Understanding Before Executing

Taking the time to learn your customers' needs more precisely before you begin detailed design delivers new products, processes, and services with a hard-to-copy competitive advantage.

Part two of a series exploring each of the six Lean Product and Process Guiding Principles.

lppd

Dear Reader,

Thank you for downloading part two of our ebook series, where we explore the practical application of Lean Product and Process Development (LPPD) guiding principles. This edition's theme is "understand before you execute," one of a set of principles and practices that LEI's LPPD initiative has identified as proven to improve development performance.

In this ebook, we share many perspectives from lean thought leaders and practitioners on how best to understand your customer and context before beginning a detailed design. All the contributors agree on the importance of developing a deep understanding of how your product will create innovative value — right at the start of the project.

We hope you enjoy the insights distilled here and wish you good luck in your journey to adopt the lean product and process development guiding principles.
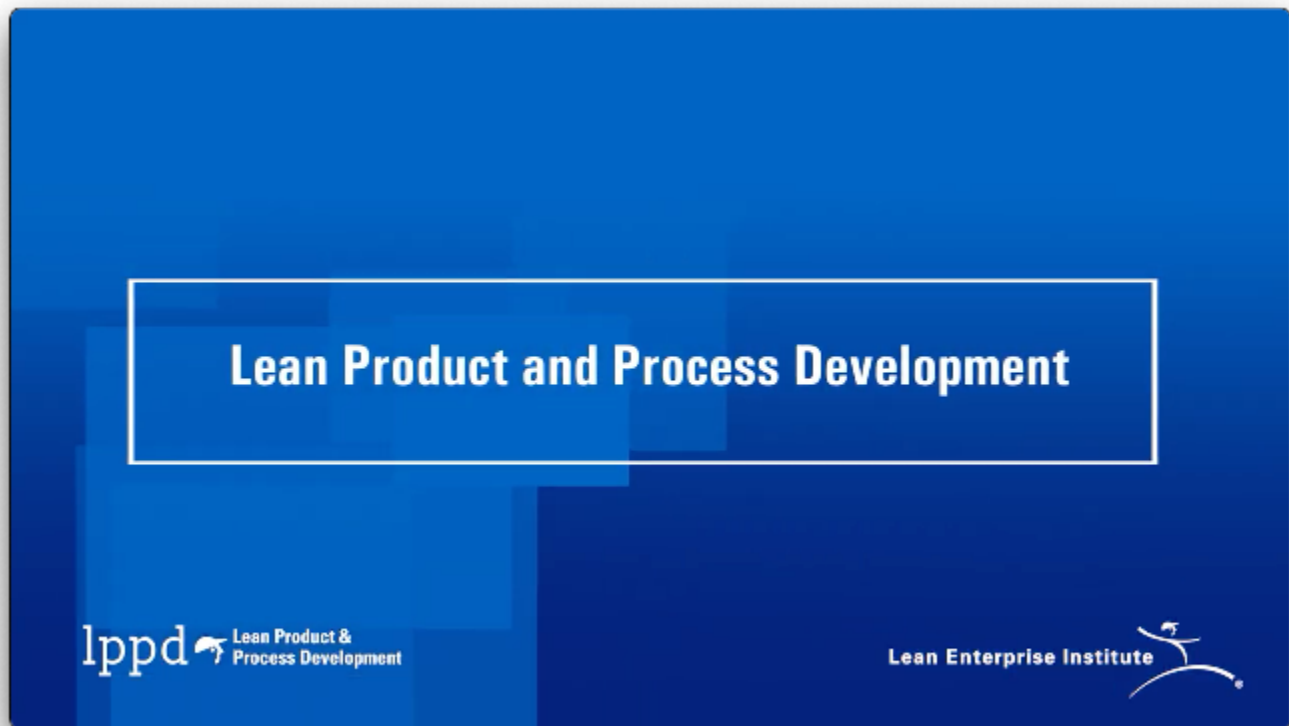
Sincerely,

Jim Morgan, PhD
Senior Advisor, LPPD
Lean Enterprise Institute

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Introducing the Guiding Principles of Lean Product and Process Development

