

# Building the lean MACHINE

**5** Spend a few days inside a lean manufacturing conference, and you might think you've stumbled into a religious revival meeting. "You must lead them across Jordan to the promised land," says one keynote speaker. "Take heart, you can do this." So what is it about lean manufacturing that has North America's vice-presidents, plant managers and engineers pumped up with optimism? For many, it's the first time in their careers that they've found an idea with the power to transform their operations into the flexible and efficient plants needed to survive in the new century. And, as true believers, they need the tools to convince those around them — their bosses, shareholders and shop floor workers — that they too must diligently prepare for the lean journey. That's why more than 300 lean disciples descended upon St. Louis, Missouri in October for the 4th Annual Best of North America conference. They came to hear experts share their lean wisdom and teachings, to hear case studies of how other companies implemented lean, and to buy the latest books and training materials from the event's sponsor. Newly-energized, and filled with missionary zeal, they return to their plants, roll up their sleeves, and get back to building the lean machine. BY TODD PHILLIPS *continues* ➔

**T**he first thing you learn about lean manufacturing is that it's a journey you set out upon, toward a destination you'll never quite reach.

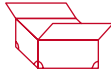


The next thing you discover is that when you've set up a lean manufacturing plant — it's not enough. You've got to build a lean enterprise: from accounting, to upper management, to the shipping docks. If you can manage that, and many companies have, then you still have to target your suppliers, and politely convince them — or outright order them — to get lean.

And it won't be easy; it's expensive; you can't do it yourself; it could take from two to 10 years; and many people will get lost on the journey.

Lean manufacturing isn't the type of fast-return, instant gratification project that most North American manufacturers like. But ready or not, lean manufacturing is here. An old idea, conceived in Toyota's car-making plants more than 30 years ago, is being born again in boardrooms and factories.

THE NEW LEAN ORDER

Comparison of requirements for mass and lean enterprise

AREAS AFFECTED	MASS PRODUCTION	LEAN ENTERPRISE
<b>Business strategy</b> 	Product-out strategy focused on exploiting economies of scale of stable product designs and non-unique technologies.	Customer focused strategy focused on identifying and exploiting shifting competitive advantage
<b>Organizational structure</b> 	Hierarchical structures that encourage following orders and discourage the flow of vital information that highlights defects, operator errors, equipment abnormalities, and organizational deficiencies.	Flat structures that encourage initiative and encourage the flow of vital information that highlights defects, operator errors, equipment abnormalities, and organizational deficiencies.
<b>Operational capability</b> 	Dumb tools that assume an extreme division of labour, the following of orders, and no problem solving skills..	Smart tools that assume standardized work, strength in problem identification, hypothesis generation, and experimentation.

SOURCE: DR. THOMAS JACKSON, *BEYOND THE PILOT PROJECT: AN ESSAY ON BECOMING LEAN*.

PRESENTED AT THE 4TH ANNUAL BEST OF NORTH AMERICA CONFERENCE, IN ST. LOUIS, MISSOURI, OCTOBER 1999.

Detroit: Lean USA

**T**he epicenter of the lean rumblings shaking up corporate North America is in Detroit. "I think the automobile companies are beginning to step up to the plate," says Dr. Thomas Jackson, author of several books on lean manufacturing, and vice-president of Productivity Inc., the Portland, Oregon-based education, training and consulting firm that held the St. Louis conference on lean manufacturing. "Certainly Productivity has been holding

its lean conferences for years, but to have Ford Motor Company stand up and say, 'Thou shalt become lean' it has a completely different meaning. Suddenly you have 4,000 first-tier suppliers who say, 'Uh oh, we'd better get lean.' And they are willing to spend money and dedicate resources."

