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Whatever Happened to Quality First

Rethinking Product Development in the Wake of Recalls and Catastrophic Failures

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Welcome,

This month's *Design Brief* is a challenge to improve your new product and process quality. I realize that this may not be a particularly popular topic right now. Many would rather talk about breakthrough innovation or shipping minimally acceptable products. But the news is full of stories about serious quality issues in nearly every industry. Boeing, Ford, Tesla, and many other companies continually struggle with quality spills and recalls for which some even publicly blame their customers and others, predictably, revert to the "5 who's" blame protocol. Frankly, this discussion is long overdue.

Those who are part of the lean community understand that basic quality is meeting or exceeding customer expectations and is foundational to a lean enterprise. We also know that the cost of re-work and returns can be enormous. Worse is the hit your reputation takes. Some organizations never recover.

But even the most seasoned lean practitioner can get distracted by the "new" and ephemeral. (There is a whole lot of snake oil out there.) But many of these practices lead to lazy thinking and sloppy work that can infect your entire organization. We can't afford to lose sight of the basics of delivering actual customer value. As Akihiko Saito, executive vice president of Toyota, wrote in the foreword to *Toyota Styled Mizenbushi Method* (Tokyo: JUSE Press Ltd., 2002), "While our company's method of production such as the 'Toyota Production System' and 'Toyota Way' has caught the industry's attention, I feel strongly there is a need to reform and return to the basics when we first started in the automotive business of thoroughly emphasizing that 'quality comes first' and 'the customer comes first.'" A valuable reminder for us all to keep our eye on the ball.

The place to solve quality issues is in development

The place to start a "quality first" and "customer first" mentality is not on the shop floor – it's in development. Development has much more leverage than any place else in the organization – not only on the efficacy of the product for the ultimate customer but for everyone along the value stream. Development can make it easy for people to execute their jobs correctly or nearly impossible. Lean Product and Process Development (LPPD) principles, practices, and tools are powerful enablers of high-quality, reliable products and processes. Improving your design practices, design reviews, quality operating system, testing, knowledge capture and reuse through LPPD methods are quite effective in improving quality. But your people will determine your ultimate success.

The heart of the matter

Consistently high-quality products come from organizations that relentlessly focus on their customer. That starts with leadership. Leaders get the culture they demonstrate and tolerate – and that is especially true for quality. And I believe that many leaders are flat out failing their organizations regarding quality.

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Good leaders demonstrate quality as a priority. They provide the time, resources, quality operating infrastructure, training, and decision-making that enables their people to deliver. They lead by example and embody the customer-first mindset. They roll up their sleeves, know their stuff, and do the little things well – demonstrating the required discipline and attention to detail – every day. Poor leaders try to get away with a sincere-sounding press release and a feel-good speaker at a management off-site. It doesn't work. Such leaders are failing their organizations and customers. Consider how millions of car customers must feel.

Don't wait for your own quality crisis to act. Once a major spill has occurred, it can be nearly impossible to dig out from under. Just ask leadership at Boeing or Ford. Start now, and start in development, focusing on your customer to improve the quality of your products and processes. Start your own return to basics as suggested by Saito, "There is a need to reform and return to the basics when we first started in the automotive business of thoroughly emphasizing that 'quality comes first' and 'the customer comes first.'" Your customers will certainly thank you, and you will be amazed at the positive changes to your organization.

In this month's Design Brief

- Fabrice Bernhard, cofounder and CTO of Theodo, a global lean software consultancy, contributes an essential piece on applying Toyota's dantotsu (Japanese for "radical") quality improvement method to software development. Fabrice reveals breakthrough improvement practices for an industry in dire need of a rethink regarding quality.
- Matthew Savas and I share a summary of our remarkable discussions with Tatsuhiko Yoshimura, PhD, former Toyota engineering and quality executive and creator of the breakthrough Toyota quality method known as mizenboushi GD3, for surfacing and fixing latent problems in designs.
- Steve Shoemaker, former vice president of engineering at Caterpillar's Earth Moving Division, shares his experiences of how lean principles were applied within Caterpillar and, in a span of fewer than five years, quality improved by more than 50 percent while warranty dropped by $90 million. New product introductions were no longer firefighting events but methodical marches to the marketplace with few surprises.
- And finally, Mathew Savas has a conversation with my good friend and former colleague, Jeri Ford, vice president of quality at electric vehicle maker Lucid Motors, about ensuring quality through the value stream, from design to supply chain and manufacturing.