In this 12-minute video overview, you'll hear practitioners briefly describe how the LPPD Guiding Principles helped them improve their product, process, and services development.
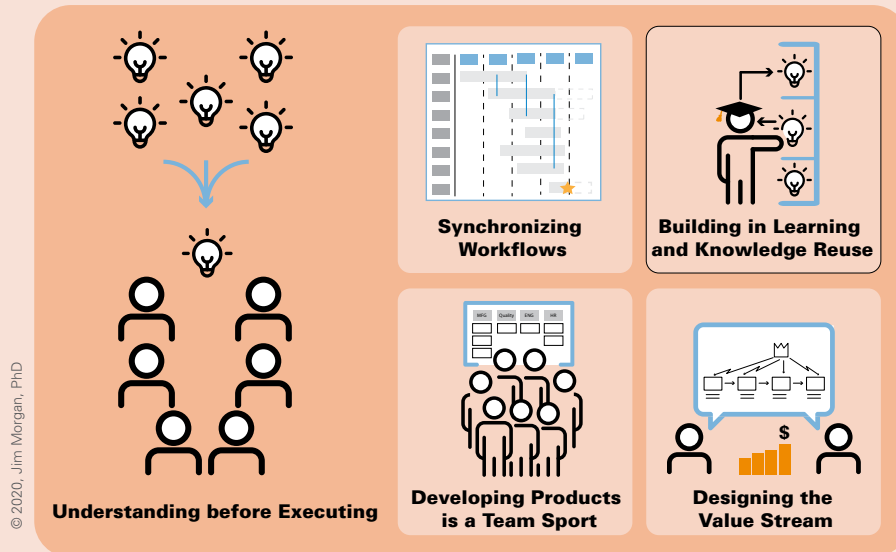

"The success of your product
determines the success of
your organization – and every
organization creates a product."

Jim Morgan

Putting People First

Synchronizing Workflows

Building in Learning and Knowledge Reuse

Understanding before Executing

Developing Products is a Team Sport

Designing the Value Stream

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Lean Product and Process Development (LPPD) Guiding Principles

1. **Putting People First:** Organizing your development system and using lean practices to support people to reach their full potential and perform their best sets up your organization to develop great products and services your customers will love.

2. **Understanding before Executing:** Taking the time to understand your customers and their context while exploring and experimenting to develop knowledge helps you discover better solutions that meet your customers' needs.

3. **Developing Products is a Team Sport:** Leveraging a deliberate process and supporting practices to engage team members across the enterprise from initial ideas to delivery ensures that you maximize value creation.

4. **Synchronizing Workflows:** Organizing and managing the work concurrently to maximize the utility of incomplete yet stable data enables you to achieve flow across the enterprise and reduce time to market.

5. **Building in Learning and Knowledge Reuse:** Creating a development system that encourages rapid learning, reuses existing knowledge, and captures new knowledge to make it easier to use in the future helps you build a long-term competitive advantage.

6. **Designing the Value Stream:** Making trade-offs and decisions throughout the development cycle through a lens of what best supports the success of the future delivery value stream will improve its operational performance.

The LPPD Guiding Principles provide a holistic framework for effective and efficient product and service development, enabling you to achieve your development goals.

How Understanding Before Executing Enhances Development Success

By Jim Morgan

In the very early phases of designing the electrically powered Amazon delivery vehicles at Rivian, our designers and engineers spent countless hours closely observing Amazon drivers and other logistics stakeholders as they did their work. We debated observations based on first principles, formed hypotheses, rapidly built many different virtual and physical prototypes, tested them with users, got their feedback, rigorously tested them again, deselected, combined, and eventually converged on solutions. We did all this work before starting to do detailed design because we knew that was how we would create the best possible value.

This anecdote should come as no surprise to practitioners of Lean Product and Process Development. One of the critical findings from my product development research in the late '90s was that Toyota put far more time and effort into understanding their customer and context at the very beginning of each program than their competitors did. They worked tirelessly to understand and solve the customer's problem and deliver unique and targeted value with their products.

The other critical difference at Toyota was that a Chief Engineer and a small team of designers and engineers were directly involved in both understanding the customer

and executing the program. Having the same people lead both phases of development ensured they would deeply understand what their customers need — and what their product needed to be.

> ## Toyota leveraged the tools and methods of this upfront "kentou," or study period, effectively.