The principles of lean might sound good on paper, but are companies really buying into it? At a Rockwell Automation conference in Long Beach, California in December, panelist John McLenahen,

senior editor of the respected U.S. journal, *Industry Week* was asked about his readers' experiences. "I think they are looking at lean manufacturing," says McLenahen. "We are witnessing companies very much in transition... it's becoming more of a constant process." McLenahen says for many companies going lean simply means outsourcing, and for others, it means outsourcing only their distribution. He says what people are really moving towards is more flexible and agile manufacturing,

LEAN IN ACTION

A smarter way to make smart bombs

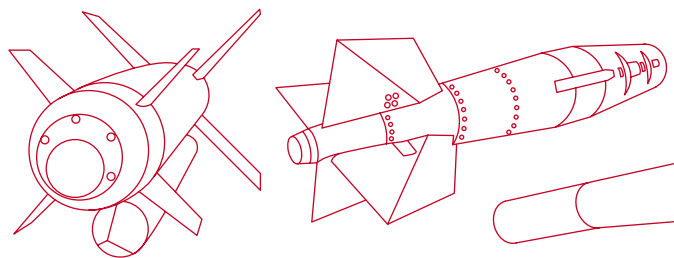
Boeing's new missile-making line showcases the company's commitment to lean manufacturing

**B**oeing's missiles are so damn smart that trained soldiers can launch them from safety miles away from the heat of battle, and remotely steer them to within inches of their targets. But the process for manufacturing some of those smart bombs hasn't quite kept pace with the incredible advances in missile guidance technology.

At its St. Charles, Missouri missile plant, a 20 minute drive from downtown St. Louis, Boeing makes a variety of missiles for U.S. and foreign clients. They also use a range of manufacturing methods. A tour of the Boeing plant was one of the highlights for many of the delegates who attended Productivity Inc.'s Best of North America conference. It's one thing to talk about lean, it's another to see it work.

For its older missiles, like the Harpoons, SLAMs and CALCMs, the missile assembly lines we were shown look much like traditional batch and queue operations that depend on a trained workforce using manual assembly techniques. And there's a lot to assemble. These missiles consist of about 98 percent outsourced parts, and two percent Boeing-made parts.

Seated on stools, workers pick small parts from bins, then stretch and stick their hands inside tight compartments to assemble the missile's inner



brains. Ticketed work-in-progress is visible in various stages of assembly; there is little automation, and the workers work in cells and mostly in isolation from one another. Company officials say that, over the years, these employees have squeezed tremendous efficiencies out of the process, but Boeing would like to introduce more advanced manufacturing practices.

After a short bus trip across the facility, and when you walk inside Boeing's new production facility for its JDAM (Joint Direct Attack Munition) line of missiles, you see a whole different world — lean manufacturing.

Starting from scratch, a group of lean manufacturing devotees within Boeing's missile division knew they had an opportunity to create the ideal lean assembly plant. They benchmarked with dozens of other facilities, studied best practices, conducted internal performance audits, attended lean manufacturing conferences, and did their homework. The result? A simple looking, but highly-efficient production line that can produce top quality mis-

## The e-commerce promise

**L**ean textbooks are also being dusted off and lean theory revisited because of the new pressures for quicker response and shorter cycle times that e-commerce and e-manufacturing are imposing. Manufacturers are grasping whatever they can to help them thrive in an e-commerce world.

Kevin Prouty, a senior analyst with AMR Research, a leading manufacturing analyst firm, says that he sees more companies taking a closer look at lean. "As e-business puts more pressure on the plant, I think you'll see companies that philosophically weren't ready to adopt it are now willing to adopt it because they have to."

While Prouty says he believes lean has a lot to offer, he remains skeptical about the ability of many companies to pull off the company-wide cultural transformation needed to make lean really work.

The turmoil created by e-commerce is what Martyn Jones calls the "Internet effect." Jones is director of research for discrete industries at the ARC Advisory Group, an industry analyst firm that pro-

vides technology assessments and advisory services for global manufacturers. "With the Internet, everybody knows one thing for sure — everything's going to change," says Jones.

competitive advantage instantly."

## Quick fix lean doesn't stick

**E**ven many North American manufacturers are eager for instant

### LEAN DEFINED

#### What is lean manufacturing?

**L**ean production is aimed at the elimination of waste in every area of production including customer relations, product design, supplier networks and factory management. Its goal is to incorporate less human effort, less inventory, less time to develop products, and less

space to become highly responsive to customer demand while producing top quality products in the most efficient and economical manner possible.



