English conversion of these words, which are very effective in conveying the original meanings. Just as a point of interest, while the Japanese formalized this process, Henry Ford first developed it back in the early 1900’s.

The 5S System

SORT: During this step, we walk into a given area with the intent of sorting through what is necessary and unnecessary for inventory and/or tools. We remove unneeded items to a different area; we call this a red tag holding area.

From the red tag area the unneeded items get disposition. This means some items are thrown out, some are cleaned up and placed elsewhere, and, some go to auction and are sold. Regardless, they are no longer where they are not needed.

SET IN ORDER: This step requires that we organize everything in the area in order for all things to be where they need to be. This includes equipment, inventory, information and work instructions.

As part of the 'Setting in Order' step, we make sure to put lines, labels and signboards on the floors and walls. This way everyone knows what work is being performed in the area and where the workspace ends and the aisles begin.

SHINE: This step is all about keeping the place clean. Cleanliness is a way of inspecting in the future. As we keep spaces clean, we can also make sure that everything is where it needs to be (i.e. material and tools are in their place).

We also make sure we inspect equipment that we are running while we are cleaning. Such inspections can eliminate downtime for that equipment by finding a problem before it happens.

STANDARDIZE: Based on what was achieved with the first three steps, we develop best practices and try to standardize to that level. Here are some examples…

- We can develop standards for Sort such as having a monthly "red tag" event. All employees are tag items that are not needed.
- We could standardize Set-in-Order by creating color-coding standards and agreeing upon how to locate tools and information for the entire organization.
- We could standardize Shine by ensuring that there is a cleaning cart available when it is time to clean the area. We could show pictures of what the standard is and expect everyone to follow it.

SUSTAIN: Finally, the fifth "S" is Sustain. This is the step where many companies fail. We need to maintain the change we made by sustaining the improvements. Less than 10% of companies that start with 5S stay with it. The fact is it never ends when you start. If you want to be part of the 10% that benefit from sustaining their 5S improvements.

Selecting a Team for 5S

Selecting the area to start the first 5S is important. The area you select will be your benchmark for future 5S projects (i.e. your showcase area). You should strive to initiate major improvements, which are not overly difficult, but still provide a challenge to your team. It needs to be a win-win for both the company and the employees. The end product is a sense of accomplishment, ownership and pride for great results.

The most important part of a 5S project is the selection of your team. Here are some attributes of a good team to look for:

- Team members must to be team players.
- The team should be willing to make changes.
- Ideally, the team has been exposed to 5S before.
- They team should not be afraid to promote novel ideas in a meeting.

Realistically, you cannot always pick an ideal team. In one company, the heat-treatment area was picked for a showcase 5S-area. It was selected because it was a bottleneck and it had a large number of safety issues. One of the employees, John, felt that too much time and money was being spent on 5S. He also felt that 5S was simply a waste of effort. He complained that funds could have been better used for the upcoming new labor contract. Ultimately, since John was a key employee in the department, he needed to be on the team. Our first priority then? Make sure the improvements on the line would make John’s job easier. Your teams’ buy-in is crucial to success.

We started by installing a scissor lift for the operators, thereby eliminating a very awkward work position. This improved the quality of the work by providing a better sightline. Next, we improved the task lighting, installed a shelf for commonly used tools, and, eliminated over 40 safety issues.

After completing 5S on that line, John became the biggest supporter for the 5S system and for Lean, because we considered his needs first. The other team members were inspired to take a similar stance. That 5S project and those that followed were a huge success.

The most critical part of the 5S process is the workplace scan (see Figure 2-8). This is when all the workers in an area are called together to create a list of the current and desired conditions. By asking workers what they want to see, a shared vision is created. Management gets the result they want – more efficiency. Workers get what they value most – owning the changes.

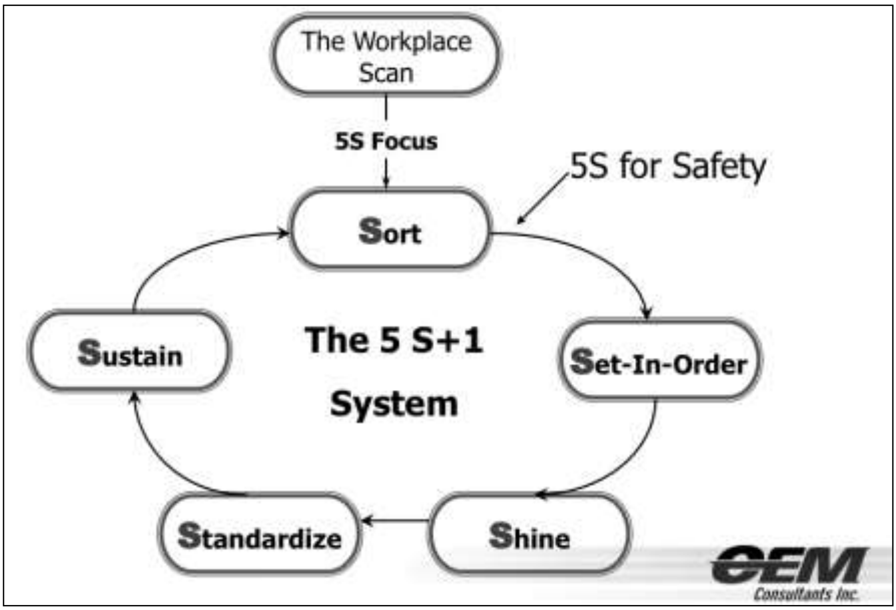


Figure 2-8: 5S+1 or 6S is a workplace organization and standardization process that works.

Subsequently, during the Sort stage, all of the employees in the area are asked to fix yellow tags on surfaces and areas where safety problems existed. Safety issues are logged on an area map and categorized (see Figure 2-9). Logging each safety item on an area map ensures that they are not forgotten. As each issue is resolved, a different color sticker is placed above the old sticker. This indicates that the safety issue is gone. This same convention is used when placing red tags on items that need to move to the red tag holding area. Over time, everyone starts to recognize that they are responsible for their own area. Employee ownership is a vital part of a successful 5S initiative.

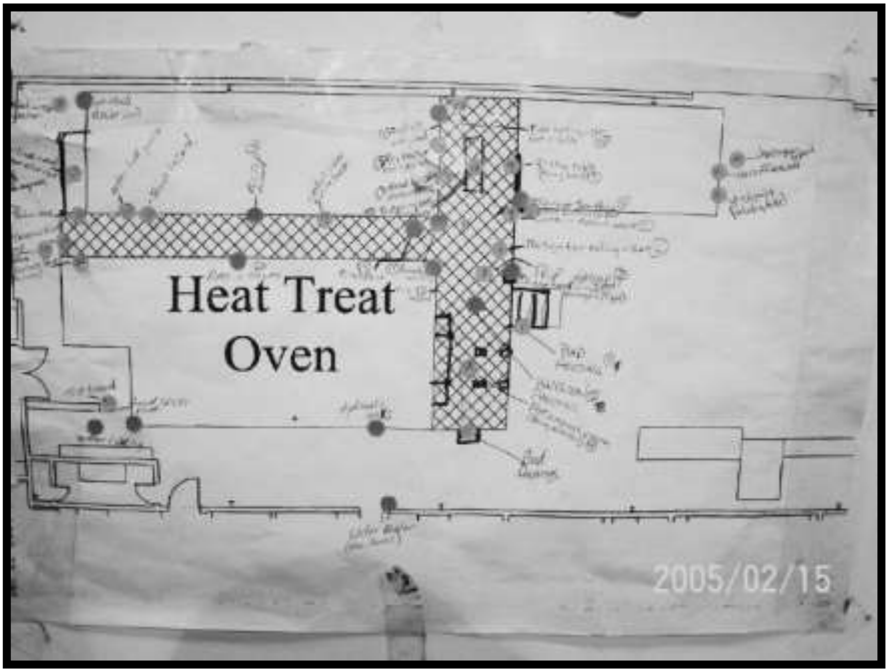


Figure 2-9: Example of an area map with safety issues identified

The 5S System is a set of universal principles and activities that sustain high performance in companies of any industry. An uncluttered, well-organized and understandable workplace is an essential foundation. It results in efficient, low-inventory production; total quality management; total productive maintenance; any other advanced change initiative or improvement approach.

The 5S Program is a systematic approach that organizes and standardizes the workplace. It promotes safety, good housekeeping, improved workflow, better product quality, reduced inventory waste, and – above all – puts people in control of their work areas.

It is not possible to be a world-class company without being organized. The 5S System is widely used across North America and has proven to be very successful. It is a program that improves safe working conditions while addressing many employee concerns. I highly endorse it.

5S represents the basic process in manufacturing in which the employees are continually thinking about the maintenance of their workspace. By thinking about the five words that start with the letter “S”, all employees are able to communicate clearly about a process that they are helping to implement. The 5S’s help them ensure that their work area is maintained to a standard. The true test is when anyone could “jump in” and do the designated work in an area without a lot of searching for tools or information.

5S is very applicable to our home lives. As you view the pictures in the following pages think about how 5S applies to your home life. One clear indicator of success I get is when someone from the team comes up to me and says, “George, I did it. I went home and 5S’d my garage – it’s awesome!” This is when I know they got it. When they start applying it to the area that they hold most sacred.

On The Job Insights

Can you imagine finding anything in these drawers (see Figure 2-10)?

Figure 2-10: The first step in 5S for these drawers would be to SORT.

What about at home or at work? Can you always find what you are looking for?

How easy is it for you to find information on your computer?

How about ingredients in your kitchen?

If you cannot find things, it is good to know how they can be sorted in a better fashion. Remind yourself you should only keep what you need in each area.

If I know I want a tool board, I use a little trick. Get the right size board manufactured. Here's how…

- I place all of the tools on the floor first.
- I then move things around, as I would like to see them.
- Then I get the measurements for that tool board.

In this way, I ensure the right size of board is made to hold all of the tools (see Figure 2-11).

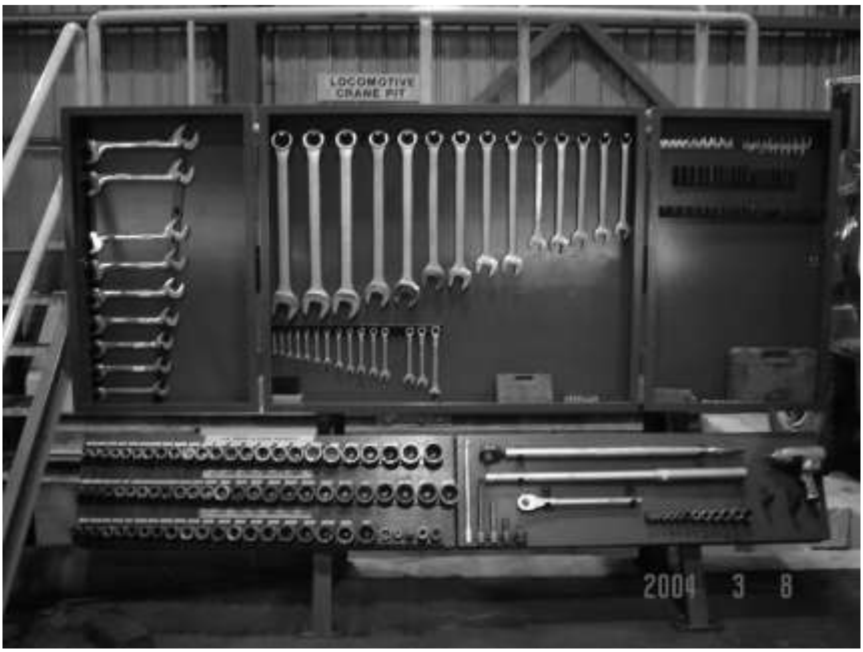


Figure 2-11: Customize your tool board and get things SET IN ORDER.

The biggest benefit of doing Shine is that you can isolate where a leak may be coming from. For example, by painting the floor, you are able to root cause this problem and eliminate it; thereby, fixing the problem (see Figure 2-12).

Figure 2-12: Painting a floor helps identify equipment leaks during SHINE.

In this scenario, Standardizing saved this company a lot of money (see Figure 2-13).

Figure 2-13: Using color-coding during STANDARDIZE can save you money.

By ensuring shims were color coded, the operators rarely made the very expensive error of using the wrong shim. Color-coding is a very valuable technique. As long as you do not forget to back up the color scheme with words for those that are colorblind.

Figure 2-14: Hyundai plant in Ulsan, South Korea provides a good example of SUSTAIN.

The best way to sustain is to build an environment for it (see Figure 2-14). When at the Hyundai plant – in Ulsan, South Korea – I was impressed with the one-point lessons and the work instructions that were standardized in each area.

Notably, sustain is very much about appreciating the human being who works beside you. The concept of the boss at the top working for all of their employees in the plant is a very good one. I would gladly state that I work for each of you. Unfortunately, the reality is that I do not. I am forced to strive for my business goals like everyone else; and, let us face it, my personal goals.

Truthfully, we all work for one another when we have a shared goal. In such a case, where I can help you, I will. I suspect that you will help me too, reciprocally. This is the beauty of the world we live in. We all feel life’s stressors; more often than not, we put these on ourselves. Regardless, we are all available to help each other make it through life’s challenges. It is my firm belief that we should.

Getting back to my experience in Korea, while I do not speak their language, my tour guide did. He had worked with the leaders of this Hyundai plant for many years. This led to many doors being opened for me during my visit. This kind of respect is earned through a commitment to acts of service towards others. My tour guide had earned his respect.

Respecting each other is what it is about. Therefore, out of respect I tell you this. Forget the notion that you as a manager work for all of your employees. Also, forget the old paradigm that your employees work for you. It is your job to be a leader and energize people around you. Only by demonstrating to them what a leader is will they then be in a good position to mimic you. That is truly the only way to ensure that things are sustainable.

#7 - The Waste of Defects

This particular waste, the waste of defects, is very obvious to everybody. When we have a defect, it means the product does not work or the service does not work. The customer will let you know about it – and maybe, not in a nice way (see Figure 2-15).

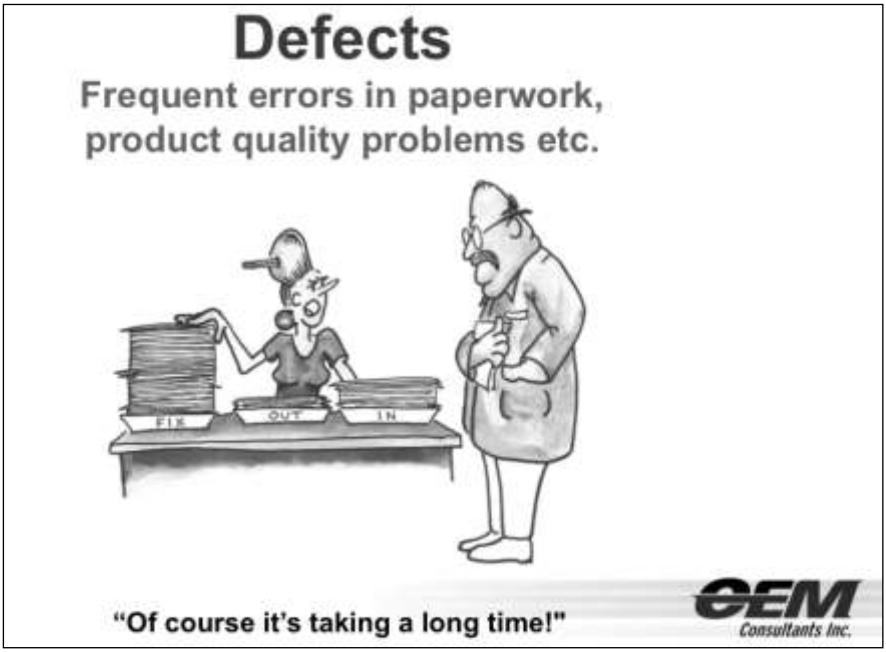


Figure 2-15: Definition of "The Waste of Defects."

Companies tend to think that they have solved their defect related problems. Usually, they do not really know whether they have or not. Typically, that is when other problems emerge. This is because there can be more than one root cause to a problem. Defects are rarely measured to ensure that they are truly gone. Making sure they are gone, and that they stay gone forever, should be part of a company's main goals.

This brings us to one of the most effective tools when it comes to eliminating defects. It is called the Five Why process. At the heart of this process is asking, "Why is this a defect?" – 5 times.

To give you an example, if cylinders coming out of a machine are defective, we will start by asking, "Why are they coming out defective?" If the answer is that they leak, we then become more specific by asking, "Why is there a leak?" After some testing, it is determined that they all leak at the port weld area. This prompts the next 'Why' question. "Why do they leak at the port weld?" This line of questioning would continue until we reach the root cause of the problem. It might mean that we have to ask ‘Why’ 5 times, or more, or less. The number of times is not important. What is important is that we eventually get to know what the root cause to a problem is. That is when we can begin the process of eliminating that cause from ever being a factor again in the future.

At PAL Manufacturing, the entire team worked together to create a future state map. After the meeting, one of the managers pulled me aside and told me that we were not ready for implementation. He said, “George, it’s not going to work because we have defects coming off of our CNC machine.” Was I concerned? I absolutely was.

I told our team to get to the root cause of the defects. We started root causing with the inspector. We asked, “Why do we have these defects?” “Why are things **not** working the way he expects them to?” “Why is the product **not** coming out exactly right?”

Here is what we found out. Three years prior, when they had originally bought the CNC machine, somebody had changed the original manufacturer’s nozzle to a different one. For the next three years, they had one person programming that machine. All the programs were faulty. Three years’ worth of programs went into the garbage when we root caused where the problem was coming from. We started again from scratch.

Now I ask you – are we looking to blame people? No. As much as the overwhelming urge to do so exists in us, it is not the right thing to do. Know, for certain, as soon as you start blaming people, your Lean initiative comes to an abrupt end.

We actually need to celebrate that we found the problem. When we find a problem, we eliminate it and we are moving forward. This is the key. By finding the defects we are able give the reason(s) why something has not worked. We learn why we cannot do things a certain way and how to get rid of the defect(s).

Two More Wastes

There are two more wastes I want to bring up (see Figure 2-16).

Figure 2-16: Two more important wastes to mention.

What is the waste of untapped human potential? Untapped human potential is not getting the ideas out of the people who work in the area; and this does not have to be just at work. Employees might go home and run a small business on the side. This business might grow into a multi-million dollar enterprise someday. Can you imagine if you had that talent working for you? Why didn't you let them help you run your business?

Untapped human potential is about getting great ideas out of your group and implanting them as a system that the business wants to abide by. In fact, people who have been working for a company under six months should be considered the most valuable employees in the company.

Why would I say that?

Fresh eyes are the reason why. As managers, we very seldom approach the employees who have been with us under six months and say, “What stupid things do you see that we are doing as a company, that we should stop doing?” You have to say it that way, and do not forget, wait for an answer. Definitely, remember not to say it this way: “What stupid things are *you* doing?” It comes across as a reprimand to the employee – especially if he or she is still on probation. Good luck trying to get an answer from them.

To keep it simple is an art that everybody should get back to. I do not care what business you are in or what job you are doing. We all have a tendency to make things more complex than they have to be. A colleague of mine was working as a VP of manufacturing. One of his managers brought the following problem to his attention one day, “We’ve got this product that has a shelf life of one year.” This means that the product was no good one year after the date of manufacturing. Additionally, the company had a tendency to ship some of the most recent items to the customer – leaving older inventory to expire. This was adding unnecessary costs. The VP wanted a solution to this problem. They put their minds to it and came up with an elaborate system. This system consisted of getting everything barcoded when it came off the production line, prior to being placed onto a rack. When a customer order would come in, a pick list would be generated. The pick list told them the order in which items would be manufactured. Sounds like a good solution right?

As a result, the oldest item in the facility would then be packed and shipped out every time. What do you think the ticket price was for that improvement? By the time they got the right computers and the whole system up and running, it would cost $100,000! This was a hard pill to swallow but maybe it would pay for itself in the long run.

“We should practice what we preach; let’s ask our frontline people what kind of system they feel would work,” the VP said. They presented their request to the rest of the employees. One of the team leads stepped up and said to leave it with him for two weeks.

They came back after two weeks, and the VP immediately asked, "Before I go any further, what's it going to cost me?" What do you think the cost was? A mere $25. Amazed, the VP asked, "How did you do that?" The team lead responded, "It's simple. We bought some masking tape and some markers. When the product comes off the end of the line, we take masking tape and put a date on it. We have reserved a spot in the warehouse for this stuff. As a result, we have gotten into the habit putting products in sequence. Now we pick, by the oldest date, and we get it out to the customer – it never fails." So $25 for masking a tape and magic markers; that was it! I repeat – we have a way of making everything more complicated than it actually is….

Look at this "*Before*-picture" (see Figure 2-17).

Figure 2-17: PAL Manufacturing – *Before* picture.

You can see a lot of racks. This results in a waste of inventory and a waste of motion. In addition, they had to bring a forklift in to get items out. This caused waste of inappropriate processing. Items could not be put together due to wrong sized shafts and tubes on these racks.

Here is the "*After*-picture" when they were done with their improvements (see Figure 2-18).

Figure 2-18: PAL Manufacturing – *After* picture.

It is very impressive wouldn't you say? The credit goes completely to the people in that area. They did a fabulous job and I take absolutely no credit for their ability to work together as a team and make it happen. Somebody added, "We made no changes to the lighting; adding just a coat of paint made a big difference."

CHAPTER 3

IDENTIFYING THE VALUE STREAM

The Value Stream Map (VSM)

The second principle of Lean Thinking is to identify the value stream. In order to do this, you really need to know what a value stream is. It is all of the value added (VA) and non-value added (NVA) activities that deliver a product/service to the customer.

One way to identify the value stream is to draw a map. We call this a Value Stream map (VSM). It helps identify all VA and NVA activities, as well as, the processes to deliver a product or service. Value Stream mapping makes it easy for anybody to record the value stream and be part of the process. This is why Value Stream mapping is a paper and pencil exercise.

When we draw a VSM we focus on the material transformation process first. Our first step is to draw the existing process in the value stream**.** We start with the customer. Then we identify the start of the material transformation process by drawing the activity closest to the customer (i.e. where the product is being delivered). Then we work our way upstream through the process. As we are drawing and calculating relevant information, we ask people, “What do you think about the current state material transformation process?” “What are the challenges that you see?” We also include the inventory levels and information flow on the map.

Once we get a handle on the current state, we are ready to draw a second VSM – i.e. a future state map. As we draw the future state, we brainstorm and look for ways to eliminate the NVA activities. So the future state map helps us answer the following question:

“What would the process look like if we were able to eliminate some of these Non-Value Added (NVA) activities?”

Drawing a future state VSM is a very powerful tool. We are asking "What if?" and following the question by drawing a new map - one that is not limited by the current rules. At this point, the action plan that we develop connects the current state and the future state.

Although the skill for drawing value stream maps is a course onto itself, this book will introduce you to some of the concepts and icons needed to run through a case study and simulation of this process.

Generally, the goal of value stream mapping is to provide a communication platform between organizations utilizing a standard language (see Figure 3-1). If you have two cross-functional teams doing mapping within an organization, each team must be able to look at the others' map and understand what is happening.

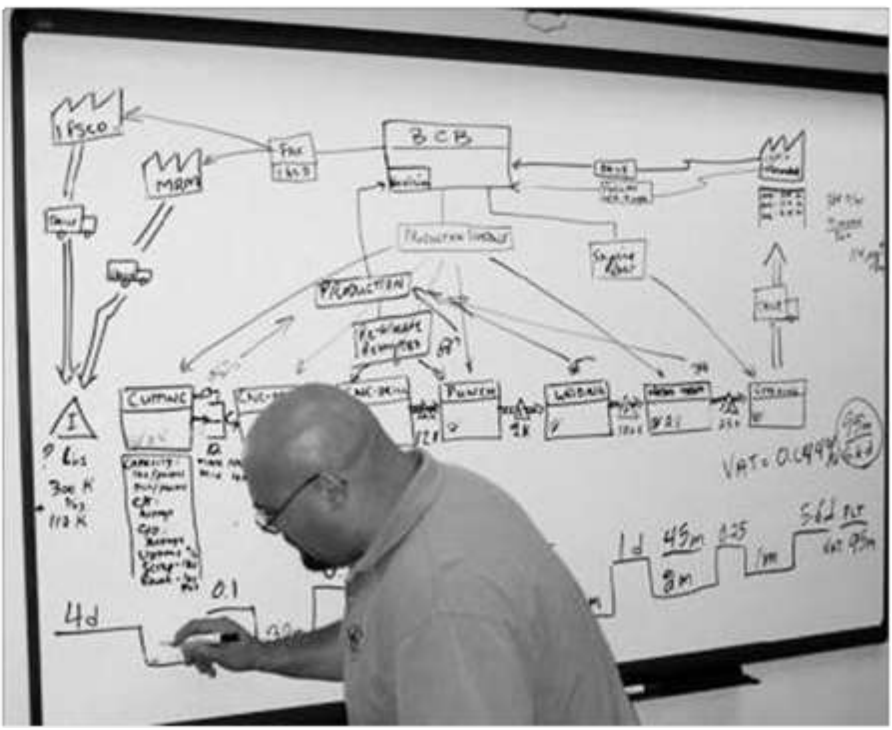


Figure 3-1: Drawing a value stream map.

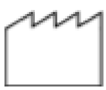
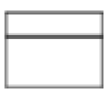
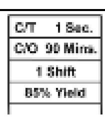
Let use PAL manufacturing as an example for a moment. In retail, the value stream starts with the external customer. When a customer comes into the store, value should be generated. The value stream refers to all activities, VA or NVA, which satisfy the customer’s needs. PAL manufacturing has numerous different products so we have a little bit of a challenge.

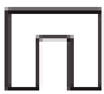
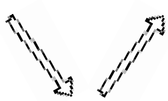
To make things simpler, we decided that cylinders were going to be the pilot value stream for them – not compressors, washers or anything else. This allowed us to focus on getting the job done for that product group. When we consider retail, what do you think we are picking as a value stream? Is it *every* item in the store? It is *not*. For instance, with this retail store, we focused on promotional items only.

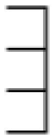
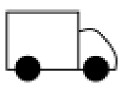
Mapping your Value Stream

Let us familiarize you with some icons (see Figure 3-2).

Figure 3-2: Value Stream Mapping (VSM) icons commonly used.

 **Customer/Supplier**	This icon represents the supplier when in the upper left, the usual starting point for material flow. The customer is represented when placed in the upper right, the usual end point for material flow.
 **Dedicated Process**	This icon is a process, operation, machine or department through which material flows. To avoid unwieldy mapping of every single processing step, it represents one department with a continuous internal fixed flow path.
	This icon goes under other icons that have significant data required for analyzing and observing the

Data Box	system. Typical information placed in a data box underneath factory icons is the frequency of shipping during any shift, material handling information, transfer batch size, demand quantity per period, etc.
 **Work cell**	This symbol indicates that multiple processes are integrated in a manufacturing work cell. Such cells usually process a limited family of similar products or a single product. Product moves from process step to process step in small batches or single pieces.
 **Inventory**	This icon shows inventory between two processes. While mapping the current state, the amount of inventory can be approximated by a quick count. That amount is noted beneath the triangle. If there is more than one inventory accumulation, use an icon for each. This icon also represents storage for raw materials and finished goods.
 **Shipments**	This icon represents movement of raw materials from suppliers to the receiving dock(s) of the factory; or, the movement of finished goods from the shipping dock(s) of the factory to the customers.
	This icon represents the push of material from one process to the next process. Push means that a

Push Arrow	process produces something regardless of the immediate needs of the downstream process.
 **Supermarket**	This is an inventory supermarket (Kanban stock point) icon. Like a supermarket, a small inventory is available and one or more downstream customers come to the supermarket to pick out what they need. The upstream work center then replenishes stocks as required.
 **Material Pull**	Supermarkets connect to downstream processes with this "pull" icon that indicates physical removal.
 **External Shipment**	This icon represents shipments from suppliers or to customers using external transport.

When was the last time you went out to buy a car and found exactly what you wanted? Because of the vast number of options, most customers end up compromising. They might buy a color they do not want or buy a sound system they do not need.

Why do modern non-lean factories manufacture an abundance of product that sits as inventory, yet they don't have exactly what the customer wants? I ask myself this question all the time. Not having exactly what the customer wants is not a new problem.

Historically, mass production was typified by buying the biggest presses available to stamp out huge volumes of parts. Mass production lowered individual piece prices and this was great when there was unlimited demand. Not so good, as the demand dipped. The problem with mass production thinking is that people are focused on optimizing pieces of the system instead of looking at the whole value stream.

A value stream map (VSM) shows the flow of raw material, inventory and information within a factory, or, all the way to the final customer. Value stream mapping is the process of creating the value stream map and is widely accepted as the main tool to use for a Lean Thinking implementation.

The VSM tool allows anyone to diagram their current value stream, identifying the bottlenecks that prevent them from making what their customers want – when they want it. Finally, it helps you develop a vision of what your future lean picture should look like.

Even companies that work hard at implementing Lean Manufacturing are caught up in creating islands of excellence. Creating a cell or reducing changeover time is not the same thing as creating a Lean value stream. Before making any improvements, it is important to know why we need to make the change. What if the improvement just makes a machine run more, building even more unnecessary inventory? With a value stream vision, you know what to improve. It allows you to become more flexible and reduce inventory in the process.

Value Stream improvement looks at the whole business. Since only senior managers have responsibility for the entire business, they must lead value stream mapping efforts and steer the improvement action plan needed to reach the future state.

Many companies are familiar with process maps but value stream mapping is different. Like other process maps, it focuses on the material and information flows central to a production system. Here are a few things different about the VSM. It allows us to visualize a closed circuit of information coming back from the customer to the supplier. It provides us with the material transformation process that the product undergoes until it reaches the customer. Finally, it identifies the inventory levels and how the inventory travels through the process. These things, combined with a timeline at the bottom of every VSM, make this map a very powerful tool. It is very effective in communicating where we are and where we want to be in the future.

Henry Ford was drawing process maps back in 1914. He included the steps, the amount of time and the distance between the steps. As we pointed out though, process maps are not the same as VSM's. Value stream mapping takes process mapping to a new level. For instance, process maps only have push arrows to indicate that material and/or information is PUSHED from one station to the next. VSM's utilize PULL icons and supermarkets, which become useful methods for preventing over production.

Drawing with the Value Stream Mapping (VSM) Tool

1. Select a Product Family
2. Draw a Current State Map
3. Draw a Future State Map
4. Implement an Action Plan

Let us get started by explaining the elements of drawing a **current state** map – here are the steps for doing this.

First, you have to select the product family that you are going to map. The easiest way to do this is to target one of your largest customers. Pick out a product or product family that you ship to that customer. Remember, the value stream map always starts with your customer. In this case, let us assume the map is for ACME Stamping, a fictional company. The part they produce is a steering bracket. Their customer is identified as State Street Assembly.

All the data in a value stream map is based on the customer's TAKT time (see Figure 3-3).

$$\text{TAKT Time} = \frac{\text{Available Work Time}}{\text{Customer Demand}}$$

$$\text{60 Seconds per Part} = \frac{\text{27,600 Seconds per Shift}}{\text{460 Pieces per Shift}}$$

Figure 3-3: TAKT time formula.

TAKT time is the heartbeat of the market. It is the voice of the customer in operational terms coming back to you. It equates to the available work time divided by the customer demand.

With an available work time of 27,600 seconds per shift and customer demand at 460 pieces per shift, ACME's TAKT time is 60 Seconds. In this example, the ideal value stream would be for all processes to be producing one part every minute with no waste in the overall process. We know this does not currently exist. Nonetheless, we always need to strive for perfection – continually.

The ACME current state map shows where ACME Stamping is today. As we look at it, we note it reveals obvious opportunities for improvement. One of the biggest 'ah-ha' moments in value stream mapping comes when you draw a timeline at the bottom of a map to show the amount of value added work being performed on the product.

The lower Timeline shows the actual time spent on the product where the product is transformed to what the customer wants (see Figure 3-4). This is the value-added time (VAT), which in ACME's case is 188 seconds. The data in the upper timeline is more revealing. It is showing the product lead-time (PLT) is over 23 days. Here is the good way to visualize this. Let us say we placed a "red dot" on a coil coming from Michigan Steel Company (our fictional supplier). As we follow the red dot the coil converts to a stamped part, then it is welded and then it is assembled. By doing this, you would observe that over 23 days go by before the red dot is shipped to State Street Assembly.

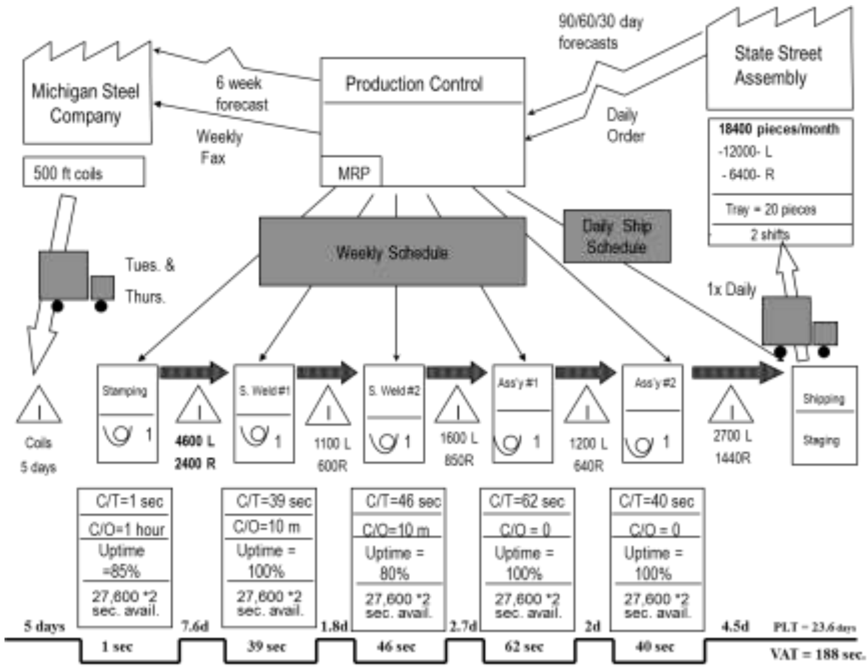


Figure 3-4: Current State Map for ACME Stamping.

Each value added step at ACME is shown as a process box. Traditional non-lean manufacturing improvements have focused on squeezing out mere seconds from these processes. Lean manufacturing focuses our attention on eliminating all activities that are of no value (or wasteful). Value stream mapping helps us to identify these wastes. Any reduction in time will be the result of eliminating the wastes. This is why lean manufacturers do not focus on eliminating time (the measure), but eliminating the waste (the root cause of excess time spent).

Value Stream Mapping is divided into three sections

- Material Flow
- Physical Transformation Process
- Information Flow

Notably, by mapping the information flow, you develop an understanding of why inventory is being created. In the case of ACME Stamping, like many companies, have individual operations that are scheduled by production control. Everything is based on a weekly schedule. Ill-advisedly, individual operations build according to the schedule regardless of whether the next operation really needs it. Fortunately, drawing a current state map gives you a high-level view of waste in your system.

When mapping the current state, do not get caught up in unimportant details. Make each map as simple as possible. Use paper and pencil. Go to the factory floor and collect key information. Most VSM's can be done within hours. For collaborative value stream mapping, sticky notes can be used. Most importantly, just DO IT!

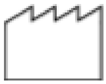
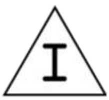
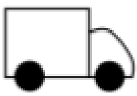
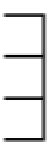
At this point, we can move to drawing a **future state** map.

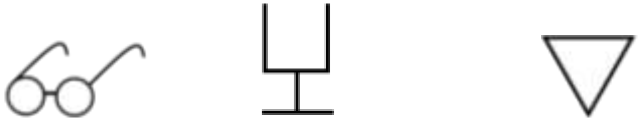
After measuring and identifying waste, put the current state map aside. The next part is the enjoyable and creative part of value stream mapping. Developing a future state map for your Lean system. When the future state map is done, you are ready for the final stage of your VSM. While referencing the two maps you have drawn, you can now develop and implement an action plan. The action plan aims at moving your process from the current state to the future state.

Let us focus on the future state for a moment. Value stream mapping provides its own set of icons for designing the future state. Most traditional process mapping leaves out such concepts as pull systems and supermarket style storage areas. The super market is an inventory location that holds the proper level of strategic inventory. Think of strategic inventory as that which is needed to assure FLOW.