Toyota leveraged the tools and methods of this upfront "kentou," or study period, effectively. The company created many breakthrough, best-selling products, including the phenomenally successful Lexus brand — much to the chagrin of many "industry experts" who said Toyota could never design a luxury car. My coauthor Jeff Liker and I shared many of these stories in the book *The Toyota Product Development System*. The subsequent rise in popularity of practices such as design and MVP (minimum viable product) thinking serves as testimony to their broad efficacy, ensuring design teams "understand before they execute."

But there is much more to the study period than

Set Based Design
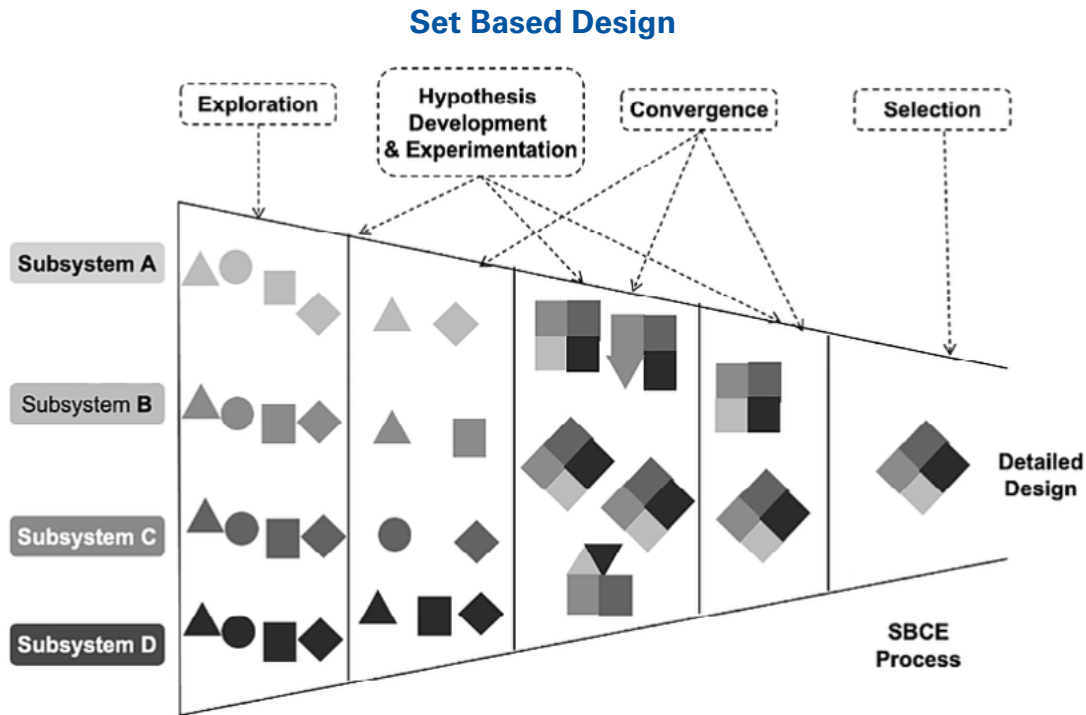
observing your customer. In parallel with deep customer understanding, the team needs to identify and close critical knowledge gaps that stand between their current know-how and what they need to learn to create new value. Whether in engineering, manufacturing, installation, logistics, or service, you must understand how you will deliver unique value.

Closing Critical Knowledge Gaps

Set-based experimentation continues to be a powerful tool as you add more workstreams to the process of understanding. Researching broadly, searching for patterns, debating, forming hypotheses, rigorously testing, deselecting and converging across workstreams. Fortunately, a host of digital design and simulation tools are available to enable a more wide-ranging, robust, and faster set-based approach to innovation than ever before.

A final and often overlooked element of the study period is the concept paper, which should continually evolve as your understanding of your customer and your product takes shape. The concept paper is a powerful way to share the product vision, align around a plan to deliver, and enroll the team in the mission. John Drogosz has written more about the concept paper in this month's "Coaches Corner." ∎

Set-Based Concurrent Engineering

An approach to the design of products and services in which developers consider sets of ideas rather than single ideas. To do this, developers:

- Use trade-off curves and design guidelines to characterize (or describe) known feasible design sets, and thus focus the search for designs.