— THE PRODUCTION SYSTEM DESIGN LABORATORY (PSD), MASSACHUSETTS

INSTITUTE OF TECHNOLOGY (MIT)  
[HTTP://LEAN2.MIT.EDU/](http://lean2.mit.edu/)

"They are not sure what it will change to... so they are trying to get into position to react to whatever it is."

Jones says if you go lean, you've got to stick to your guns. "If you look at the people who have been really successful over time, this is a religion, or a lifestyle," says Jones. "You have to adopt it wholeheartedly. If you just do some band-aiding, you'll get some short-haul benefits, but when the next wave comes — you are not going to be any better prepared. You'll lose your

results, try to steal the "quick fix" parts of lean and awkwardly force them into their existing plants to attack the enemy of lean: waste. Here's what the enemy, *muda* to the Japanese, looks like. (as described by the Massachusetts Institute of Technology.) The Toyota Production System defines seven types of waste:

- **Overproduction:** to produce more than demanded or produce it before it is needed. It is visible as storage of material. It is the result of producing to speculative demand;

- **Inventory or Work In Process (WIP):** is material between operations due to large lot production or processes with long cycle times;

- **Transportation:** does not add any value to the product. Instead of improving the transportation, it should be minimized or eliminated (e.g. forming cells);

- **Processing waste:** should be minimized by asking why a specific processing step is needed and why a specific product is produced. All unnecessary processing steps should be eliminated;

- **Motion:** of the workers, machines, and transport (e.g. due to the inappropriate location of tools and parts) is waste. Instead of automating wasted motion, the operation itself should be improved;

- **Waiting:** for a machine to process should be eliminated. The principle is to maximize the utilization/efficiency of the worker instead of maximizing the utilization of the machines;

- **Making defective products:** is pure waste. Prevent the occurrence of defects instead of finding and repairing defects.

## Beware the endless

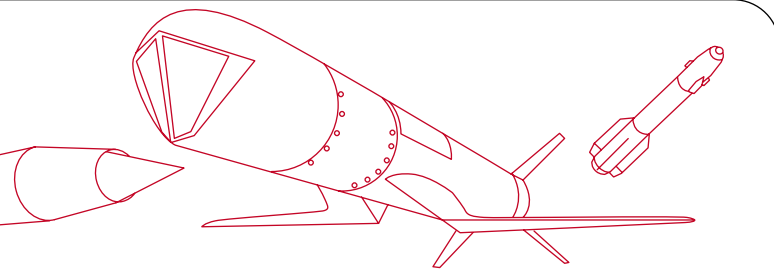
### Kaizen blitz syndrome

**O**ne "quick fix" lean tool that many manufacturers turn to is the increasingly popular Kaizen blitz: a team set up to attack waste and inefficiencies in one element of a manufacturing process, and to suggest immediate solutions. Like much of the lean lingo, Kaizen (incremental improvement) is one of a number of Japanese terms that North Americans are quickly adopting and adapting.

But experts caution that stealing bits and pieces of lean isn't enough. "You will never Kaizen your way to lean," says Productivity's Thomas Jackson. Even someone who took part in more than 200 Kaizen blitzes says it's tough to make the gains stick. "Kaizen is a good catalyst for change, but it won't sustain a major cultural change," says Tony Laraia, CEO of Eastern Plastics, Inc., and author of *The Kaizen Blitz*. "It's problem is its rapidity," said Laraia during his presentation at the lean manufacturing conference. "In the long-run, only simple solutions sustain. It's easy to say — hard to make happen."

### Mass vs. lean thinking

**M**any North American companies find themselves stuck part way between mass and lean production. The problem, says Jackson, is that most managers, trained in the principles of Newtonian science, view additions to scientific knowledge in small, incremental improvements. They just aren't trained to make the



siles at a low cost — about US\$20,000 per missile. The line now makes about 1,000 missiles a year, but the system could crank out as many as 20,000.