Let us familiarize ourselves with the key icons we will use (see Figure 3-5). With these icons, you will be able to create your future state vision.

Figure 3-5: Icons for drawing the future state VSM.

	This is a **Customer & Vendor Facility** icon.
	Value Added Steps are illustrated as Process Boxes
	**Inventory** is drawn as a triangle; or, as in the original Toyota Model, a tombstone representing dead material.
	**Transportation**, a necessary but non-value added activity, is shown as a truck.
	A **Push Arrow** illustrates traditional product movement. This is where a product is made and pushed to the next process whether it needs it or not.
	A leaner approach is the **Pull Arrow** represented by a circular arrow.
	Instead of Inventory stockrooms, lean manufacturing uses a **Supermarket** concept. Each supermarket has a small, well-managed inventory where employees can pick only what they need.



Go See **Kanban Post** **Triangle Kanban**

These three icons represent ways of controlling material and information so that flow can be achieved.

The ACME Stamping future state map starts with the customer and the TAKT Time. We now place an emphasis on how the product flows through the system. Accordingly, we should see supermarkets, Kanbans, pull systems and frequent deliveries of product to the customer.

Their future state map predicts the production lead-time will shrink from over 23 days to 4.5 days and the processing time will be reduced by a few seconds. Once improvements are implemented, ACME can be much more responsive to changes in customer demand. They will hold far less inventory and free up floor space for future business.

CASE STUDY: The Mock Company

TASK 1: Drawing the Current State VSM

Let us draw the current state map of the Mock Company by working backwards through the system. By backwards, I mean from the customer upstream to the supplier.

We begin with our customer icon (see Figure 3-6).

Figure 3-6: Customer icon.

You may wish to get a paper and pencil and follow along with this next part. After writing a title and date on the top of your paper, use your pencil and draw the customer icon at the top right corner. As we draw the map together, try to observe the way the material and information flows. **Material flow** identifies the movement of physical product through the value stream. Material flows from left to right on your paper; it flows from the supplier to the customer. **Information flow** shows sources of data that tell a process what to do or produce. Information flows from right to left on your paper; from the customer upstream to the supplier.

Pay close attention to the **Material Transformation Process** in which raw materials are transformed as they make their way downstream in the process. This transformation process converts raw materials into subassemblies and eventually into the final product.

Here we see an icon that represents a material source. This type of icon can be used to show a customer, a supplier or an outside manufacturing process (see Figure 3-7).

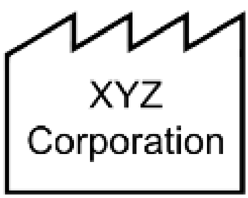


Figure 3-7: Outside Source icon.

The Mock Company's customer demand is presently 1,000 pieces per day. It is shown in the truck icon (see Figure 3-8). The arrow between the truck and the customer represents another material movement icon used to represent a shipment of finished goods. The frequency is important as it translates the customer demand into terms your company can understand and guide its internal operations towards achieving.

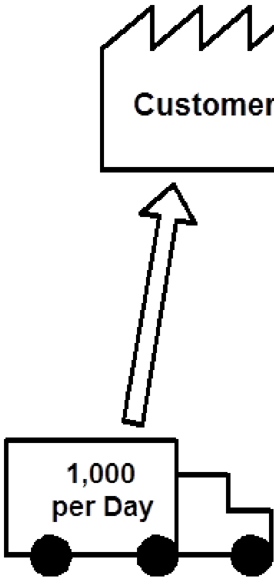


Figure 3-8: Truck icon.

Here we see our current state map beginning to take shape (see Figure 3-9).

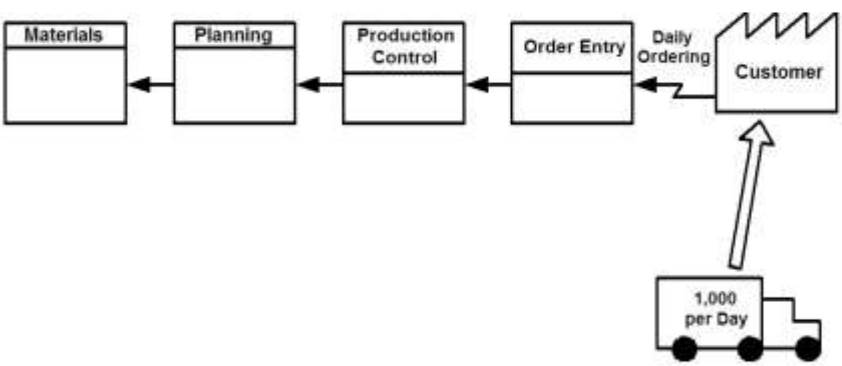


Figure 3-9: Start of the Mock Company current state map.

The arrows moving from right to left represent information flow. The customer sends in daily orders and they are processed. The row of boxes represents the flow that the information takes in translating a customer order into an internal shop order. Each process box represents the best description that you have as to where the information goes. Remember that processes must always be labeled. The boxes are also used to describe departments. For example, a box might represent Production Control. In this case study, orders go through Order Entry, then to Production Control, then to Planning and then to Materials.

The zigzag arrows, as seen in the diagram, represent electronic information flow – e.g. an Electronic Data Interchange (EDI). The straight arrows represent manual information flow – e.g. a production schedule or shipping schedule. These are communicated on paper (manually).

Let us follow some of the material flow through the plant. We have added various manufacturing processes to the bottom of the map going from right to left (see Figure 3-10).

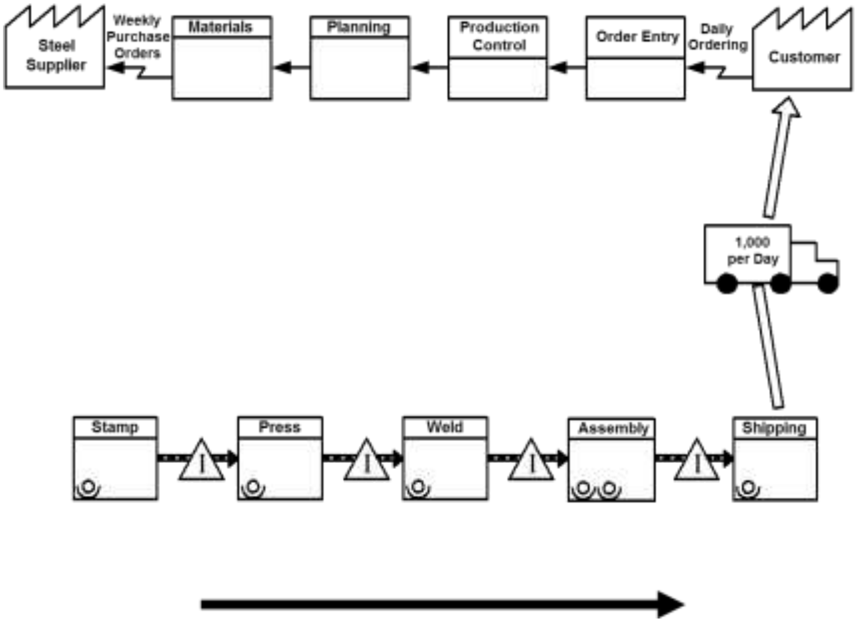


Figure 3-10: Mock Company current state map continued.

Always work your way upstream, from the customer towards the supplier. It should be obvious that the material flows from left to right, as the big arrow at the bottom of Figure 3-10 indicates. However, when mapping, make sure you place your process boxes on the map from right to left.

This technique of PULL is also utilized in Lean construction, where we start from the end (right) and pull trades into action via hand-offs.

This next icon represents an operator for a given process (see Figure 3-11).

Figure 3-11: Operator icon.

If a process requires more than one operator (see Assembly area in the map), then additional icons are added accordingly (or a number can be placed beside the icon).

This arrow represents the movement of production material by push (see Figure 3-12).

Figure 3-12: Movement of Production Material by PUSH

This means material is produced and moves forward before the next process needs it. This is usually based on a schedule.

A triangular icon represents inventory between each of the operations (see Figure 3-13).

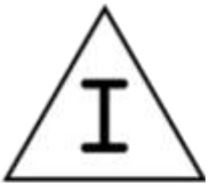


Figure 3-13: Inventory icon.

The inventory count must be noted. When we walked the process in the Mock Company, we found the follow amounts of inventory between the processes (see Figure 3-14):

- Between stamp and press we have 1,500 pieces,
- Between Press and Weld, 1,750 pieces,
- Between Weld and Assembly, 2,000 pieces,
- Between Assembly and Shipping, 2,000 pieces.

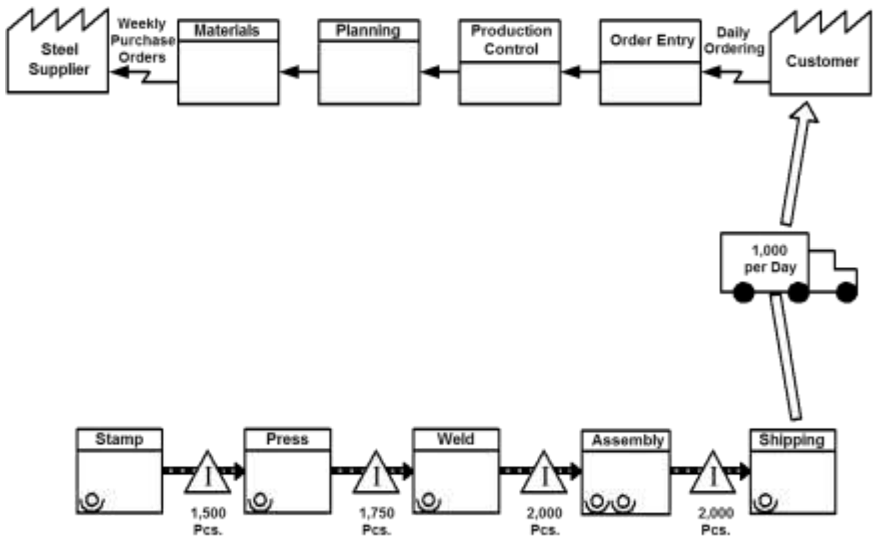


Figure 3-14: Note the inventory between the processes.

The steel supplier is shipping weekly. The truck shipment is two coils. Each coil represents 1,500 pieces.

Data boxes are used below each of the operations to record information relating to a manufacturing process, a department, a customer, etc. (see Figure 3-15). Next, the Mock Company gathers information for each of the operations. They want to include as much meaningful information as possible in these data boxes.

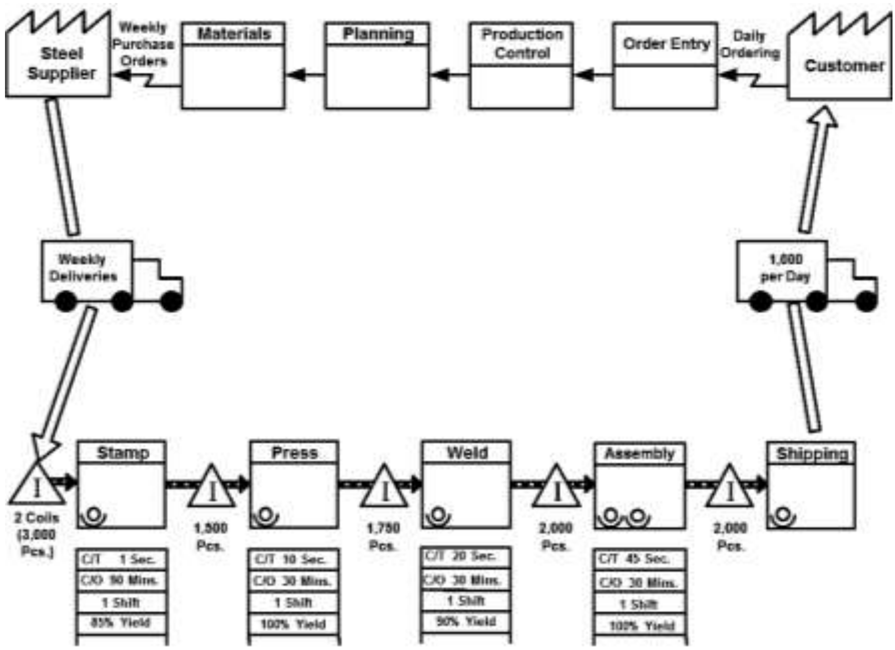


Figure 3-15: Note how data boxes are used below the operations.

Let us zoom in on the data box for the Stamp Operation (see Figure 3-16).

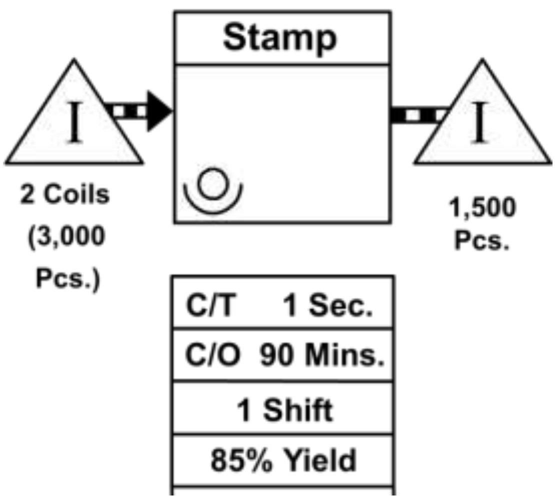


Figure 3-16: A closer look at the data box for the stamp operation.

Cycle time (C/T) specifies how frequently an item (or product) goes through a process as timed by direct observation. This is also known as the time it takes to get a good part after another is completed in the process. It can also represent the time it takes an operator to go through all of his or her work elements before repeating them.

Changeover (C/O) occurs when production has to be stopped for a piece of equipment. This is so it can be refitted to produce a different item. For example, the installation of a different processing tool in a metal working machine; a different color paint in a painting system; a new plastic resin and mold in an injection-molding machine; loading different software; and so on. Changeover time specifies how long it takes between the last good part in the previous run of parts to the first good part in the next run of parts.

The third piece of information in this data box lets us know that we are running one shift.

Finally, the yield measures the percentage of material that is accepted by the downstream operation as being "good" or acceptable without rework. This implies that whatever is left over is scrapped.

As we compare the data across all of the operations, we make the following observations:

- The cycle time for stamp is 1 second:
  - Press = 10 seconds;
  - Weld = 20 seconds;
  - Assembly = 45 seconds
- The changeover times are:
  - Stamp = 90 minutes;
  - Press = 30 minutes;
  - Weld = 30 minutes;
  - Assembly = 30 minutes
- Yields are:

- Stamp = 85%;
- Press = 100%;
- Weld = 90%;
- Assembly = 100%.

Let us assume we know that planning gives a weekly schedule to Stamp, Press, Weld, and Assembly. The schedule is adjusted daily. An information icon (i.e. the Weekly Schedule) represents this and some manual information flow arrows (see Figure 3-17).

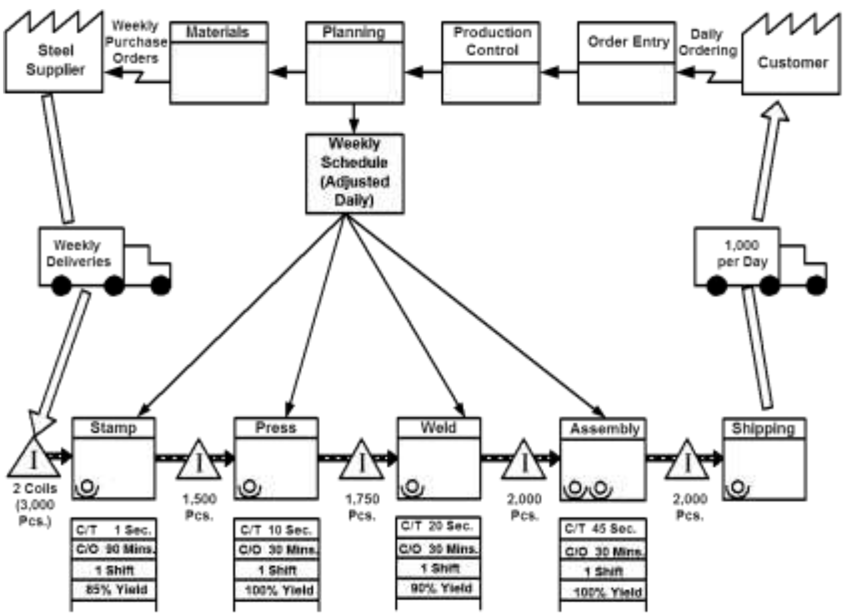


Figure 3-17: Information icon representing a weekly schedule.

The Mock Company does some daily expediting, during which they gather information from each of the operations. They check inventory levels and adjust schedules (see Figure 3-18).

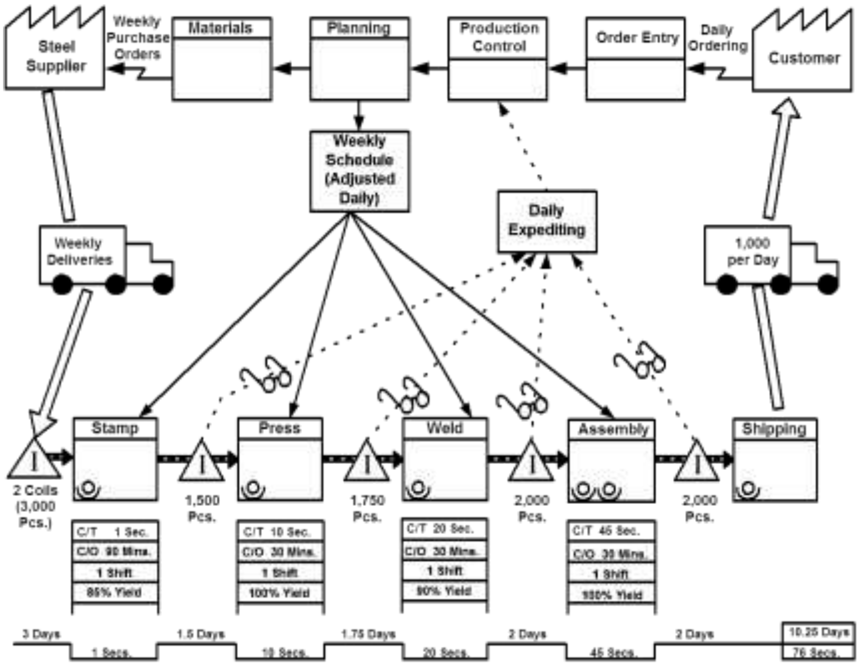


Figure 3-18: The Mock Company's daily expediting activities.

The "eye glasses" represent "Go See", an information icon that symbolizes the scheduling function (or production control). This information is fed back to the Mock Company's production control and then to planning – as indicated by the dotted arrows. Subsequently, schedules are adjusted accordingly.

The graph along the bottom of the map looks at the value added time and the production lead-time. Lead-time is the time required for one piece to move all the way through the value stream from start to finish. By looking at this graph, we can determine the Percent Value Added time for this Product Line.

<u>FACT</u>: The percent VA time in most non-lean manufacturing processes is 0.02%.

A value stream map can be created for every business. The icons used may be different. The process boxes might be labeled differently. The information in the data boxes at the bottom may be used to collect different types of information. The tool though, can be applied to every business.

Value stream mapping is applied to product development, healthcare, dentistry, retail, government, and many other businesses. They all have on one thing in common. They consider time to be a competitive factor for their success. Time is the ultimate measure of determining whether you are working towards a more Lean system. Remember though, we do not focus on eliminating time. We focus on eliminating waste that will result in reducing the time it takes to produce a product. You be certain that you are able to make this distinction.

CASE STUDY: The Mock Company

TASK 2: Evaluating the Current State VSM

The current state map allows us to come to a conclusion about NVA activities present in an organization. This is most effective when everybody is involved. Some of the most significant information will come from the operators themselves; especially, when these people are new hires. As stated earlier, they bring fresh eyes to the situation. Also, remember that the customer's perspective needs to be kept in mind as you highlight the wastes in your system. Now ask yourself, "What is one type of waste you see in the three processes below (see Figure 3-19)?"

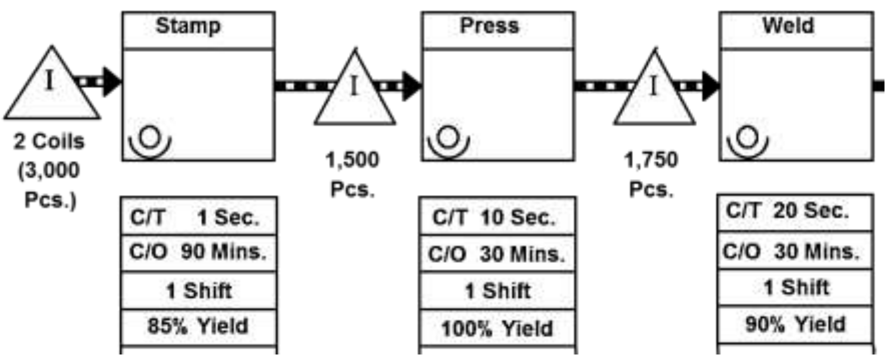


Figure 3-19: Can you see one type of waste in these three processes?

Let us assume you responded, "Scrap." Let us do an evaluation of material waste due to scrap (see Figure 3-20).

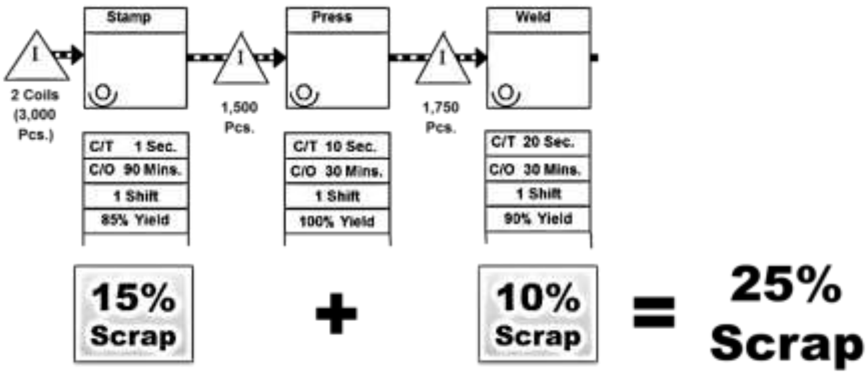


Figure 3-20: An illustration of material waste due to scrap.

We can see from the stamping operation that an 85% yield results in 15% scrap. Welding has a 90% yields and results in 10% scrap. This represents 25% scrap in the entire process. This is 25% scrap that the customer does not want to pay for. Recognize this – scrap represents the waste of defects.

I am sure most of us, intuitively, recognize that scrap is a waste of material. With this in mind, let us take another look at stamping. Stamping has an 85% yield, which means 15% of it is scrap. The time spent producing that scrap is also viewed as a waste. We waste our labor and, more importantly, we incur a lost opportunity to produce a good product. Consequently, this scrap has associated to it a lost opportunity cost. Looking further back in the process, we note that the freight that we spent on the scrap portion of our material is also a waste. This is because we will never use that scrap to produce anything of value.

Sadly, many NVA activities are virtually invisible to us as we are working in the details of the process. Statistically, it has been shown that we cannot see 50% of the waste. This is why I emphasize that we have to ask new employee to help us see the “dumb” things we are doing in our process. By making that inquiry, we are able to identify even more waste. It is a great way to help us see what we need to improve upon. This works in life too.

Undoubtedly, it is not always easy to identify all the waste within a company. In our example above, the scrap report took the Stamp and Weld operators 10 minutes daily to fill out. It then went to the supervisor who compiled all of the data in about half an hour. From there the information traveled to quality assurance, which aggregated the daily figures into a report for their monthly meeting. Do you see where I am going with this?

Naturally, everyone gets concerned about the scrap report. Eventually, it ends up in the hands of production control. Now their team has to accommodate for more materials because of the scrap process. This also has a snowball effect on every person in the organization that is given access to the report and then proceeds to make adjustments.

The real problem, that no one is focused on solving, is the scrap itself. Believe it or not, this is a real issue for many organizations. They spend hours on end measuring things instead of using the same time and manpower to fix things.

Here is an interesting metric. Just to report this kind of waste takes two full time people. This means 16 hours per day used to execute unnecessary activities. Time and manpower is also a waste.

This is why value stream mapping is a very important tool. It brings waste to light so we can see it. Only then can we do something about it.

Let us go a little further with the Mock Company case and identify how much inventory is between the processes. We want to know if there is excess or not, so we actually go out and count the inventory. Looking at the diagram (see Figure 3-21), you will notice there is quite a large amount of inventory.

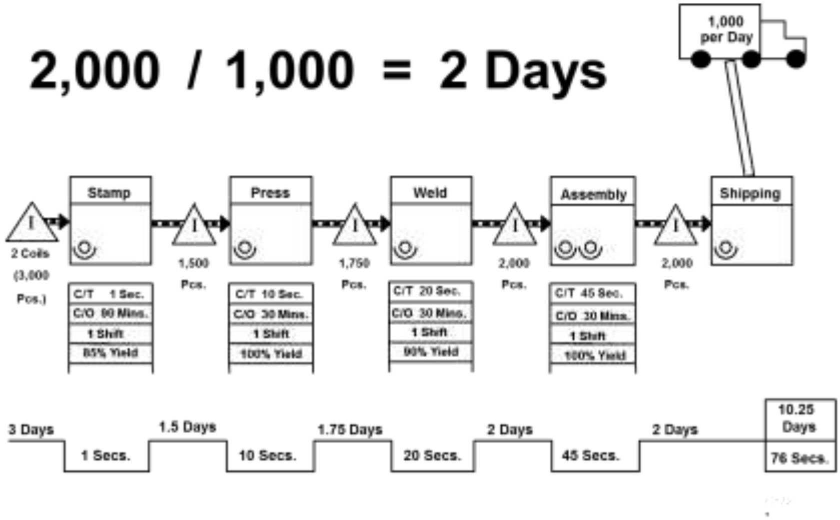


Figure 3-21: Evaluating the amount of inventory between the processes.

How do we know how many days of inventory we have in the system?

We note we have 2,000 pieces of inventory between assembly and shipping and we ship 1,000 pieces per day to the customer. This means we have two days of inventory in that spot. Has anyone ever asked whether we need twice the usable inventory here?

Inventory represents waste in time. As we analyze the process for value added time, we can use information from the data boxes. We consider stamping to be a Value Added activity. In this instance, its Value Added time is 1 second. This is the cycle-time. We consider cycle-time to be value added time. When we sum all of the amounts up we end up with 76 seconds of value added time over a period of 10.25 days.

This may be a little difficult to grasp if you are looking at it for the first time. So here is that “red dot” scenario again (see Figure 3-22).

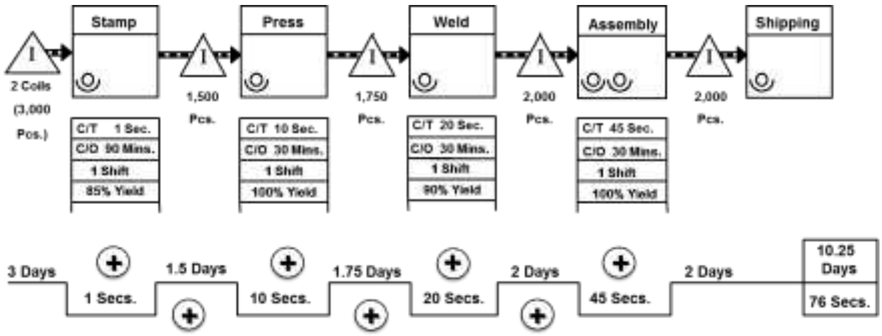


Figure 3-22: Using the “red dot” scenario for understanding.

If we followed a red dot that we placed on a coil at the beginning of our process, it would take 10.25 days for that red dot to get to shipping. Now imagine that we only consider these processes (i.e. stamp, press, weld, and assembly) to be the value added part of our process. This red dot would have 76 seconds of value added time to it. This is terrible! I could not believe this when I first saw a value stream map.

Let us continue. Value added time as a percentage is calculated as follows. Convert the 10.25 days to seconds. There are 60 seconds in a minute, 60 minutes in an hour, and 8 hours in a workday. When you do the math, our workday is equal to…

60 * 60 * 8 = 28,800 seconds

Multiply that by 10.25 days and you get 295,200 seconds. Now comes the shocker! Take 76 seconds and divide that by 295,200 seconds and you get 0.026 % value added time. Notice we used 8 hours in a day (i.e. we could have chosen 24 hours). Regardless of what you use, keep it consistent. This way, improvements are always measured the same way.

Of course, this seemed like a ridiculously small number to me. So I tested the claim with real companies, over and over again. The average I experienced is 0.05% value added time.

The following picture is an actual PAL Manufacturing value stream map (see Figure 3-23).

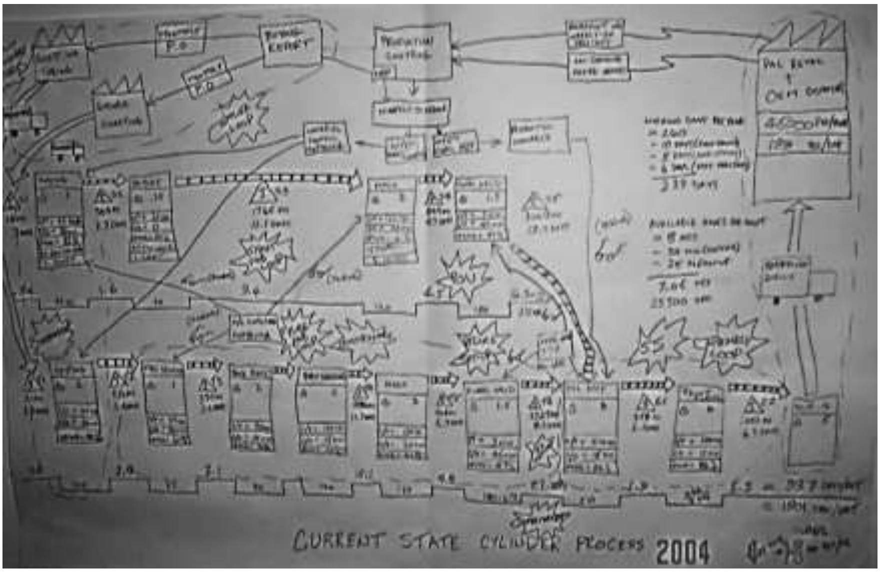


Figure 3-23: PAL Manufacturing value stream map

PAL Manufacturing supplies stock cylinders to over 30 retail stores in Canada. It also engineers cylinders to customer order. To simplify the map we decided to map both custom and standard cylinders. We did this because the main components of the cylinder are the shaft and the tube. The shaft and tube come together in assembly where the cylinder is tested to the final customer specifications. The steps to make the tube are cutting, tube drilling, base plate welding, port weld, machining, final weld and cylinder assembly. When we totaled the numbers, to calculate how many seconds of value added time there was, we got the following. Of 39.7 days for the overall process, we estimated that there was 1800 seconds (30 minutes) of value added activity. It ended up that value was being added to the cylinder only 0.06% of the time. Incredible!

However, I want to point out the biggest “ah-ha”. We had 843 shafts and 1327 tubes of inventory before assembly. Of this inventory, because one shaft goes with one tube, we assumed that we could put together 843 cylinders for the customer. In fact, we only had 110 shafts and tubes that could be matched to make 110 cylinders. The inventory was being made without regard for the customer. The MRP (computer) system in place helped create this Push disaster. Unfortunately, people in this process of pushing work through the shop did not see the waste. When we all saw it, we immediately wanted to fix it.

During the excitement on the shop floor, the engineering team wanted to make improvements as well. Lean Engineering is an interesting concept we can mention here.

When we mapped the information flow, we learned that most of their engineering time was dedicated to managing customer specified cylinders. We decided to focus on this area. It turned out that we could take 625 bills of material and reduces them to just 25. So, we did!

Amazingly enough, the concept of Lean implies that, whatever you choose to do, the result should always be the same. You will do it quicker the next time. This elimination of 600 bills of materials saved the team over 50% of their engineering time.

Lean offers you and your organization a great opportunity to make improvements. Please enjoy the simulation in Chapter 4. All of my implementations on Lean Thinking start with this amazing example. It gets everyone thinking the same way regardless of the industry.

<u>**NOTE**</u>: If you decide to educate your company using the “Airplane Simulation” in this book, make sure to purchase a kit from ***Visionary Products Inc***. They are sure to welcome you as another owner of this powerful educational simulation.

www.visionaryproducts.biz

CHAPTER 4

SIMULATION – SKY VIEW AIRPLANE CO

PUTTING THEORY INTO PRACTICE

Sky-View Airplane Company

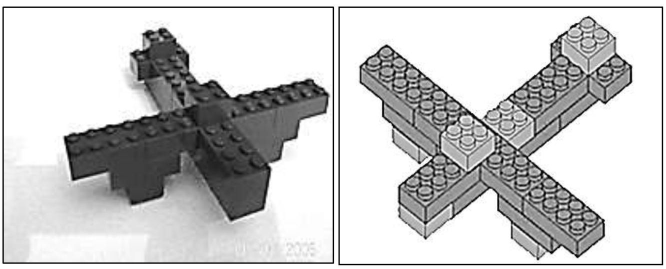


Figure 4-1: A sample of the high quality airplanes they build.

Source: Airplane simulation developed by Visionary Products, Inc.

A "Lean" Simulation

By switching from the Mock Company case study to the *Sky-View Airplane Company simulation,* we can see theory being put into practice. For practical purposes, the simulation uses interlocking-plastic blocks to mimic airplane components (see Figure 4-1). Let us start off by providing some background information on the Sky-View Airplane Company (SVAC). This will help you understand the steps and visualize as we describe, with words and pictures, the events that occurred during our simulation exercise.

Sky View Backgrounder (Information Sheet)

Sky-View Airplane Company (SVAC) produces a high quality product. However, it has large inventories and a history of not being able to deliver on time. Currently, the company is trying to deliver 10 airplanes per day consistently. This has been a challenge.

SVAC is negotiating a large contract, which requires that they guarantee a delivery of 24 airplanes per day. The president of the company is asking his direct reports to help him guarantee 24 airplanes per day. This means in negotiating this contract, they will need to improve on deliveries and increase their production.

SVAC is considered a 'traditional' manufacturing operation. They use quarterly sales forecasts that drive their MRP system. A Master Production Schedule (MPS) is generated through the available information and weekly spreadsheet schedules are prepared and delivered to Workstations 2 and 4. As situational changes occur in the plant, daily adjustments to the schedule are made.

For those who are unfamiliar with the term MRP system, it stands for Materials Requirements Planning System. This consists of taking sales forecasts and putting them into a computer program. The program then computes using a planning process; what the raw material, manpower requirements and other capacity requirements are. This type of information is then used to schedule the facility in order to support its processes.

Daily orders are received from customers and a daily shipping schedule is given to the shipping department, which must ship an average of 10 airplanes per day.

Expeditors conduct daily checks at Workstations 2, 3 and 5 to ensure parts are available to meet the customer's requirements. The information gathered is then fed back to the scheduler.

Sky-View Industries (SVI) is the main supplier of parts to SVAC. SVAC gives Sky-View Industries a monthly forecast of their requirements and sends them purchase orders that will cover them for the following week's production. Sky-View Industries is within 5 miles of SVAC and can deliver any day of the week. SVAC decided that it would take deliveries of parts on Mondays.

SVAC has decided to adopt a 'Lean Thinking' strategy to try to improve their deliveries and reduce their cost of running the company.

The following additional information is available:

- It is assumed all of the critical components required to build the aircraft are brought into the plant from Sky-View Industries.
- At this point SVAC has decided to concentrate its initial efforts on their assembly plant.
- The parts coming into the plant are spot checked for conformance to specifications.

In our simulation, the critical components of the Aircraft are represented by interlocking-plastic blocks, which are stored in raw materials bins and placed somewhere inside the plant.

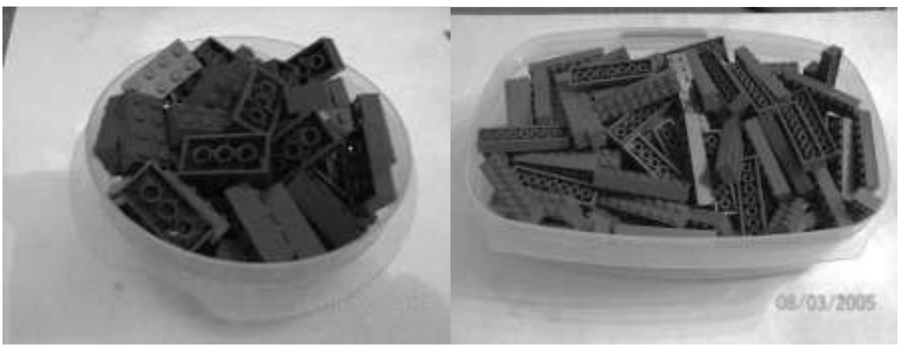


Figure 4-2: Raw materials.