Regards,

Jim Morgan, PhD
Senior Advisor, LPPD
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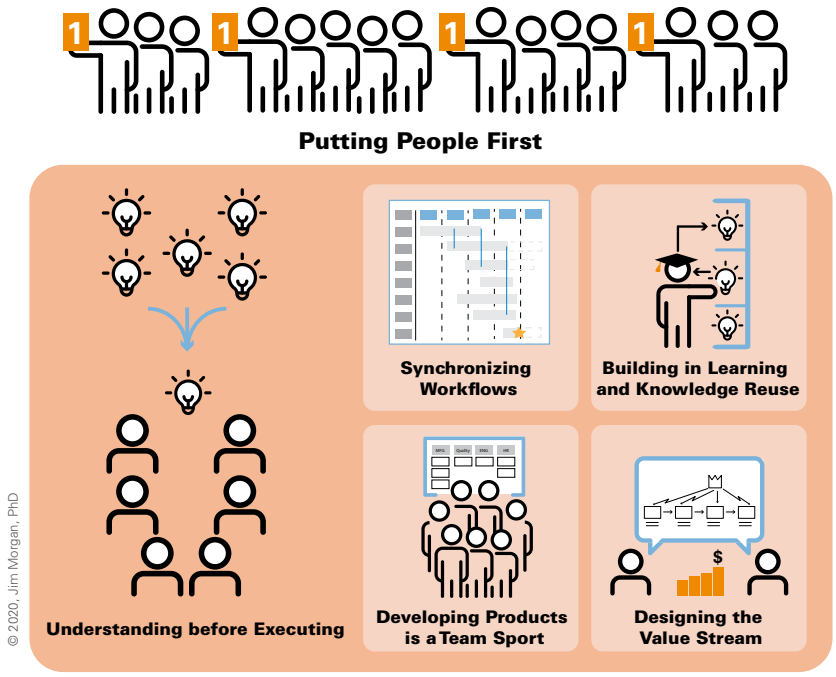
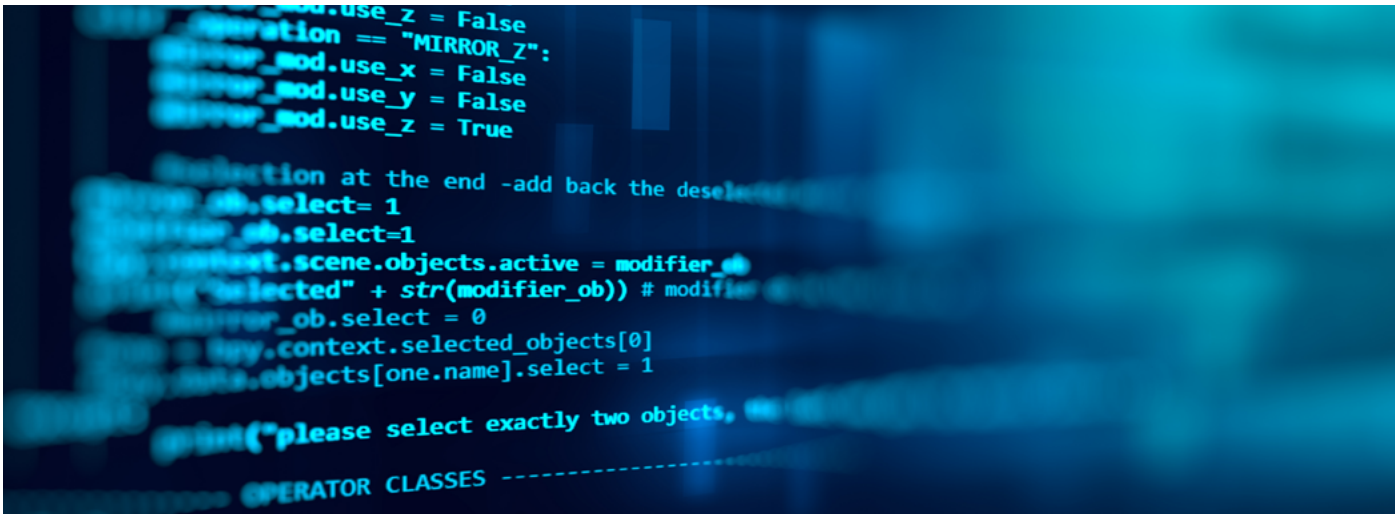


Lean Product and Process Development (LPPD) Guiding Principles

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.



Software's Quality Leap: Three Lessons from Toyota's Dantotsu Approach to Reduce Defects at Scale at Theodo

By Fabrice Bernhard

Software is eating the world. That means the software industry cannot keep producing the estimated average of 10 defects per 1,000 lines of code.

One solution is to adopt the standards of the aerospace industry. The software engineering team for the space shuttle produced one defect in 400,000 lines of code, a 4000x better quality standard. But at what cost? Their processes include writing four pages of specifications for every ten lines of code. This is not a scalable approach to writing the volume of software the world requires.

Looking for alternative solutions to achieve quality and scale, we stumbled upon Sadao Nomura's book *The Toyota Way of Dantotsu Radical Quality Improvement*, where he describes his incredible quality achievements at Toyota Logistics & Forklift (TL&F).

Sadao Nomura had been at Toyota Motor Corporation since 1965 when executives assigned him to improve quality at TL&F in 2006. It was not his first time leading quality improvement programs; he had successfully turned around a GM plant in Australia and helped Toyota South Africa achieve the quality levels Toyota HQ needed to authorize global export. He did everything from the inside, building strong relationships with teams over many years.

At TL&F, he served as an advisor to seven plants across five countries, most of which the company had recently acquired. He started the typical lean way by frequently going to see at the gemba. He captured his problem-solving insights on A3s and shared them with management. But no change happened. It seemed no one was paying attention to his advice. It didn't help that the plants' quality was relatively good compared to industry standards.

Nomura tried twice more to share his wisdom without success. After the third attempt failed and a year passed, he changed his strategy to make sure quality would become

Gemba

Gemba is the Japanese term for "actual place," often used for the shop floor or any place where value-creating work actually occurs. It is also spelled genba. Lean Thinkers use it to mean the place where value is created. Japanese companies often supplement gemba with the related term "genchi gembutsu" — essentially "go and see" — to stress the importance of empiricism.

A3 Report

An A3 Report is a Toyota-pioneered practice of getting the problem, the analysis, the corrective actions, and the action plan down on a single sheet of large (A3) paper, often with the use of graphics. At Toyota, A3 reports have evolved into a standard method for summarizing problem-solving exercises, status reports, and planning exercises like value-stream mapping.

a priority for everyone. With support from headquarters, he created a program called "Dantotsu Quality Activities." Dantotsu is a Japanese term that means "extreme," "radical," or "unparalleled." The program aimed to motivate and train workers to achieve the ambitious goal of halving defects yearly. Through relentless adherence to dantotsu activities, the team should reach the three-year target of reducing defects by 88 percent.

Teams on the ground had seen quality programs fail before, so they only half-trusted this new one. However, they realized the need for something different, and Nomura's dantotsu approach was decidedly different. By obsessively focusing on improving quality, he finally brought change to the factories. After eight years, the seven plants reduced defects between 91-98 percent. Raymond Corporation, the U.S. plant, won the "Best Plant Award" from Industry Week magazine.

Nomura's story is about improving quality in manufacturing plants. Nonetheless, it inspired Theodo to adopt a right-first-time approach in software engineering. Here are three ideas we took from the book and transposed to software.

A new approach to measuring defects

The way to improve quality is straightforward – decrease the number of defects. But the simplest way to decrease the number of defects is to expend less effort looking for them. To avoid this, Nomura categorizes issues by detection stage and emphasizes not reducing the number of defects but detecting them as early as possible in production. We applied this to software engineering with the following detection stages:

- **Stage A** if it was detected by the developer in a final review before pushing the code;
- **Stage B** if it was detected by someone else on the team or by the continuous integration pipeline before reaching an internal customer;
- **Stage C** if it was detected after reaching an internal customer (product owner, QA, etc.) and before pushing to production;
- **Stage D** if it was detected after pushing to production, where it could have affected an external customer, and before receiving a complaint;
- **Stage E** if it resulted in a customer complaint.

This categorization provides a healthy target. Teams strive to detect defects in stages A and B before they affect end-users. It is also easier and cheaper to fix defects in these stages. By doing so, teams can avoid defects in stages D and E before they impact end-users. This is known as a shift-left approach.