- Identify and develop multiple alternatives, and eliminate alternatives only when proven inferior or infeasible.

- Start with design targets, and allow the actual specifications and tolerances to emerge through analysis and testing.

- Delay selecting the final design or establishing the final specifications until the team knows enough to make a good decision.

This approach yields substantial organizational learning. It also takes less time and costs less in the long term than typical point-based engineering, where a design solution is selected early in the process, resulting in the need for multiple design iterations (rework) and, frequently, a less than optimal solution.

Understanding before Executing

LPPD practitioners join Jim Morgan to explain how "understanding before executing" was vital to their development efforts.
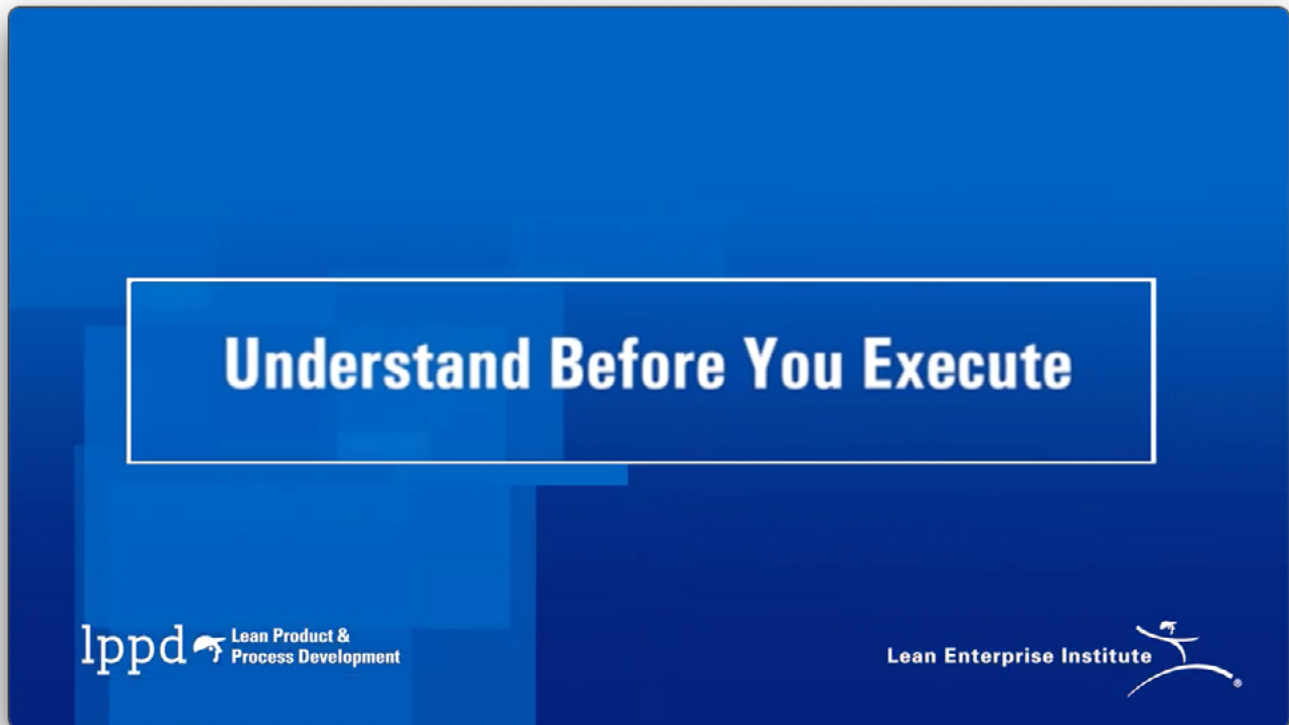
This 12-minute video features stories from a wide variety of organizations that have put the principle of "understand before you execute" into practice. Dave Pericak, director of Icons at Ford Motor Company, gives us an insider's look into the early development stages of the all-new, path-breaking Bronco.

Valerie Cole, software architecture manager at Schilling Robotics, a division of TechnipFMC, describes how her team applied this principle to software development on a game-changing, deep-sea remotely operated underwater vehicle (ROV). And the clinical design and innovation team from Michigan Medicine describes how it used these practices to develop clinical processes that led to far better outcomes.