Source: Airplane simulation developed by Visionary Products, Inc.

- The plant operates on a one-shift basis of 8 hours with a 30-minute lunch break and two 10-minute coffee breaks. For our simulation, we run it for 8 minutes. Each minute represents one hour in real life.
- At present, a lack of skilled people has prevented them from operating additional shifts.
- There are no extra shifts available.

There are four assembly operations, one inspection operation and a shipping operation:

1) Assembly of Primary Wing/Airframe Section (Figure 4-3)
2) Assembly of Two Wing Sections (Figure 4-4)
3) Assembly of Large Section of the Tail (Figure 4-5)
4) Assembly of Nose, Fuselage, Cockpit, Tail & Wheels (Figure 4-6)

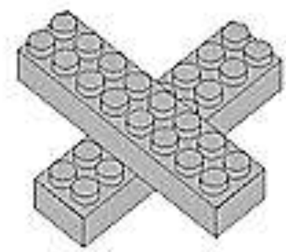


Figure 4-3: Operation # 1

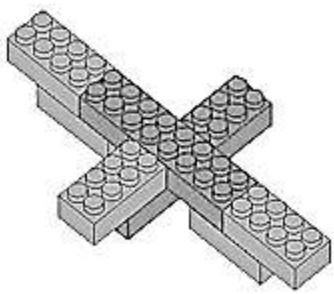


Figure 4-4: Operation #2

Figure 4-5: Operation # 3

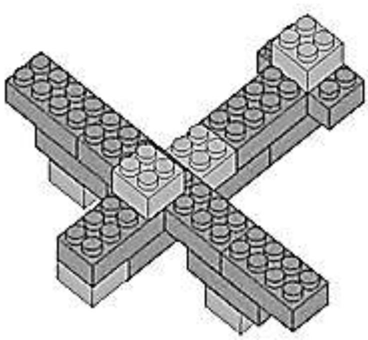


Figure 4-6: Operation #4

Source: Airplane simulation developed by Visionary Products, Inc.

5) Inspection and Quality Control
6) Information Gathering and Shipping

<u>Additional information</u>:

- A “Set-up” or “Changeover” is required at Assembly Operation #3.
- The current plant effectiveness is at 80%.

The Challenge

SKY VIEW AIRPLANE COMPANY

- Traditional manufacturing set-up
- Produces a high quality product
- Has large inventories

By using the principles of “Lean Thinking”, we will explore improvements that will make our customers successful – i.e. by achieving deliveries of 24 airplanes per day.

This is an exciting new opportunity for Sky-View Airplane Company and they are eager to meet the challenge head on.

Deliverables for Airplane Assembly

The following is the airplane assembly layout (see Figure 4-7):

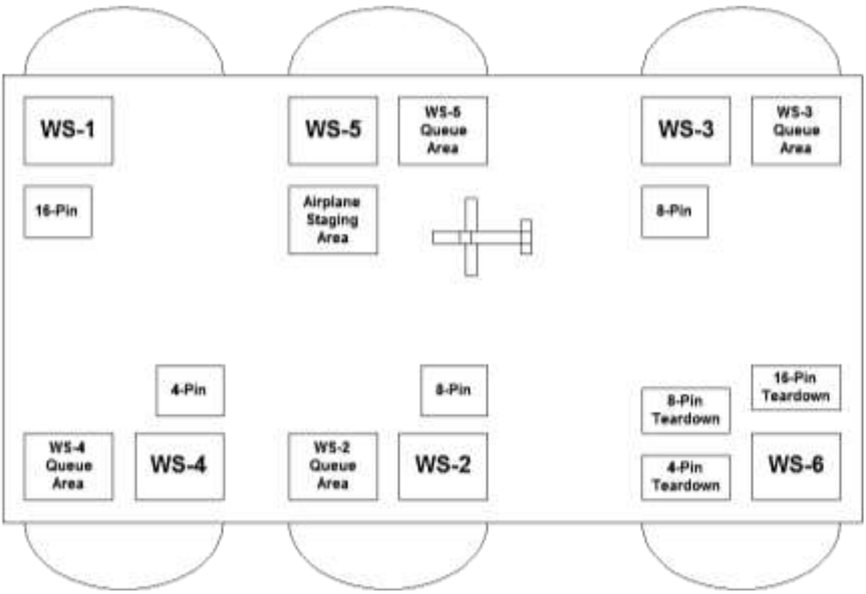


Figure 4-7: Airplane assembly layout.

Source: Airplane simulation developed by Visionary Products, Inc.

Here are the instructions for assembling the airplanes**…**

<u>Operation #1</u>: Primary Wing/Airframe Section

2 – 16 pin blocks are required at Workstation 1. These are assembled at Workstation 1 (see Figure 4-8)

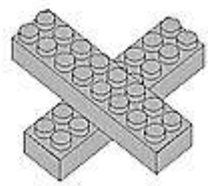


Figure 4-8: At WS-1 the primary wing/airframe section is assembled.

Source: Airplane simulation developed by Visionary Products, Inc.

At this point, the plane moves to workstation 2.

<u>Operation #2</u>: Assembly of Two Wing Sections

Five 8-pin blocks of raw materials are added to the assembly.

The operator adds components to the wings and to the front section of the nose. (see Figure 4-9).

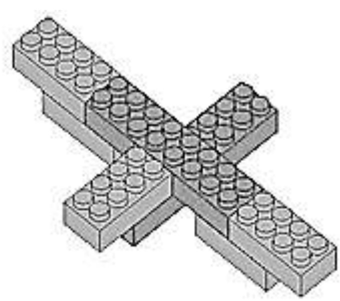


Figure 4-9: At WS-2 the two wing sections are assembled.

Source: Airplane simulation developed by Visionary Products, Inc.

The assembly now moves to workstation 3.

Operation #3: Assembly of Large Section of the Tail

Three 8-pin blocks of raw materials are added which constitute the tail section (see Figure 4-10).

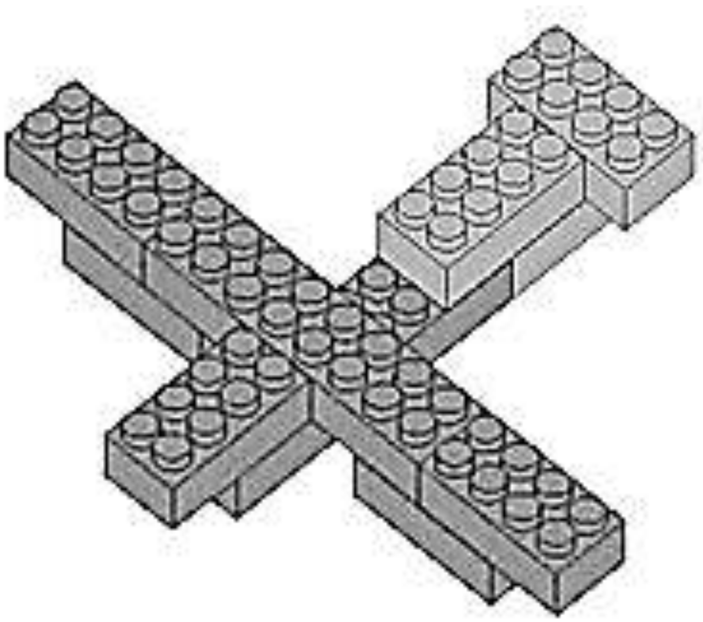


Figure 4-10: At WS-3 the large section of the tail is assembled.

Source: Airplane simulation developed by Visionary Products, Inc.

Once the tail section has been added the operator checks the plane for length using a checking fixture. The plane now moves to workstation 4.

<u>Operation #4</u>: Assembly of Nose, Fuselage, Cockpit, Tail and Wheels

The operator installs the section under the nose, the fuselage, and adds a cockpit, the remaining part of the tail and the wheels using 6 four-pin blocks of raw material (see Figure 4-11).

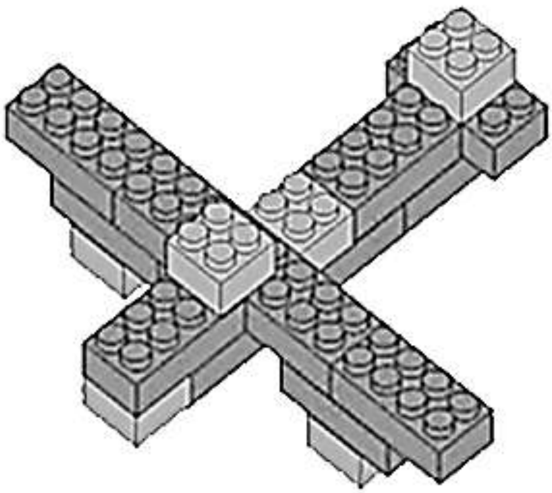


Figure 4-11: At WS-4 the nose, fuselage, cockpit, tail and wheels are assembled.

Source: Airplane simulation developed by Visionary Products, Inc.

<u>Operation #5</u>: Inspection and Quality Control

Operation 5 is a checkpoint, where the assembly undergoes stringent quality control. The operator checks various stress points (see Figure 4-12)

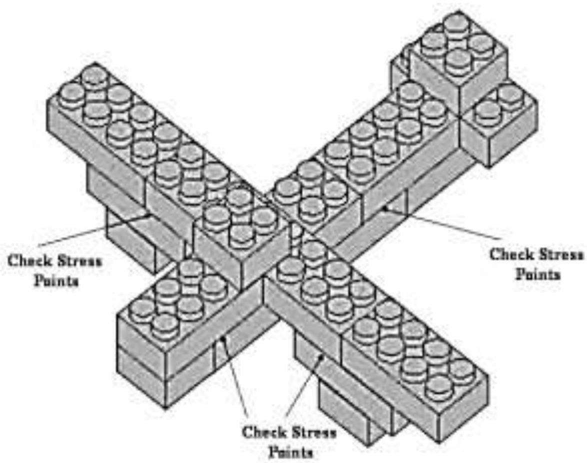


Figure 4-12: At WS-5 the assembly goes through inspection and quality control.

Source: Airplane simulation developed by Visionary Products, Inc.

If a crack in the frame is detected, the aircraft is reworked.

When the plane passes all QC tests, it is sent to workstation 6, which is the shipping area. All planes that arrive at Workstation 6 are considered *shipped*.

Operation #6: Information Gathering and Shipping

The operator counts and records the number of planes that are shipped. These planes are then torn down in order to prep for the next part of the simulation. *The teardown is of no significance to the data being gathered.*

<u>**SPECIAL NOTE**</u>: At Operation 3, there is a changeover required.

Figure 4-13: WS-3 can accommodate special orders for a white airplane.

Source: Refer to www.visionaryproducts.biz

The company makes a white plane whenever a customer puts in a special order (see Figure 4-13).

Steps for Special Order White Plan Changeover

STEP 1: When a white plane arrives into the queue area of workstation 3, the operator must change the checking fixture – which checks length (see Figure 4-14).

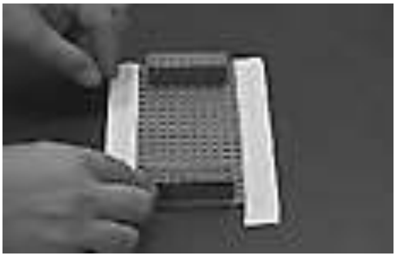


Figure 4-14: Operator must change the checking fixture.

Source: Refer to www.visionaryproducts.biz

The operator must take the tape off the top and bottom of the green fixture.

STEP 2: He must then pick up the green fixture and take it to storage (see Figure 4-15).

Figure 4-15: Operator takes the green fixture to storage.

Source: Refer to www.visionaryproducts.biz

STEP 3: The green fixture is temporarily replaced by a white fixture – i.e. back at workstation 3 (see Figure 4-16).

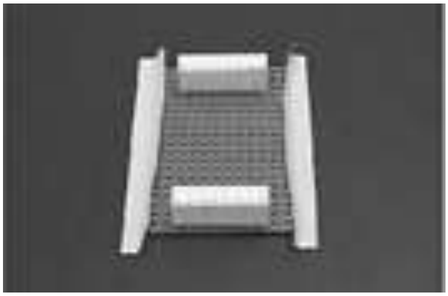


Figure 4-16: Green fixture is temporarily replaced by a white fixture.

Source: Refer to www.visionaryproducts.biz

STEP 4: They must then tape the white fixture down and measure the length of the white plane (see Figure 4-17)

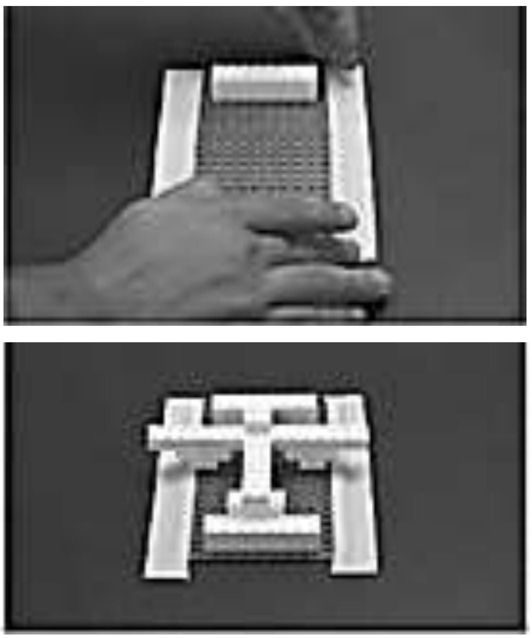


Figure 4-17: White fixture is taped down and length is measured.

Source: Refer to www.visionaryproducts.biz

Repeat STEPS 1-4: Once this is done, the process is repeated, this time from the white fixture back to the green one again (see Figure 4-18).

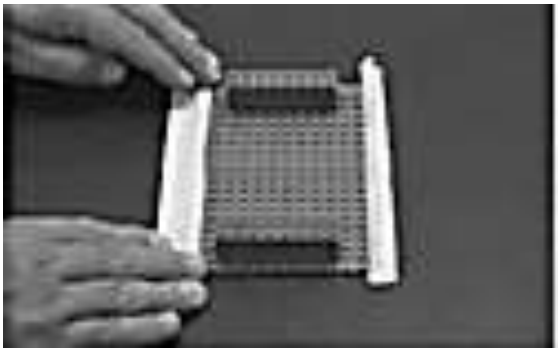


Figure 4-18: Switch back the green fixture in place of the white fixture.

Source: Refer to www.visionaryproducts.biz

When the green fixture is back in place, it is business as usual until the next special order of a white plane.

Finally, there are two engineers who check for performance and record the relevant data. Both engineers use a stopwatch to make their observations.

The first engineer checks for the following cycle times:

- The time of construction at workstation 1,
- The delivery of the assembly or assemblies into the queue of workstation 2,
- The cycle times of movement into each of the subsequent workstations.

The second engineer checks the lead-time. This is the period it takes to move from the beginning of assembly at workstation 1 to the end as a plane goes into the queue at workstation 6 (see Figure 4-19). Remember, every minute of our 8-minute day in the simulation represents one hour of an 8-hour day.

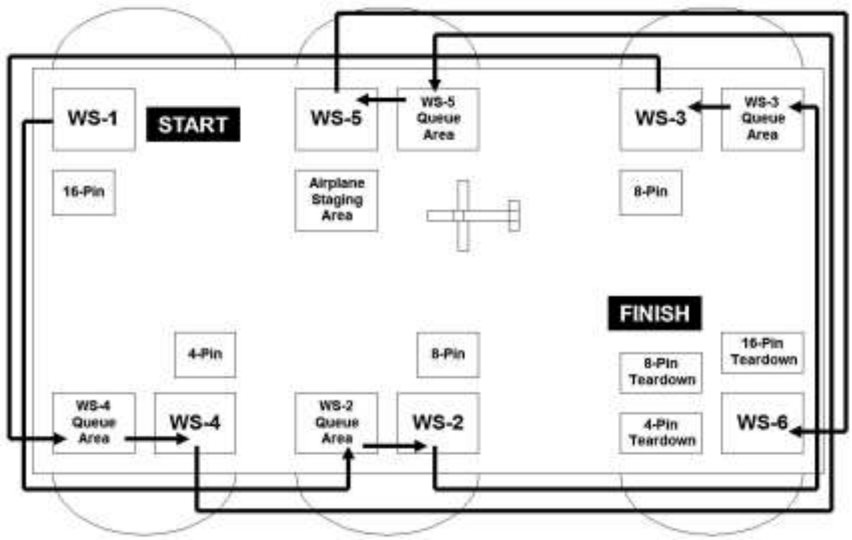


Figure 4-19: The path of airplane assembly for the current state.

Source: Refer **to** www.visionaryproducts.biz

Rules of Engagement

DAY 1 – RESOURCES

- 4 Assembly Stations
- 1 Inspection Station
- 1 Shipping, Tear-Down and Recording Station
- 2 Industrial Engineers

Let us get familiar with the rules of engagement for Day 1.

The resources in the simulation will remain the same for the next three days. Workstations 1 through 4 are assembly stations. We have one operator for each of these stations. At workstation 3, we have a need for a setup. Workstation 5 is an inspection station. We have one inspector at this station. Workstation 6 is for shipping, teardown and recording where an operator records relevant information. We also have two industrial engineers. They calculate the cycle time and lead time through the process using a stopwatch.

We build in batches of 5, because our computers determined the economic order quantity (EOQ) is five. With that number, we hope our cost per unit is less. Batches must remain together through to final inspection. This means the product must be built and transported from one station to the other, right through to workstation 5, then brought to workstation 6 for delivery.

Operators themselves must deliver the batches to the next operation. They cannot move the planes across the table because of safety concerns. They have to get up out of their chairs and deliver the product to the next station.

<u>DAY 1</u> – INSTRUCTIONS

- Build in batches of 5
- Batches must remain together through final inspections
- Operators deliver batches to next operation
- Operators must procure their own parts
- Operators must maintain a steady rate of production

Operators must procure their own parts. When they run out of parts, they must go to material stores and bring back what they need to their stations. Operators must maintain a steady state of production. This means after an operator delivers the appropriate structure to the next workstation, he or she gets back to work and production continues on the next plane.

- At operation 3 a set-up has to be done
- Inspector must identify quality problems and set them aside but cannot communicate with operators
- Tear down operator will gather the data to measure how production is performing

At workstation 3, a set-up is required; we also call this a changeover. We try to do this very consistently each time so the quality of the product remains the same. We need to go through a standard operating procedure with very specific rules on setup so that the time and product quality are taken into account each time. The inspector must identify quality problems and set the planes aside. They cannot communicate with the rest of the plant, which is not unusual in this type of environment.

At workstation 6, the operator handles the shipping, tear down and recording. The operator considers the product shipped at that point in time. The information needed for daily production numbers is recorded at this time. This feedback is given to production to indicate how well they are doing.

Generating the Sky View Airplane Co. (SVAC)

Current State Map for the Start of the Simulation

Before we start our simulation, it is important to be able to visualize the entire business. For this reason, we are going to create a Value Stream map prior to starting the simulation (see Figure 4-20 on the next page). First, you draw the customer on the right hand side with their requirements as of today. In this instance, the requirements are 10 per day. The new contract calls for 24 planes per day but – if we do not understand our current state – there is no way we should be experimenting with our future.

After placing the customer icon on the right hand side of our over-sized piece of paper, we start to identify the current requirements from our customer. Then we work our way upstream from the customer to our shipping department. We identify how we ship to our customer. Then we follow with all of the assembly processes (5 through 1) and continue upstream of that to our supplier. Our observations of our inventory levels in the past are averaged as shown below. We have 60 sets of parts in the warehouse, which is put on the map as well.

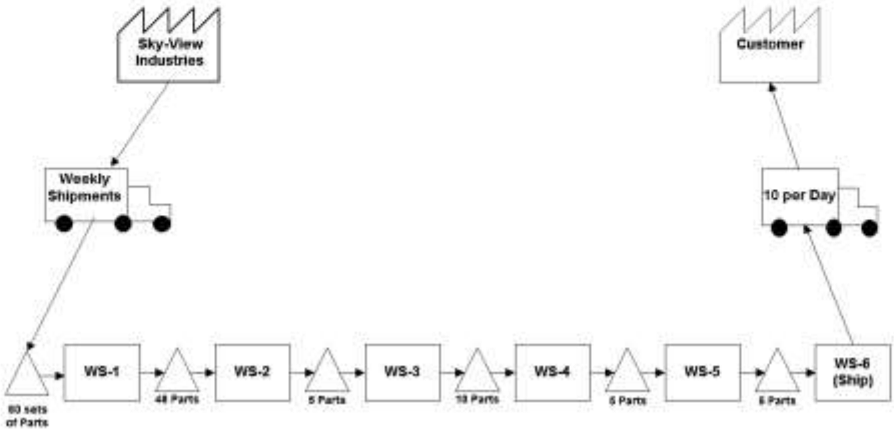


Figure 4-20: The Sky View Airplane Co. (SVAC) current state map.

SVAC gets weekly shipments from SVI (Sky-View Industries). We show this as information that we place on the truck icon between the supplier SVI and SVAC. We average 60 sets of parts in our warehouse so we use the average.

Cycle time represents the number of seconds it takes to do one operation at workstation one for one part. As you know, we run based on our MRP systems recommendations of making five airplanes each time. Therefore, we have to take the time related to making five airplanes and divide that by 5 to get the cycle time (C/T) per airplane.

We are interested in the value added time for one airplane. Thus, we add up the cycle times in each of the assembly stations to get this total value-added time.

At workstation 3, we have a change over time. We indicate this separately, and do not consider it as part of our cycle time. We can now put the information on a graph to better analyze our production. Looking at other relevant information in map, we see that our utilization for the company is 80% (given to us from the data). This implies our productivity level is about 80% (see Figure 4-21).

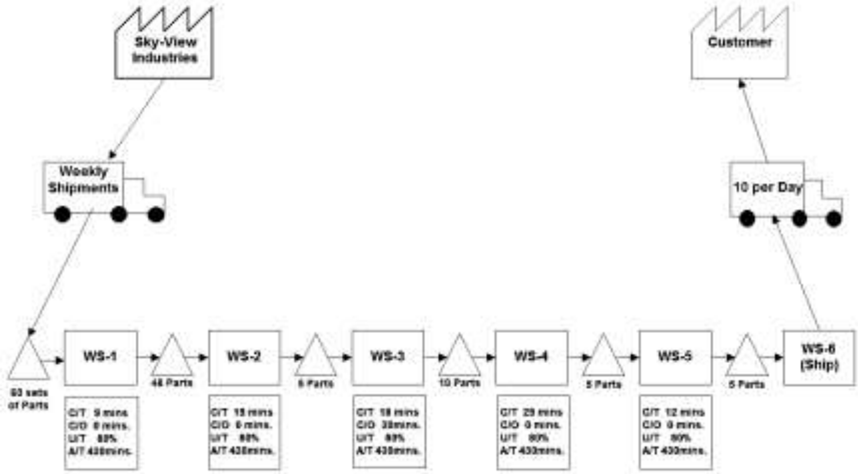


Figure 4-21: The data implies that the productivity level is 80%.

Our available time is 430 minutes out of a day. If you are wondering how we came up with 430 minutes, its 60 minutes per hour x 8 hours/day = 480 minutes/day, minus (30 minutes for lunch and two 10 minute breaks) 50 minutes/day = 430 minutes/day (see Figure 4-22).

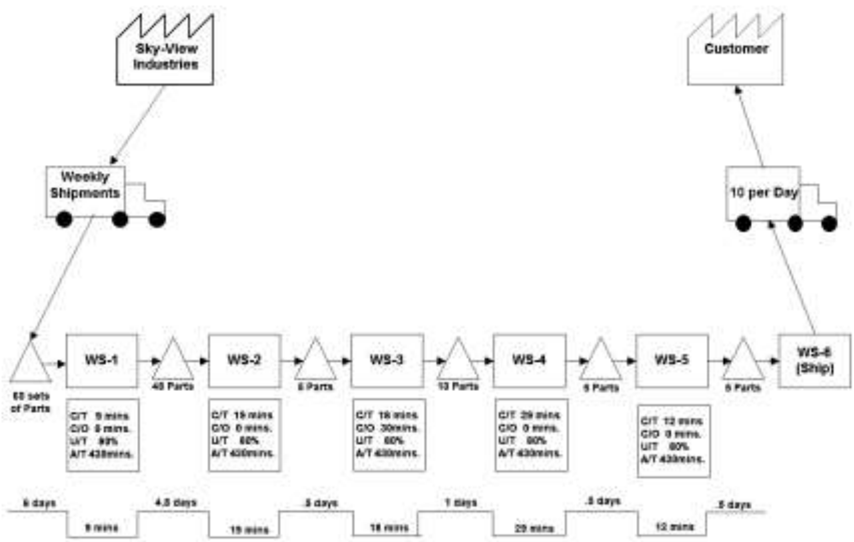


Figure 4-22: Identifying the value added time spent assembling airplanes.

We have identified how much value added time we are spending on these particular planes. With the inventory levels as stated, we convert that into number of days of supply.

Is there any value added at workstation 5? Quality is important for the customer, so you would be inclined to say yes. Even if we did it right the first time, does the customer care about it? In this case, yes. The customer expects the inspection process to happen and recognizes they must pay for this. In most companies, inspection is not viewed as value added; we would classify it as a type 2 waste – Non-value-added but necessary. If we do not inspect here, we could be passing on defects to the customer. The US Air Force and the Canadian Air Force want the inspection done for their records and for obvious reasons.

It is time to convert the data to meaningful information. If I were looking at a value stream map, I would always look at the bottom line. The bottom right hand corner in this case (see Figure 4-23). It tells the whole picture. Here is how to interpret this.

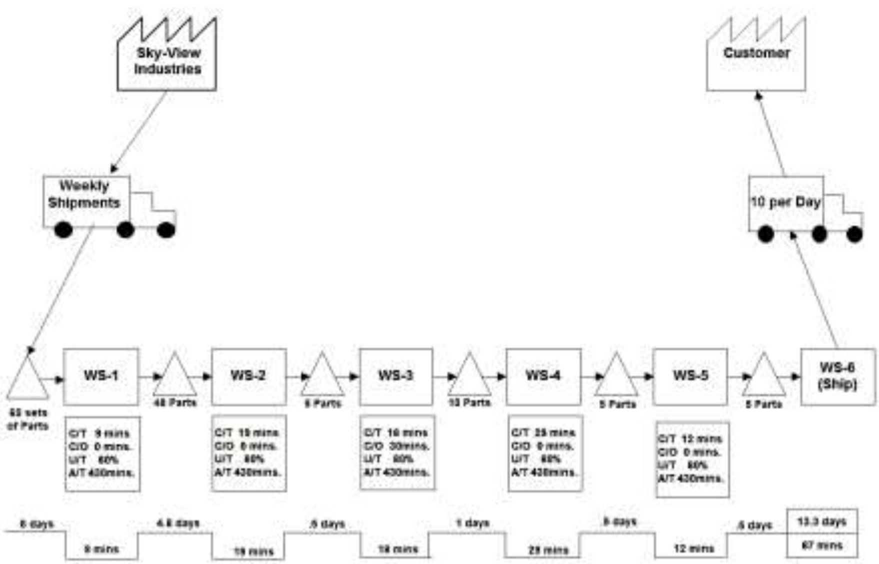


Figure 4-23: Getting to the meaningful information at the bottom of the map.

First, we convert our entire inventory to “days of supply.” For example, given we produce ten planes per day and we have 5 parts (airplanes) on hand, we have half a day of inventory. At ten parts between station 3 & 4 we have one day of inventory.

With 48 parts between station 1 and 2, we have 4.8 days of supply. In our system, we have quite a few days of inventory; i.e. when you add it up and take a look at the value added process.

The available supply is 13.3 days and we have a total of 87 minutes of Value Added Time. To get a percent for the value added time – convert the 13.3 days to minutes, then take 87 minutes and divide that by the 13.3 days (in minutes), then multiply by 100. It is a small percentage, more on this later.

The value stream map does not end with the material flow. We are actually looking at the information flow as well (see Figure 4-24). We get quarterly sales forecasts from the customer, along with their daily orders. It all goes into our MRP System; we then send a monthly forecast to our supplier, along with weekly deliveries, amounting to a weekly schedule.

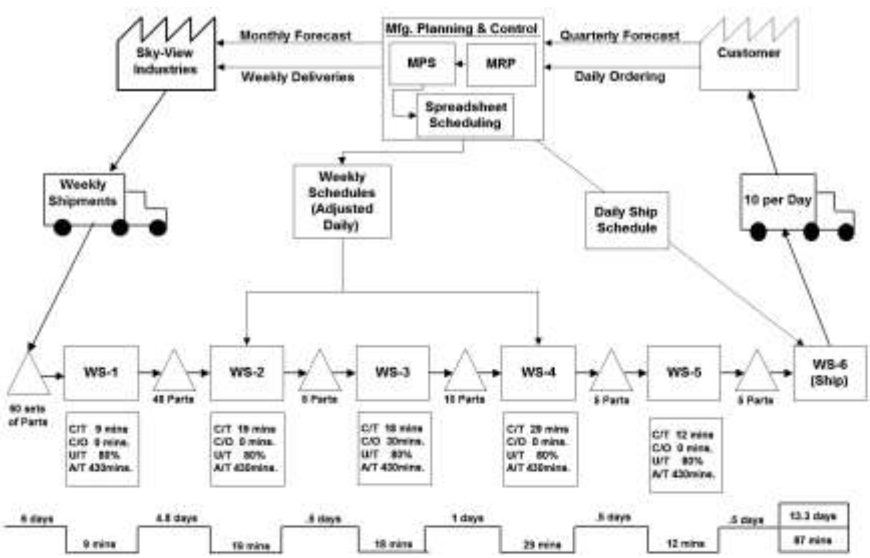


Figure 4-24: Note the information flow at the top of the VSM.

Recall that we have daily checks at Workstations 3, 4, and 5. We use "Go See" icons (glasses) to remind us to perform daily checks at those workstations (see Figure 4-25).

Is this wasteful?

Of course, the customer does not care about checking inventory.

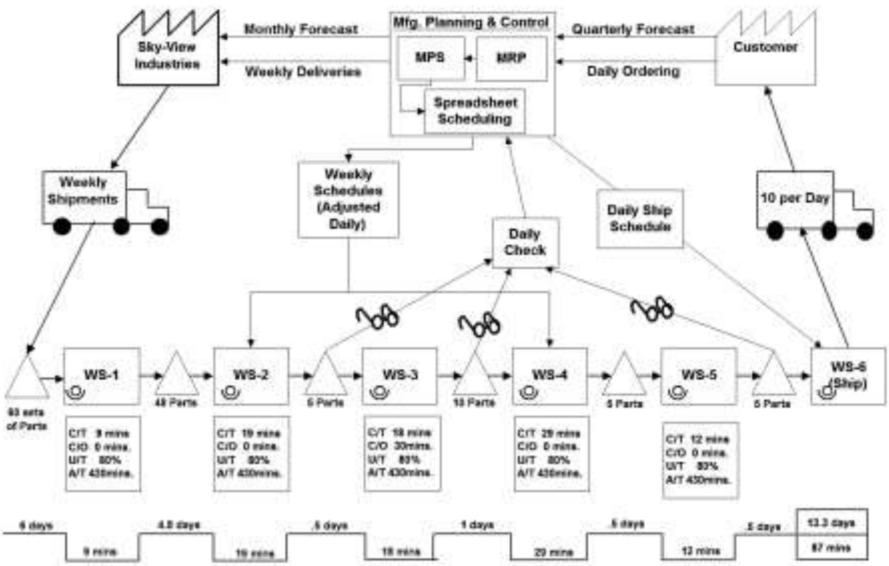


Figure 4-25: Note the daily checks at Workstations 3, 4 and 5.

This map now gives us a concrete idea of how we are doing business today. It also provides us with an understanding of how much inventory we are sitting on. We can see how it is flowing towards shipping to support the output of 10 planes per day. Having developed an understanding of our business is important; this should always be done before we start making improvements.

Start of Simulation – Ready, Set…Go!

We begin a day in the life of Sky View Airplane Company (SVAC). It all starts with observation. Before you go through a Plan-Do-Check-Adjust process, you should observe.

In this simulation, **Day 1** represents an understanding of the current state of SVAC. After an 8-minute simulation, we understand what some of the problems are. For the purposes of this simulation, one minute is equal to one hour of SVAC time; one second represents one minute of SVAC time.

So let us get started into our 8-minute day. Remember, we have two engineers, so one will measure the cycle time and the other will measure the overall lead-time. *Ready, set…GO!*

Timer: 00:00 of 08:00
Event: Production starts

Operator 1 completes his first batch of five and delivers into the queue of workstation 2 in good time (see Figure 4-26).

<u>Observations</u>:

- This workstation has the smallest workload and experiences the fastest cycle time.
- This results in overproduction. A fast cycle time is a smaller number.

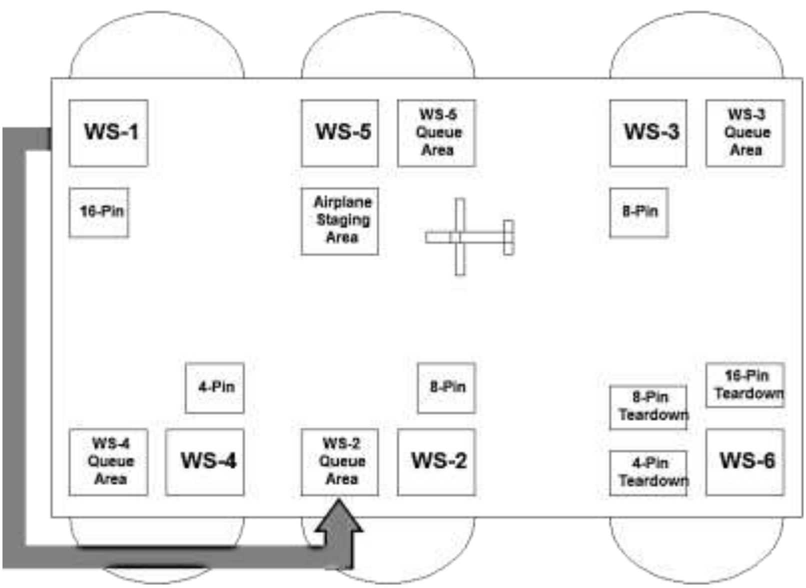


Figure 4-26: Day 1 at 00:00 min.'s of production.

Timer: 00:51 of 08:00
Event: First batch of five received in WS-2 Queue

Operator 2 takes more time to complete his assemblies (see Figure 4-27).

<u>Observations</u>:

- This results in a slower time (i.e. a longer cycle time) than that of Operator 1.
- Before operator 2 can complete the work, inventory starts to build-up between Workstations 1 and 2.
- This reinforces that there is an imbalance in the workloads; the waste of unnecessary inventory represents this.

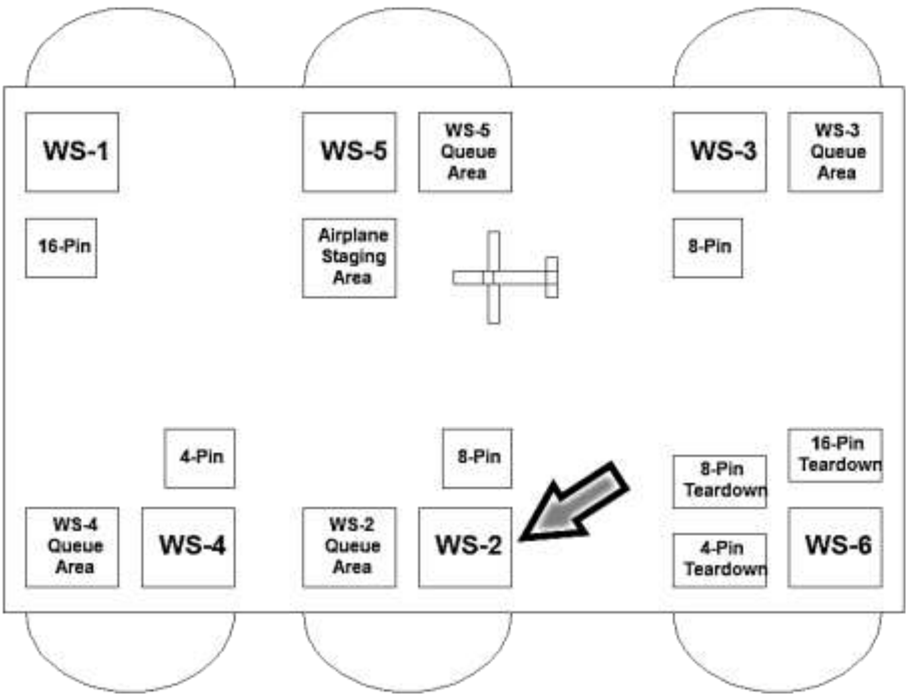


Figure 4-27: Day 1 at 00:51 min.'s of production.