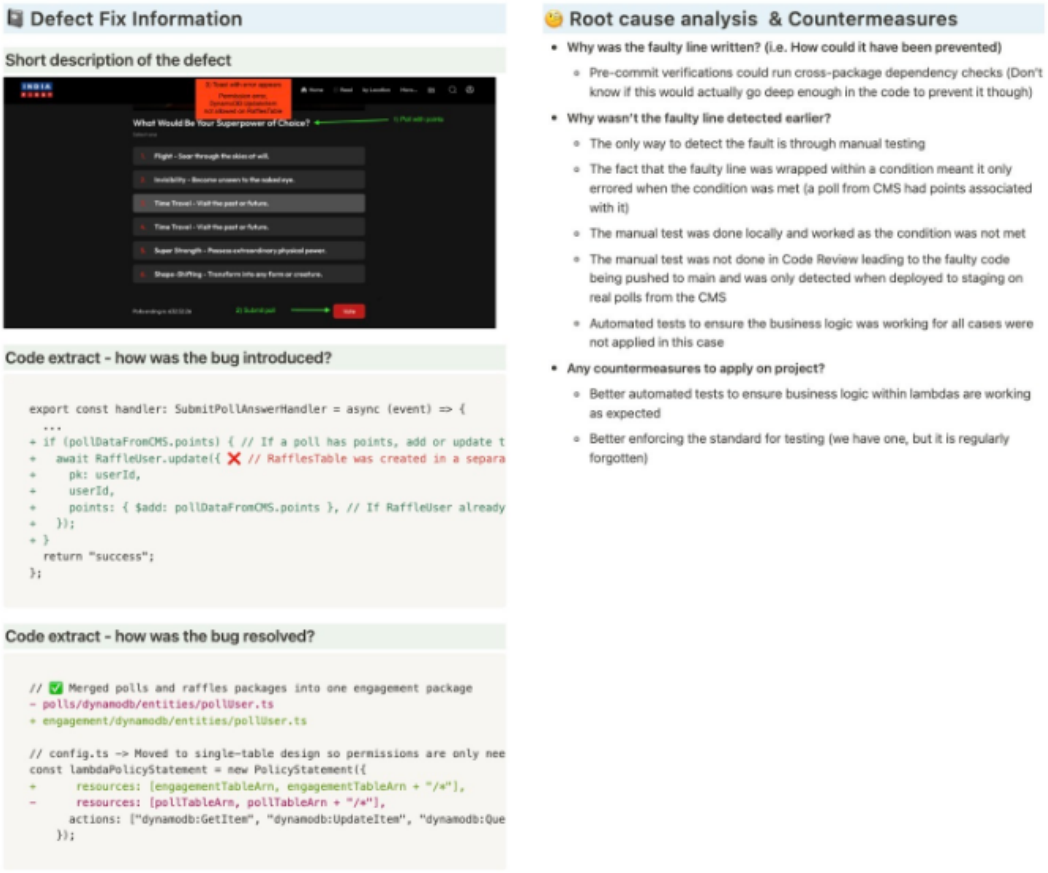
Systematically analyzing defects

By having a systematic approach to analyzing the defects they produce, teams can quickly identify the source of quality problems and how to prevent them. It also helps the team leaders frame the quality challenge as a learning opportunity. Analyzing defects reveals knowledge gaps that can then be addressed with training.

Nomura's book has significantly improved our approach to analyzing defects, including settling an old debate about whether to focus on preventing a defect or detecting it earlier. Nomura's answer is straightforward: we should analyze both how the team could have prevented the defect and how they could have detected it earlier.

Adoption of weak point management

By systematically analyzing defects, teams start to see patterns and identify categories of causes. Nomura calls these "weak points." Once teams clarify weak points, they can choose one to address and eradicate once and for all.



Example of a dantotsu analysis at Theodo.

For example, we had been suffering for quite some time from intermittent failures in the automated testing of our code. These were not related to underlying issues in our code but to deeper issues in the Jest open-source testing library we were using. The teams had dismissed them as "unavoidable flakiness." Since it was a known problem affecting many of our teams and others worldwide, we decided to investigate further. It was a hard problem to solve. But with focused effort, we devised a permanent fix, which we contributed to the open-source library. The problem is now permanently solved not only for our teams but for all the library's other users, not to mention the energy savings that would result from preventing millions of wasted CPU cycles.

After two years of deploying such learnings across Theodo, 80 percent of our projects now measure the number of defects categorized by detection stages A to E. We have refined a standard for effectively analyzing those defects to help tech leads adopt it within their teams. And we are working on making defect analysis part of the team's routine to accelerate their learning and identify the recurring problems that would benefit from an organizational solution.

A few teams are even experimenting with systematic defect analysis at Stage A. Teams mark a code contribution as defective if it fails at the first human check. This is an original approach, as engineers code iteratively with multiple rounds of writing code and visually checking that it works. But those teams decided to aim for right-first-time code. The results are promising. One team built a medical application with 6,000 lines of code and delivered only two defects in production. That's 30 times less than the industry average without having to document every line of code over hundreds of pages.

We are still early in our journey of transposing Sadao Nomura's book to software, but seeing such dramatic improvements has been inspiring. It is another example of how lean is an indispensable source of learning – no matter the industry – when it comes to achieving quality at scale. ■

From Concept to Perfection: Toyota's GD³ Method Sets a New Standard in Product Quality

By Jim Morgan and Matthew Savas

Toyota's quality, reliability, and durability are legendary. Toyota has dominated automotive quality measures for decades and perennially tops the lists of most highly recommended vehicles released by Consumer Reports, J.D. Power, and others. So, you can imagine our excitement to meet with one of the principal architects of Toyota's vaunted quality system, Professor Tatsuhiko Yoshimura, PhD, and his colleague Hidetoshi Shimizu. This was a singular opportunity to deepen our understanding of the underpinnings of Toyota's phenomenal quality record and how they might help other organizations improve their quality performance.

We met in a series of late-night Zoom meetings with the goal of more deeply understanding the history, principles, and application of the innovative mizenboushi method developed by Toyota for evaluating the vulnerability of new product designs to quality problems. Translated as "reliability problem prevention," mizenboushi is sometimes given the shorthand of "GD³," which succinctly and accurately sums it up as "good discussion, good dissection, good design." For brevity and clarity, that's what we'll call it.