Coach's Corner

Understanding the Value of a Concept Paper

By John Drogosz

QUESTION: I have read about the Concept Paper done by Chief Engineers at Toyota but have never seen one. It sounds a lot like the Marketing Requirement Document we use. How is it different?

Response: Thank you for your question. I wish I could share a Concept Paper with you, but, frankly, I am not sure that doing so, by itself, would be particularly helpful in answering your question. So, let me do the best I can to explain.

For those who are not familiar with the Concept Paper: it is the guiding document the Chief Engineer at Toyota uses to define the product scope and project goals. It is a brief document that describes:

- customer/market needs,
- competitive analyses,
- product targets,
- timeline,
- expected financial outcomes.

Ultimately, the Concept Paper strives to clarify what is value-added in the eyes of the customer and what is important for the business.

On the surface, most of the information listed above are items most project teams consider today. However, in most circumstances, each part is led by a different

Gemba

The Japanese term for "actual place," often used for the shop floor or any place where value-creating work actually occurs; also spelled genba.

The term often is used to stress that real improvement requires a shop-floor focus based on direct observation of current conditions, whether that is seeing how a customer is using the product/service in their actual environment or an operator is fabricating the product. For example, standardized work for a machine operator should not simply be written at a desk in the engineering office but should be created with the people who do the work at the gemba.

group at different times during the project, leading to misunderstandings that cause extra work and frustration. In this situation, everyone in the organization is looking at the product through their specific lens, so nobody is necessarily "right or wrong" in their viewpoint.

The difference with — and the value of — the Concept Paper is more about the process used to align the message and obtain buy-in from all internal stakeholders.

The Concept Paper is not a one-and-done, fill-in-the-blanks document. It evolves over the study, or concept, phase of a project. The first version kicks off the study

phase by providing guidance to the team on what the product must be and what it is not to be! This first version is based on a lot of going to the gemba to understand what customers need and value. At this stage, the Concept Paper is used to challenge and motivate the organization to create new value for its customers while providing guardrails that prevent teams from looking for solutions that may not address the customers' and organization's core needs.

"Think of a concept paper as the outline of a story you are trying to write."

Throughout the study phase, the Concept Paper prompts the team members to ask questions and challenge their assumptions about their customers' needs and what they truly value. The team continues to gain a deeper understanding about their customers by clarifying the inherent paradoxes in their stated and observed needs. They are also exploring alternatives to close knowledge gaps so they can ultimately deliver that value. Invariably, conflicts will arise between needs, wants, and capabilities. The Concept Paper makes those questions and conflicts visible and helps constructively focus the team toward

understanding and addressing the critical tradeoffs that they, inevitably, must make to design a great and profitable product!

As they are working through these tradeoffs, the project team engages key stakeholders for their input to clarify and align internal goals with the external customers' needs.

At the end of the study phase, the Concept Paper is frozen along with the product concept. At this point, it becomes a contract between the team and the organization. The team is committing to deliver the value within the scope defined in the Concept Paper, and the organization is committing to provide the needed support.

As the project team enters the execution phase, the Concept Paper keeps team members centered on their mission. It also effectively helps to enroll all the organization's stakeholders provide their input and resources to help the project team successfully deliver the stated value to the customer and a profitable value stream to the organization.

Think of a concept paper as the outline of a story you are trying to write. A good story starts with a solid outline. Without one, your story will not come together cohesively, and no one will understand or want to buy it! ∎

Chief Engineer

The role defined at Toyota for the leader who has total responsibility for the development, launch, and market success of a product.

The Chief Engineer is more than just a role; it is a system that encompasses a project from beginning to end. The chief engineer represents the customer and translates their needs into clear, consistent, and prioritized requirements to focus the project team around a coherent and compelling vision for the product (concept paper). The chief engineer also guides the development and industrialization of the product, acting as the system integrator and referee to ensure the customer is represented throughout the process.

The chief engineer system drives continuous improvement by challenging the organization to innovate to meet the customer needs while managing the risks. However, chief engineers do not directly supervise most of the developers who work on their products.

Instead, the system creates a natural tension between the project leader, who wants to realize his product vision, and the functional leaders, who intimately understand what is possible. This creative tension becomes a source of innovation as the project leaders continually push the organization into new territory according to market needs. While at the same time, the functional units try to keep the project leaders true to the organization's technological capabilities.