Timer: 01:26 of 08:00
Event: Operator 2 moves work-in-progress inventory to Operator 3

Operator 2 delivers into the Queue of Workstation 3 (see Figure 4-28).

<u>Observations</u>:

- We note that all of the operators are experiencing the waste of transportation.
- The waste of transportation occurs each time an operator delivers the work-in-progress batch into the queue of another workstation.
- It also occurs when they go and get more raw materials from stores, which are located a fair distance from the point of use.

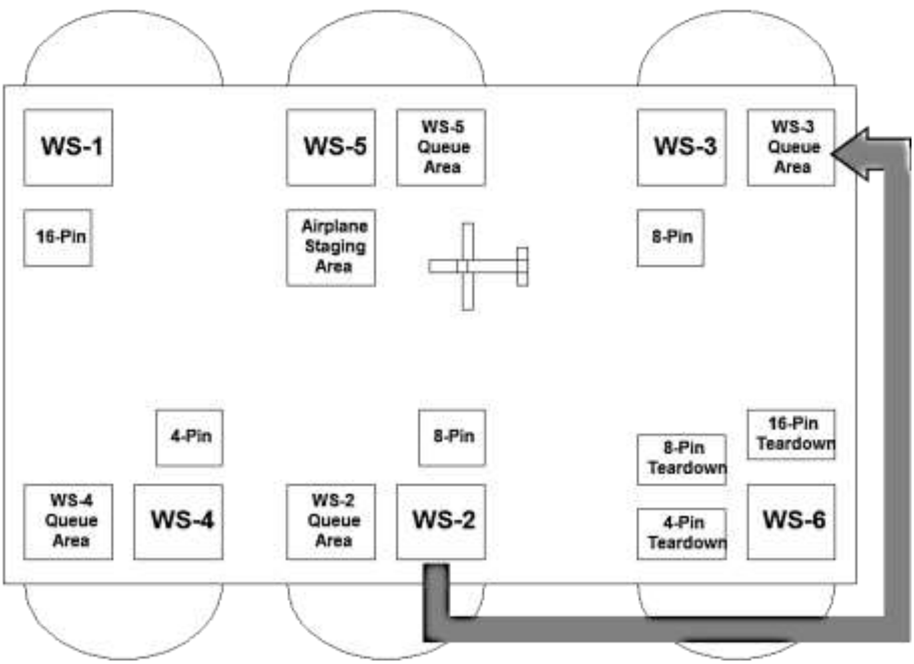


Figure 4-28: Day 1 at 01:26 min.'s of production.

Timer: 02:34 of 08:00
Event: First batch of five received in WS-3 Queue

Operator 3 must deal with extra responsibilities.

Timer: 03:00 of 08:00
Event: Start of Changeover (C/O)

Operator 3 must do a set up (changeover) of fixtures during this first batch to accommodate white plane orders (see Figure 4-29)

Observations:

- This results in the slowest cycle time amongst all the workstations.
- One extra responsibility is checking the planes for length.
- The white plane fixture is located some distance from the point of use.
- The extra responsibilities and transportation required of this operator will result in some inventory buildup between Workstations 2 and 3.

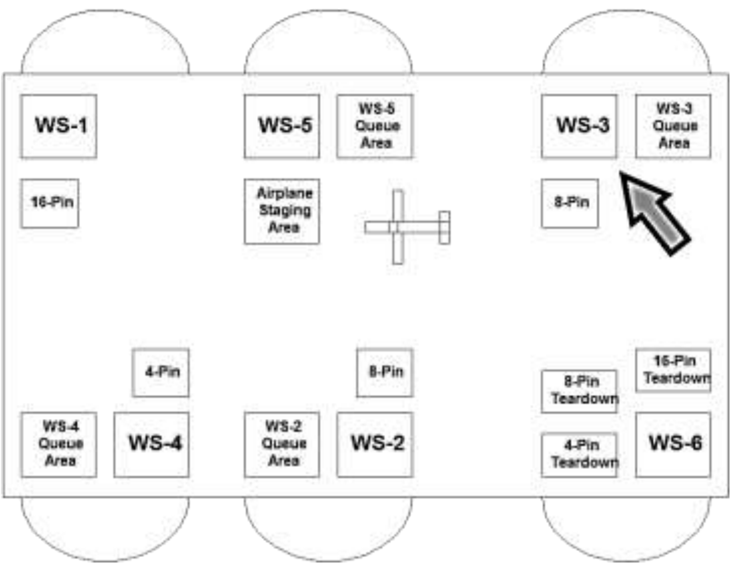


Figure 4-29: Day 1 at 03:00 min.'s of production.

Timer: 03:48 of 08:00
Event: First batch of five received in WS-4 Queue
Operator 3 completes the first batch and delivers it into the queue of Workstation 4 (see Figure 4-30).

<u>Observations</u>:

- The operator at Workstation 4 has been waiting a long time for the first batch to arrive from Workstation 3.
- A plant accident occurs during this drop-off due to elevated stress levels among the workers. Dealing with it results in a brief break in productivity.

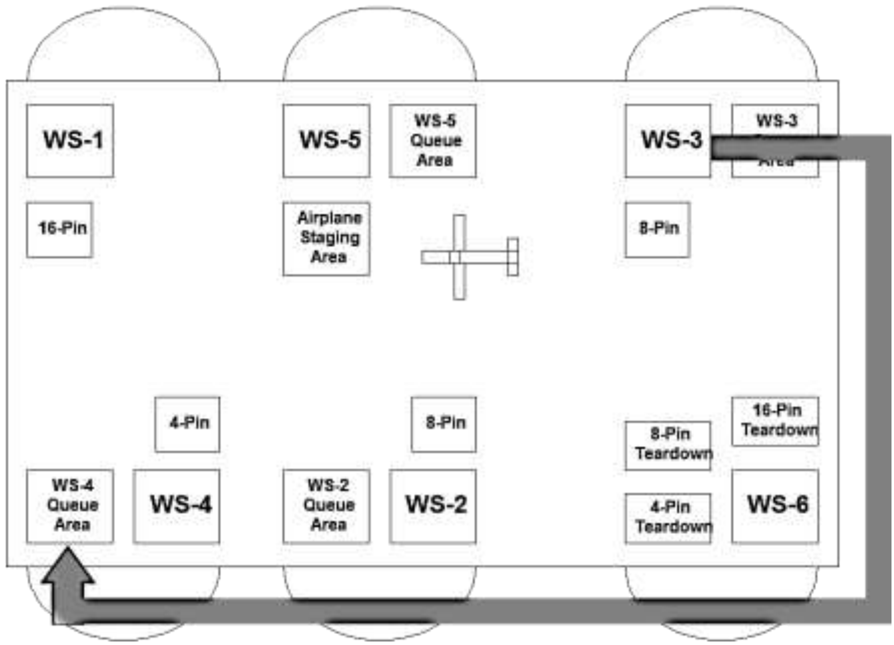


Figure 4-30: Day 1 at 03:48 min.'s of production.

Timer: 05:08 of 08:00
Event: Defect noticed at Workstation 4

The occurrence of some defects in airplane construction is noticed at Workstation 4 (see Figure 4-31).

<u>Observations</u>:

- This adds to operator 4’s cycle time.

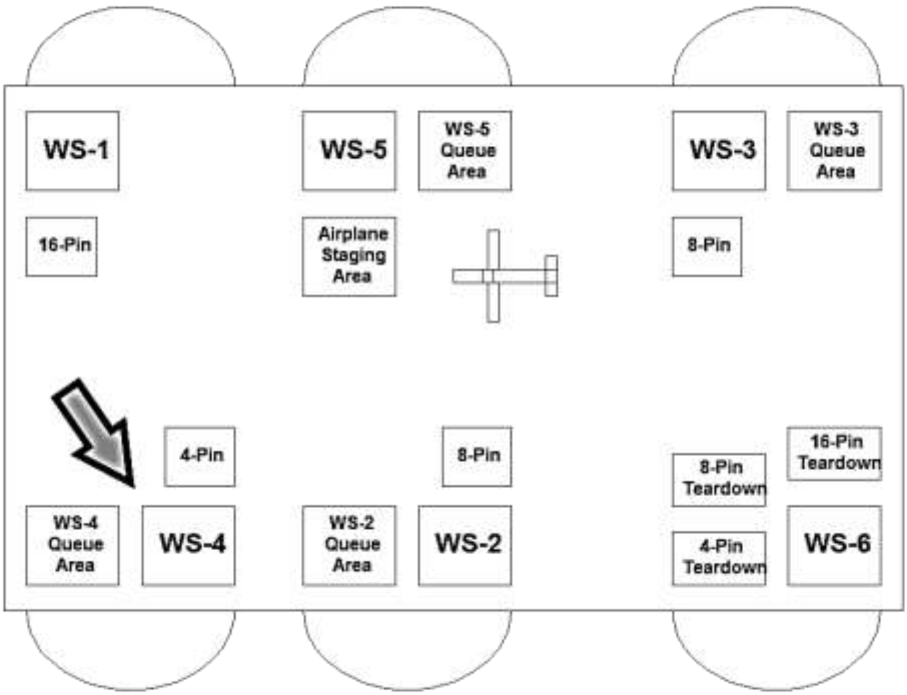


Figure 4-31: Day 1 at 05:08 min.’s of production.

Timer: 06:00 of 08:00
Event: Whistle blows – the simulation is paused temporarily

The simulation is paused at exactly 6 minutes (6 hours) into our Day 1 of assembly.

Observations:

- Operator in WS-4 is still working to assemble the nose, fuselage, and cockpit when, all of a sudden, a whistle blows.
- We are now 6 hours into the SVAC workday and the inspector at Workstation 5 has not received any planes yet.
- The operator at Workstation 6 has not started working either.
- They have been waiting patiently….

ASIDE: We have a little over 2 minutes left in our simulation. For the purposes of discussing potential scrap costs, each operator counts how much inventory is in their area and in the queue of the next workstation. ***The clock then starts up again.***

Timer: 06:33 of 08:00
Event: First batch of five received in WS-5 Queue

Workstation 5 has received the first batch of five and is in the process of inspecting them (see Figure 4-32)

<u>Observations</u>:

- In the final minutes of the simulation, this team has predicted that they will complete the batch of five. This is nowhere near the expected shipment of 24 the customer wants. However, our understanding is starting to deepen as to why.

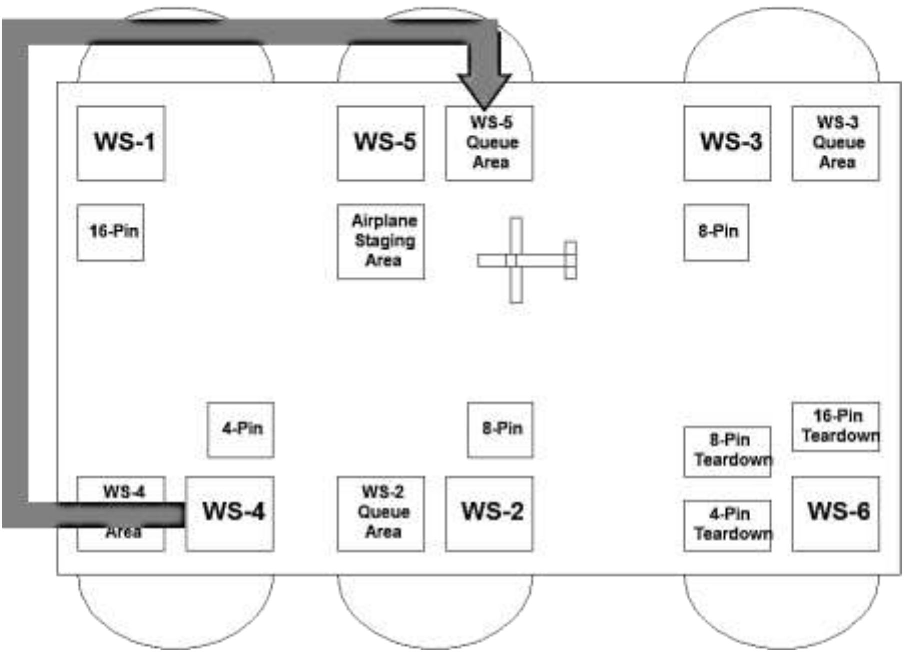


Figure 4-32: Day 1 at 06:33 min.'s of production.

Timer: 07:08 of 08:00
Event: Defective airplane noticed

The inspector at Workstation 5 declares one of the airplanes as defective. As a result, only four planes make it to shipping before the 8-hour day is over.

Timer: 08:00 of 08:00
Event: Whistle blows – the day is over

The team has shipped four airplanes by the end of Day 1. As soon as the airplanes arrived in WS-6, we considered them shipped (Figure 4-33)

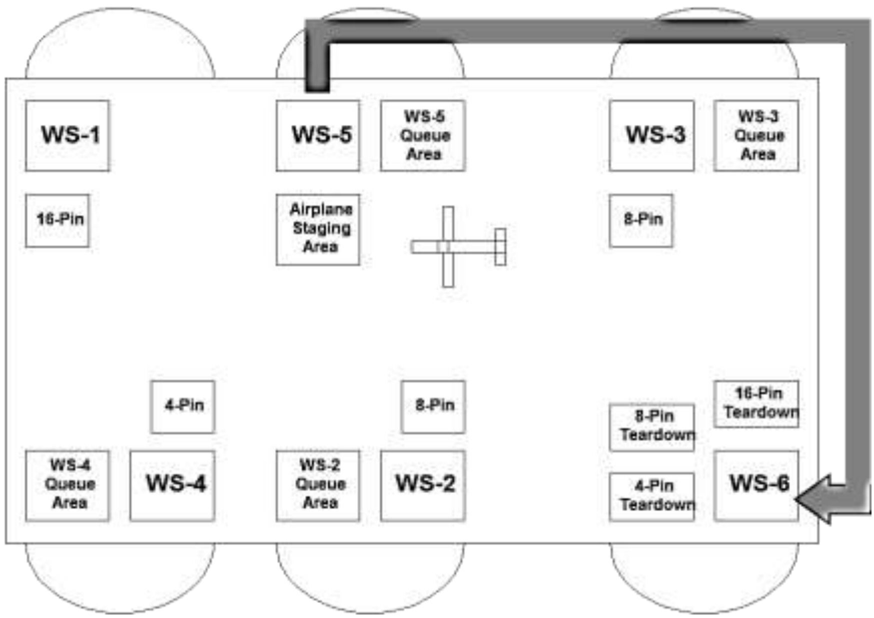


Figure 4-33: Day 1 at 08:00 min.'s of production.

Discussion: Day 1 – Scrap Costs

At this point, we will rewind our timer back to the 6-minute mark in order to have a discussion about what occurred at that time…

Timer: Rewind to 06:00 of 08:00
Event: Raw materials failed our inspection process

Let us talk about why this occurred -- let us talk about scrap.

Suppose we have a customer ordering an airplane. Airplanes are expensive and must meet the specifications of the customer. In this case, the customer only wants a certain type of steel to be used. This particular type of steel does not repel lightning as well as other types of steel.

The company's engineers test this steel regularly because the suppliers send the wrong material from time to time.

This inspection happens at 2:00 pm, which is 6 hours into the 8-hour shift.

In this case, let us assume they received a bad batch of steel. All of the airplanes produced during this shift would not meet the customer's specifications.

How much would it cost us to tear them apart and rebuild them?

If the wrong steel is used, what is the exposure to this problem?

EXPOSURE = (Number of Assemblies) X (Cost Per Assembly)

The exposure is calculated by multiplying the number of assemblies by the cost per assembly. It makes sense for us to say that in order to minimize the potential scrap cost the amount of inventory in the plant should be kept as low as possible.

Now let us take a look at what our scrap exposure is for the Sky-View Airplane Company. This table shows all of the scrap cost calculations (see Figure 4-34).

Sky-View Ariplane Company

Scrap Costs Calculation

16 Pin Costs	$10,000.00	8 Pin Costs	$5,000.00	4 Pin Costs	$3,000.00

Day 1	Scrap									
		16 Pin			8 Pin			4 Pin		
	Sub Assy's	Parts per Assembly	Total Parts	Cost	Parts per Assembly	Total Parts	Cost	Parts per Assembly	Total Parts	Cost
Workstation 1	22	2	44	$ 440,000	0			0		
Workstation 2	9	2	18	$ 180,000	5	45	$ 225,000	0		
Workstation 3	6	2	12	$ 120,000	8	48	$ 240,000	0		
Workstation 4	0	2	0	$ -	8	0	$ -	6	0	$ -
Total Sub Assy's	37			$ 740,000			$ 465,000			$ -

Total Scrap Cost **$ 1,205,000**

Figure 4-34: SVAC Day 1 Scrap Costs.

The first step is to count the number of assemblies between WS-1 and WS-2. We count all of the assemblies finished either in WS-1 or in the queue of WS-2. Remember, this was done at 06:00 minutes into our simulation. At that point, in time we only had inventory up to WS-4; none of the inventory had made its way to WS-5 yet.

Each piece of interlocking-plastic block in our assembly has a cost. The 16-pin pieces are $10,000 each. The 8-pin pieces are $5.000 each. The 4-pin pieces cost $3,000 each. The number of assemblies between WS-1 and WS-2 is 22; at two parts per assembly, it is equal to 44 parts. Each of these parts are 16-pin parts; there are 44 parts at $10,000 each for a cost $440,000.

We can do similar calculations for each finished sub-assembly. We note the high cost of the assemblies between the workstations 3 & 4. At the six-minute mark, there are no assemblies between workstations 5 & 6 yet. The total cost for the 16-pin assemblies is $740,000.

The total cost for the 8-pin assemblies is $465,000. The total scrap cost is calculated to be $1,205,000.

If SVI were to send us the wrong kind of steel, the manner in which we produce airplanes in Day 1 costs our company $1,205,000 in scrap. It makes sense that we should keep the number of sub-assemblies between workstations as low as possible.

Discussion: Day 1 – Inventory Carrying Cost Calculations

Carrying cost is a measure usually expressed as a percentage of the cost to hold inventory. Simply put, inventory that sits in the plant has a cost associated to it (see Figure 4-35).

Figure 4-35: Inventory that sits has a cost associated to it.

The following costs contribute to this…

- The item
- Insurance
- Obsolescence
- Theft
- Damage
- Storage

It is extremely important that our company associate inventory as a liability and not as an asset. Many companies perform year-end inventory counts. Sky-View Airplane Company is no different.

Let us assume that the company uses a bank for financing. If the bank were to charge SVAC for the risks that it takes in financing their inventory, it would go about it in a very thorough manner. The bank would calculate what it needs to charge on the overall annual inventory tied up by the company. They would count material or physical inventory between machines, processes, or activities waiting to be processed. The bank charges 24% interest per year on the carrying costs for your inventory. This means it charges 2% per month. We use this number for purposes of making our point; inventory costs money. If we do not associate a cost to the inventory, we will not consider it a problem. Inventory levels above a strategic minimum should be considered a problem.

The assumption is that the amount of inventory does not fluctuate too much. As long as this system remains the same, this count is a valid measure with which to determine your monthly average.

We calculate the carrying cost by multiplying the inventory value by 2%. At the end of day 1, we stopped after 8 hours of work.

At this point we ask ourselves, what if that was the amount of the inventory at the end of the month. We assume this is true and complete our carrying cost calculations.

Our count becomes the amount we use to represent the physical inventory at the end of the month. For example, the amount could be $250,000 worth of inventory. Multiply that by 2%; our inventory costs become $5,000 per month. So, in some ways, that 2% is the cost of borrowing money from the bank.

Let us take a look now at the inventory carrying costs for SVAC operations. This table shows all inventory carrying cost calculations (see Figure 4-36). That is, for Work in Progress.

Sky-View Ariplane Company

Inventory Carrying Costs Calculation (WIP)

16 Pin Costs	$10,000.00	8 Pin Costs	$5,000.00	4 Pin Costs	$3,000.00

Day 1	Inventory									
		16 Pin			8 Pin			4 Pin		
	Sub Assy's	Parts per Assembly	Total Parts	Cost	Parts per Assembly	Total Parts	Cost	Parts per Assembly	Total Parts	Cost
Workstation 1	25	2	50	$ 500,000	0			0		
Workstation 2	7	2	14	$ 140,000	5	35	$ 175,000	0		
Workstation 3	9	2	18	$ 180,000	8	72	$ 360,000	0		
Workstation 4	6	2	12	$ 120,000	8	48	$ 240,000	6	36	$ 108,000
Workstation 5	0	2	0	$ -	8	0	$ -	6	0	$ -
Workstation 6										
Total Sub Assy's	47			$ 940,000			$ 775,000			$ 108,000

Total Inventories	$ 1,823,000
Carrying Cost per Month (2%)	$ 36,460

Figure 4-36: SVAC day 1 inventory carrying costs.

Our first step is to calculate the amount of inventory between WS-1 & 2. There are more assemblies now because we have completed the last two hours of our workday. Once again, we count all of the finished assemblies in WS-1 and in the queue of WS-2.

As we stated earlier, each Lego piece in our assembly has a cost. The pin cost remains the same as in the earlier calculations.

We calculate the cost of assemblies in the same fashion as in the scrap table.

Thus, in this example the total cost for the 16-pin assemblies is $940,000. For the 8-pin assemblies the cost is $775,000. For the 4-pin assemblies the cost is $108,000. Our total inventory cost for stock between WS-1 to WS-6 is $1,823,000.

At 2% per month, this works out to be $36,460 per month. This means that the manner in which we are doing business on day one costs our company $36,460 per month for the inventory carrying costs. It will be our goal to reduce the amount of inventory that sits between our workstations. This in turn will bring our costs down and will make us more competitive.

Gathering Data – SVAC Future State Requirements.

$$\text{TAKT Time} = \frac{\text{Available Time}}{\text{Customer Demand}}$$

Let us graph out our findings to give our engineers some numbers to work with. Following that, we are going to develop what is called a TAKT time. TAKT is German for the word 'beat'. Thus, it is the beat of the drum, or, beat of the market (the customer). How many planes does our customer want? They want ten right now. 24 if we can guarantee the 24. We have to translate the Customer's requirements into our organization. Currently, we need to get 10 planes out per day. What does our TAKT time need to be? In the future, if we want to get 24 planes per day, how many planes do we need to get out per minute? Maybe a better question is: How many minutes does it take to get a plane out?

Let us look at how we calculate TAKT time. We can use PAL Manufacturing as an example.

The demand for cylinders was 45,000 per year. When we looked at it, we said we had 480 minutes available per shift. We were running two shifts, giving us an available 960 minutes per day. What we want to do is get 200 cylinders out per day. If we could get 200 cylinders per day, we would have no problem in attaining the goal for the year.

If we can this amount every day, we know we can easily produce the target number of cylinders per year.

- Available Time per Shift = 480 mins.
- Number of Shifts = 2
- Total Available Time = 960 mins.
- Customer Demand = 45,000 units/year

- TAKT Time = $\dfrac{\text{Available Time}}{\text{Customer Demand}}$

TAKT time is simply the available time we have during the day divided by the customer demand.

In this case, we have 960 minutes available in the day divided by the daily 200 cylinders. This turns out to be one cylinder every 4.8 minutes. This is what our TAKT time is. Knowing the TAKT time is critical to helping us balance the work between stations. Each station's cycle time must be lower than the TAKT time.

Let us calculate our TAKT time for the Sky-View Airplane Company. In our day, we have to calculate the available minutes. You get a paid 30-minute break, and two 10-minute breaks. This leaves us 430 minutes per shift. Therefore, 24 is the planned number of planes we need to get out in a day. It means we need to get a plane out every 17.9 minutes. If we need to get a plane out every 17.9 minutes, it means our cycle time per plane must be lower than 17.9 minutes. If it is higher (or a bigger number), then we have a bottleneck in our system.

TAKT TIME = 17.9 minutes per airplane.

We ask the engineers to give us the cycle time for getting a plane through the system. At WS-1, how long did it take for five assemblies to be completed? To respond to this, the observations over the entire day were taken into account; not just the first batch of five planes. In order to make this simple, our engineer said it took 27 seconds to complete the first five airplane assemblies in WS-1. We place that number in the "C/T (sec) for 5 Planes…" column. Since we are looking for the cycle time for one airplane, we divide it by 5. This ends up being 5.4 seconds per assembly in WS-1.

This means on a per plane basis, it takes 5.4 seconds on average to get a plane from WS-1 to the queue of WS-2. This number is below the TAKT Time; therefore, we can guarantee we can meet our customer's demand in this workstation.

Remember for WS-3 we need to include the set up time. We now plug in the rest of these numbers and we can complete the calculations (see Figure 4-37).

Workstation Number	Cycle Time	TAKT Time	C/T (sec) for 5 Planes...
1	5.4	17.9	27
2	18.6	17.9	93
3	27	17.9	135
4	18.8	17.9	94
5	12	17.9	60

$$\text{TAKT Time} = \frac{\text{Available Time}}{\text{Customer Demand}} = \frac{430}{24} = \boxed{17.9}$$

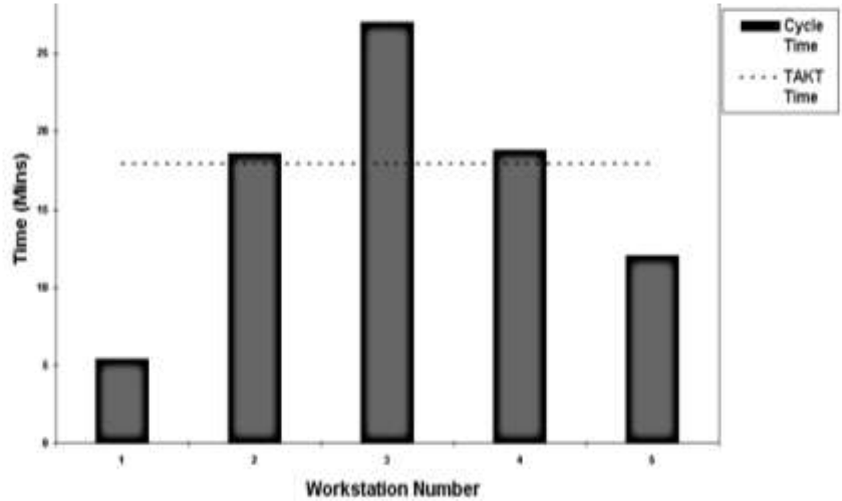


Figure 4-37: SVAC day 1 airplane production data.

CHAPTER 5

FLOW AND PULL

Developing the Future State

I want to pause at this point to talk about Day 1 and help you understand the current state of the business. Usually, it takes an average of six weeks to get to this point with a company. We help our teams understand the principles of Lean thinking in order to design a future Lean system. They need to see and understand the complexities and the root cause of the problems they are facing today.

We invite the entire team to participate in designing the future state. They are pretty excited about it because it makes a lot of sense. Moreover, why shouldn't it, they created it. Now they need to get out there and just do it. As they move on this, they cannot forget the golden rule of involving everybody affected by the change. We always have some forces working against us and change is a force to be reckoned with. My suggestion is to just do it, but keep the people side very high up on your priorities.

Make the Process Flow

Make the process Flow is the third principle of Lean thinking.

How do you make the process flow?

How does the customer get what they want?

To answer these two questions, let us look at what happens in manufacturing.

We identified value added time by recording it at the bottom of a value stream map. Making the process flow means the company needs to get as much waste out of the process as they can. The immediate goal should be to go for the big things that shrink the production lead-time first.

The rule of thumb is FLOW where you can, and PULL where flow is not currently possible. Flow implies that you are able to remove all – or as many – obstacles that impede value getting to the customer. Flow is the next item on the priority list – i.e. before pull. However, for the purposes of this simulation, we choose to focus on pull next instead.

Develop Pull by the Customer

The fourth principle of lean thinking is to **Develop Pull from the Customer's perspective**. Downstream operations, just like a river trickling down a mountain, flow in a certain direction.

In our example of the cylinder value stream, the tube has the first operation of cutting, then tube drilling, etc. Tube drilling is the downstream operation to cutting. It is the next step. Therefore, as we look at this, we are talking about the next downstream customer getting what they want by having it available to them in a supermarket. Pulling inventory and signaling the supplier to replenish is how it is done. In a nutshell, that is the system of developing pull from the customer.

A key ingredient that is almost always missing in pull systems is the understanding around velocity. In short, as you decrease the number of signals (inventory) between each customer and supplier, the velocity increases. As the inventory moves quicker, problems become exposed. Arguably, developing a pull-system should be more about exposing problems than the technique of signaling your supplier for replenishment. For now though, we will learn about what it means to signal (pull from) your supplier.

Example of a PULL System – Bread

A good example of a pull system for most people is the pull system for bread. We describe how this type of pull system works here in order to develop a sense for the concept of PULL.

The customers realize their household is running low on bread. They must replenish the breadbox (see Figure 5-1).

Figure 5-1: The customer wants bread.

They must go to a super market and buy some bread. There is more than one supermarket to choose from (see Figure 5-2).

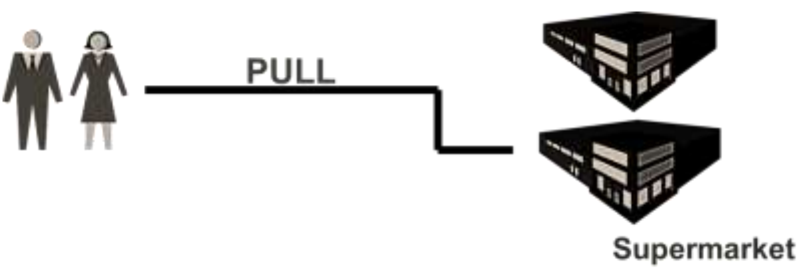


Figure 5-2: The customer must PULL bread from a supermarket.

The customers choose a supermarket to go into. They go to the bread aisle, take a loaf of bread off the shelf, pay for it, and take it home for consumption (see Figure 5-3).

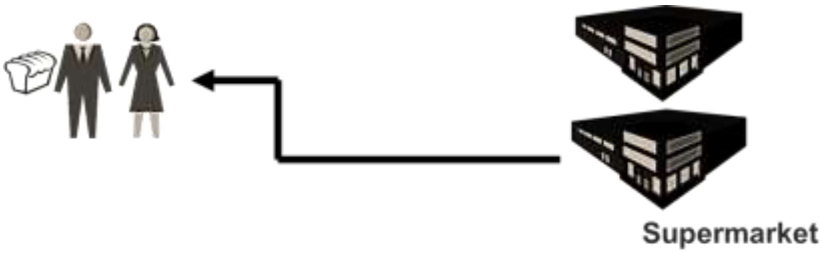


Figure 5-3: The customer PULLS bread from a supermarket and consumes it.

As more customers come into the supermarket and buy bread, the racks become empty. The empty racks signal the store staff to take the racks into the back of the store. Full racks are then taken from the back and moved to the empty homes (places) in the bread aisle. The bread inventory is filled again. When the supermarket's inventory of bread runs low, it is time to order more bread from the bakery (see Figure 5-4).

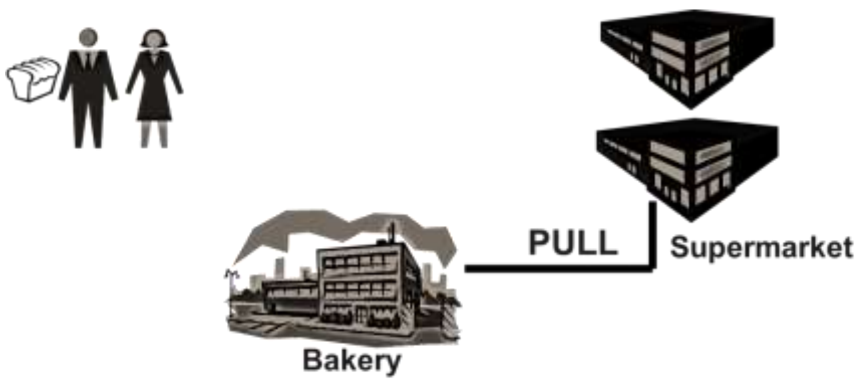


Figure 5-4: The supermarket must PULL bread from a bakery.

The bakery fills up their trucks each day and can deliver a shipment to the supermarket daily (see Figure 5-5).

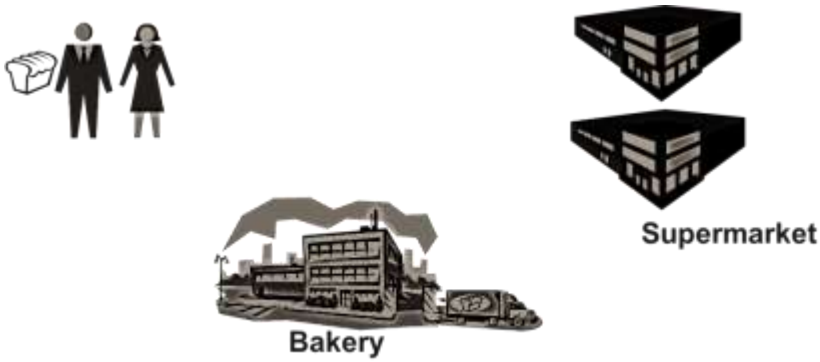


Figure 5-5: The bakery is able to provide a daily supply to the supermarket.

The bakery trucks deliver a shipment to the supermarket. The supermarket staff fills up the racks in the back. The supermarket is once again able to replenish the empty homes in the bread aisle (see Figure 5-6).

Figure 5-6: The supermarket PULLS bread from the bakery and sells it.

The bakery uses a variety of ingredients for its bread recipe. For example, flour. Sooner or later, its flour inventory runs low. The bakery must pull from the flourmill (see Figure 5-7).

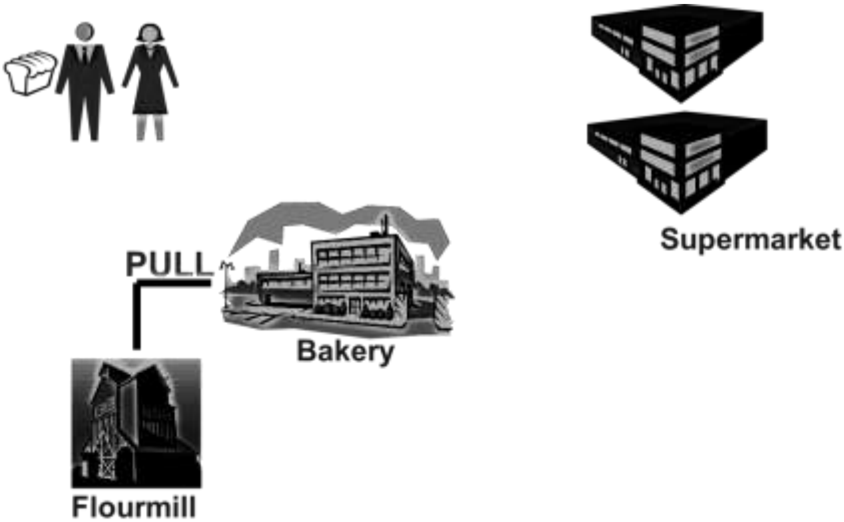


Figure 5-7: The bakery must PULL flour from a flourmill.

Flour is then shipped to the bakery to replenish the flour inventory.

The flourmill uses wheat to make the flour. When the flourmill runs low on wheat it pulls from the farm (see Figure 5-8).