Yoshimura's development of GD³ changed the way engineers thought about quality problems and enabled them to anticipate and design out quality problems before they occur. Shimizu is a longtime practitioner of the methodology at Toyota and elsewhere.

> "If you can solve problems and prevent their reoccurrence, why can't you just prevent them from happening in the first place?"
>
> - Akihiko Saito

Yoshimura focused on design and development quality throughout his engineering career in Toyota's Chassis Engineering, Reliability Engineering, and Quality Engineering departments. After retiring from Toyota as a senior executive, General Motors recruited him to help lead a quality renaissance. Yoshimura is capping his storied career as a professor at Kyushu University and a

frequent contributor to the Union of Japanese Scientists and Engineers (JUSE). He documented the quality method in his book Toyota Styled Mizenbushi Method – GD³ Preventative Measures – How to Prevent a Problem Before it Occurs (JUSE Press Ltd., Tokyo, 2002).

A brief history of GD³

The genesis of GD³ was a discussion between Yoshimura and his then-boss, Akihiko Saito. Yoshimura rightly felt pretty good about the reliability of Toyota vehicles and Engineering's problem-solving and problem-recurrence prevention work. While Saito agreed, he was not satisfied. "If you can solve problems and prevent their reoccurrence, why can't you just prevent them from happening in the first place?" A daunting assignment to be sure.

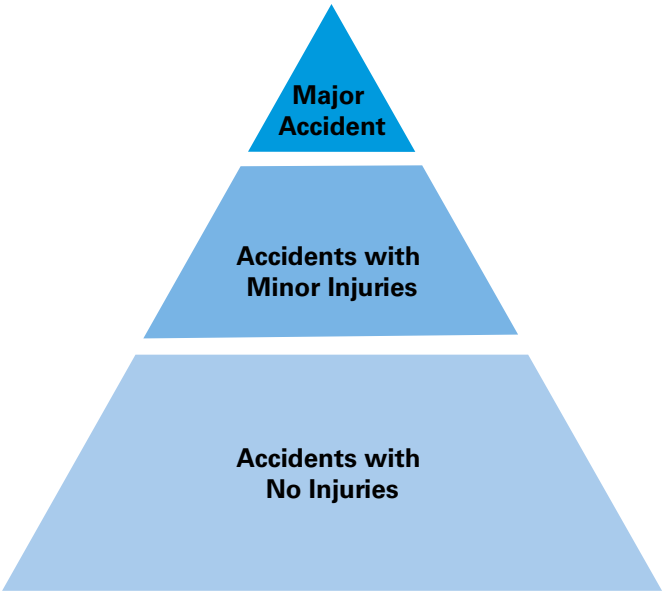
Yoshimura started this assignment with a "study period" to deeply understand the challenge before acting. He began by asking questions and researching existing quality methodologies. A colleague in supplier quality suggested he look at the Failure Mode and Effects Analysis (FMEA) tool that some of the Toyota suppliers used.

So, Yoshimura and a small team began to study the FMEA methodology. They were astounded in their first meeting when supplier engineers brought stacks of 40-to-50-page documents for their review. They spent long hours poring over them, working to understand them in detail. The team developed dozens of questions for the supplier engineers, but the engineers could not answer them. The more they discussed the documents, the clearer it became that the engineers did not really understand what was in them.

The supplier engineers explained that they reused previous FMEAs and updated them with a "cut-and-paste" exercise. From this work, Yoshimura concluded that the FMEAs, while useful, were largely based on previous problems and were no more effective than Toyota's existing standards and checklists. He also intuitively understood that FMEA was too bureaucratic, insufficiently focused, and lacked the collaborative enablers he knew were needed. In Yoshimura's words, "FMEA is a tool to explain that there is no problem and not a tool to uncover a problem through collaboration." Worse, the way the supplier (and others) used the documents made them simply muda.

"FMEA is a tool to explain that there is no problem and not a tool to uncover a problem through collaboration."

Yoshimura and the team were similarly disappointed in design for six sigma, QS 9000 auditing, and numerous other existing quality methodologies. Consequently, Yoshimura began to feel frustrated about this assignment. He was an engineer, not a fortune teller. How was he supposed to predict problems before they happened? He began to envy his former quality control team members, who were busy solving problems and making things better.



Learning from accident prevention

That's when he decided to look beyond quality discipline to see what he could learn from alternative fields. One of the areas he studied was industrial accident prevention work and the way it approached risk. Specifically, he studied the work of William Herbert Heinrich and "Heinrich's Law." Based on his study of thousands of accidents, Heinrich determined that at least 95 percent of accidents are caused by unsafe behaviors. His resulting law states that for every accident that causes major injury, there were 29 accidents that caused minor injury, 300 accidents that caused no injuries, and before that thousands of risky behaviors. Imagine a tradesman accidentally dropping a hammer from the tenth story to the ground. While it injured no one

on the way down, the accident had the potential to cause serious harm, and thus, it deserves a proactive response to prevent a major injury from happening in the future.

Yoshimura saw strong similarities between risk mitigation in safety and quality. Consequently, he started to think about new engineering behaviors, principles, and practices that could solve not just the relatively small number of evident problems but the much larger number of hidden problems lurking in product designs.

Understanding that quality is a function of discipline, Yoshimura modeled the behavior of his most successful engineers. They would call attention to the smallest issues. They understood acting on the 300 hidden problems was far better than reacting to one catastrophe.

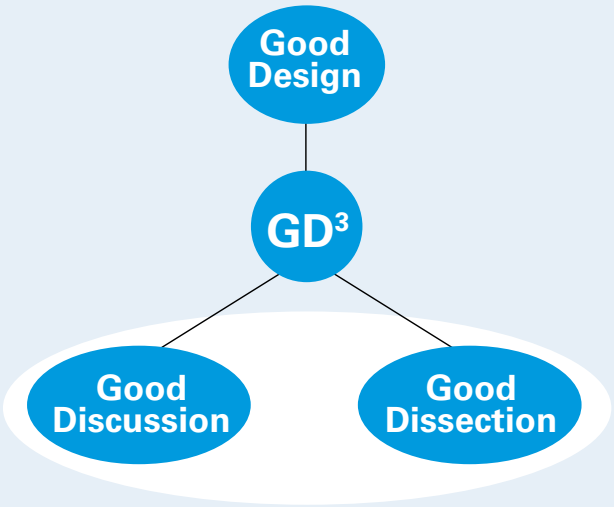
He also studied the Toyota Production System. He was inspired by such system practices as working on the process and process inputs instead of just measuring outcomes, making problems visible early in the process, pursuing root causes of problems, studying problems by going to where they occur, and most of all, its unwavering focus on the customer. All these lessons influenced his thinking about GD^3.