Chief engineers typically have been groomed over time and have strong technical skills to effectively lead the technical component integration and optimize the product's value to the customer.

Contributor's Corner

Front-Load Your Design Process By Using Set-Based Design

By Jeffrey Liker

In the 90s, I was heavily involved in research on Toyota's product development approach, while most others were investigating lean manufacturing. As a part of that research program, I partnered with Alan Ward, a young professor of mechanical engineering at the University of Michigan. Al had an intriguing — and a bit abstract — idea he called "set-based non-recursive design." He had worked in developing products and then got a PhD at the Massachusetts Institute of Technology, focusing on his pet peeve: Most companies seemed to leap into a particular design solution before considering alternatives. He called this approach "point-based design." Once a company's designers committed to a small part of the solution space, they got stuck.

> "The theory behind set-based design was — and is — that it is more effective to start by broadly considering a range of alternatives from multiple perspectives."

They were committed to that solution and then spent their effort on making it work. More often than not, there were limits to their initial idea, which would fail in many ways, so they iterated as they discovered the various problems. The problems were generally discovered over time, particularly as the drawings were passed on, in waterfall fashion, to the next function. The result was endless iteration fixing things until time ran out, and they launched what they had — often continuing iteration after the product was in the hands of customers.

The theory behind set-based design was — and is — that it is more effective to start by broadly considering a range of alternatives from multiple perspectives, which Jim Morgan and I called front-end loading. Over time as you test out the set of ideas, you converge toward the solution that is working out the best. The convergence of ideas happens in parallel across functions. This new theory presented a new, more effective way to develop products, processes, and services — an excellent idea, but would it work?

Putting Set-Based Design to the Test

Trying to address this question is the reason I got involved. Al was not sure how to test his ideas, and I was trained as a sociologist to conduct research studies testing hypotheses, so we partnered. At some point, we got the idea that Japanese companies might be more apt to use a set-based approach, so we compared U.S. and Japanese companies' approaches to automotive development.

We conducted several interviews at American auto

companies and some of their primary suppliers, and the verdict was clear. What they were doing was mainly point-based in waterfall fashion with a lot of iteration. In fact, most of the design effort was on fixing the design with relatively little time spent upfront exploring alternatives.

When we went to Japan, we were excited to finally find at Toyota — after a few disappointments — good examples of Al's theory in practice. We visited Mazda, which mainly used point–based, and the set-based ideas did not seem to make sense to them. Ditto a few of their suppliers. Same story at Nissan. We might as well have been speaking Martian.

We were dejected by the time we traveled to Toyota in a hot, humid summer carrying our bags from the railroad station. But why not one more? In his usual energetic fashion, Al started to explain his theory to a general manager of Body Engineering who did not appear to understand well what he was saying. Finally, the GM stopped Al and said he was going to a conference to explain Toyota's approach to development, and he could show us what he was going to say.

He started drawing on the board a perfect representation of Al's set-based design process across functions, and the rest is history. We wrote about it in *Sloan Management Review* in 1997 in an article called "The Second Toyota Paradox: How Delaying Decisions Can Make Better Cars Faster." The first paradox was just-in-time: With less inventory, you can go faster, better, at a lower cost with fewer parts shortages.

When Jim Morgan delved more deeply into this for his PhD dissertation focusing on Toyota's automotive-body development, a few things became clear.

Design Must Start with a Customer-Driven Concept

Toyota does a lot of up-front planning for the portfolio of products they will work on, setting guidelines for price, cost, features, and customer base before launching a particular vehicle program. To start a program, the company names a Chief Engineer (discussed below), who is expected to form a team of some of the best and brightest engineers of

critical functions.

In this stage, the broad guidelines and specific targets for cost and features are set, but the solution space is wide open. The chief engineer starts by gathering information from the customers, suppliers, and the engineering team, with the aim of writing a concept paper that will lay out his vision for the vehicle, its target market, and many key attributes — size, general look, target customers, features, competitive products, and more. The chief engineer then presents the concept paper to a large group representing essential functions and suppliers, officially launching the development process.