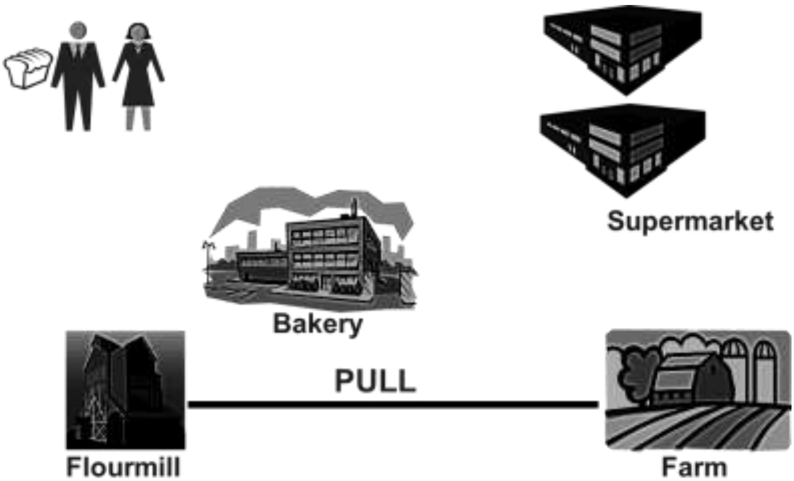


Figure 5-8: The flourmill must PULL wheat from a farm.

Wheat is then shipped to the flourmill to replenish the wheat inventory.

Here is the simple pull system for bread (see Figure 5-9).

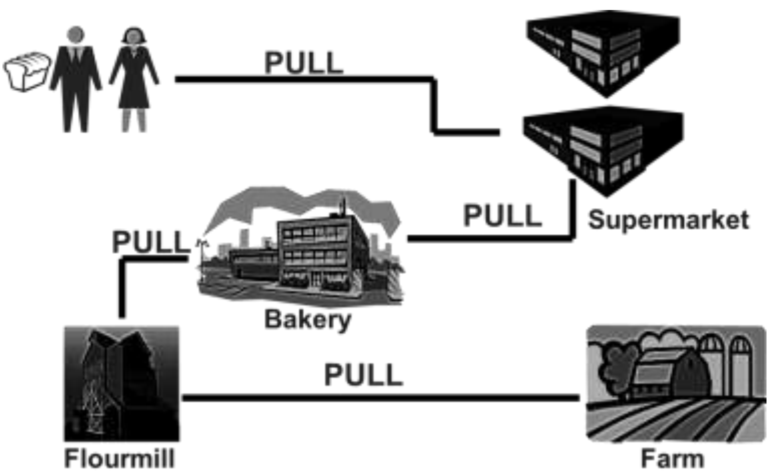


Figure 5-9: The simple PULL system for bread.

The customer pulls what they need from a supermarket that was designed to have what they want, when they want it. This pulling generates a chain reaction. As the spots become empty, the upstream supplier gets the signal to transport to the next supplier's supermarket. As each supplier uses inventory, their downstream suppliers do the same. Eventually, it becomes obvious to everyone in the value stream that there is only one trigger. It is the customer who physically takes inventory.

The Mock Company VSM – Future State

A main objective of the entire Lean Production effort is the concept of *flow*. Ideally, production should flow continuously from raw materials to the customer. Envision realizing this ideal through a production system that acts as one long conveyor.

In our case study, that would mean making our current state process flow smoothly from our supplier of raw materials to stamp, to press, to weld, to assembly, to shipping and out to the customer (see Figure 5-10).

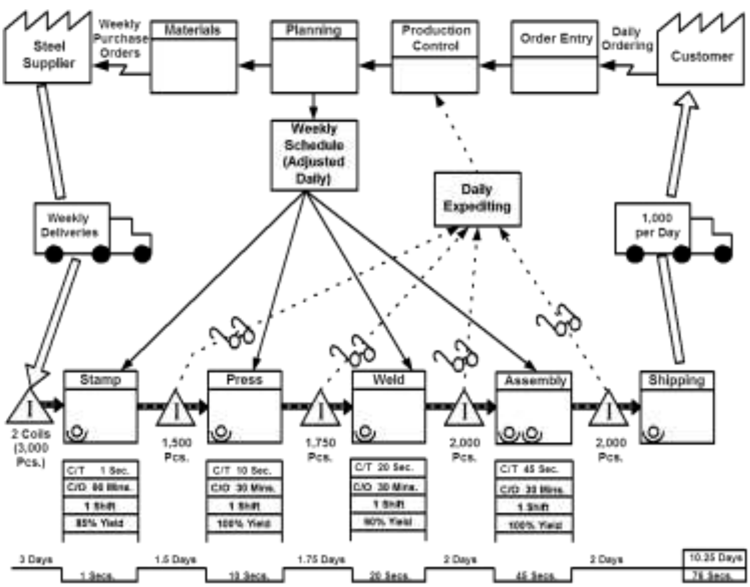


Figure 5-10: Recall The Mock Company current state VSM.

Presently, our production lead-time is 10.25 days. The goal is to reduce this lead-time. Perfection represents reducing it to the theoretical minimum of 76 Seconds. Improvements to the present value stream will have to be made. A future state map will be drawn that takes into account the whole system and makes improvements where they are most needed.

After brainstorming for improvements, the Mock Company produces the following Future State Map (see Figure 5-11).

A decision is made to bring some of the machines together to create a Press, Weld, and Assembly Cell.

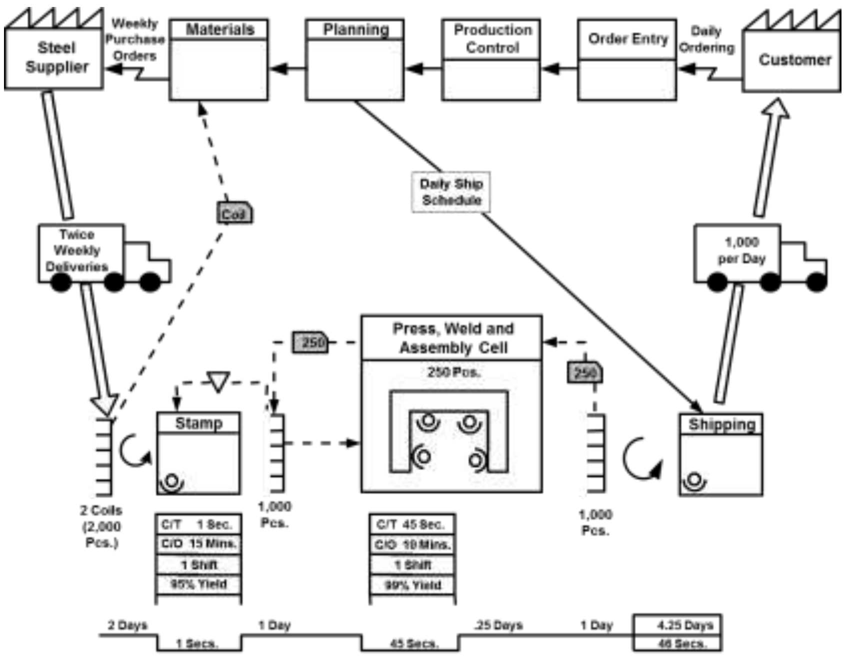


Figure 5-11: The Mock Company future state VSM.

The machines are still in their natural order of processing and form the shape of a U. Cell operators may handle multiple processes and the number of operators is changed when the customer demand changes. The U shaped equipment layout is used to allow more alternatives for distributing work elements among operators and to permit the lead off and final operations to be performed by the same operator.

Another benefit is inventory goes directly to the machine rather than constantly moving inventory on and off a rack.

Our original Value Stream Map identified what is called a batch and queue (or, batch and push) production system. This means we are producing more than one piece of an item and then moving those items forward to the next operation before they are actually needed there. Thus, items need to be waiting in a queue. This is also called a batch and push system.

In contrast to this is the concept of a Pull System. This icon represents a pull of materials usually from a supermarket (see Figure 5-12). This is an alternative to scheduling individual processes.

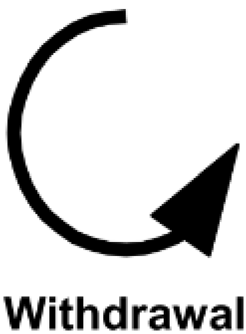


Figure 5-12: Icon representing a pull of materials.

Note how weekly schedules that were adjusted daily on the previous map, for each of the Stamp, Weld, Press and Assembly operations, have now been replaced with just one daily ship schedule (refer back to Figure 5-11).

This icon represents a supermarket (see Figure 5-13).

Figure 5-13: Icon representing a controlled inventory of items.

Supermarkets are a controlled inventory of items used to schedule production to an upstream process. The number below the icon represents the number of pieces that must be maintained at all times. With a pull system, a downstream operation or customer process withdraws the items it needs from a supermarket and the supplying process produces to replenish what was withdrawn.

There are two types of kanban – production and withdrawal. Production kanbans (signals) authorize the upstream operation to produce. Withdrawal kanbans (signals) authorize the material handler to replenish what was taken.

This information icon is a withdrawal Kanban (see Figure 5-14).

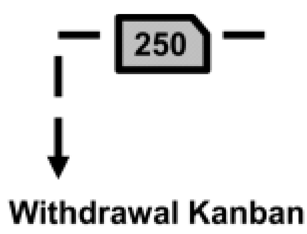


Figure 5-14: Icon represents a signal for a material handler to replenish what was taken.

This is a card or device that instructs a material handler to get parts from a supplying source and deliver it to the supermarket, which triggered the material handler to replenish.

In our case study, shipping pulls inventory as it needs it; it (the inventory) gets to a level where a batch of 250 units is sent upstream triggering either production or material replenishment. The cell is signaled to produce 250 more and then to replenish the supermarket (see Figure 5-15).

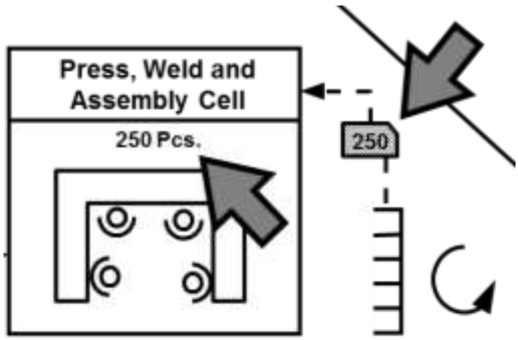


Figure 5-15: Cell is signaled to produce 250 units – then replenish the supermarket.

In order for the cell to achieve this, it must pull its parts from another supermarket set up to supply their needs. For example, a withdrawal kanban of 250 goes to the Stamping supermarket and inventory is withdrawn (see Figure 5-16).

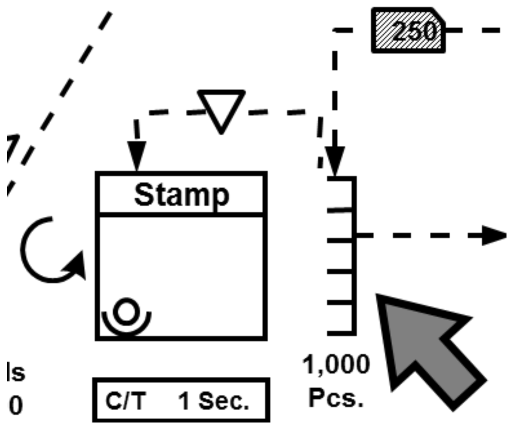


Figure 5-16: A withdrawal kanban signals to the stamp supermarket.

This next information icon is a signal kanban (see Figure 5-17).

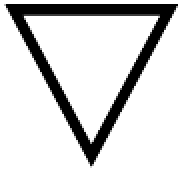


Figure 5-17: Icon represents a signal kanban indicating overproduction.

A signal kanban is used when the amount of the kanban is right sized. In other words, the amount of this signal kanban is much greater than 250. The reason for this is obvious when you do the math. The change over time of this machine is 15 minutes. If we were to ask to replenish only 250 pieces, then it would take us 15 minutes to set up (change over) the machine, and, a little over 4 minutes to run all of the 250 parts. For this reason, we use a kanban that represents overproduction; this is known as a signal kanban.

As a general convention, if it takes 15 minutes to set up (change over) a machine then you should run the machine for at least 15 minutes. A signal kanban lets everyone know that this type of inefficiency exists because of the economics of running the stamping machine for less time than it takes to change over. This signal would authorize the stamping process to produce an economic amount of inventory (say 1000 pieces) versus the 250 that was just withdrawn.

Once produced, the supermarket is brought up to its quota of 1000 pieces once again.

Let us go a little further with another example (see Figure 5-18). Stamp pulls from the raw materials (coils) supermarket and causes another chain reaction. The coil kanban card goes to the materials department. Then the materials department places another coil order on to the weekly purchase order. This goes to the steel supplier. The supplier delivers twice weekly. The number of coils ordered is the number that is replenished.

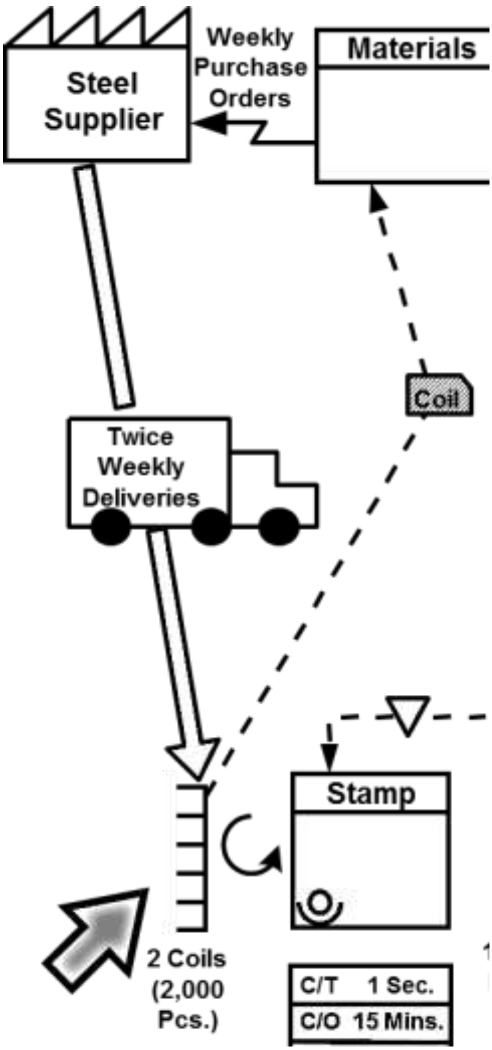


Figure 5-18: An example of kanban signals in action.

In every "real" Lean system, there is only one trigger that starts everything in motion. It is very important to understand and build in this trigger so priorities are not confused and everyone has a chance to work within their loop of responsibility. You see everything is a closed-loop. The information flow and the material flow.

The information works its way from the upstream customer. Conversely, the material flows from the downstream supplier. The information in our data boxes tells us there is an increase in the yield (see Figure 5-19).

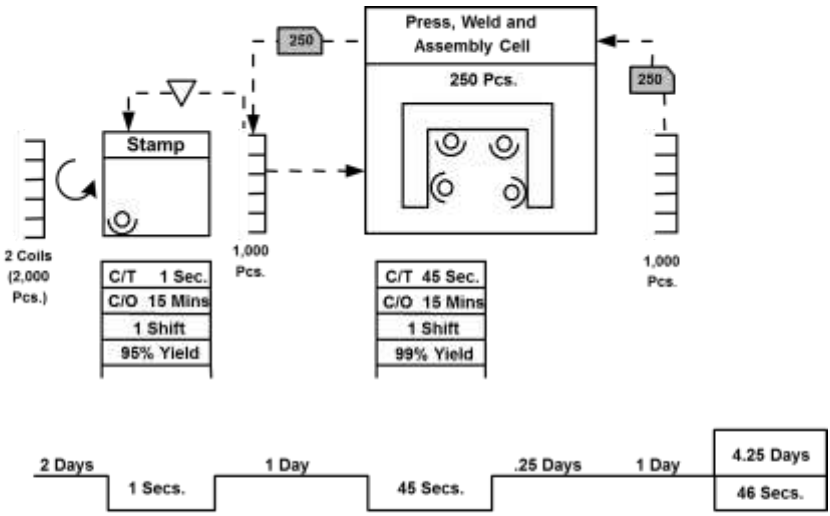


Figure 5-19: An increase in yield results in a significant reduction in scrap.

This results in a significant reduction in scrap. The way to achieve these improved results is by having the group most impacted by scrap focused on reducing the scrap. In this way, we get to the root cause of the problem and eliminate it. The cycle time is now 45 seconds. The changeover times have been reduced as well. Deliveries from our supplier have been increased to twice weekly and coil sizes are smaller.

When we look at our lead-time graph, we can see that the lead-time can be reduced from 10.25 to 4.25 days. This is on paper. This is how the future state design begins – on paper.

These positive changes are due to overall efforts by the Mock Company to improve their system. Once all of these improvements have been made, the value stream will be studied again in an effort to brainstorm more improvements. The future state becomes the current state, and the process of continuous improvement begins. This is done over and over until we have driven out as much waste as possible; and, eliminated as much variability in our process as possible.

Continuous Flow Production

One good example of next generation improvements is to create Continuous Flow Production. This means the items are produced and removed from one processing step to the next, one piece at a time. Each process makes only the one piece that the next process needs and the transfer batch size is a batch of one. This is also called a single-piece or one-piece flow. The benefits of such an improvement will be revealed in the next few sections of this book.

Value Stream Management is a process of continuous improvement. It is designed to try to reach the ideal. Although the theoretical minimum will never be reached, companies should continue to try to reduce overall production lead-time. This translates into higher potential sales simply because customers will always want it done faster. Value stream management is the process of mapping over and over again until you reach the ideal state (NOTE: you never reach this state). Value stream management represents the journey you take towards the ideal.

The Runner, Walking the Process

One of the companies I have worked with, CTD Company, produces Hydraulic Cylinders. Part of their value stream is the shaft fabrication loop. This is a subassembly of a cylinder.

CTD decided to video record the path a materials handler had to travel, with materials as they were being processed, up to the point of assembly. The return on investment was represented by the improvement in time.

In this example, the CTD operators have achieved the first step of their future state condition. If we were to walk the process, we would see systems of pull and flow put into action. Let me walk you through it…

Let us begin with the batch size set at 40 pieces.

Figure 5-20: CTD Co. uses tote boxes to transfer parts between operations.

Tote boxes such as this one are used to transfer parts between operations (see Figure 5-20). Originally, the operators moved their own raw materials and subassemblies between the workstations.

CTD decided that there would be less waste if a newly appointed materials handler did the movement. Another excellent reason to appoint a material handler, and give them a specific route with timing, is that this person could report on whether production is meeting the pace that was set.

If every 3 hours a bin of parts needed to be ready, then the material handler should be there every three hours (see Figure 5-21).

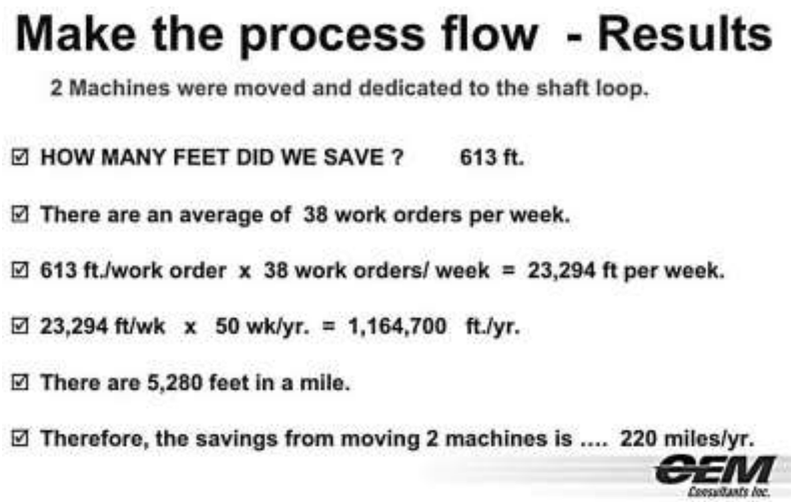


Figure 5-21: CTD Co. applied simple changes to achieve great results.

Walking the Process, Kanban Example

As we walk the process, you would note that the route taken by the runner is a Waste of Transportation. In a later stage, we will create another future state generation in which we will reorganize the work area to a cellular layout. For now, the company is using squares painted on the shop floor and near their workstations as their Kanban Device.

As you read the next couple of pages of this book, pay close attention to the kanbans or signals used to control the Inventory and the rate of production. As we said earlier, a kanban is any signaling device that gives instruction for production or conveyance of items in a pull system.

This is a **QUEUE** square (see Figure 5-22). Simply put, when the Queue is empty, the runner provides a batch of 40 to that spot on the floor. These are pulled from the workstation upstream from this one.

Figure 5-22: Example of a Kanban signaling device – the QUEUE square.

This is the **IN** Square (Figure 5-23). When the operator is ready to work or produce, he or she moves the batch from the Queue to the IN Square and begins.

Figure 5-23: Example of a kanban signaling device – the IN square.

This is the **OUT** Square (Figure 5-24). If the floor space marked OUT is empty, it signals the operator to produce 40 more pieces and fill that spot on the floor. When all the OUT spots in the workstation are full, this is the signal to the operator to stop producing. It is the runner's job to move items out of the OUT boxes and into the next downstream operation at the appropriate moment. In this way, overproduction is being eliminated.

Figure 5-24: Example of a kanban signaling device – the OUT square.

Brainstorming the SVAC Improvements

Sky-View Airplane Company

Achieving a Future State

Upon reflecting on Day 1 of our airplane simulation, it becomes evident that the team knows what to do. We ask the group for feedback and start brainstorming for what improvements we can make. Here they are:

- Move materials to Point of Use
- Rearrange the layout
- Rebalance the workload
- Open up communication
- Reduce the lot size from 5 to 1
- Reduce the Set Up time
- PULL from the customer

Can we do all of the changes in one day? No, change must be gradual. For no other reason that I am the owner and I would like a controlled chaos for my first experience with Lean manufacturing.

Too much change all at once would result in much frustration for the workers in our plant. This frustration can lead to an unstable manufacturing line. This could result in the stopping of the flow of product. For this reason, only 4 of the seven improvements are implemented during day 2:

DAY 2 – Improvements

- Move materials to Point of Use ✓
- Rearrange the layout ✓
- Open up communication ✓
- Reduce the Set Up time ✓

A key improvement we will consider first is *moving material to point of use*. Operators will no longer have to go to the stores to replenish their bins. All of the parts will be placed near the point of use. We will then rearrange the layout. Each workstation will now be situated right near the workstation that precedes it. Next, we will open up the communication. All operators will be allowed to advise each other of defects and suggest improvements as they think of them. In a sense, everybody will share the duties of quality assurance.

Finally, we will reduce the set up time. Both fixtures will become immediately available, as the operator needs them. Either fixture can be used to measure the lengths of the white and the green planes. In this way, the need for a changeover is eliminated.

It is expected these improvements will bring the Sky-View Airplane Company closer to their goal of being able to guarantee their customer deliveries of 24 airplanes per day. Let us see the results of these selected improvements in the next lesson.

DAY 2 – Scrap Cost Calculations

In this simulation, one minute is equal to one hour of real time.

Timer: 00:00 of 08:00
Event: Start Production

Workstation 1 delivers into the queue of workstation 2. However, we are still producing in batches of 5. Workstation 2 delivers into the Queue of Workstation 3 (see Figure 5-25).

Observations:

- Note how all workstations have been arranged in a Cellular Layout next to each other.
- This reduces the transportation waste experienced in Day 1.

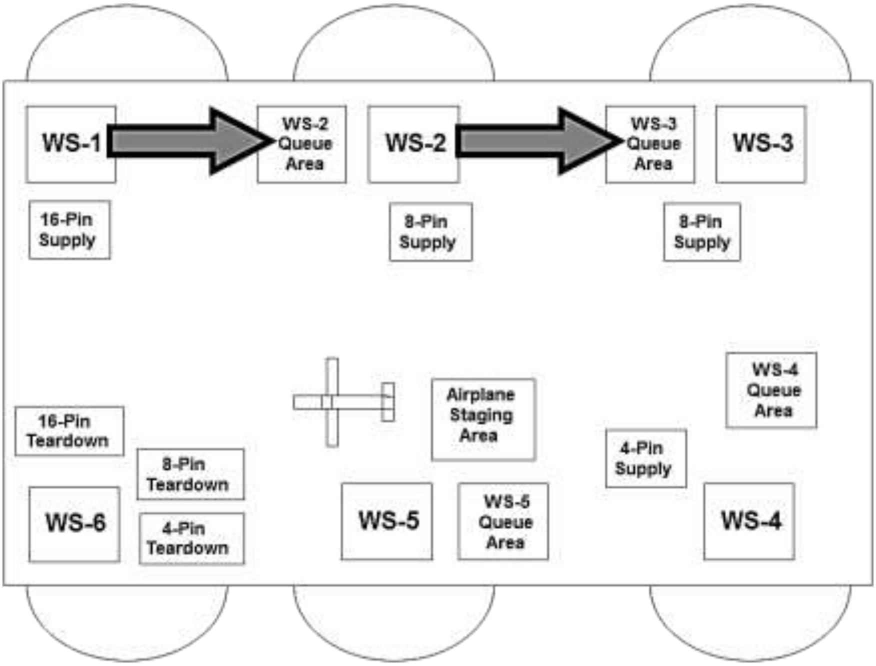


Figure 5-25: Day 2 at 00:00 min.'s of production.

Timer: 01:04 of 08:00
Event: Start the White Airplane

Operator 3 makes the white plane first and decides to switch fixtures to measure the plane length (see Figure 5-26).

<u>Observations</u>:

- Inappropriate processing occurs, as the fixture should have been right at the point of use (POU) and not on the other side of the room.
- The effort to reduce set up time has been compromised.

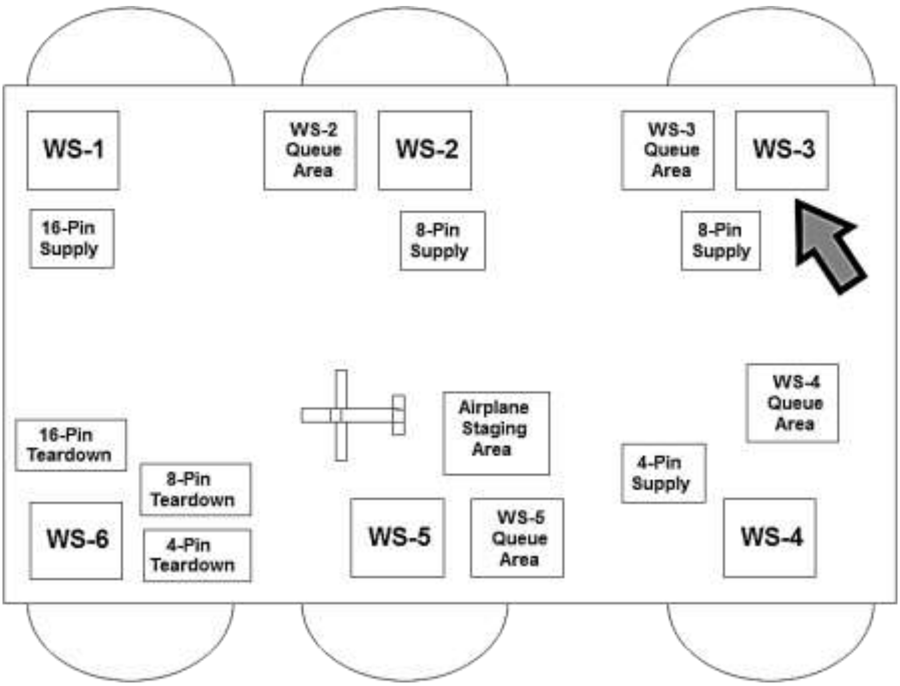


Figure 5-26: Day 2 at 01:04 min.'s of production.

Timer: 02:33 of 08:00
Event: Changeover Occurs Again

Operator 3 is allowed to skip the 2nd Change Over in order to preserve the integrity of the simulation (see Figure 5-27). She is also allowed to correct defects.

Observations:

- The batch is finally delivered into the Queue of WS-4 in good order.
- Unnecessary Inventory between stations beginning to accumulate. Note how it becomes the source of some confusion.

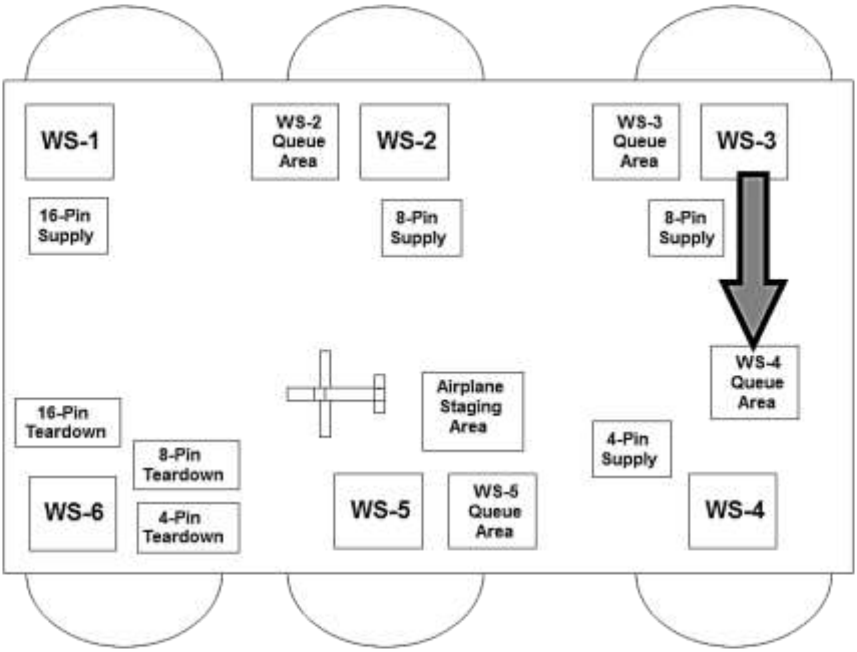


Figure 5-27: Day 2 at 02:33 min.'s of production.

Timer: 04:22 of 08:00
Event: Batch of 5 Received in Queue of WS-5

Operator 4 delivers into the Queue of Workstation 5 (see Figure 5-28).

<u>Observations</u>:

- Open communication has allowed operators to alert each other to Defects and make on the spot improvements.
- We have experienced an enhancement in Cycle Times from all of the workstations.

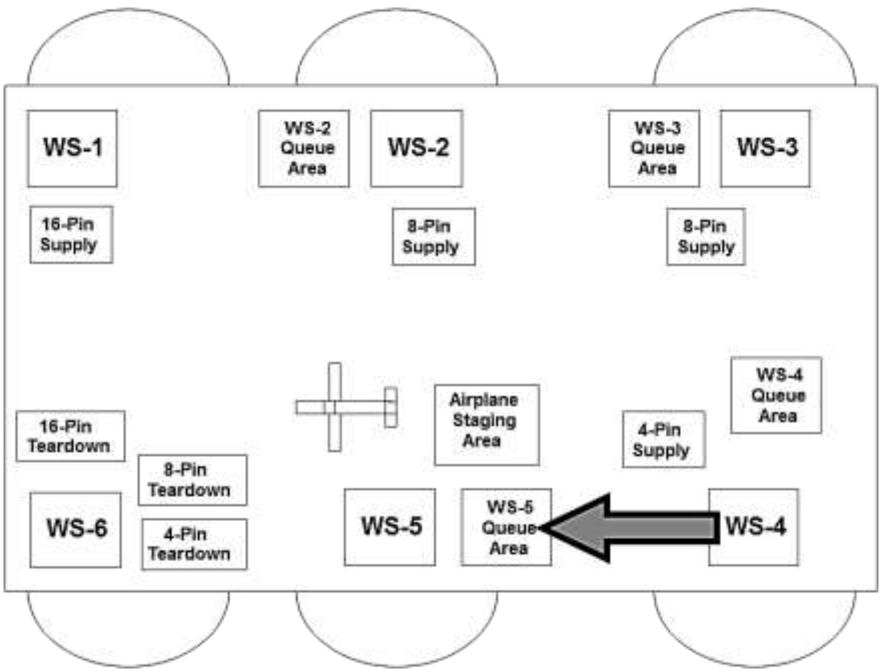


Figure 5-28: Day 2 at 04:22 min.'s of production.

Timer: 05:06 of 08:00
Event: Batch of 5 Airplanes are Passed to Inspection

The first batch of 5 airplanes passes inspection. They are briskly moved into Workstation 6; they are ready to be shipped to the customer (see Figure 5-29).

Observations:

- Operator 6 is glad to be able to record a better Lead Time than was experienced in Day 1.
- We reach the 6-minute mark before the next batch arrives.

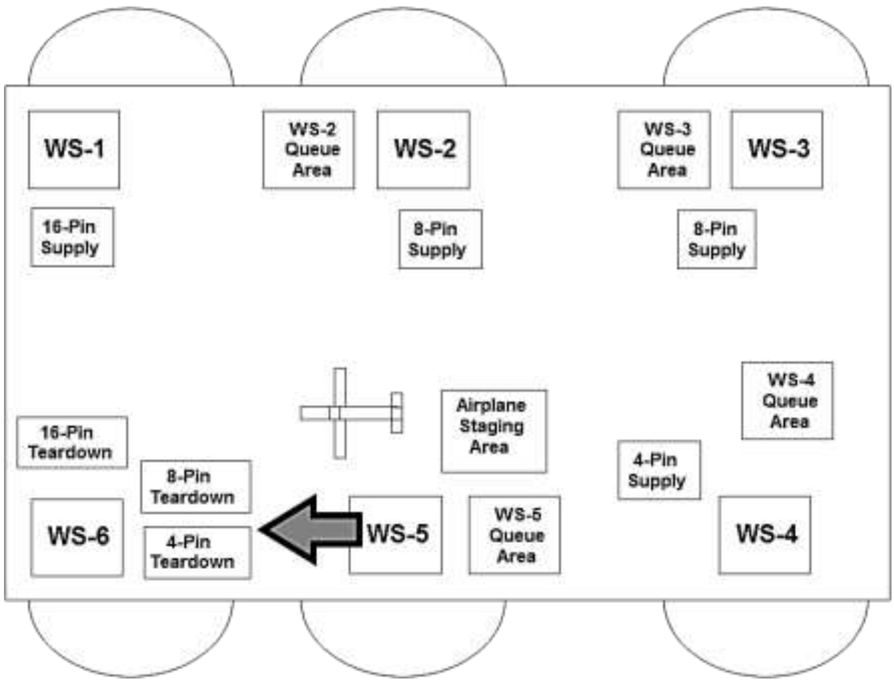


Figure 5-29: Day 2 at 05:06 min.'s of production.

Timer: 06:00 of 08:00
Event: Whistle blows – the simulation is paused temporarily

On Day 2 of our simulation, we stop once again at the 6th hour of production to collect data and calculate our *exposure* to **scrap costs** (see Figure 5-30).

Sky-View Ariplane Company

Scrap Costs Calculation

16 Pin Cost $10,000.00 | 8 Pin Costs $5,000.00 | 4 Pin Cost $3,000.00

Day 2	Scrap									
		16 Pin			8 Pin			4 Pin		
	Sub Assy's	Parts per Assembly	Total Parts	Cost	Parts per Assembly	Total Parts	Cost	Parts per Assembly	Total Parts	Cost
Workstation 1	43	2	86	$ 860,000	0			0		
Workstation 2	14	2	28	$ 280,000	5	70	$350,000	0		
Workstation 3	5	2	10	$ 100,000	8	40	$200,000	0		
Workstation 4	5	2	10	$ 100,000	8	40	$200,000	6	30	$ 90,000
Total Sub Assy's	67			$ 1,340,000			$750,000			$ 90,000

Total Scrap Cost $ 2,180,000

Figure 5-30: SVAC day 2 scrap costs.

It is important to note that, although we have improved our production, we now have even more subassemblies between workstations.

The total number of subassemblies is 67. This works out to $1,340,000 for the 16-pin parts used, $750,000 for the 8-pin parts, and $90,000 for the 4-pin parts used. The grand total of our company's exposure to the scrap cost problem is $2,180,000. It has become apparent we have become more efficient at producing airplanes, and more efficient at producing scrap. This is a problem that SVAC does not wish to have.

Timer: 06:33 of 08:00
Event: Another batch of 5 airplanes completed.

We have 2 minutes left in our Day 2 production (see Figure 5-31). During the last two minutes, 3 batches of 5 are completed for a total of 15 airplanes.

Observations:

- Operators are experiencing some success towards reaching their goal of 24 airplanes per day.
- They are still far from achieving this goal though.