With these influences in mind, he went to work experimenting with concepts and practices derived from what he had learned.

The three elements of GD^3

Good design emphasizes creating robust designs by reusing proven components and proven design characteristics wherever possible. It captures critical characteristics from both successful designs and the most successful designers to minimize risk. It is equally important to learn from previous failures and less successful design practices and share those lessons. It also focuses on limiting the amount and severity of changes that impact a single subsystem. Finally, product features are designed such that they will make a budding problem apparent as early as possible, like a smoke detector chirping when the battery gets low.

Good discussion drives cross-functional analysis and debate, especially focused on any new features, new parts, new environments, and all critical interfaces. The discussion should be wide-ranging. The goal is to create an environment in your design reviews that promotes exposing



Source: Kyushu University Professor Tatsuhiko Yoshimura, PhD, PowerPoint Presentation on the development of the GD3 method and culture at Toyota.

Introduce GD3 at a design review by asking these questions:

- What is new or changed?
- What concerns you about the change?
- What other related areas of the system have changed?
- What concerns do others have about this?
- What other concerns do you have?
- What impact will it have on the customer?
- What measures have you already taken to ensure your concerns do not become reality?
- What other measures can we take to ensure this does not impact the customer?

problems and collaborating on solutions instead of hiding or denying potential problems. The specific forum for this debate is referred to as design review based on failure mode (DRBFM) and prioritizes areas of potential risk. Yoshimura claims that this process is more robust and efficient than traditional FMEA because it is a more focused approach; it concentrates on the areas of greatest risk.

Good dissection is a method for analyzing test results that starts with an extremely detailed review of any signs of unacceptable or inconsistent performance during testing. Parts from completed tests are dissected and closely studied for any signs of wear or degradation that might signal a potential weakness in design. Yoshimura also introduced a tool to help enable this process, called "design review based on test results (DRBTR)," which enables debate and captures learning to further strengthen the GD^3 system.

The social side of GD^3

Critically, GD^3 is equal parts technical and social. Yoshimura explains that the first step to successful problem identification is to map a hierarchy of systems, subsystems, and components along with their corresponding organizations. This is to ensure the team knows precisely with whom to communicate. This can become especially challenging when a complex product requires multiple systems staffed by different teams to interact with one another. So, it is important to align around responsibilities.

When combined with an exclusive focus on areas of change, GD^3 enables creativity to solve latent problems. Rather than being overwhelmed by an endless list of potential risks across systems and components, a team can focus its energy only on components undergoing change.

Design review based on failure mode (DRBFM)

We have often written about the importance of effective design reviews before and provided some principles and practices to improve them. Yoshimura agrees with the importance of design reviews and suggests that they are the perfect forum to introduce creative GD^3. He provides some structure for introducing the GD^3 method to a design review, starting with a basic process outline.

While Yoshimura did not find what he was looking for in FMEA methodology, he did appreciate the idea of a worksheet to aid in the discovery of budding problems. However, he rejected what he considered the tedious, mechanistic approach of FMEA for a more creative approach. He emphasizes that the entire approach is designed to stimulate participants' creativity. The tools' simplicity belies the terrific collaborative analysis underpinning them (examples follow).

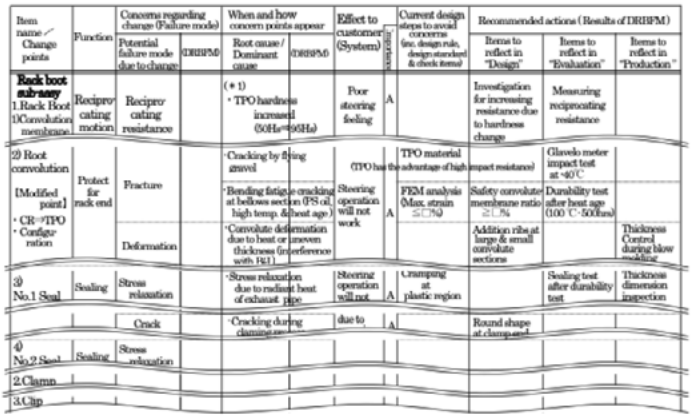
As with all things lean, tools only work when combined with people and processes. For example, the point of an A3 is not to complete a series of boxes. The aim is twofold:

- To visualize thinking so management can provide effective coaching to develop the A3 owner's problem-solving capability; and
- To socialize a problem across an organization to deepen understanding and alignment around countermeasures to ensure its permanent elimination.

The piece of paper is incidental, though its 11x17 size forces clarity.

Similarly, completing the matrices and question sequences used in GD^3 is hardly indicative of effectiveness. What matters is the conversations and analysis that go into completing them. Individuals do not achieve quality through submitting paperwork; teams achieve quality through obsessive collaboration, investigation, and action.

The goal, Yoshimura notes, is to find latent problems in designs and take specific measures, correct them, and improve design quality. To that end, he created the following process and worksheet:



Source: Shimizu, Hirokazu, Otsuka, Yuichi, and Noguchi, Hiroshi. "Design Review Based on Failure Mode to Visualize Reliability Problems in the Development Stage of Mechanical Products."

This table is a detailed breakdown from a DRBFM analysis for a rack boot subassembly. It illustrates a structured approach to identifying and addressing potential failure modes in the product's design by examining changes at various points. Each item under review is analyzed for its function, potential failure modes due to change, and the corresponding effects on the customer. It also suggests design, evaluation, and production measures to mitigate these risks, illustrating a proactive step towards quality and reliability in product development. The table is the product of a cross-functional team's creative exploration of a design's vulnerabilities. To learn more, we suggest reading the journal article "Design Review Based on Failure Mode to Visualize Reliability Problems in the Development Stage of Mechanical Products."