One Person Must Be the Chief Architect and Integrator

As Al and I presented the set-based design model at conferences and to individual companies, we found our audiences were most interested in learning more about Toyota's Chief Engineer role. It seemed to us that most organizations' program managers focused on cost, quality, timing, and features but cost and timing seemed to be their primary concerns — they were, first and foremost, project managers. Often, a separate, less powerful role, called something like "technical lead," focused on the program's engineering issues.

At Toyota, there is one person, the Chief Engineer, who treats the program as a start-up company. This person is the founder, visionary, chief architect, and key integrator from start to launch and sales. It is often said, "this is the chief engineer's car."

> "At Toyota, there is one person, the Chief Engineer, who treats the program as a start-up company. "

The starting point of development at Toyota is getting to understand customer needs, which can include living with customers like an anthropologist combined with the unique insights of the chief engineer — these special individuals who have been groomed intentionally for the role over

several decades. As much as we believe in teams as the heart and soul of product development, the guiding brain is an individual — the chief engineer.

Study Drawings Enable Broad Exploration

The concept paper launches the "kentou" phase, which is a study period. During this time, the design team broadly explores the solution space from every perspective: customer, supplier, engineering functions, manufacturing. The key tool for Toyota is the study drawing, which most often are sketches, many of them hand drawn. Drawing on a computer adds complexity to the rendering process and tends to cause engineers to commit prematurely to a detailed design. Sketching is freer and, Toyota veterans believe, creates a superior mind-body connection. Sketching, sharing ideas, discussing, and then sketching some more allows for a broad exploration of the solution space before making commitments.

Technical Excellence is Paramount

In addition to being obsessive about listening to the customer, Toyota believes in deep functional expertise — specialist know-how. Most engineers specialize in a specific function, such as body or transmission engineering. If the Chief Engineer is the chief architect of the vehicle, the General Manager of a function is the chief developer of Engineers. The general manager is the master black belt who is responsible for providing to the chief engineer top level engineers expert within that function.

Chief engineers rarely request specific people for their team; they expect that whoever the General Manager assigns will be excellent. In the kentou stage, only the best and most experienced explore and make critical decisions about overall vehicle specifications. As the program develops and people are added, they are mentored by these top-level experts. One of the senior experts' skills is that they can predict the outcome of tests by looking at a drawing before completing the test. They have almost a second sense about their specialty — plastic, steel bodies, glass, and the like.

> "If the Chief Engineer is the chief architect of the vehicle, the General Manager of a function is the chief developer of Engineers."

Once the concept is developed and the main target specifications for the vehicle are determined, the execution stage — the bulk of labor hours — focus on working out engineering details, running tests, building prototypes, preparing the factory, and generally refining the design. Refining a poorly conceived design is considered as just spinning wheels — a lot of waste. The most important intellectual work happens in the front end of set-based exploration. ■

Faculty Highlight

Katrina Appell, PhD

Senior Lean Coach
Lean Product and Process Development
Lean Enterprise Institute

President
Katrina Appell Consulting

Katrina is passionate about supporting organizations in improvement and transformation with over 15 years of coaching, facilitating, training, and team development experience. Her doctoral research at the University of Michigan focused on effective methods for putting lean product and process development principles and practices into practice. She has coached lean principles and practices at many companies in various industries, including Caterpillar, Michigan Medicine, TechnipFMC, US Synthetic, and Whirlpool. Katrina codeveloped and is an instructor of LEI's Designing the Future Remotely: A Lean Product & Process Development Immersive Learning Experience workshop.

John Drogosz, PhD

Senior Lean Coach
Lean Product and Process Development
Lean Enterprise Institute

Vice President
Liker Lean Advisors

John has over 25 years of experience applying lean principles and practices in manufacturing, product development, and services. He has led lean transformations in numerous companies and industries, including Northrop Grumman, Johnson Controls, Harley-Davidson, Embraer, and Caterpillar. John also teaches classes in Lean Product and Process Development for the College of Engineering at the University of Michigan. He has contributed to several books and articles, including *The Toyota Product Development System* and *The Toyota Way to Continuous Improvement*. In addition, John codeveloped and is an instructor of LEI's Designing the Future Remotely: A Lean Product & Process Development Immersive Learning Experience workshop.