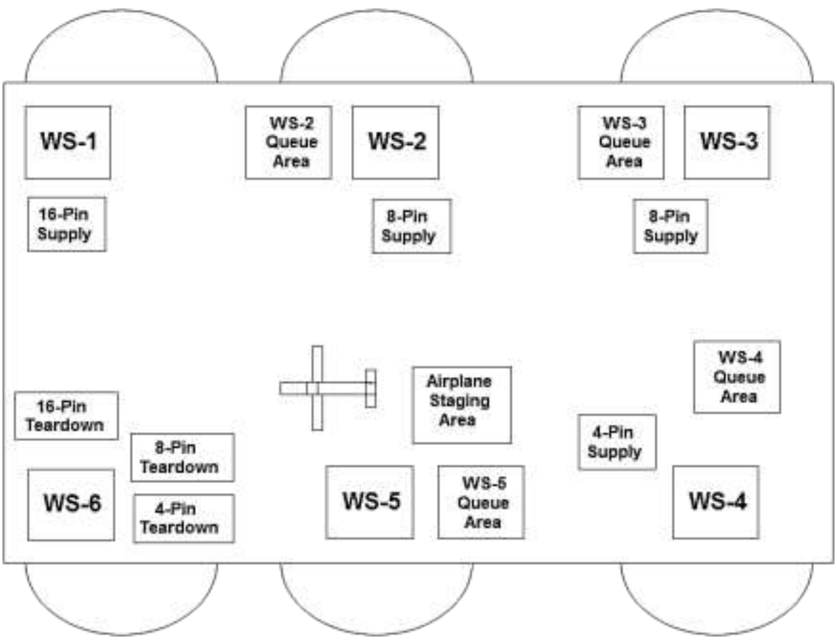


Figure 5-31: Day 2 at 06:33 min.'s of production.

A total of 15 planes will be completed over the next 2 minutes indicating a great improvement in production. The goal of 24 airplanes shipped has not been reached yet though.

DAY 2 – Scrap Carrying Cost Calculations

At the end of day 2, we stop and calculate what our carrying costs are (see Figure 5-32).

Sky-View Ariplane Company

Inventory Carrying Costs Calculation (WIP)

16 Pin Cost $10,000.00 | 8 Pin Costs $5,000.00 | 4 Pin Cost $3,000.00

Day 2	Inventory									
		16 Pin			8 Pin			4 Pin		
	Sub Assy's	Parts per Assembly	Total Parts	Cost	Parts per Assembly	Total Parts	Cost	Parts per Assembly	Total Parts	Cost
Workstation 1	52	2	104	$ 1,040,000	0			0		
Workstation 2	11	2	22	$ 220,000	5	55	$275,000	0		
Workstation 3	6	2	12	$ 120,000	8	48	$240,000	0		
Workstation 4	4	2	8	$ 80,000	8	32	$160,000	6	24	$ 72,000
Workstation 5	0	2	0	$ -	8	0	$ -	6	0	$ -
Workstation 6										
Total Sub Assy'	73			$ 1,460,000			$675,000			$ 72,000

Total Inventories $ 2,207,000

Carrying Cost per Month (2%) $ 44,140

Figure 5-32: SVAC day 2 carrying costs.

The number of subassemblies in Day 2 is greater than that of Day 1. The total # of subassemblies is now 73. This works out to a cost of $1,460,000 for the 16-pin parts used, $675,000 for the 8-pin parts used, and $72,000 for the 4-pin parts used.

This gives us a total of $2,207,000. We get charged 2% monthly for the carrying costs of having this inventory. This works out to $44,140 per month. It is a substantial amount to be paying out and SVAC realizes they still have challenges that need resolving.

DAY 2 – Cycle Times

Let us take a look now at our cycle times between workstations (see Figure 5-33).

Improved Airplane Production

Workstation Number	Cycle Time	TAKT Time	C/T (sec) for 5 Planes...
1	4.2	17.9	21
2	15.2	17.9	76
3	22.4	17.9	112
4	15.8	17.9	79
5	5.2	17.9	26

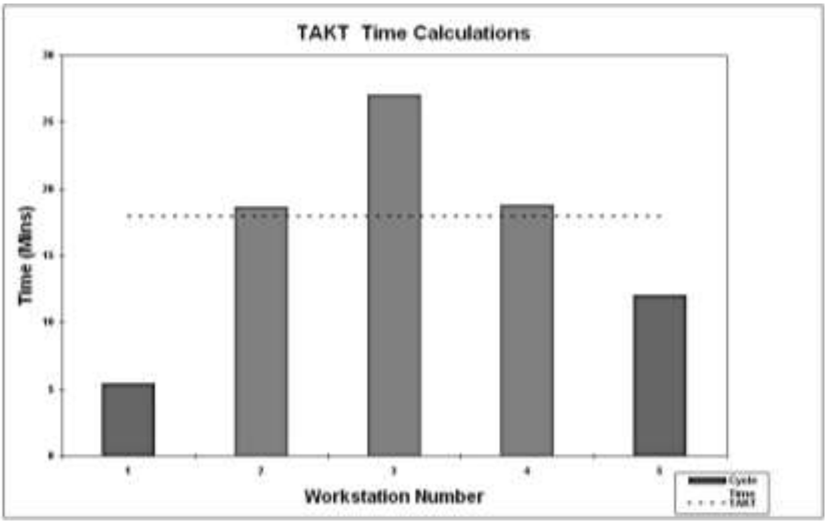
$$\text{TAKT Time} = \frac{\text{Available Time}}{\text{Customer Demand}} = \frac{430}{24} = 17.9$$

Figure 5-33: SVAC day 2 cycle times.

We mentioned earlier our TAKT time is 17.9 seconds. This means all of our cycle times should be less than 17.9 seconds. We observe that SVAC has achieved this goal in four out of the five workstations. Work Station 3 is still producing at a cycle time that is higher than the TAKT time. This is enough to hinder the company from producing the 24 airplanes that need to be guaranteed before they can accept their new contract.

Let us compare the graphs of Day 1 versus Day 2 (see Figure 5-44).

DAY 1



DAY 2

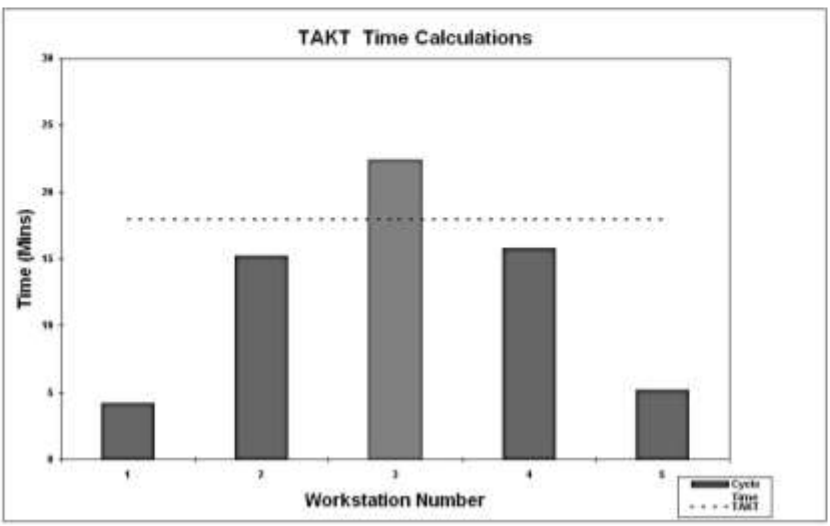


Figure 5-44: Day 1 versus Day 2 comparison.

Day one has 3 workstations not producing to the required TAKT time. Day 2 has only 1 Work Station not producing to the required TAKT Time. A conventional, non-lean solution to Day 2 is that an extra operator could be placed at Work Station 3 in order to bring down the cycle time and meet production goals. Unfortunately, this would not eliminate the large amount of inventory scattered throughout the plant.

The day 2 results continue to pose problems in the areas of scrap cost and inventory carrying costs. Another issue is all of the inventory lying around gives rise to the presence of the seven wastes. This too would jeopardize SVAC's ability to guarantee their customer 24 airplanes per day. It becomes obvious that a better system is needed.

DAY 3 – Rest of the Improvements

- Rebalance the workload ✓
- Reduce the lot size from 5 to 1 ✓
- PULL from the customer ✓

Four of the seven improvements were implemented during Day 2. This was not enough to yield the desired results.

During Day 3, we will add the rest of our desired improvements, thus achieving a much-improved Lean system. We will rebalance the workload. Operators are given new instructions to follow at their workstations.

As the workload is rebalanced, the changes required occur in all workstations, we only show two of them below:

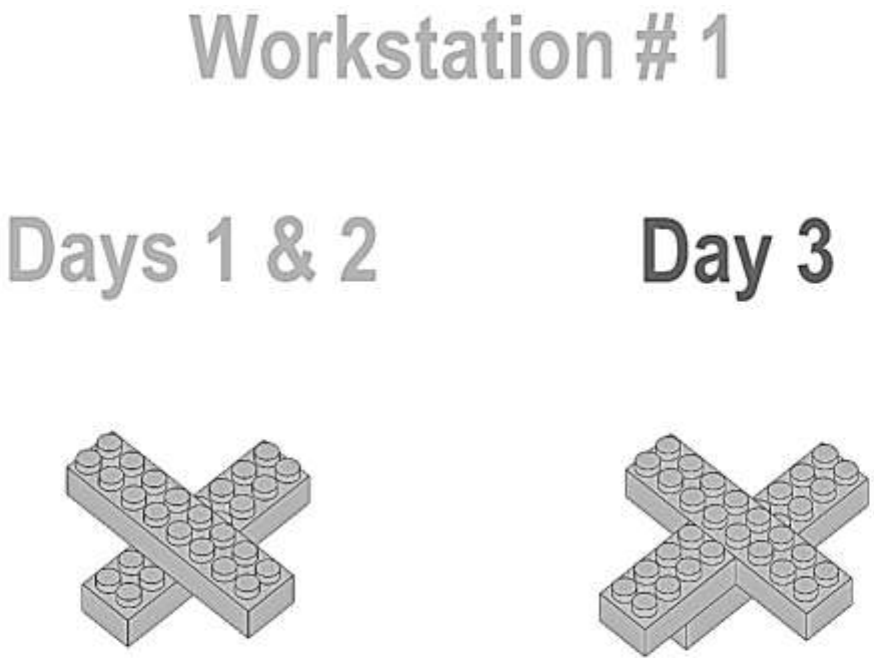


Figure 5-45: WS-1 day 3 improvements

Source: Refer to **www.visionaryproducts.biz**

.

For changes to the workload in Workstation #2 and Workstation #3, the change was similar. We distributed the workload to create balance between the operators workload (see Figure 5-45). Workstation #4 looks like the picture below (see Figure 5-46), as you may notice, we are still missing the landing gear.

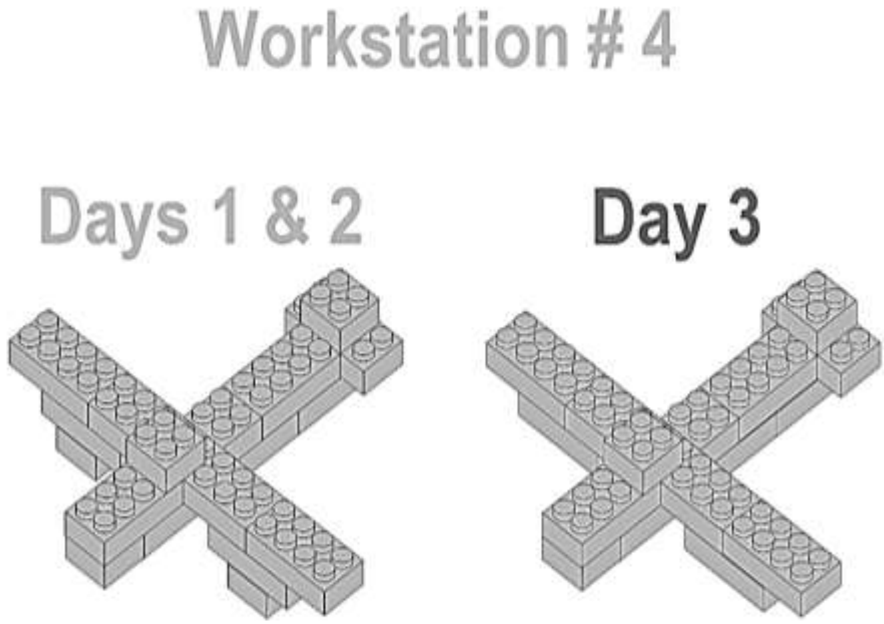


Figure 5-46: WS-4 day 3 improvements.

Source: Refer to www.visionaryproducts.biz

Workstation #5 now has the responsibility of placing the landing gear on along with doing the inspection process. I might point out that there needs to be a buy-in by the team for these types of changes to occur. To this end, it is always easier to get buy in when everyone knows “Why?” they need to change.

Why: In order to take on more work.

What: We need to implement “Lean Thinking” principles.

How: Through brainstorming, and good facilitation by George, we identified the initiatives that will get us to the future state.

Next, we further reduce the lot size from 5 to 1. We do this by creating a simple rule. All operators must adhere to this rule. There must never be more than one plane in any given workstation. In addition, there must not be more than one plane in the queue of any workstation downstream from the operator. Once the queue has been emptied, the operator can place his or her completed subassembly into it and begin working on the next one.

By using this signal created by an empty queue, we have created PULL from the customer. This in turn triggers a chain reaction wherein each of the workstation is signaled to build one more in order to replenish the supermarket.

We now return to our interlocking-plastic blocks simulation for the 3rd day of work. Management is excited about the prospect that, this time, their goal should most definitely be reached. The task of successfully building 24 airplanes is now in sight.

DAY 3 – Scrap Cost Calculations

As previously, one minute is equal to one hour of real time.

Timer: 00:00 of 08:00
Event: Start of Production.

Cycle Times improve dramatically this round (see Figure 5-47):

- Between WS-1 and WS-2 = 4 seconds
- Between WS-2 and WS-3 = 3 seconds
- Between WS-3 and WS-4 = 6 seconds
- Between WS-4 and WS-5 = 5 seconds
- Between WS-5 and WS-6 = 14 seconds

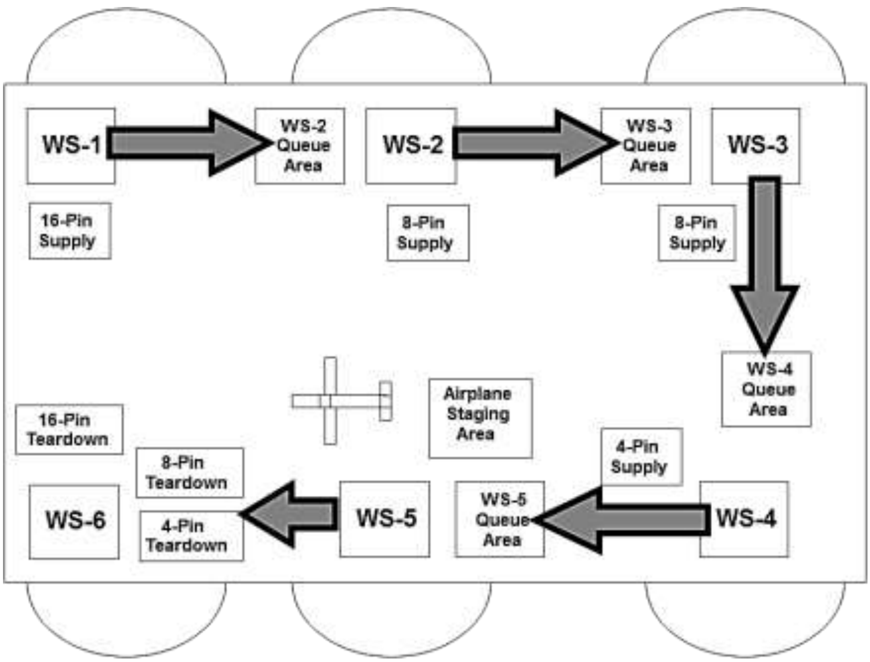


Figure 5-47: Day 3 at 00:00 min.'s of production.
Cycle time improvements will be dramatic on Day 3.

Timer: 00:32 of 08:00
Event: First Airplane is shipped.

The first batch arrives at Workstation 6 in 32 seconds (see Figure 5-48).

<u>Observations</u>:

- Lead Time has been cut down considerably.
- At this point, operators have **PUSHED** the first batch of 1 all the way through the system. From here on, all workstations are operating on the principle of **PULL**.

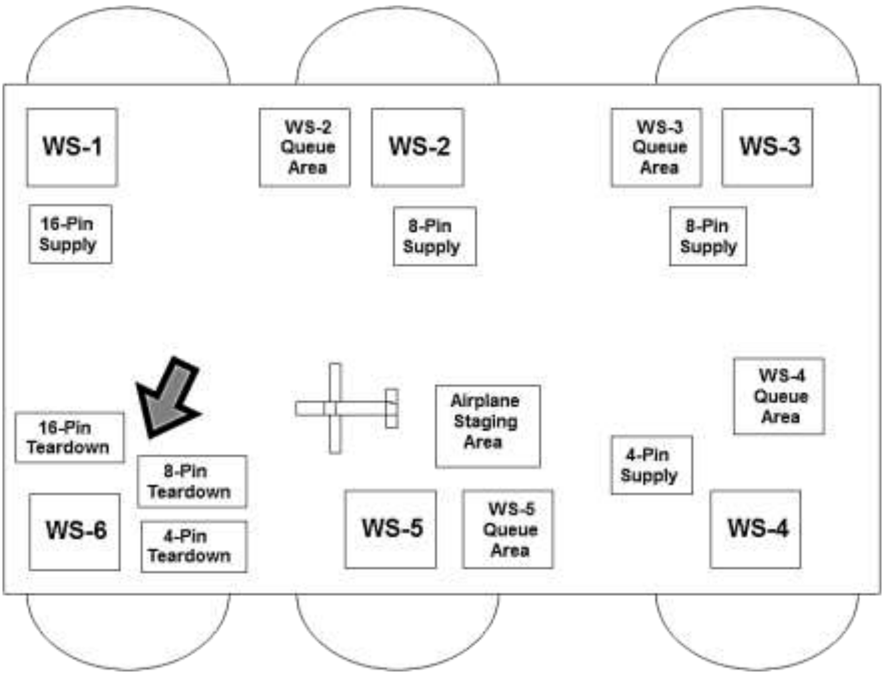


Figure 5-48: Day 3 at 00:32 min.'s of production.

Timer: 01:58 of 08:00
Event: The Team is shocked at the Improvement.

Production has become efficient (see Figure 5-49).

Observations:

- Operators experience moments of down time.
- This is used to prep raw materials so they are ready each time a new plane comes through the system.
- Down time is short lived due to a re-balancing of the workloads at all workstation.

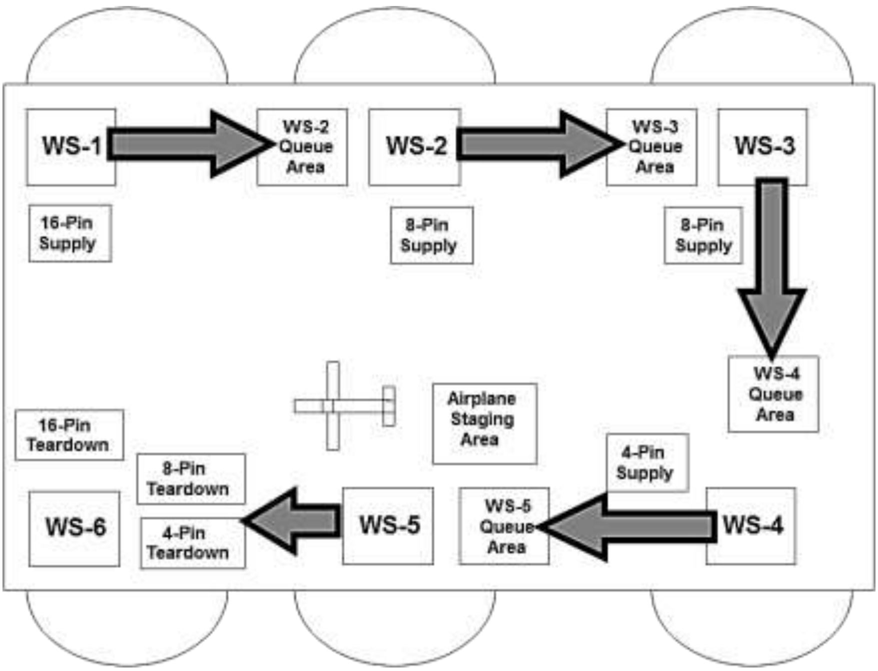


Figure 5-49: Day 3 at 01:58 min.'s of production.

Timer: 03:52 of 08:00
Event: Synchronization of Production Achieved.

There is never more than 1 airplane in any of the Queues and/or in any of the work areas (see Figure 5-50).

<u>Observations</u>:

- At the 3-minute mark, operators have already assembled 15 airplanes.
- At this point, operators are producing airplanes faster than Sales can sell them.

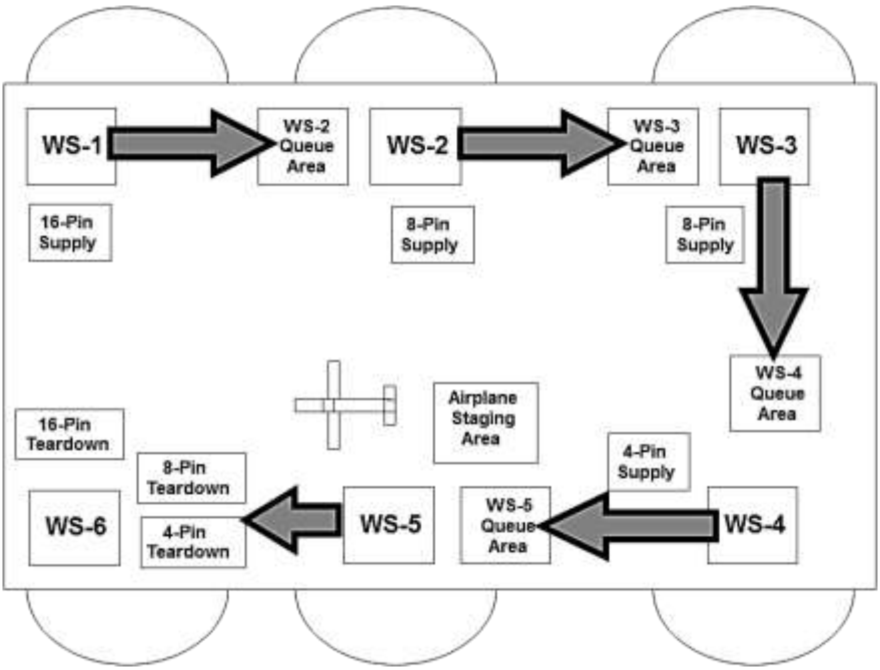


Figure 5-50: Day 3 at 03:52 min.'s of production.

Timer: 06:00 of 08:00
Event: Whistle blows – production is paused temporarily

At our sixth hour of production, we stop to collect our data and calculate our *exposure* to scrap costs (see Figure 5-51).

<u>Observations</u>:

- It is important to note that we have dramatically improved our production. We have also effectively reduced the number of subassemblies between workstations.

Sky-View Ariplane Company

Scrap Costs Calculation

16 Pin Cost: $10,000.00 | 8 Pin Costs $5,000.00 | 4 Pin Cost: $3,000.00

Day 3	Scrap									
		16 Pin			8 Pin			4 Pin		
	Sub Assy's	Parts per Assembly	Total Parts	Cost	Parts per Assembly	Total Parts	Cost	Parts per Assembly	Total Parts	Cost
Workstation 1	2	2	4	$ 40,000	0			0		
Workstation 2	1	2	2	$ 20,000	5	5	$ 25,000	0		
Workstation 3	2	2	4	$ 40,000	8	16	$ 80,000	0		
Workstation 4	0	2	0	$ -	8	0	$ -	6	0	$ -
Total Sub Assy'	5			$ 100,000			$105,000			$ -

Total Scrap Cost $ 205,000

Figure 5-51: SVAC day 3 scrap costs.

The total number of subassemblies is 5. This works out to a cost of $100,000 for the 16-pin parts used, $105,000 for the 8-pin parts used and $0 dollars for the 4-pin parts used. It is apparent that there is a lot less inventory sitting on the plant floor waiting to be assembled.

The grand total for our company's exposure to scrap cost is $205,000. These are much better results than experienced in both Day 1 and Day 2. We are now overly effective at producing airplanes. This is a good problem to have. Our scrap problem has been minimized. SVAC will have to slow down their production or else sell more airplanes. Everyone votes for selling more airplanes!

DAY 3 – Inventory Carrying Cost Calculations

Timer: 08:00 of 08:00
Event: Whistle blows – End of production for Day 3.

In the last two minutes, operators complete enough airplanes to bring the total to 39 airplanes shipped (see Figure 5-52).

<u>Observations</u>:

- They have become a well-oiled, efficient, super-airplane-producing machine.
- Their superiors are very pleased with performance and will be providing sizeable wage increases for all operators in the plant.

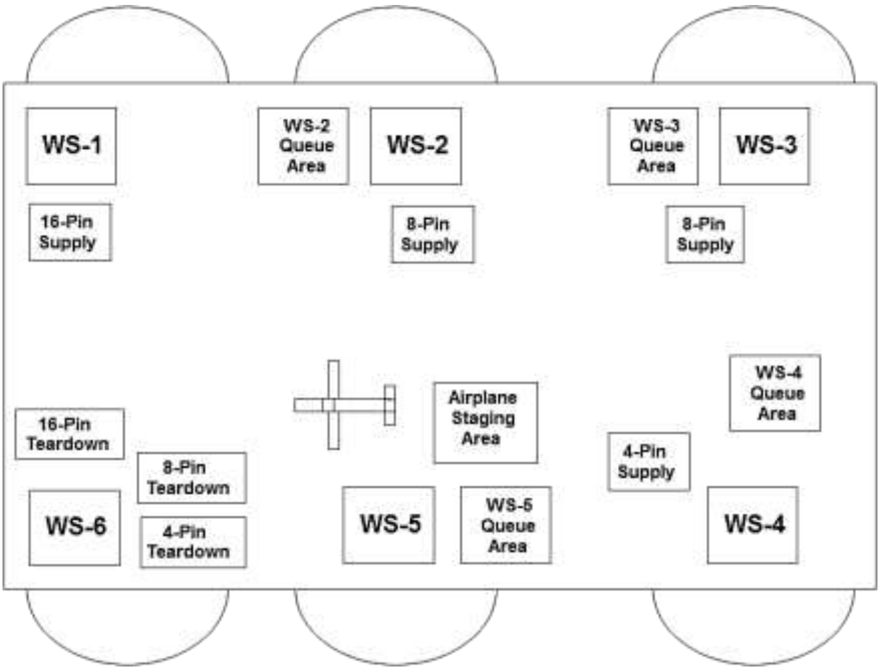


Figure 5-52: Day 3 at 08:00 min.'s of production.

A total of 39 planes have been completed by the end of production. The goal of having 24 airplanes shipped has been exceeded by 15.

We now stop and calculate what our inventory carrying costs are (see Figure 5-53).

The number of subassemblies in workstations is dramatically less in Day 3 than it was in Days 1 or 2. The total number of subassemblies is now 5. This works out to $100,000 for the 16-pin parts, $90,000 for the 8-pin parts, and $0 dollars for the 4 pin parts used. The total worth of the SVAC's inventories is $190,000.

We get charged 2% monthly for the carrying cost of having this inventory. This works out to $3,800 per month. This is a much lower amount to be paying than that of Day 1 or Day 2. SVAC realizes they have been able to exceed their goal of producing 24 airplanes per day. They are ecstatic!

Sky-View Ariplane Company

Inventory Carrying Costs Calculation (WIP)

16 Pin Cost $10,000.00 | 8 Pin Costs $5,000.00 | 4 Pin Cost $1,000.00

Day 3	Inventory									
		16 Pin			8 Pin			4 Pin		
	Sub Assy's	Parts per Assembly	Total Parts	Cost	Parts per Assembly	Total Parts	Cost	Parts per Assembly	Total Parts	Cost
Workstation 1	2	2	4	$ 40,000	0			0		
Workstation 2	2	2	4	$ 40,000	5	10	$ 50,000	0		
Workstation 3	1	2	2	$ 20,000	8	8	$ 40,000	0		
Workstation 4	0	2	0	$ -	8	0	$ -	6	0	$ -
Workstation 5	0	2	0	$ -	8	0	$ -	6	0	$ -
Workstation 6										
Total Sub Assy's	5			$ 100,000			$ 90,000			$ -

Total Inventories	$ 190,000
Carrying Cost per Month (2%)	$ 3,800

Figure 5-53: SVAC day 3 inventory carrying costs.

DAY 3 – Cycle Times

Let us take a look again at our cycle times between the workstations (see Figure 5-54).

Our TAKT time is 17.9 seconds. We know our cycle times should be less than 17.9 seconds. We observe that SVAC has achieved this goal in all five workstations on Day 3. There is nothing to hinder the company from producing these 24 airplanes. This now guarantees they can achieve the required production rate of this new contract.

Improved Airplane Production

Workstation Number	Cycle Time	TAKT Time
1	4	17.9
2	3	17.9
3	6	17.9
4	5	17.9
5	14	17.9

$$\text{TAKT Time} = \frac{\text{Available Time}}{\text{Customer Demand}} = \frac{430}{24} = \underline{17.9}$$

Figure 5-54: SVAC day 3 cycle times.

CHAPTER 6

STRIVE FOR PERFECTION

Evaluating the Final Data

The production went from 4 planes the first day to 15 on the second. It went to 39 planes per day on day 3 (see Figure 6-1).

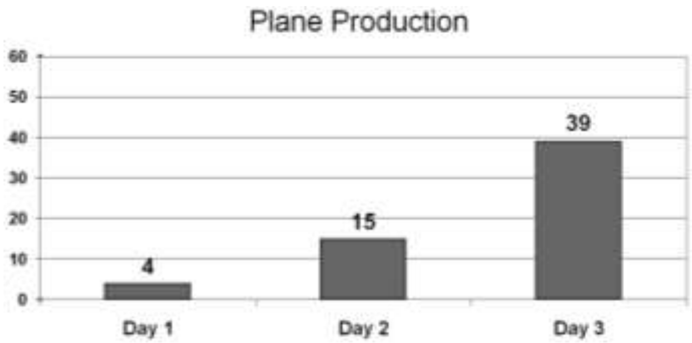


Figure 6-1: Comparison of the number of planes produced days 1, 2 and 3.

Lead-time came down dramatically to get that first plane through (see Figure 6-2).

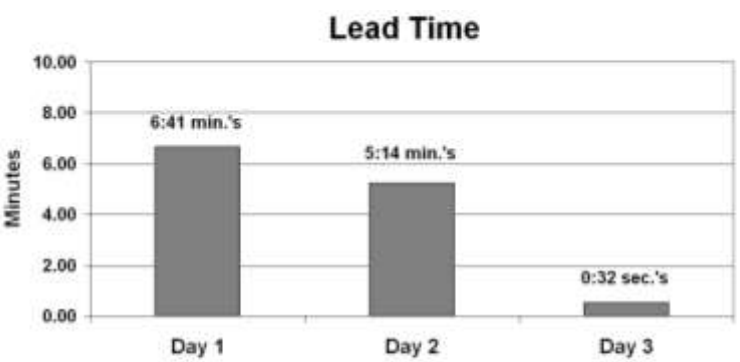


Figure 6-2: Comparison of the lead times for days 1, 2 and 3.

Now why did that lead-time come down? The answer is simple.

Lean results in a better system!

Here is a graph (workload balance chart) comparison of Days 1, 2 and 3 (see Figures 6-3, 6-4 & 6-5). Our best scenario is to make all the changes we have brainstormed. Day 3 improvements are the logical choice.

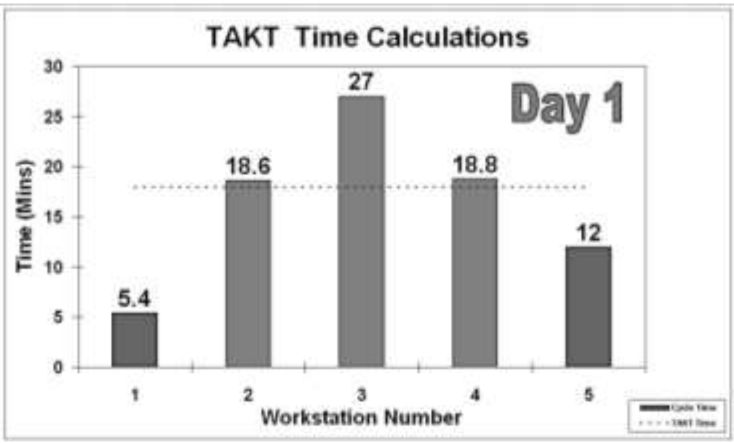


Figure 6-3: Day 1 cycle time calculations show that WS-2, WS-3, and WS-4, does not meet TAKT time.

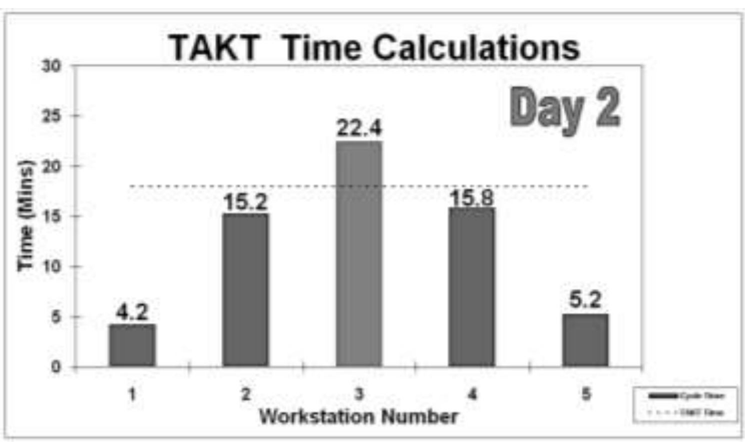


Figure 6-4: Day 2 cycle time calculations show that WS-3 does not meet TAKT time.

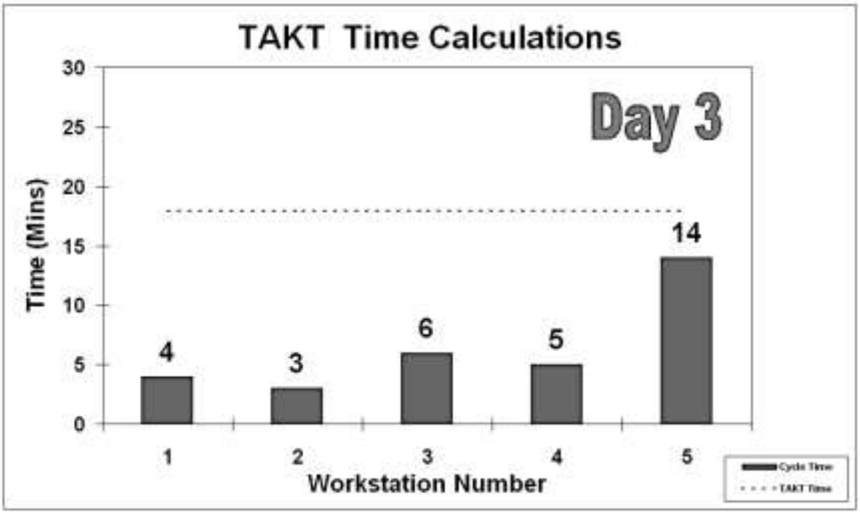


Figure 6-5: Day 3 Cycle time calculations show that we are below TAKT time, and can easily meet demand.

We wanted to be less than 17.9 minutes per plane in order to commit to the 24 planes we needed to get our contract.

Can we guarantee 24 planes for our customer? We sure can! Nonetheless, we still have waste in the system.

Where is the waste?

Let us look at Day 3. Where is the bottleneck? We will talk about a bottleneck rather than waste. Workstation 5 appears to be the bottleneck – but is it really? How many planes do we need to produce? How many did we produce here? We actually produced 15 more planes than we needed. We do not have an internal bottleneck. So where is the bottleneck coming from? The answer is sales and marketing!

Therefore, if sales went out and sold more, they could increase the demand. The TAKT time would come down. We found out that we could produce more so we should be pushing sales to sell more. This should be easy considering our new production lead-time. It is very possible that they could take orders away from our competitors. That is exactly what they should do. How can they do this? Not only have we increased the number of planes per day that we can deliver, but we have also reduced the per-plane cost. This means we can sell at a lower cost than our competitors sell and, maybe, even make more profit!