Design reviews based on test results (DRBTR)

DRBTR is part of good dissection. It is like DRBFM except that while DRBFM supports broad, cross-functional, and wide-ranging discussions, DRBTR is more focused, detailed, and based on testing and simulation results. It also occurs later in the development process for obvious reasons. In his book, Yoshimura provides the following questions as a general guide to assist in this process:

- As a result of your observations, what symptoms have you noticed?
- What problems might arise from these symptoms?
- What other symptoms are present?
- Under what situation will the symptom occur as a problem?
- What effects could it have on the customer?
- What measures have you taken to prevent the symptom from becoming a problem?
- Can this symptom manifest in any other area of the product as a problem?
- What measures have you taken for that?
- What problems can the group think of that might occur because of this symptom?
- Under what situation?
- Are there other possible problems?
- What measures does the group recommend?

Yoshimura provides some advice on computer simulation results. While simulation is fast and enables you to test many variables, do not neglect the value of actual physical testing. In particular, do not neglect testing to failure, as merely testing to specification does not provide a complete understanding of the limits of your product. Finally, like DRBFM, DRBTR should be done at the gemba (where work is done) whenever possible. The group should be able to see symptoms and results for themselves.

Some suggestions for success in design reviews based on failure mode

Preparation is critical. In his book, Yoshimura provides details on good preparation, including:

- Product or product computer-aided design (CAD) models;
- All contextual information, relevant standards, and best practices;
- Customer and environmental information;
- Relevant manufacturing processes

It is also critical to have the people with the best knowledge and experience in attendance. Finally, it is helpful to involve a facilitator or coach who has experience with DRBFM.

Four steps to get started with GD^3

Successful implementation of the GD^3 method and improved quality in product development starts with leaders and the culture they create. Quality, including meeting customer expectations, must be a demonstrated priority from the CEO down. Without the right quality mindset, recognizing that even small design changes can produce big problems without the proper intervention, GD^3 will fail. Leadership must obsessively focus on customer value, drive attention to process improvement versus relying on correction, create an environment where problems are welcomed versus feared, demonstrate humility and a desire to learn, and give responsibility to process owners closest to problems.

Yoshimura notes, for example, that GM had better tools, but Toyota had a better quality mindset and that the mindset was more important. That said, he suggests four steps to experiment with GD³ in your organization:

1. Reinvigorate your design review process;
2. Identify a specific pilot project to experiment on;
3. Train all those who will participate in the pilot;
4. Select a facilitator or reviewer who knows the product or subsystem well, is a proven, adept problem solver, and understands and supports the GD³ method.

Conclusion

Toyota's consistently high-quality performance has been unmatched for more than 20 years. It is amazing, especially when you consider the complexity of their product and the diversity of their customers. Obviously, GD is not the only reason for this. But it has been a significant factor. We think that it effectively demonstrates their relentless commitment to their customer, starting in development. Even when their quality and reliability led the industry, they were still looking for ways to get better. For us, this is the most important part of this story.

We realize that this article alone is not enough for you to become a GD³ practitioner. And perhaps the specific practices are not appropriate for your circumstances. That's okay. We can only ask that you, in the words of Bruce Lee, "Adapt what is useful, reject what is useless, and add what is specifically your own."

What matters most is that you create a culture of transparency and rigor. An organization that attacks problems, not people. Attacking people is the surest way to guarantee quality issues will go into stealth mode. And hiding problems is the surest way to a quality crisis. Leadership must create an environment that seeks out problems – big and small – giving teams not only permission but the responsibility to raise issues.

What is a Design Review?

A design review evaluates a design to ensure that it meets the requirements and is feasible to implement. It is an integral part of the product development process, as it can help identify and correct problems early on before they become costly.

Who Should be Involved in a Design Review?

The people involved in a design review will vary depending on the project but typically include the following:

- The design team
- Engineers
- Quality assurance (QA) professionals
- Product managers
- Business stakeholders

It is vital to have a diverse group of people involved in the design review, as this will help to ensure that all aspects of the design are considered.

We urge you to start your own journey to improve your quality. If you are already good at problem-solving and recurrence prevention, move to preventative quality. Research your options. Try some experiments. Don't be satisfied – keep pushing forward, focusing on your customer. Practice, practice, practice. By doing this you are almost certain to create what Professor Yoshimura referred to as the most potent quality attribute – a quality-first and customer-first mindset.

Good luck. ■

Operations *Is* Your Customer

By Steve Shoemaker

"No Way!" barked my department chief engineer when I suggested that the true customer of engineering is operations. "I despise those SOBs and there is no way in the world I would ever consider them my customer," he emphatically pronounced.

I had spent the past two years investigating the causes of our "quality escapes"—our term for issues found by customers in the field. Our team suspected that poor (if any) communication between the designer and the supplier or factory was a primary cause of defects in the field. If so, our designers were creating plans with no more than an assumption that the factory could make or assemble the part. For most parts, there is no issue and because of this the designer is too often lulled into a confidence that talking to the factory is not required.

Putting a spotlight on the ramifications of this mindset, I'm reminded of a situation early in my tenure at the Earthmoving Division. A high-profile product launch had quickly turned from "christening the ship" to a "train wreck." When hundreds of parts begin meeting each other at the assembly line at production volumes and takt times, mole hills actually do become mountains. Small issues that made assembly difficult mushroomed into line stoppages. We were forced to deploy engineers to the line for months and trace issues deep into the supply chain. Issues that could have been resolved during design were now impacting our ability to meet commitments to end users in the high-quality way they had come to expect.

Allen Ward, PhD, LPPD expert and author of *Lean Product and Process Development*, highlighted the need to treat manufacturing as a customer of engineering as an essential element of product development:

> *"We don't make money until customers buy what comes out of our plants. Development exists to create operational value streams. Operations is our customer. We should listen to and serve operations just like external customers."*

Obviously, this is easier said than done. Day in and day out, factory managers are paid to build and ship product. Seldom do they have time to discuss a future product with the development team. In my own experience, getting engagement in early concept and development activity was like pulling teeth. It wasn't that the manufacturing teams didn't want to be involved, but rather the issue of what gets measured gets done. There was little reward in expending manpower on a project that may not hit the factory floor for another three years.

It was no different in dealing with external suppliers, except they were more friendly because they wanted to win the business. In the case of an external supplier, they would be asked to participate in projects even before the business had been awarded and could even still be competing for the business. Suppliers, too often, would commit to designs, including cost points, that may or may not be achievable. Like the factory, purchasing people were more focused on meeting the demands of the day than with future programs.

I would emphasize that there is no nefarious intent on the part of the factories or suppliers. They are simply doing the best they can with the resources they have to ensure parts get shipped today and that there is something to build tomorrow. Executives beat on the frontline managers to ship more product and to remove material, variable, and period costs from the value stream. There are never rewards handed out to a team or factory whose costs went up year over year.