On the assembly line, each munitions mechanic follows clearly outlined standardized work procedures, and spends the same time — 17 minutes — during each stage of the assembly process. There is no rework on the line, and parts are stored adjacent to where they are assembled. Each mechanic does every other job, from unloading raw goods from trucks, to assembly, to packing up the finished product in collapsible and reusable bar-coded containers with no packaging waste for shipping.

Boeing officials said the lean missile plant is patterned after the Massachusetts Institute of Technology's Lean Aerospace Initiative and the Toyota Production System. The key principles are value; flow, pull, value stream and perfection. Key features are self-directed work teams, reduced cycle time, continuous flow, waste elimination, set-up reductions and kanbans. TP

quantum leaps in thinking that are needed. “We have managers and engineers who don’t know what to do when God throws them a curve ball,” says Jackson. “The Toyota Production Method is about learning — the culture of science — continuous learning.”

Mass production models, says Jackson, are rigid creatures, that focus on exploiting economies of scale, and use organizational hierarchies that could have been borrowed from medieval princes: the strict following of orders by

untrained soldiers. Those soldiers are also expected to do the same boring tasks, hour after hour, day-in and day-out.

A lean manufacturing enterprise, he says, thinks more about its customers than it does about running big machines fast to absorb labour and overhead. The lean enterprise has a flat, team-based structure, with a high degree of work autonomy. A lean organization breaks down organizational barriers. Instead of dumb soldiers, a lean enterprise develops highly-trained, motivated employees

who investigate problems and find solutions as part of their job. A lean enterprise must also integrate its suppliers.

**Go lean: or else**

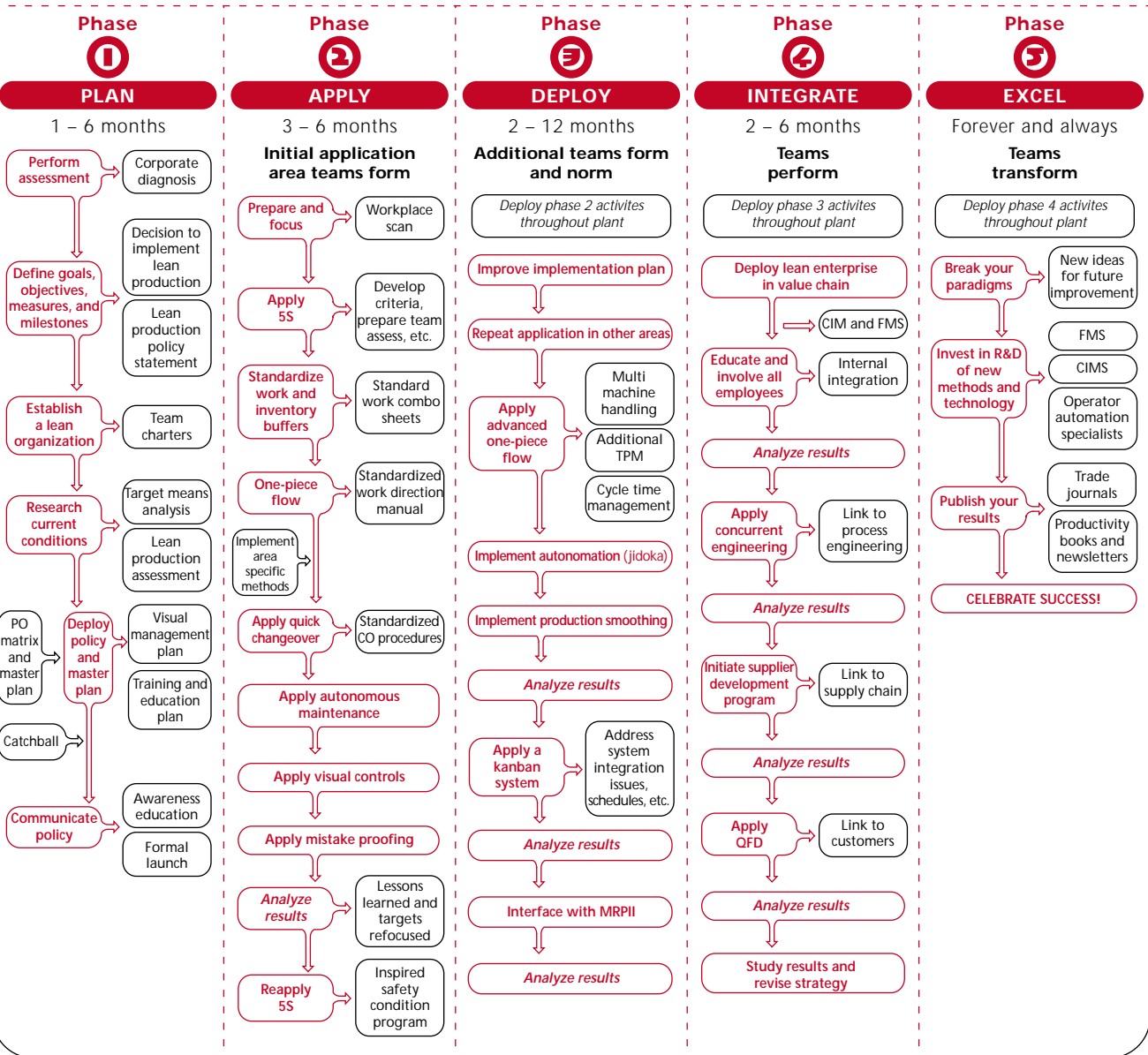
**I**f one of your key customers goes lean, guess what? You’re going lean too or you risk losing that customer. The gains from lean manufacturing can’t be sustained without pushing lean to your supply chain. In Boeing’s lean manufacturing missile plant in St. Charles, Missouri, a large sign board outside the assembly area lists