Eric Ethington

Senior Lean Coach & Program Manager
Lean Product and Process Development
Lean Enterprise Institute

President
Lean Shift Consulting

Eric is a recognized expert in process development and problem-solving methodologies, stemming from 27 years of industry experience in frontline through executive-leadership roles at Delphi and Textron and 12 years of consulting practice. His experience in applying lean includes most types of industries and functional areas, including organizations as varied as Medtronic, Michigan Medicine, Coca-Cola Enterprises, and Goodwill. Eric holds a Bachelor of Science in Industrial Engineering from General Motors Institute (now Kettering University) and a Master of Business Administration from the University of Michigan-Flint. Additionally, Eric is the coauthor of the book *The Power of Process, a Story of Innovative Lean Process Development.*
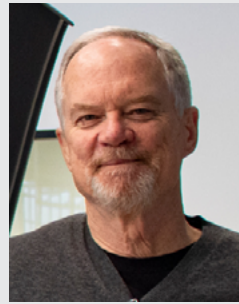
Jim Morgan, PhD

Senior Advisor
Lean Enterprise Institute

Jim is recognized globally for his expertise in product and process development. Jim's know-how comes from a unique combination of industry experience as a senior executive and rigorous scholarship. His most recent industry role was as Chief Operating Officer for Rivian, an electric vehicle manufacturer, during a critical transition period. Before that, he was Global Director of Body and SBU Engineering and Tooling Operations during Ford's historic, product-led revitalization under then CEO Alan Mulally. Before joining Ford, Jim served as Vice President of Operations at TDM, a tier-one global automotive supplier during a period of rapid growth. He holds a PhD in engineering from the University of Michigan. In addition to his more than thirty years of industry experience, Jim has authored or coauthored two books, three book chapters, and numerous articles.

LEI's Co-Learning Partner Program is for leaders looking to transform their enterprise and contribute to the lean thinking and practice body of knowledge. You and your team will closely partner with LEI Coaches in a journey of discovery that will take your organization to the next level.

Become a Co-Learning Partner, LEI's Most Extensive Custom Learning Experiences

Partner with the Lean Enterprise Institute (LEI) to accelerate your lean journey and jointly conduct experiments on the best way to advance your lean transformation. As one of a select group of companies, you'll work closely with LEI thought leaders, such as John Shook, Jim Morgan, and other top-flight LEI Coaches and subject-matter experts.

Within the partnership, LEI Coaches will guide you as you design and evaluate the experiments that will help you discover the best lean approach to address a business problem or achieve breakthrough performance. We don't come in with a cookie-cutter solution. Instead, LEI Coaches bring their decades of lean thinking, practice, and coaching to bear on the business issues you need to address and guide you through discovering — for your organization and in the specific situation — how to resolve it.

By offering targeted, immersive experiences that demonstrate the value of addressing all five dimensions of the Lean Transformation Framework, LEI Coaches ensure you and your team gain an in-depth understanding through crucial guided practice.

Join a Learning Group

LEI's most advanced partners — those who have reached the highest levels of lean thinking and practice — are invited to participate in an LEI facilitated learning group. Open only to those who have and are willing to share advanced lean thinking and practices, this learning opportunity allows organizations and their teams to learn from one another. While participants in the learning groups collectively direct the learning, LEI Coaches facilitate the meetings three to four times per year and share related learning materials.

The meetings are held on–site at a learning group company or in virtual gatherings. The learning groups are organized around a specific LT&P discipline, industry, business function, and the like.

The longest-running Learning Group is focused on Lean Product and Process Development (LPPD), bringing together partner companies interested in transforming their product, process, and service development systems. Much of this Learning Group's learning was captured in Jim Morgan's and Jeff Liker's *Designing the Future*, which LEI co-published with McGraw Hill in 2019. Who knows, maybe your lean transformation story will become part of an upcoming book published by LEI.

Some of our LPPD Learning Group Partners

Lean Enterprise Institute

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lean.org

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About The Lean Enterprise Institute

The Lean Enterprise Institute, Inc., was founded in 1997 by management expert James P. Womack, PhD, as a nonprofit research, education, publishing, and conferencing company. As part of its mission to advance lean thinking around the world, LEI supports the Lean Global Network (leanglobal.org), the Lean Education Academic Network (teachinglean.org), and the Healthcare Value Network (healthcarevalueleaders.org).