So why does this matter and what can be done to improve things?

Working well across organizational boundaries is a secret to lean value streams. One in which the wastes of rework, hand-offs, and wait times is minimized so that end users are happy to trade their hard-earned dollars for the product that our factories produce.

Back to the "train wreck," not only did engineering need to pull people off value-added activities to rework issues found during production ramp-up, but purchasing people were refocused to address inbound quality problems; i.e., parts that were not meeting print specifications as they entered the factory. Furthermore, valuable operation people had to rework machines once design and supplier issues were resolved with new parts. Ship dates were missed, and scheduling and logistics teams had to shuffle schedules of inbound material and finished product delivery dates. Perhaps worst of all, customer commitments (end users) were missed and had to be managed to prevent migration to competitive products.

Unfortunately, this is not a once in a career type of story. Recovering within a crisis; e.g., a train wreck, becomes a visible issue that requires an "all hands on deck" mentality. Teams leap into action and are celebrated for heroic efforts and hours dedicated to righting the ship. This "forced teamwork" is nonnegotiable and accepted by all organizations. Firefighting is recognized and rewarded.

LPPD offers a better way. By employing LPPD, the development team converts firefighting into fire marshalling. Responsive actions occurring late into the development cycle are moved to planned activities early in development. People in all parts of the value stream can do things right the first time, rather than rework perhaps multiple times on the road to production. In the world of development, this requires intentional behavior that is often counterintuitive and, even more challenging, counterculture.

By counterculture, I mean that traditional thinking will be altered in a way that will be uncomfortable for many. It took months for the chief engineer I mentioned earlier to come to this realization. It was not by me making him believe this statement, but rather the application of lean principles that led him and his team to the conclusion that operations is the customer of engineering.

Traditional thinking has engineering create a design and hand it to a supplier to make. Lean thinking involves the supplier as the design is created and gains insight from the maker of the part. I often told my team that we want to design into the "sweet spot" of the supplier. This means doing things the supplier is good at already. The goal is to have perfect parts coming into the assembly factories. If we ask a supplier to manufacture a part that is difficult for their processes, we have significantly increased our project's risk profile.

It is not just engineering that has to think differently. Purchasing must change the way it works with suppliers. In the normal environment, suppliers are managed primarily to deliver at the lowest cost possible while hitting challenging quality and delivery targets. Suppliers want and need the business. They typically agree to what the customer; e.g., purchasing, is asking them to do and figure out how to make money along the way. In the case of a new part, they will agree to the design handed to them and when problems come up along the way, they will request changes to the part late in the development process and often after production launch.

I recall discussing the print release status on a new machine program with the lead project engineer. I asked if the supplier had seen the latest version of the production drawings. The answer was troubling. "I don't have time to talk to the supplier," stated the leader. "They will ask for changes as we ramp up for production, and we will revise the drawings then." The timeline was more important than doing things right the first time. You might be thinking I should fire the engineer. It is not his fault. The management culture created an environment where this behavior is not only tolerated but celebrated. Hitting your dates becomes a badge of honor. Until recently, this behavior had not been traced back to the quality escapes in the field. People behave within the reward system the leaders of the company create.

To embed a more collaborative environment between engineering and operations, both assembly factories and suppliers, teams containing purchasing, manufacturing, and engineering were created. The teams were broken down by systems such as light fabrications, heavy structures, powertrain, controls, electrical, etc. These teams were responsible for both new and current production, which provided a feedback loop for new designs from the good and bad elements of today's products. The combined disciplines working together caused the product (design) and the process (design) to make the products to be addressed concurrently. This is fire marshal work.

During a visit with a company that had embedded LPPD, I pushed back on the concept just to test my own beliefs. "How do you know this LPPD stuff works?" I inquired of an engineer who had a visible outer shell that signaled he had been through many firefighting activities in his career. "Because people are happier!" he belted out as if I were the only person in the room who didn't know the answer. I did know the answer and simply wanted someone to reinforce what I felt the moment I walked into their building. It was like a fresh breeze on a sunny spring day.

As these lean principles were applied within my own company, in a span of less than five years, quality improved by more than 50 percent while warranty costs dropped by $90M. New product introductions were no longer firefighting events but methodical marches to the marketplace with few surprises.

> "Moving reactive firefighting to proactive fire marshalling is where the true heroic behavior happens."

Operations is the customer of engineering. Ensuring that designs can be made by suppliers and those parts assembled in the factories is the most important element of development once the external customer need is met. Moving reactive firefighting to proactive fire marshalling is where the true heroic behavior happens. Allowing teams to do things right the first time rather than iterating with rework after production saves time and money and will create more engaged employees from the design centers to the shop floor. ■

Quality Leadership at the Forefront of Innovation: A Conversation with Jeri Ford of Lucid Motors

By Jeri Ford and Matthew Savas

Electrification has given rise to new American automotive ventures such as Tesla, Rivian, and Lucid Motors. Aside from the powertrain, these companies are innovating the driving experience through breakthrough performance and by deeply integrating software into vehicle architecture.

These disruptions demonstrate exciting possibilities but raise a challenge: how can companies innovate while upholding customer expectations of quality?

In an episode of the WLEI podcast, LEI sat down with industry veteran and Lucid Motors' Vice President of Quality Jeri Ford to explore that question. Jeri has over 30 years of experience in the automotive industry, having held leadership roles at Ford and Rivian before joining Lucid.

The conversation explores:

- How product development impacts quality downstream in manufacturing and supply chain.
- The importance of collaboration between functions to achieve quality objectives.
- Balancing speed and quality in bringing new vehicles to market.
- Adapting processes for the integration of software and hardware in modern vehicles.
- Building alignment and a culture of quality in a startup environment.
- Listen to gain these insights and learn about the challenges facing the automotive industry in an era of technological change.

Listen at lean.org/QualityLeadership

Contributor Highlight

Fabrice Bernhard

Fabrice Bernhard is the coauthor of *The Lean Tech Manifesto* and the chief technology officer of Theodo, a leading technology consultancy he cofounded with Benoît Charles-Lavauzelle and scaled from $1 million in revenue and 10 people in 2012 to $100 million in revenue and 700 people in 2022.