all of the corporation’s gold, silver and bronze suppliers. It’s no coincidence that the most favoured suppliers are also lean. So why do some companies bully their suppliers into going lean?

Consider this simple image: a dozen red cables, about six inches long, sitting in a bin, awaiting inspection from Boeing’s engineers. Boeing bought those cables from a reliable and preferred supplier. But there was a small problem with the cable connectors and — boom — they failed quality

A GUIDE FOR THE LEAN JOURNEY

Lean production implementation roadmap



tests. It also disrupted operations on Boeing's lean manufacturing assembly line for its Joint Direct Attack Missiles (JDAM). There is no room for rework on their continuous flow assembly line, so how do you get new cables back in? Do you wait for a new, improved batch from your supplier? No, you toss out the whole lot, find a new supplier who understands the stringent demands of a lean operation, and put a big X next to the supplier who screwed up your production. Quality and guaranteed delivery from your supply chain is vital to lean. So, how much do you think those cables cost that supplier? Somewhere in North America, you'll likely find an unemployed cable salesman, drinking himself stupid, telling a bartender his side of this story. So, should you take the lean journey?

Even the most devoted lean teachers agree that this new philosophy can be disruptive, at times chaotic, that it can hurt company morale, and won't deliver quick, measurable returns. So why bother?

For Jackson, there aren't many alternatives for companies that want to be in business in 100 years. "We know it works," says Jackson. "We also know that it is an excellent environment to introduce advanced technical manufacturing solutions. Lean companies tend to be very thoughtful in their applications of advanced manufacturing systems."

So to the faithful, lean is a tool that can lead them to the promised land of zero-waste manufacturing. To the skeptical, it's a great idea, but it's too hard to pull off. What you think, will depend on where you are on your journey. **AM**

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TERMINOLOGY

Learn the lean lingo

Master these terms, and you'll sound like a lean manufacturing expert in no time.