SVAC will now look at improving their marketing and sales departments in order to meet the new demand created by their increased ability to produce their product. They need more customers.

What about scrap?

The system got more efficient at creating scrap during Day 2 (see Figure 6-6).

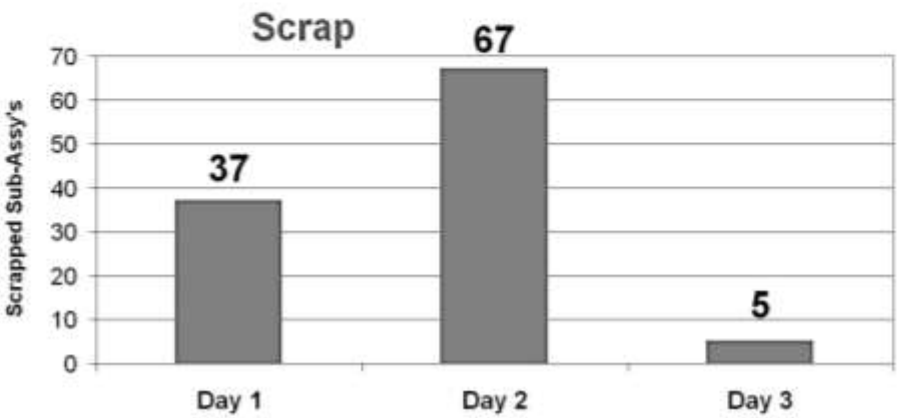


Figure 6-6: Comparison of the costs for days 1, 2 and 3.

Then, in Day 3, we went down to very little scrap again. As we forced the system to control the amount of inventory, the result was predictable.

We placed the limit to no more than one in the queue and no more than one in each area. As we counted the scrap, there should have been only one in queue and one being worked on. This way the system did not allow us to have more scrap.

We had a lot of inventory in Work in Process. Work in process went down as well (see Figure 6-7).

Figure 6-7: Comparison of the work in process for days 1, 2 and 3.

If you look at all the changes at the end of Day 2, you will note that we only did half of the total number we brainstormed. The result was that we were not able to do a very good job. Things were still chaotic; we got more efficient at making scrap – scrap was too high.

If we implement half a system, the results are skewed. We know we are doing well, and on the right track, but the results will not show us how well we are doing. They are skewed.

It is obvious though, after implementing all of the changes, we are now doing much better. Overall, if we implement the complete system we are doing fantastic!

Now what do you think the efficiency was (Day 1, Day 2 and Day 3)? From an efficiency standpoint, does everybody know what efficiency means in manufacturing? Efficiency is the comparison as a percentage of the actual time versus the standard time. Do we do it to that standard, yes or no?

An engineer went to workstation 1 and timed how long it takes to perform the work. When the operator is not hitting that time and taking longer, then they are less efficient. 100% efficient means they did it 100% to the standard in the standard amount of time. So when we look at the numbers, which do you think has the highest standard, Day 1, 2, or 3? Base your response on how many we are supposed to make.

In order to calculate efficiency levels, we need to prorate the time being wasted between workstations. In an exercise outside of this one, the standards were calculated (see Figure 6-8). The task for us was to compare the actual to the standard to get efficiency (see Figure 6-8). On Day 1, you could say the efficiency rate was at 85% -- Day 2 was at 94%. Does that make any sense? We were working a lot harder during Day 2. We produced a lot more scrap as well. This made us a lot more efficient at producing scrap as well as assemblies. Finally, during Day 3 – this might come as a surprise – we were 76% efficient. We have a lot more products out the door, but our efficiency was lower. Any ideas as to why? Why on the day that we get the most planes out would our efficiency be the lowest?

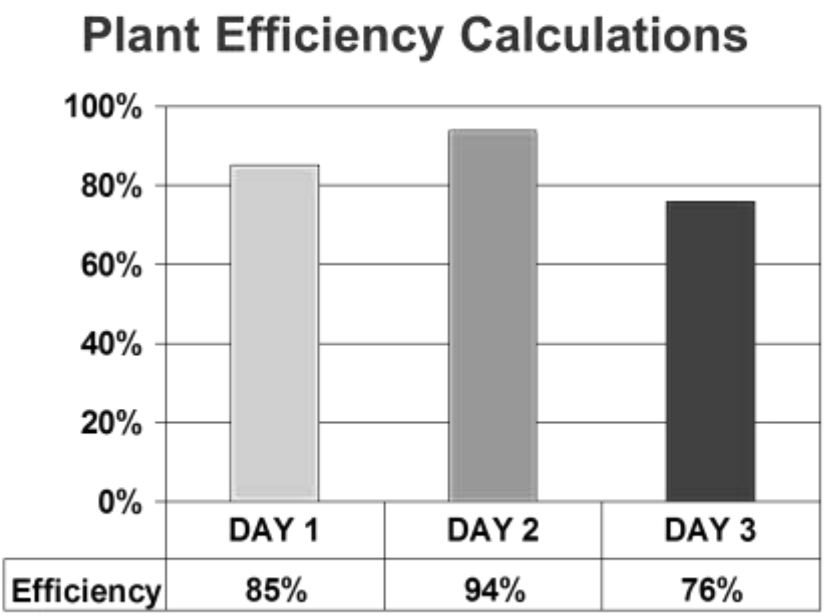


Figure 6-8: Comparison of plant efficiency for days 1, 2 and 3.

A lot of manufacturing companies use efficiency as the number one metric but they do not look at the whole operation. They do not try to optimize efficiency and reduce lead-time at the same time. As a matter of fact, when we looked at this with PAL Manufacturing, everybody said, "That's crazy! Let's not do that again." Although a company wants to get stuff out the door as quickly as possible, it is best we look at the entire system – not just how well one operation is doing.

However, it was pretty shocking to see how bad our efficiency was on Day 3. This was our best day. Efficiency is, therefore, not a good indicator by itself. In this case, the best gauge to use would be the number of defect-free planes shipped.

Achieving a Future State

Let us now talk about the operator balance chart (see Figure 6-9).

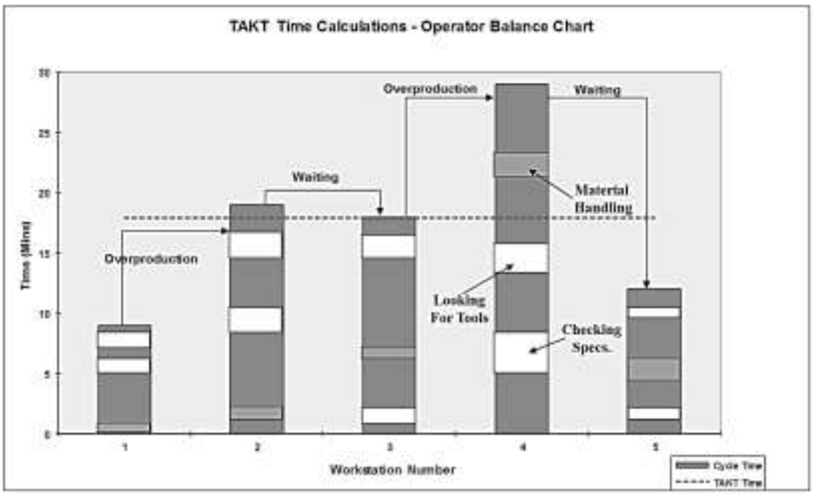


Figure 6-9: The operator balance chart.

When we first started off, we were asked to take a look at this chart. WS-1 was producing much better than the TAKT time. The cycle time was below the TAKT time.

So what happened between WS-1 & WS-2?

We had overproduction, which resulted in inventory piling up.

What happened between WS-2 & WS-3?

We had waiting, because one operator was going faster than the other one.

What about between WS-3 & WS-4?

We had overproduction. As you are waiting, inventory builds up. After a while, you become even slower because you have inventory building up.

How about between WS-4 & WS-5?

Waiting, yet again.

Now we know how each situation looks, we have to go from one WS to another and look for the wastes. It all makes sense when you look at the results.

This is how it would look for SVAC (see Figure 6-10). The wastes we have identified are overproduction and waiting, then overproduction and waiting again.

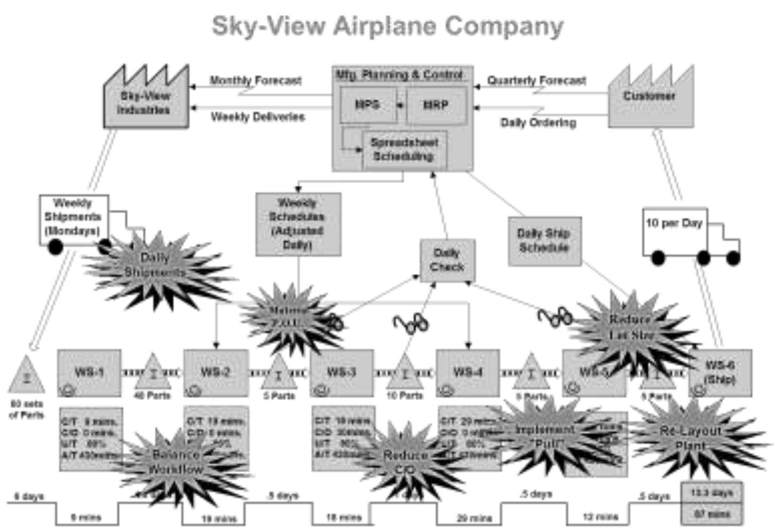


Figure 6-10: The SVAC future state map.

To sum up, the future state of this company went to 13.3 days lead-time and 87 minutes Value added time. We implemented changeover reduction, pull and point of use inventory.

Future State Questions

1. What is the TAKT Time?
2. Will we build to shipping or to a supermarket?
3. Where can we use continuous flow?
4. Where do we have to use a supermarket pull system?
5. At what single point in the production chain do we trigger production?
6. How do we level the production mix at the pacemaker process?
7. What increment of work will we release and take away at the pacemaker process?
8. What process improvements will be necessary to achieve our future state?

We always need to ask ourselves, “How are we going to produce to a TAKT time?” Remember TAKT time production is the heartbeat of the customer. How do we make sure that we internally are producing to the customer’s needs? How do we pull the inventory through to create a continuous flow? At what point in the production chain did we trigger something to be produced? When we asked such questions, we had a system at the end of Day 3.

Let us assume we are coming into work at SVAC at Day 4. What needs to be done before any plane can move out of the system? There is only one point at which we have to do something and then everything else is triggered and happens automatically.

We just need to ship one plane. This creates an empty queue, which is the start of the day’s production. If we develop a system like that, no matter where it is (retail, production, office) we have little waiting and little overproduction. This is because everyone knows what to do and when to do it. This is how the whole production chain works.

Understandably, we do not want one person working harder than another person does. However, we should make problems visible. So having someone standing around while everyone else is working is a sign that a problem exists. This is good. We need signs like this so we can focus on the problem.

The title of this graph should read "Cycle Time Calculations" (see Figure 6-11). TAKT time is consistent at 17.9 min.

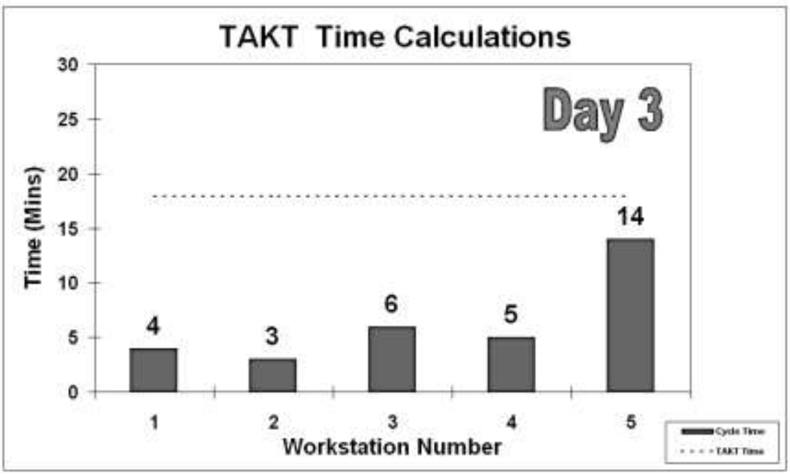


Figure 6-11: The SVAC day 3 TAKT time calculations.

Problem: Our assembly operation is "over-producing" to the customer demand.

Solution:

- Ensure everyone is cross-trained.
- Identify the total FULL-TIME people needed in the area.
- Resource the area properly.
- Allow 15% of their time to go to continuous improvement.

Recognize that in a Lean implementation we respect the people and their families. If we reduce the workforce in this assembly area, we need to find other, more meaningful work, for those that are re-assigned.

For example, by adding up the C/T you get 32 minutes. Three operators would be able to produce to the TAKT time and have extra time for continuous improvement activities. The other two operators are freed up to work with the engineers in new product development. The company should be working on securing their future in the marketplace.

We need to have the right attitude. We say, “Here’s how we are going to get the job done – so let’s go do it! Let us test it. If it doesn’t work, instead of saying it doesn’t work, we are going to make changes and do it the right way so it can work.” Then, we will implement slowly. We make sure that, as we are going through, we do not introduce too much change. We are in it for the long run.

If you look at this value stream map, you will see a supermarket at the end of WS-5 (see Figure 6-12).

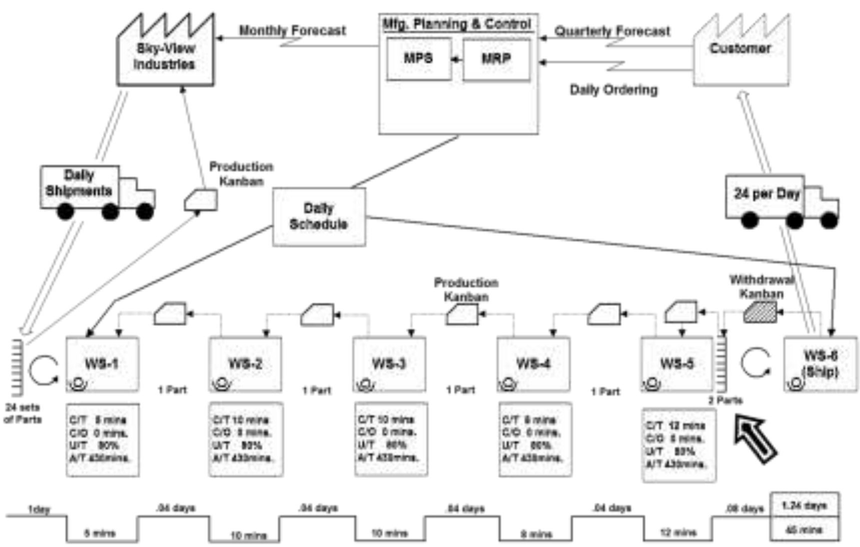


Figure 6-12: The SVAC day 3 TAKT time calculations.

The internal customer, shipping (WS-6), pulls and ships to the customer. This triggers WS-5 and signals it to produce more work. WS-5 takes it from the queue, which triggers WS-4 to produce more work. WS-4 does the same, which triggers WS-3, WS-2, and WS-1 to do the same.

Why does this daily schedule show information going to WS-1? What are they producing? Two models which come in two colors: green and white. The schedule tells them what color needs to be produced. If the customer calls and wants a white plane, we have to tell WS-1 to start making one. Otherwise, no other WS is affected by this change. This is why the sequence or Final Assembly Schedule has to go to WS-1.

Review & Conclusion

Let us do a quick review of the 7 wastes – we covered all of them. Here is a quick way to remember them. For the 7 Wastes, you might want to remember them as "Tim Wood."

SEVEN FORMS OF WASTE
"TIM WOOD" ACRONYM

T	Transportation
I	Inventory
M	Motion
W	Waiting
O	Overproduction
O	Over processing
D	Defects

That is one way to remember the seven wastes, but do not forget the other two wastes. They are the waste of human potential and the waste of complexity. Typically, organizations do not use the thinking power of their employee. Remember, this results in everyone getting stuck on situations that are more complex than they need to be.

Now let us revisit the 5 principles of Lean.

REVIEW: **THE 5 PRINCIPLES OF LEAN THINKING**

- Define value from the customer perspective
- Identify the value stream
- Make the process flow
- Pull from the customer
- Strive for Perfection

This is where we started. As soon as you are doing the first 4 principles right, the fifth one is in sight. You can see things getting much better. This motivates you to start move in the right direction. Keep on exposing problems and solving them. Ensure you have a system to do that.

Skill Testing Question**:**

We have a series of operations, Op. #1 to Op. #5, and they run in series. We want to go from 10 pieces per hour to 20 pieces per hour in Operation #3. All we have to do is invest $100 (see Figure 6-13). Should we do it?

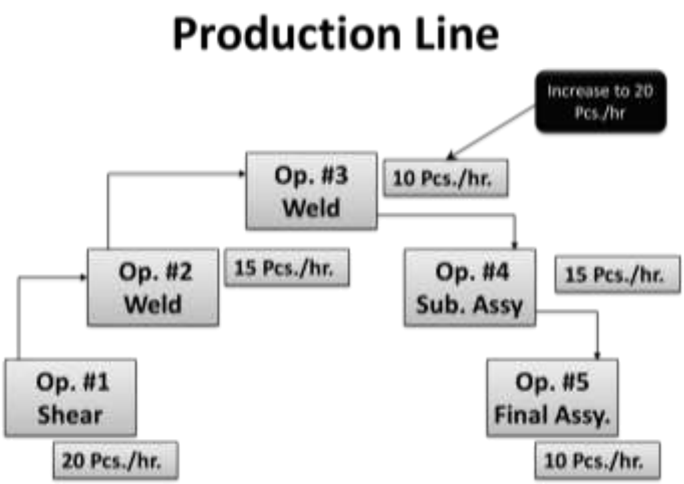


Figure 6-13: Skill testing question.

This is a system. You should not spend a single dime on any area other than the bottleneck. If you look at Figure 6-13, there are different quantities of production at each station.

Even if you spent money at Operation 3, can the current system produce more? No. Therefore, you would be wasting your money. The system has to be the entire process we are looking at. By the way, what if sales could only sell eight pieces per hour? There is no point looking to increase production.

In 1926, Henry Ford turned Iron ore into a finished car in 41 hours. That is pretty Lean is it not? Why were cars only available in black? It was the fastest drying color. So even in those days, they were thinking Lean. Black paint contributes to shrinking the lead-time.

In 1943, B-17 bombers were being built by farmer's wives. Here is the actual plant floor layout (see Figure 6-14). They actually built 17 B-17 bombers every day.

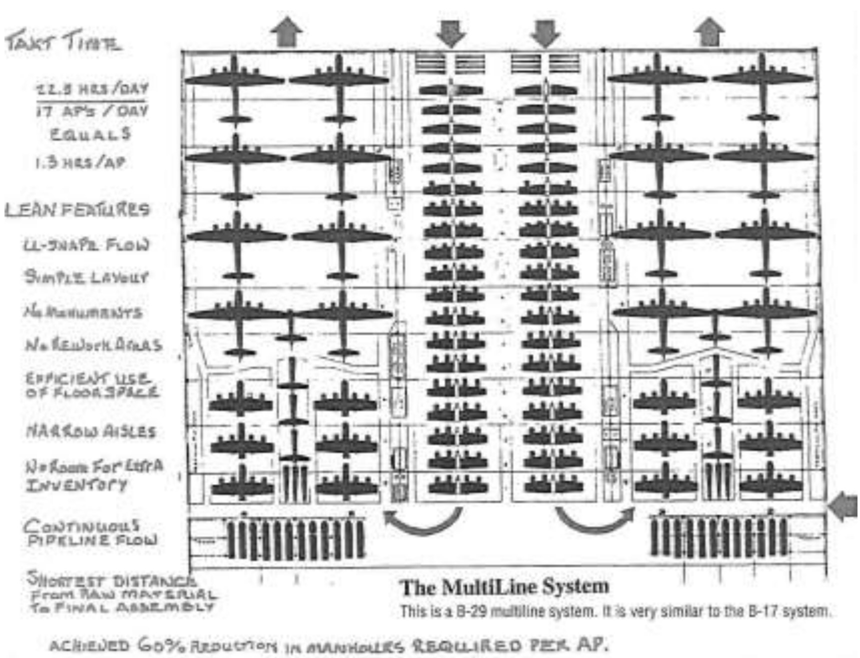


Figure 6-14: Plant floor layout (1943).

When you look at this plant floor layout, you can kind of see the flow. Every 1.3 hours the line would move. What is that called? It is the TAKT time. They balanced the cycle time of every operation to 1.3 hours. In those days, they were already implementing Lean. The concept is very simple. The problem is that we think we need to be engineers to understand it. As an engineer, let me tell you that most engineers do not know this stuff. This is because many of our institutions do not teach them about the history and these Lean principles.

Production skyrocketed from 1941 to a peak of 370 airplanes per month in March 1943 (see Figure 6-15).

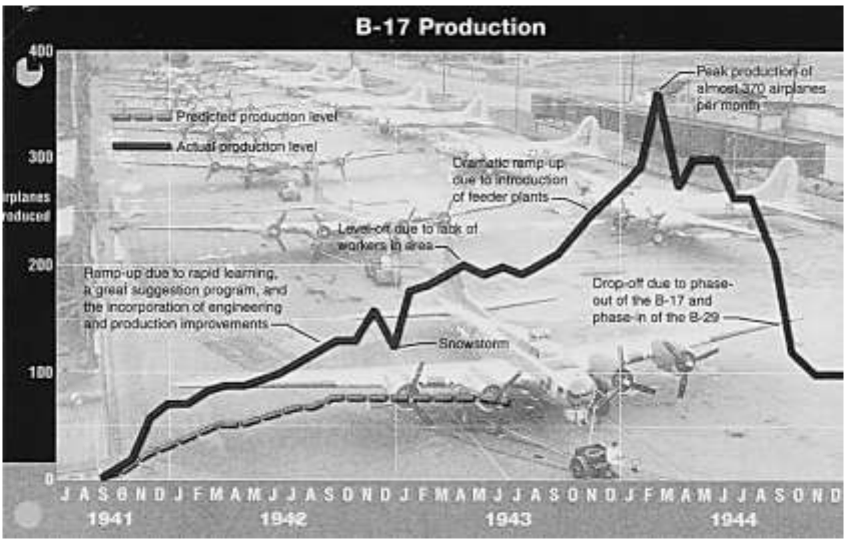


Figure 6-15: Plant floor layout (1943).

This translated to 17 planes per day. The war had forced manufacturers to do things differently. The workers they hired had little or no knowledge of how to build planes. Neither did the managers. So, they got together and decided collaboratively (in a Lean way) how to build planes. They used sketches on the front lines to describe the build process. Every day they thought about how to do it better - they had to. Their husbands and sons were depending on it.

What do you think happened after that?

The experts came home and they started companies. They were doing it right in those days and that is what a lot of manufacturing companies are going back to today.

CONFUCIUS SAYS

What I Hear, I Forget…

What I See, I Remember…

What I Do, I Understand.

Let us take a closer look at this saying…

What I hear – I Forget	90% of what is heard is forgotten.
What I See – I Remember	Approximately 50% of what you see you remember.
What I Do – I Understand	The airplane simulation we did was an exercise that should stay with you, especially if you can participate in the hands-on activity.

<u>Cash Flow Example:</u>

Lean is all about Cash flow. It is about reducing the time from order to cash. Cash is what pays the bills. Effectively lowering your Cycle Times (C/T), increasing your throughput and reducing cash-to-cash lead-time is what it is all about.

The following diagram shows a typical manufacturing environment headed for disaster (see Figure 6-16). This is how most companies go broke!

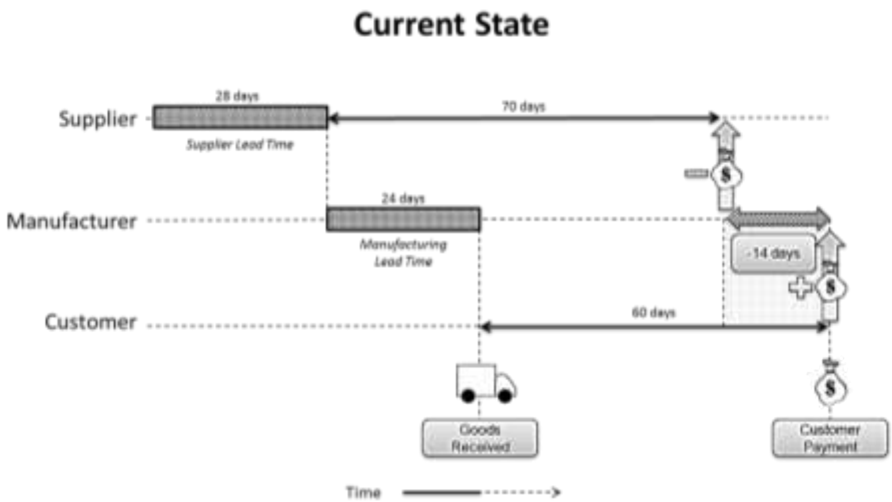


Figure 6-16: A typical manufacturing environment headed for disaster.

In the current state, we notice:

- The Supplier Lead Time is 28 days and that the manufacturer has 70 days payment terms.
- The Manufacturing Lead Time is 24 days. This encompasses everything from the manufacturing process to the delivery of the goods to the customer.
- The Customer has payment terms of 60 days, effective from the time the goods are received.

Many companies have this kind of situation for doing business. These same companies experience cash flow problems eventually. This becomes a bigger problem when the customer orders increase or grow. With more customer orders come more requirements. With more requirements comes a greater need for raw materials. With more raw materials, more money is owed to the suppliers. This is the situation that companies fall into. This business will not survive in the long run.

The visual represented by Figure 6-16 (i.e. the current state) shows a cash flow deficit of 14 days. This means the company is out money 14 days (for that order) before it receives money from the customer.

After Lean principles are applied to the manufacturer, we see the manufacturing cycle has been reduced from 24 to 4 days. This reduction completely changes the cash flow situation from a deficit to a surplus of 6 days (see Figure 6-17).

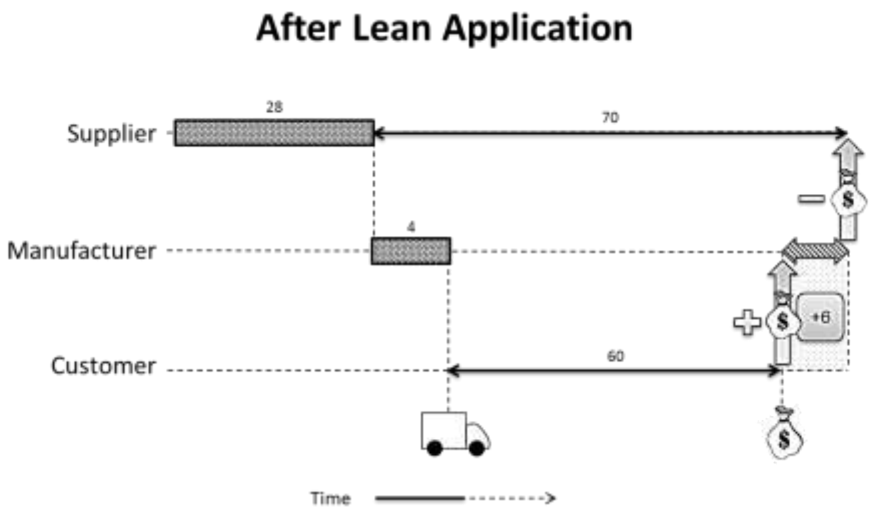


Figure 6-17: After Lean principles are applied to the manufacturing environment the future state yields significant improvements.

While this has significantly improved the manufacturer's cash position, it can be improved even more by sharing these strategies with your suppliers. In this way, your business is taking ownership of its entire value stream.

This next diagram shows how the cash flow surplus can be further enhanced (see Figure 6-18). By working with the supplier to make improvements, we expect a drastic drop in the supplier lead-time from 28 days to 7 days. With overall improvements in supplier and manufacturing lead times, customer payment terms can then be negotiated – in this case down to 30 days.

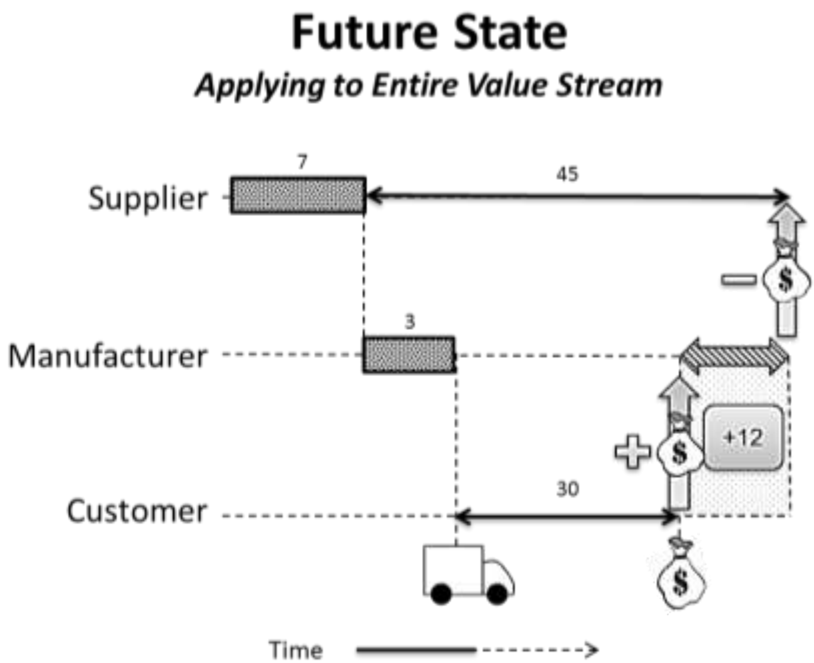


Figure 6-18: Improving the entire value stream yields even better results.

The bottom line is that everyone is happy. The supplier gets their materials out faster and is paid much quicker. The customer gets their order delivered sooner. The manufacturer gets the benefit of having established a more efficient fulfillment stream. By removing much of the waste out of the process, the manufacturer can also become more competitive in their pricing. This always results in attracting more customers. Don't forget though. The gains do not stop there. By repeating this process over and over again, we continue to work on the right stuff. We instill the right principles within our organizations.

“Without constant attention, the principles will fade. The principles have to be ingrained; it must be the way one thinks”

- Taiichi Ohno, creator of the Toyota Production System (TPS)

CHAPTER 7

From Tools to Systems

What Level are you playing at?

If you take lean thinking and break it up into three levels, with each part being a more comprehensive understanding of lean than the other, you may choose the following distinction:

Level 1 - Application of Tools and Techniques

Level 2 – Understanding that everything is a Process

Level 3 – Defining the truths of your Business and leveraging them.

Lean Thinking has many tools and techniques associated with it. These are quite well understood and therefore you will find many books on their topics. For example the spaghetti diagram (see Figure 2-4) previously shown in Chapter 2. When a tool is applied to a business process, what you see is the completed product, say the drawing. A tool would show up in a business as an artifact. It would be something you can take a picture of and see the evidence of something being communicated to others.

Another tool would be an operator balance chart (see Figure 6-3), where it becomes evident there is a gap between what should be – being able to meet the takt – versus what is. This tool allows us to focus our attention in a certain direction.

If I were to set you on a track for learning, and your vision was to be a great “Lean Thinker”, one of the first things I would do is to make a list of all of the more common tools used in lean and tell you to initiate the learning process by doing. Complete an example of each of these tools in a “real life” situation. You cannot learn Lean from a book. You have to learn Lean by applying the tools to problems that you are tasked to solve.

The most effective tool in Lean is the Value Stream Map

Applying Lean in a Dentist Practice

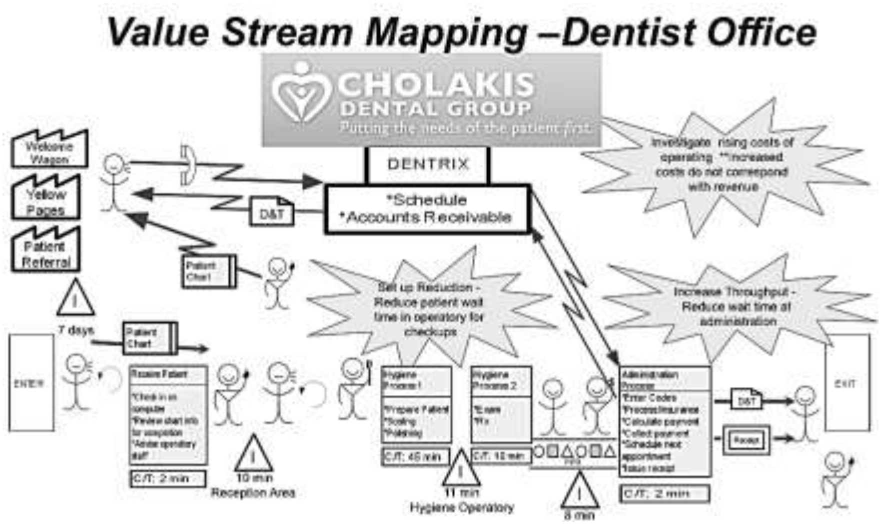


Figure 7-2: The initial Future State Map for a Dentist Practice.

I was sitting in my dentist’s office one day, with my mouth wide open. I do not know how I managed to get the words out, “You need to apply Lean Thinking to your practice.” Well my dentist just happened to be one of the most forward thinking dentists in the country. Not only did he take me up on my offer but he also demanded that his suppliers get aligned with his company so it can deliver an experience for its customers that exceed their expectations.

When we started mapping out this process, it became very evident the process was exactly the same as in a production environment. We needed to identify the current state with the team, and communicate it on a whiteboard or piece of paper. All that was missing were a few icons. The rest of the ingredients were there. We created an icon for every position (example shown in Figure 7-2) in his organization, and used the other basic material and information flow icons to communicate the current state.

Figure 7-2: Icons created to tell a story, collections, hygienist, and receptionist icons.

By mapping the patient as being the thing going through the process we mapped what the patient experiences as they go through the process. By mapping the entire value stream, it became evident to everyone that in order to improve drastically, certain suppliers needed to be considered as an extension of the business. So we included them as part of the whole. This extended value stream included the manufacturer of bridges and crowns. Success meant daily deliveries and this daily demand was made visible by the creation of a scheduling board.

Alfa Ceramics, a direct supplier, needed a tool to understand the dentists' requirements. That tool was a visual board (see Figure 7-2). I had the pleasure of working with Alfa two years ago, approximately six years after the initial introduction of Lean, and I can tell you that the visual tools are still there, and being used.

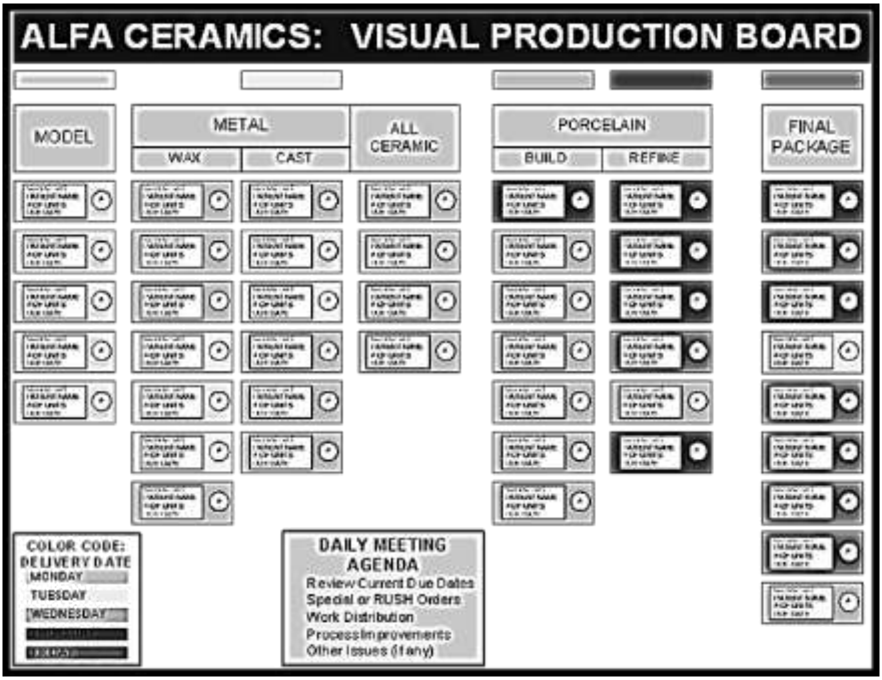


Figure 7-3: Visual Board with daily requirements color-coded

Applying the tools have very clear steps

The Value Stream Mapping Steps are:

Step 1. Gather information about the customer

Who is the main customer(s)? What is the customer demand? Packaging requirements? Then, draw customer icon on the sheet, and place all relevant information below the icon.