Theodo was featured in the FT 1000: Europe's Fastest Growing Companies and Deloitte Technology Fast 500 EMEA rankings. It has been awarded the HappyIndex® AtWork label every year since 2015. Based in New York, London, Paris, and Casablanca, Theodo uses agile, DevOps, and lean to build transformational tech products for clients all over the world, including global companies—such as VF Corporation, Raytheon Technologies, SMBC, Biogen, Colas, Tarkett, Dior, Safran, BNP Paribas, Allianz, SG—and leading tech scale-ups—such as ContentSquare, ManoMano, and Qonto. Their story has been featured in multiple articles on Planet Lean and in the book *Learning to Scale at Theodo Group*.

Fabrice is an expert in technology and large-scale transformations and contributed to multiple startups that scaled sustainably with lean thinking. He has been invited to share his experience at international conferences, including the Lean Digital Summit, DevOpsDays, and CraftConf. Fabrice is the cofounder of the Paris DevOps meetup and an active member of the Young Presidents' Organization. He studied at École Polytechnique and ETH Zürich and lives in London with his two sons.

Jeri Ford

Jeri Ford is the vice president of quality at electric vehicle startup Lucid Motors. She brings over 30 years of automotive experience to her role.

Before joining Lucid Motors, Jeri was vice president of business operations and new model programs at Rivian, another electric vehicle startup. Her lean manufacturing and purchasing expertise contributed significantly to the company's early success.

Prior to her tenure at Rivian, Jeri had a long and successful career at Ford Motor Company. Her leadership journey culminated in her role as purchasing director for electrical systems. In this capacity, she managed complex purchasing processes and played a crucial role in ensuring the quality and efficiency of Ford's products.

Jeri holds a BA in industrial engineering from Tennessee Technological University and an MA in engineering/industrial technology from Eastern Kentucky University.

Contributor Highlight

James Morgan, PhD

Jim is a senior advisor at Lean Enterprise Institute and a board member at Adrian Steel. He has a unique blend of industry leadership experience and rigorous scholarship, which he draws upon to improve organizational performance at a select group of companies.

Jim's most recent industry experience was as chief operating officer at Rivian, an electric vehicle manufacturer on a mission to keep the world adventurous.

Before joining Rivian, Jim spent a little over ten years at Ford Motor Company. He began by leading the development of the Global Product Development System. He then served the last nine years as director of Global Body and SBU Engineering and Tooling operations, where he and his team contributed to the company's historic, product-led revitalization under then-CEO Alan Mulally.

Before Ford, Jim served as vice president of operations at Troy Design and Manufacturing (TDM) during a period of dramatic growth. TDM is a tier-one global automotive supplier of engineering services, prototype tools, and low to medium-volume production parts and subassemblies.

Matthew Savas

As content director at the Lean Enterprise Institute, Matt is responsible for the institute's content strategy in all mediums. He previously served as director of the Lean Global Network, where he supported its 30-plus institutes and partners to spread lean thinking around the globe.

Matt has a BA in East Asian studies from Bates College and an MBA from the Isenberg School of Management, University of Massachusetts Amherst. He lived in Japan for five years. When he's not at work, he enjoys reading, roasting coffee, and exploring the outdoors with his wife.

Steve Shoemaker

Steve Shoemaker retired as vice president of engineering in Caterpillar's Earthmoving Division after thirty-three years. Over his career, he worked as a designer in the company's engine segment before moving into technical leadership in engines and later electronics. The last half of his career was spent developing machines, spending six years in the Building Construction Products Division where he led engineering and oversaw the build of the Clayton Machine Development Center. In 2012, he moved to the Excavation Division in Akashi, Japan where, as chief engineer, he led the Hydraulic Excavator Design Center.

In 2017, Shoemaker assumed his final role as vice president of engineering. He led the global design organization for the company's core machine portfolio, which included bulldozers, wheel loaders, motor graders, and paving equipment. In this final role, his pursuit of zero-defect quality levels benefited from 15 years of experience with Lean Product and Process Development (LPPD). Shoemaker now serves as a senior advisor with the Lean Enterprise Institute. He holds a BS in mechanical engineering from the South Dakota School of Mines and Technology. He has an MBA from Purdue University.

Are you a leader who wants to dramatically improve how your organization develops – and profitably delivers – new products and services? Do you want a chance to collaboratively run experiments with other leaders like you to help your team achieve that goal?

Then become a Co-Learning Partner

Apply to join fellow leaders in the Lean Product and Process Development (LPPD) Learning Group, our longest-running, co-learning partnership. Each partnership is focused on an industry, business function, or lean management discipline.

The LPPD group brings together diverse companies committed to transforming their product, process, and service development systems through lean thinking and practice. Much of this group's noteworthy improvements were captured by authors Jim Morgan and Jeff Liker in *Designing the Future*, co-published by the Lean Enterprise Institute (LEI) and McGraw Hill. Who knows, maybe your lean transformation story will become part of an upcoming LEI book.

Like all our co-learning partnerships, the LPPD group is open only to organizations demonstrating:

- Executive commitment to lean transformations;
- Enthusiasm for collaborative learning where work actually happens;
- Willingness to share results with the global lean community.

This learning approach allows organizations and their teams to learn from one another. While participants in the learning groups collectively direct the learning, LEI coaches facilitate meetings organized three to four times per year on-site at learning group companies or in virtual gatherings.

Companies we've partnered with

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Coaches 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 offer "cookie-cutter" solutions. Instead, coaches bring their decades of lean thinking, practice, and coaching to bear on the business issues you need to resolve. They guide you through discovering — for your organization and 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.

To learn more about becoming a Co-Learning Partner, schedule a call today with an LEI coach.

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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).

Continue Your Learning

The Lean Enterprise Institute (LEI) offers a wide range of learning resources, all with the practical knowledge you need to sustain a lean transformation:

Learning Materials

Our plain-language books, workbooks, leadership guides, and training materials reflect the essence of lean thinking — doing. They draw on years of research and real-world experiences from lean transformations in manufacturing and service organizations to provide tools that you can put to work immediately.

Education

Faculty members with extensive implementation experience teach you actual applications with the case studies, worksheets, formulas, and methodologies you need for implementation. Select from courses that address technical topics, culture change, coaching, senior management's roles, and much more.

Events

Every March, the Lean Summit explores the latest lean concepts and case studies, presented by executives and implementers. Other events focus on an issue or industry, such as starting a lean transformation or implementing lean in healthcare. Check lean.org for details and to get first notice of these limited-attendance events.

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A quick and secure sign-up delivers these online learning resources:

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