- **Andon lights / boards:** A visual control device in a production area.
- **Autonomation:** automation with a human touch. Refers to semi-automatic processes where the operator and machine work together. Autonomation allows man-machine separation. Also referred to as Jidoka.
- **Balanced production:** all operations or cells produce at the same cycle time. In a balanced system, the cell cycle time is less than takt time.
- **Error-proofing:** designing a potential failure or cause of failure out of a product or process.
- **Flow manufacturing:** a manufacturing methodology that pulls items from suppliers through a synchronized manufacturing process to the end product. The principle goal is faster response to customer demand.
- **Hoshin Kanri:** A strategic planning approach that integrates the practices of leadership with the practices of management.
- **Kaizen:** Japanese term for incremental improvement. A team approach to quickly tear down and rebuild a process layout to function more efficiently.
- **Kanban:** techniques named after the Japanese word for card or communication. Stocking technique using containers, cards and electronic signals to make production systems respond to real needs and not predictions and forecasts.
- **Just-in-Time (JIT):** manufacturing method where downstream operations pull required parts needed from upstream operations at the required time. Implementing JIT requires most features of lean manufacturing.
- **Mistake-proofing:** any change to an operation that helps the operator reduce or eliminate mistakes.
- **Muda:** Anything that interrupts the flow of products and services through the value stream and out to the customer is designated muda — or waste.
- **One piece flow:** Producing one unit at a time, as opposed to producing in large lots.

- **Poka-Yoke:** Techniques to mistake-proof a process.
- **6 Sigma:** A structured process improvement program for achieving virtually zero defects (3.4 parts per million) in manufacturing and business processes.
- **Standard operations:** Clearly defined operations and standardized steps for both workers and machines.
- **Takt time:** Takt is German for pace. Takt time defines the manufacturing line speed and the cycle times for all manufacturing operations. Takt time is computed as: Available work time per day / daily required demand (parts/day).

● **Value Stream Mapping:** A process to determine the value added to a product as it goes through a manufacturing process.

SOURCES: MASSACHUSETTS INSTITUTE OF TECHNOLOGY (HTTP://LEAN2.MIT.EDU); RUTHERFORD ASSOCIATES INC.; AMR RESEARCH INC., THE REPORT ON MANUFACTURING, SEPT. 1999; THE UAH MANUFACTURING EXTENSION PROGRAM; EFFECTIVENESS OF ERROR/MISTAKE PROOFING, PAPER BY JUDY KILPATRICK, ERNIE LABUTTE; OVERVIEW OF LEAN ACCOUNTING, PAPER BY BRIAN MASKELL; BEYOND THE PILOT PROJECT, PAPER BY DR. THOMAS JACKSON; AIS TECHNOLOGIES (AIS-TECH.COM); PRODUCTIVITY INC. WEBSITE: (PRODUCTIVITYCONSULTING.COM).



LEAN RESOURCES

Need some help getting lean?

If your company is going lean you might consider tapping into some of the excellent consulting, training and educational resources now available.

Most major consulting firms have experts familiar with lean manufacturing and the Toyota Production Method. They may use slightly different terminology, for example Ford calls its system the Ford Production System, but that's not a big deal.

Just be sure to check out the credentials of anyone you are thinking of hiring. Have they toured lean plants? Have they been to Japan? Have they read the original teachings of lean manufacturing?

Which companies have they successfully helped transform into a lean manufacturing operation? Can you contact those companies for a referral?

There is little formal training available in universities on lean manufacturing, but there are excellent resources available. You can even find lots of good stuff on the Internet. Type in "lean manufacturing" at the search engine, [www.northernlight.com](http://www.northernlight.com) and you'll be busy for the next week surfing thousands of sites. To shorten your search, you might start with the people who do "lean" for a living. That includes the Portland, Ore-

gon-based firm Productivity Inc., that has translated the original works from the Japanese inventors of lean manufacturing. They have dozens of books, shop-floor training manuals, videos, and also have consultants who can help you with your lean manufacturing implementation. You can check out their offerings at their website: [www.productivityinc.com](http://www.productivityinc.com) or give them a call at: (800) 394-6868.

You might also go to [www.lean.org](http://www.lean.org) and see what the Lean Enterprise Institute can do for you. That organization, founded by James Womack, one of the leading authors in the lean manufacturing world, has an online lean community discussion group, holds conferences, sells books, and links to resources.

If you are in the automotive world, there are excellent articles at the Society of Automotive Engineers' (SAE) website at: [www.sae.org](http://www.sae.org). You can also read about the automotive industry's first common definition for a lean operation. The SAE's J4000 document covers six lean implementation areas: management, people, information, supplier/organization/customer calls; product and process flow. Or you can call them at 724-776-4970 to order the document for US\$25.