Step 2. Walk the process

Walk the process through at least once before you begin drawing. Then begin at the end closest to the customer (shipping) and move your way upstream. Draw the process boxes.

Step 3. Fill in data boxes and inventory levels (or wait time)

The data collected needs to be appropriate for the area, i.e. cycle time, machine capacity, shifts, people, etc. Document where inventory is held, or where queues exist. (Remember, this will be a snapshot in time.)

Step 4. Document how goods (or services) are delivered to the customer.

How often? In what quantities? Mode of transportation?

Step 5. Gather information on your suppliers

Who are the main suppliers? How are materials (services) delivered? Quantity? How often? If you have a large number of suppliers, focus on the largest ones first (possibly two or three).

Step 6. Add Information Flows

How does the customer communicate requirements to us? How are the requirements communicated to the floor (or worker)? How do employees know what to build/deliver? How does the supplier know what to send and when to send it?

Step 7. Sketch how material moves between processes.

Is it pushed, pulled, FIFO, etc.? Create your own icons if needed.

Step 8. Draw production lead-time/value-added timeline

This is added at the bottom of the current state map. It is good practice to calculate the percent value-added time. Simply divide the value added time by the Total Lead Time and multiply by 100 to get Percent Value Added Time.

The Value Stream Map is a visual picture of how the business functions for the series of processes that you are focusing on. The VSM tool is used in the Value Stream Management Process

Each tool can be part of a bigger system or process.

The Value Stream Management Process also has 8 steps, and they are…

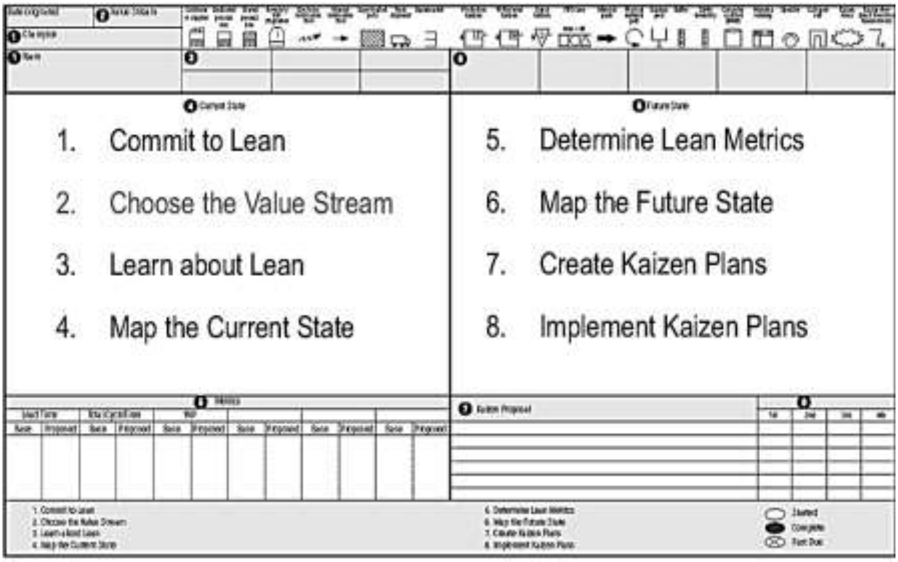


Figure 7-4: A whiteboard used during the implementation and steps followed. (From *Value Stream Management* by Don Tapping, Tom Luyster, and Tom Shuker)

The value stream mapping steps apply to steps 4, and 6 above. By making a system out of Value Stream Mapping, you could call it Value Steam Management (as shown above). Do not forget that repeating these steps over and over again will develop the habits and behaviors that make an organization "Lean." This only becomes a system if you treat it as such. What forces this repeating cycle to happen? The answer is leadership.

This cycle should be completed within 100 days, and repeated indefinitely in the process of improving. Imagine every three months a team of people are making advances towards a better state of performing that.

Until you achieve your ideal state, you are not done, and since you never achieve the ideal state, it just follows that you are never done. It is and always will be a journey. Find comfort in this fact, and drive excitement for the next iteration towards the ideal state. Enjoy the problems that arise, and treat your people like the appreciating asset of your business that you know they can be.

Defining the truths behind your business and leveraging these truths to gain complete buy-in.

One truth about the consulting business is that "word of mouth" is best way to promote yourself. When you know this, it becomes evident that spending money and time in other self-promoting arenas have limited impact compared to using a word-of-mouth strategy.

Applying Lean to a Retail Outlet

Target the ideal state and remove barriers that keep you from achieving it.

Do the stuff that gets you the biggest return on your time spent. This means you are measuring the gap from the ideal state backwards, not the current state forwards. One this is clear however, you must look at it as a system.

I was promoted by one of my clients to help their customer. Their customer was Princess Auto. This is a chain of stores across Canada known for catering to "the man." They are proud to be known as "man" stores. They have everything a guy could want come through their store at some point throughout the year. The way they advertise is through a flyer sent to a million customers throughout the country. In this way customers (a good portion are farmers) come to the store only when they know their trip into the city will be worthwhile. Only when they know the store has what they want.

Figure 7-5: Flyer cover for Princess Auto

Figure 7-6: Random circling of items to find -- formulated as an experiment

This happens to be a picture of the cover of their flyer (see figure 7-5) at the time, my consulting firm was asked to help them out. Initially I had no idea how I was going to get started, but I knew the Principles of Lean Thinking would apply.

My company performed a test to see how far from the ideal state they were. The VP of Operations, at the time, asked me to help them get organized in the store. He knew what we did with their manufacturing division was excellent, and wanted some of the same benefits. Well, manufacturing and retail are different, but everyone is able to explain what the ideal should be for the customer. The customer should be able to find what they want in the store as soon as possible. Especially considering that they have a picture in their hand.

Devise an appropriate test to determine the gap from the ideal state.

The test (see figure 7-7) that I devised was one of determining the customer’s ability to find goods. We came up with what we called the 20-item test. We circled an item on every second page of the 40-page flyer and asked the store manager to find these items in the store. We also knew that a customer would have a much harder time, but it was irrelevant, we are measuring the ideal, not the current state.

Figure 7-7: Random circling of items on the flyer

The manager predicted that the walking time would be about 6 minutes, and we agreed with his calculation. The test was performed early in the morning when the store was closed to the public to ensure there were no distractions. We recorded this test on video to show every team member the results, and more importantly the waste everyone misses each and every day. The test was very successful. It took 22 minutes, instead of 6 minutes as compared to the ideal state. The gap was huge.

Treat problems as treasures! In this case, a problem is defined as the gap between the ideal state and the current state.

The next step was to analyze where we went wrong – where the point of cause was for unexpected delays. We needed to understand what happened and what did not happen. That is why taking a video recording is critical. There is no way to do this without the analysis. After creating a spaghetti diagram of the path the manager took to acquire the goods (see figure 7-8), it was obvious there was no logic applied to his method for finding items.

There were also 5 errors that cost the company about $550 in revenue. It became apparent the manager required the use of the computer system to look up where inventory was located in the store. We show the spaghetti diagram of his path below. We only show one pathway to the warehouse (top right corner of figure 7-8) where in actuality he walked there three times. Regardless, the path the manager took looked very similar to the diagram below.

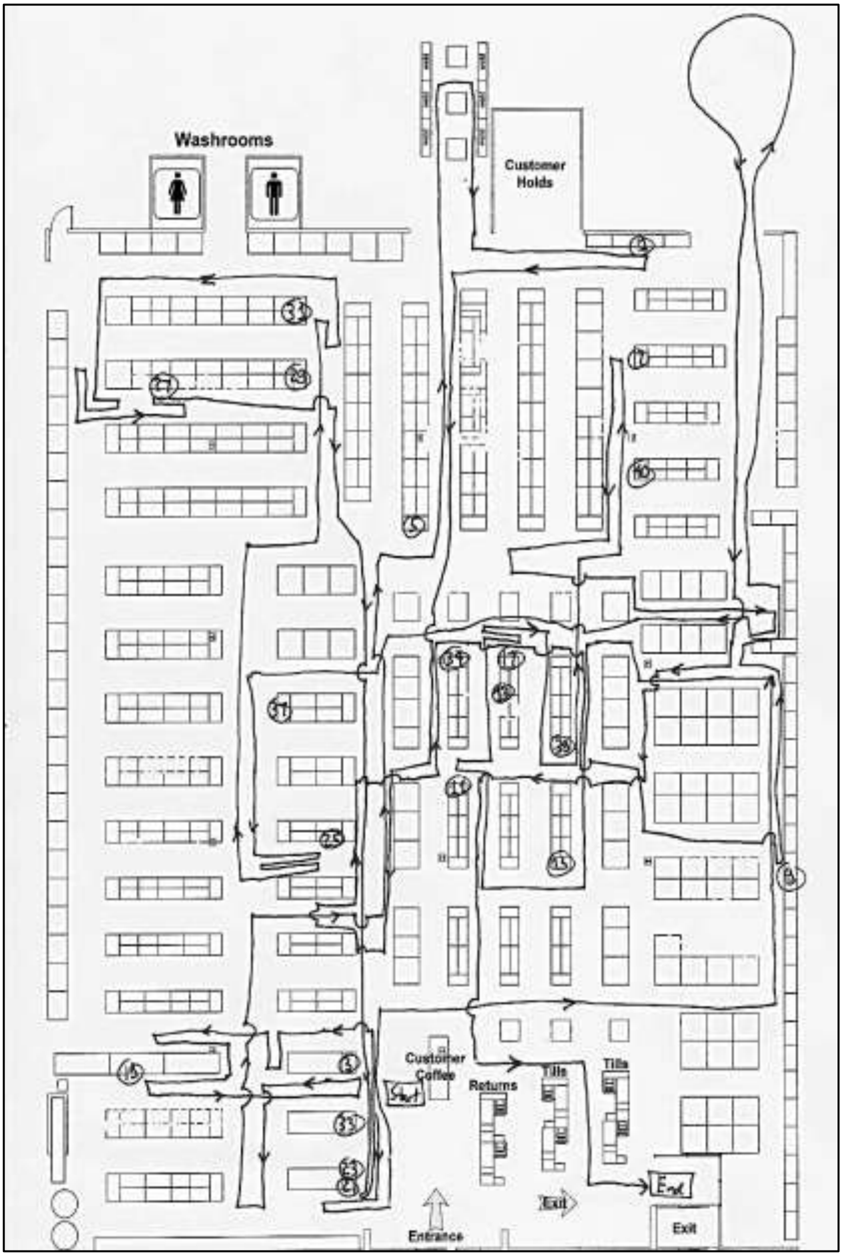


Figure 7-8: This spaghetti diagram showed the path during the 22-minute video recording to complete the experiment.

Everyone was so excited with the results that we decided to do it again with another two team leaders. The results were exactly the same. When the comparison to the ideal state was done, the questions arose out of this test became the starting point of the implementation.

What would it take for us to achieve a 6-minute turnaround without any mistakes?

Now the creative juices start flowing. After everyone realized the best manager/team leader was one of those that took part in the exercise, any criticism as to our approach was eliminated. We eliminate the tendency to blame the person when we use the best person to take part in the exercise. We had great ideas from the team. We ended up identifying certain kaizen events.

These kaizen events were:

- ✓ Develop visual systems to identify promo material.
- ✓ Develop home replenishment system.
- ✓ Develop warehouse management system.
- ✓ Develop system to identify and reduce excess inventory.

Everyone forgets the concept of PULL as being a key to working towards an ideal system. Most companies forget how visual things must be displayed in order to make waste visible for the purpose of eliminating waste of complexity. This is why I exist as a consultant. I am there to remind them the pull system works. As a matter of fact, it was the Princess Auto retail team that took part in the airplane simulation in the online course **http://Lean101.ca.**

Figure 7-9: Color-code visual Map of where to find information from the flyer

By identifying the ideal state first, the team was able to get the flyer color coded for all of the stores in Canada. Information centers were created in each of the areas allowing customers and staff to find things immediately. This reduced greatly the demand on the staff that are in the process of assisting people as they aimlessly wandered around the store looking for other staff members to assist them.

Figure 7-10: The information board contains the flyer and rack location of each part

The initial visual board contained the color-coded flyer and the rack locations for each item (see figure 7-10).

After running the 20-item test the second time, the results were dramatically improved. It took 9 minutes to get all of the items in the cart, and this time, there were no mistakes.

The team should never stop at the first iteration of change, continuing along the same journey gets them closer and close to the target. One of the biggest benefits was they worked as a team solving problems as they make their way toward their goal.

"Princess Auto has been thrilled with the work that OEM Consultants have done for us. The current project in our Panet Rd. Store has exceeded our expectations and we certainly plan on continuing to work with OEM to roll the project out to other stores across Canada."

- Michael Leach, Sr. Vice President, Retail Operations Princess Auto Ltd.

CHAPTER 8

From Lean Processes to Lean Thinking by Jeffrey K. Liker

When *The Machine that Changed the World* introduced the concept of lean, it became clear that the model was Toyota. That book was quite prophetic and took a very broad view of the lean enterprise covering every major function of the company to become an agile, innovative, learning organization, a message I have continually reinforced in my books about the Toyota Way.

Unfortunately, the broader message too often gets lost as companies focus narrowly on tools and improvement of specific processes missing the “thinking” part.

If we look back at the creation of the Toyota Production System, originally led by the great Taiichi Ohno, we see that challenging conventional thinking was always at the heart of the system. Like all great Toyota leaders, Ohno’s quest started with a challenge. Kiichiro Toyoda announced the concept of “just-in-time” as the backbone of Toyota’s efforts to become a credible global automotive company. This was no trivial feat since at the time Ford with its huge volumes was estimated to be 9 times as productive as Toyota. Moreover, the concept of JIT was just that, a concept.

Ohno’s task was to make JIT a reality and catch up to Ford’s productivity in three years—a challenge that would make many lose a lot of sleep at night. Ohno already had a good deal of experience with creating flow lines in the original loom company of the Toyoda family. But automotive was an entirely new arena. At the time, he was managing the machine shop making engine components. Machining still to this day is one of the more difficult places to apply lean as mostly they are organized into job shops with similar machines put into individual departments while parts go through routings from department to department, with a good deal of inventory sitting everywhere. There are changeovers in machining so the usual answer is building in batches to take advantage of economies of scale, which was Ford's approach to productivity. Ohno knew that with the scarce resources and tiny demand of Toyota he could not imitate Ford. He needed flexible processes with little inventory to adapt to the changing demand for small volumes of different types of vehicles in Japan.

Ohno's solution was what we now call the one-piece flow cell. He bit the bullet and moved machines into a cell organized based on the operations that needed to be done to a family of parts. This reduced inventory as long as he could reduce set up times. However, he also needed a great deal of human flexibility. This turned out to be more challenging. In Ohno's vision, machinists were machinists and should be able to operate any type of machine. This would allow Ohno to flex the number of people working in the cell based on the demand for those products, the Takt. Twice the demand meant the Takt (time to produce each piece) should be cut in half and by doubling the number of workers the Takt could be achieved.

Demand is reduced in half and the Takt increases and you take half the people out of the cell. This is simple arithmetic, but not simple to put into practice.

It turned out machinists did not consider themselves as machinists. A lathe operator ran lathes—end of story. The driller wanted to keep drilling holes. Now Ohno was faced with the challenge of changing the thinking of people, far more complex than arithmetic. When asked how he did it he explained that he had to go to the gemba and be with the people every day. He had to learn patience—totally alien to him up to this point. He had to change his own thinking about his role. He was becoming a change agent, not simply a manager or technician.

Ohno continued to be harsh and aggressive though he had a soft side. For the professionals he trained in TPS he was unforgiving and never satisfied. He was pushing them to observe deeply and think about what the real problems were asking why over and over. They had to find the root cause, solve the right problems, and always achieve the challenging goal. One disciple of Ohno explained to me that Ohno revolutionized his way of thinking and life.

He explained that as an industrial engineer he had been taught that he should always try to balance the work among team members to 85%, so that there was adequate rest breaks.

That is, if they worked at a normal pace they would complete each cycle of work in 85% of the time. Ohno insisted the only reasonable target was 100%, not by making people work themselves to death, but by eliminating waste. Ohno realized that if someone actually achieved 100% they would do further kaizen and the percent would go down naturally, as they got better giving them more rest time. Start at 85% and it will soon be 75% actual work time.

As he conducted his experiments in the machine shop, Ohno discovered what the greatest innovation in the Toyota Production System was. As he worked with the people to eliminate waste and move toward the ideal of one-piece flow the actual process became more challenging to keep running. Without inventory, and with everyone building to Takt, any disruption whatsoever would stop the cell—there was little room for error. Equipment problems, training issues, motivation issues, poorly designed parts that were hard to manufacture or any other problem would immediately surface and shut down production. This was a very immediate and dramatic consequence of disruptions. It forced an even higher level of kaizen and soon the team members were doing it, not just Ohno.

Thus, Just-In-Time, defined originally by Kiichiro Toyoda as a way to eliminate slack from all processes for the sake of cost and efficiency, really meant striving for perfection. Ohno used to talk about “the factory that god would build,” as the ideal everyone should be striving for. It would not have extra inventory, equipment would work perfectly, people would perform their job to perfection, there would be no defects, all materials coming in would be to specification and just in time, and of course it was an impossible dream.

Ohno preached that in the real world there is always waste, but through intensive kaizen everyone should be striving to eliminate that waste to move closer to the ideal of perfection.

Another term for waste that causes lead-time to be long is variation. Any variation in the way people perform the work, incoming materials, the way tools and equipment operate, of the availability of materials when they are needed will cause a lean process to stop. In fact, for work that is not completely automated Ohno took a page out of the book of Sakichi Toyoda. Sakichi Toyoda established the andon system for automated looms so they stopped when a single thread broke and a signal went up for help. Ohno set up the andon system for manual work as well and the worker signaled when they were in an out-of-standard condition and help would come. This was necessary for heavily loaded jobs as a stress-relief valve, but also was another way to surface problems and drive continuous improvement.

In short, when processes are tightly linked, problems cannot hide. They become immediately visible. This then drives problem solving. If the problem solving is mere containment—focused on the symptoms—the problems will come back and production will keep stopping. Only through finding the root cause, putting in effective countermeasures, and carefully monitoring the process will it stabilize. At that point management raises the standards, for example, by further reducing inventory. It is a brilliant system that integrates process improvement, people development, and problem solving leading toward highly stable processes that get closer and closer to perfection and people who become more and more skilled at problem solving.

So why isn't everyone doing it? Because they did not get the memo of what Ohno learned. They still think the key is to rearrange the processes into a cell and specify the standardized work and then step away and let the process improve itself. Guess what, the process self-implodes. It gets worse over time naturally. If leaders hear that, they need to focus more resources on people development they usually agree in principle but do not have the deep commitment necessary to follow through. They want results fast and cheap and patient investment in people and process improvement is simply too much working and too much thinking. It also requires a strong vision for what it takes to be excellent.

So there you have it. Weaknesses in the thinking of leaders who do not grasp or deeply believe in the power of a total lean system, will automatically resort to picking off pieces, the easy parts, and assume if they spread the tools fast and wide they will get fast results. To change the success of lean requires changing the thinking of management, which requires that they dig in and get their hands dirty to learn the hard work required and the incredible power of kaizen. *Developing Lean Leaders at all Levels* talks about the process necessary to really develop lean leaders from top to bottom. It is not a cookbook. There is no easy path that avoids patience and hard work.

Jeffrey K. Liker

Professor, University of Michigan and President of Liker Lean Advisors, LLC

Author, *Developing Lean Leaders at All Levels*

www.ToyotaWaytoLeanLeadership.com

Figure 8-1: Dr. Jeffrey K. Liker and George Trachilis on a boat ride before the Lean 2012 Conference in Winnipeg, Canada

CHAPTER 9

Implementing Lean- A Leaders' Perspective

A leader's perspective on leading people through a Lean implementation by R. Jungkind

Imagine this situation… You toured a plant that has been utilizing lean for a number of years and you want the same positive results. You have made the decision to lead the lean implementation in your organization. Should be easy right? After all, there are unlimited resources on the internet and an endless number of books. Many organizations will tell you that they have already implemented lean and they are proud to tell you how they accomplished their results. I have been involved in lean implementations for 20 years, and during that time, I have seen many variations of success. One common denominator in the most successful implementations has been the success of the leader in engaging his employees. This experience as a leader has taught me some basic guidelines that will help achieve the results you have set for your organization.

1 Expand your knowledge

As a leader, you need to understand the lean culture you want to create for your organization. Lean 101 is a great way to start your knowledge. Utilize resources from many different sources and understand the how the lean tools can be utilized to create the culture that will ultimately help achieve your vision. What are you trying to achieve with 5S? Do you want shiny machines and lines on the floor or do you want a means to visualize waste and identify opportunities to resolve in the process of achieving continuous improvement? What benefit can you get from value stream mapping? Is lean something you do during the slow season or is it a culture that becomes part of your activities at all times?

2. It is your vision.

This is your vision to communicate and support. This is not something you can delegate and ask for updates as part of your monthly review. The energy, support and enthusiasm you demonstrate will directly correlate to the success of your implementation. Be prepared to allocate 40 to 50% of your time towards this implementation. That is a big number; however, this is a big commitment. You will spend your time in meetings, kaizen events, communications training and spending time where the value added activities take place. You will be spending more time with your employees than ever before.

3. Engage your executive group

There will come a time in your implementation when you will expand beyond the boundaries of your operation. This may occur in a matrix organization or from a corporate office or another branch or division. An example of this can be material flow. You may be ready to expand the value stream to your suppliers.

If there is a lack of support from corporate purchasing you can find yourself in a situation where you will not achieve your goals. This can create friction and confusion and generally, a lack of cooperation. Even though other groups in your organization may not have the depth of your understanding or share in your enthusiasm, you will need their support. It is better to get this support as early as possible.

4. Chose a Consultant

Why chose a consultant? I have been challenged on this from all levels of the organization. “If you know so much about lean why don’t you save the money and do it yourself?” The answer is simple. You already have a busy full-time job and all the distractions that come with that job. A consultant comes in with the single focus of providing guidance for your lean implementation. They bring a different set of eyes and a wide range of experience to help you overcome obstacles.

Choose your consultant wisely. They reflect your style in their communications and interactions with your employees. They are an extension of your vision. You know you have chosen the right consultant when he is no longer thought of as a consultant but has become part of your team. Never lose sight of the fact that you are still the leader and provide direction. Eventually you will have to become self-sufficient and phase out your consultant. Make sure your consultant tells you this up front. His/her job is to work themselves out of a job.

5. **Select your lean team.**

You cannot do this alone. Who in your organization shares your enthusiasm for achieving this vision? Who will embrace the changes required? Look beyond your management team. Identify people from all levels of your organization. Form a steering committee that will help guide the direction and priorities of your lean implementation. Help this team expand their lean knowledge. Actively engage them in implementation leadership roles. These people will be the catalyst to engage more people at all levels of the organization.

6. **Identify Key Performance Indicators**

Do not confuse your organization with excess charts and metrics. What are the most important things to measure? The majority of your communications will take place where the work actually happens. Chose no more than six key measurements that indicate how your operation is performing. These indicators should be relevant, timely and easily understood at all levels of the organization.

Each department in your organization should be able to contribute to these indicators. When your people understand these indicators they will be able to identify with a tangible goal that will help direct and focus value-added activities.

Remember that it is the value of the information that will engage your associates. If it is all “dog and pony show” the novelty will wear off before any benefits are realized.

7. Look for sure fire wins

You are leading your organization through some strange tides. Even the most optimistic people in your organization will be unsure. Implement lean in stages. Pick an area with a team that you know will be successful. Start by removing doubt as early as possible and show your organization what the future can look like. These areas will be the catalyst for discussion and interest and will go a long ways towards getting people engaged early in the process.

8. Don’t Stifle Engagement

At some point during your implementation, you will not be able to keep up to the level of excitement generated in your organization. I will use 5S as an example. As stated in my earlier point, “look for sure fire wins,” I was in a situation where we had generated that sure fire win that always exists with implementing the 5S system. Soon everyone wanted 5S. We did not have the resources to train everyone and monitor the activities as per our master plan. I had a choice to make. I could hold everyone back and wait until they were trained properly. On the other hand, I could let them to do it “free style” and deal with it later. The negative was that they were not following the 5S standard as set by the implementation team. The positive was that we had areas in our organization that were previously very negative about lean, and were now actively engaged in changing their work area. In the end, we decided that misguided engagement was the better direction for us. As it turns out it, it was not very difficult to convert all areas to the same standard for 5S. That standard was different than we originally thought it would be, however far more effective than we expected. The engagement of our employees and the positive change generated was more important than the color of line on the floor or type of font on the signage.

9. Not everything is a success

As leaders, we have an expectation to always be successful. Accept the fact that you will have failure during times in your implementation. How you lead during this time will affect your overall success. Lead your organization through these opportunities. Be actively engaged and be part of the analysis of what went wrong. Help demonstrate and guide your organization as you mentor them to become effective problem solvers.

Let your employees make mistakes. If you see a project or plan going wrong, you can make a few choices. As a leader, you need to weigh your options. You can say “no that won’t work. Here is how I want you to proceed.”

You can guide them through the project as a mentor and co-worker. You can let them fail. In my experience, I always measure the impact of the failure. If it is a big impact, I will take on the role of a coach. I might let them fail if they are highly engaged and the impact will not be overly harmful to the business. We walk a fine line as leaders between stifling creativity or engagement versus standards and compliance. Be clear about the guidelines and levels of authorization for projects. The wins will far outnumber the losses. The learning experience will provide positive results now and in the future.

10. Celebrate

Take the opportunity to celebrate all your events and positive results. Early on, celebrate even the smallest of positive results. People like to know when they are doing well. Some of the most successful celebrations did not cost anything. Have a town hall meeting and acknowledge the team. Invite a member of the executive team to recognize the success of a project. Let members of the team lead new projects. When conducting plant tours actively engage team members. Let them meet customers and show your customers the improvements they have made.

11. Expand Your Knowledge again

If you are doing this right you will find that, you never stop learning. You will always have to seek out new knowledge and expand beyond your current comfort zone. This will allow you to continue to challenge and engage your employees to heights that extend beyond your original vision. Learn with your employees. Take the same courses as they do. Send them to higher-level training and let them teach you. Who doesn't like to know something that the boss doesn't?

Richard Jungkind

Figure 9-1: Richard Jungkind was a client and is now a coach for the Lean Leadership Institute.

CHAPTER 10

The Harada Method by Norman Bodek

The Toyota Production System has its focus in two key areas. **Just-in-Time** and **Jidoka**. When I went to see Norman Bodek, "The Godfather of Lean," in March 2012 for one-week training course on the Harada Method. He explained how the recent recalls done by Toyota could have been greatly minimized through the practice of Zenjidoka. Had they practiced Zenjidoka, Toyota's customer service personnel and technicians would have raised a red flag, communicated with each other across dealerships, and solved problems much sooner. The Harada Method assists in establishing a Zenjidoka system.

At the heart of this system is Monozukuri & Hitozukuri. Monozukuri is "building excellent products" and Hitozukuri is "building excellence in people." Now here is the hard part… Hitozukuri is an organization's commitment to developing the skills and knowledge of all of their employees. Not many organizations can make this commitment. Here is an excerpt from Norman's new book (not yet printed as of June 2012) on the Harada Method. After you read this, think about what you want to do with your life. Pick the most challenging goal you can. Then, follow each of these steps in sequence to get a quick understanding of the kind of insight you should be revealing for your employees. Remember, you are now developing a long-term philosophy for yourself, not your organization. This should drive your life from now on. Your long-term goal will take precedence over short-term goals that do not align with it. What a miraculous thought. We get out of the zombie like state by applying this long-term thinking.

The Harada Method is considered by many in Japan to be the world's best on day-to-day management to develop people to their fullest potential.

We normally consider senior managers to be fully self-reliant, to make the right decisions for the company, but this level of trust does not exist throughout the organization. When people are not viewed as self-reliant, they are closely monitored, and restricted. We found this amazing methodology *The Harada Method* that has been successfully applied in Japan these past fifteen years and it is our privilege to introduce it to the West.

Takashi Harada, a world-renowned coach, trainer and consultant, currently resides in Osaka, Japan. Takashi Harada initially was a junior high school track and field coach and he developed a method to transform a group of underachievers in one of the worst schools in Osaka into outstanding athletes. Thirteen students won gold medals, becoming the best in all of Japan in their age group, and the school became number one, out of 380 schools, for the next 12 years in a row. Many of these underachievers after learning from Mr. Harada achieved scholarships and went on to high school, college and into successful careers in industry.

Mr. Harada, after 20 years as a teacher, opened a consulting practice in 2002 and has taught over 55,000 people in 280 companies to use his training method to build both successful companies and successful lives.

Harada developed this marvelous technique to encourage students to excel and was able to take the same principles used to guide and build successful students into the world of business where thousands of people are improving their lives. The Harada Method leads people through a carefully thought out process, similar to a winning sport's team, to build a great company with outstanding employees.

Become an Astronaut – Example of the Method

Imagine you want to be an astronaut, a person trained by a human spaceflight program to command, pilot, or serve as a crewmember of a spacecraft. From where you are right now in life, what would you have to do to become an astronaut? :

1. First, you can clearly define your goal and you can envision what it might take for you to become an astronaut. You believe in your ability to go through the rigorous steps and know that you have the willingness to overcome all obstacles to attain your goal. You can dream and see yourself in the future inside the space station. You have some real good knowledge of how to keep your spirits high, what kind of skills are needed for you to develop yourself, what would be needed to build your physical condition and also how it would require you to maintain a balance in your life style: relations with your family, friends, teachers, fellow astronauts and your community.

2. You would then develop interim goals, building blocks, with specific measures and dates to monitor your progress. You would know when you have to be able to do certain key things that demonstrate your ability to be an astronaut.

3. Then you would look deeply within yourself to discover the real purpose and value of becoming an astronaut and what the tangible and intangible benefits can be to yourself and to others.

4. Clearly, you understand what it means to be fully self-reliant where others will be fully supportive and know that you have the integrity, the knowledge, the skill, and the ability to make the right decisions and handle correctly all future responsibilities.

5. You then analyze yourself, looking at your past successes and strengths with the thought on how to improve and repeat them in the future.

6. You also analyze yourself again but this time you look at your past failures, the things you did not succeed at, with the thought on how you can prevent those failures from re-occurring again.

7. Now try to anticipate any obstacles that might stand in your way of succeeding.

8. You then write the potential countermeasures to those obstacles.

9. It is time to create a list of detailed tasks, actions, and plans that you will have to take to build your skills and capabilities to become an astronaut. We call this the 64 chart.

10. Look at all of the above, closely noticing those habits, patterns and routines that prevented you from succeeding in your life and then write out a list of new routines that you need to do almost daily to set and keep you on the right path.

11. To gain the necessary confidence you will write down the kind of support you will need from others to attain your goals and whom you know that you will give that support.

12. Lastly, you will keep a daily diary showing your schedule for each day with the tasks to be taken to insure that you will attain your goal.

The above items are a shortened version of the Harada Method. It might seem not too spectacular but when you fill in the details and proceed to follow them every day you will give yourself the greatest chance of succeeding and becoming an astronaut. The Harada Method is your guide. It does not tell you what to do. You pick your own goal but following the method is the best way for you to succeed.

When you play a sport, you primarily motivate yourself. The coach is there to help you, but you are the one that wants to succeed. You believe in yourself. You do not want to let your team down. You measure your own success. You establish the necessary steps or tasks to attain your goal.

The Harada Method is a well thought out process on how to take the concept of great sport's activities to help you plan how to be successful at work and in your daily life.

The Harada Method is the missing link to successful Lean efforts. It is the Human Side of Lean. It overcomes the Eighth Waste: the underutilization of people's creative talents. It empowers people to take charge of their own life to become highly skilled on the job. It teaches how the company and every employee can be successful at the same time.

The Purposes of the Harada Method

- To teach managers to become leaders and coaches
- To help people develop their talents to their fullest
- To learn how to lead and motivate people to become high achievers
- To create a vision for long term personal success
- To raise your level of Self-esteem to help you achieve your vision
- To learn and understand how to communicate better within your organization
- To learn and understand the technique of goal setting
- How to be an independent person – self-reliant
- Setting both long term and short term goals and objectives
- How to build your skills and be trusted for making decisions
- Methods to enhance confidence
- How to solve problems to make your work easier and more interesting
- Why keeping a journal is important – write, write like crazy
- Everyone can work towards their personal success – success is a repeatable technique
- This is what I need to do my job better
- Unlimited growth is our target
- Why you need a coach and what are the coach's basic skills
- Attaining personal mastery
- How to be a mentor and set up a mentor/mentee process in your organization
- Self-improvement with management guidance
- To help you focus on value adding activities and to eliminate wasteful activities
- How to set new habits to lead you to success

The Method focuses on people breaking out of their constraining routine molds to achieve new levels of success.

As Mr. Harada says:

"Everyone can be successful"

When people can be empowered to pick their own goals and are taught how to achieve those goals, they come to work with a new level of enthusiasm and excitement. Throwing the javelin is not easy and takes many hours of practice, but athletes with clear goals are able to go beyond the pain and stay on course. You can do the same at work when you able to establish clear goals.

"If I decided to run the triathlon

And to do it six months from

Now; nothing will stand in the way of my practice!"

When you can pick your own growth goal, and deeply believe in your ability to attain that goal, virtually nothing can prevent you from attaining it.

Norman Bodek, the "Godfather of Lean"

www.TheHaradaMethod.com

Figure 10-1: Norman Bodek and Certified Harada Coach, George Trachilis in Portland, Oregon

CHAPTER 11

Conclusion

Lean implementations have been focused on improving processes, and doing it through the concepts of adding value, and eliminating waste. We now know that the focus for sustained Lean efforts is to focus on the people, and people improvements are ten times more difficult than process improvements.

The way to develop people is to introduce them to the world of problem solving. In this world, a problem is nothing more than a gap between the current state and the future state; said differently, a problem is the gap between the current condition and a target condition.

By making problems visible, and challenging the right person to solve the problem, we have the right formula for people development. There is only one pre-requisite to doing this in any organization, and that is Patience. Patience is the main attribute that a Lean Leader must have when coaching and developing others.

My way of doing business is to focus on helping people that help others to improve both themselves and their organizations.

Watch this video of Jeffrey K. Liker as he explains his new course, The Toyota Way to Lean Leadership.

http://youtu.be/_tJ2wg0PF1U

Improve the people and the processes will take care of themselves.

Why have 95% of the organizations failed their people?

People are very predictable. Norman Bodek shared this statistic with me during my trip to Portland. He explained how 3% of what we do is done consciously; and 97% of what we do is sub-conscience. For change to happen in people we need to be introduce them to new routines and habits.

We all know how hard it is to break a habit. Conversely, we should recognize how hard it is to create a new habit. The people side of Lean is about defining process in which we can help people improve. This is not easy. Part of the answer lies with having a good coach, and the other part is with creating routines for yourself (with your coach) that allow you do build your competence at simple tasks, and later combine these routines to do some amazing things.

The key is to start now, and start by doing something. After acting in a certain way for an extended period of time, your thought process will change. You are thinking changes simply because you are performing actions, which force new thought patterns to be created. Old habits are replaced with new ones.

Any company or organization has power over its employees: and certainly enough to leverage people in their organization to do what the business requires of them. Companies fail their employees because they do not challenge them to become better and better problem solvers. Leadership starts at the top, and we desperately need Lean Leaders that will challenge and develop others to solve problems in their day-to-day business activities.

I have one last trick to share with you. For my organization, I have made it a rule that we only ask questions during our meetings. This is a rule that everyone must follow unless they are answering a question that someone asked. When I find that the conversation has slipped and is no longer focused on information gathering, I ask, “Where is the question in that?” This brings everyone back to the topic at hand.

We started with the learning defined by Socrates, and we end in the same way. It starts and ends by asking and answering the right questions. Enjoy these techniques, and use them to make money and save time.

If you remember only one thing from this book, remember this, we all need help. Whether that help comes from a coach, mentor, family member, or friend, there is one truth that will always exist regarding your ability to receive this help; you must trust the person giving it to you.

If you would like an opportunity to work with me in the future, please join me at: **www.LeanLeadership.guru**

George visits to RUAG AVIATION, Switzerland 2014. RUAG injected 18 senior managers into Lean Leadership's Green Belt Program