The long and short of it:

Helping aerospace and defense companies take the long view of lowest total cost of ownership to avoid costs and shorten time-to-market

A white paper by Plexus Corp.

The long and short of it: Taking the long view of lowest total cost of ownership to avoid costs and shorten time-to-market

Table of contents

Introduction

Lowest Total Cost of Ownership (LTCO) refers to the lowest total cost of making, using, maintaining and refurbishing a product through the end of its useful life.

Virtually all of today's global original equipment manufacturers (OEMs) are facing tremendous pressures to reduce costs and shorten their products' time-to-market.

Short lead times are critical to the success of a product. To ensure that a product successfully enters the market and captures the maximum revenue and market share potential, management teams focus on minimizing the time it takes to introduce a new design concept to customers. If these teams encounter common pitfalls associated with bringing a product to market, they may fail to meet release schedules, increase costs and delay the product's availability.

Lowest Total Cost of Ownership (LTCO) refers to the lowest total cost of making, using, maintaining and refurbishing a product through the end of its useful life. By definition, LTCO requires product innovators, designers and manufacturers to take the longest, broadest possible view of costs incurred over the lifetime of a product, from cradle to recycling, so as to capitalize on both revenue-producing and cost-avoiding opportunities that arise over the long term. Too often, product innovators are focused on cost-per-unit statistics or immediate time-to-market pressures without carefully considering longer range factors that will affect technological obsolescence, serviceability and supply chain issues, to name a few.

Traditional engineering approaches do not account for the misaligned incentives between a product's design teams and the production and supply chain teams. Designing a product for optimal performance and designing a product for ease of manufacturability and supply chain management require very different processes, and often these processes hold competing priorities. When products are properly designed, the LTCO is achieved without sacrificing, and while many times enhancing, performance or quality.

This paper addresses the value of collaboration between design, engineering, manufacturing and supply chain experts who all focus on the long-term useful life cycle of high-tech electronic devices. In an optimal collaborative environment, each stage of product development, henceforth referred to as the Product Realization Value Stream, is reevaluated based on the customer's top priorities. These priorities are determined at the outset, initiated by good questions and thoughtful consideration, and based on the product's purpose, market sector and critical performance benchmarks. Unique product characteristics drive the need for customized, experienced

and expert product life cycle optimization that results in LTCO, and correspondingly, the highest possible customer satisfaction.

The Product Realization Value Stream is a proven system of product development that seamlessly integrates product conceptualization, design, commercialization, manufacturing, fulfillment and sustaining services to deliver comprehensive end-to-end solutions to high-tech product creators and innovators.

Subsequent sections of this paper provide an in-depth examination of the tactics to reduce a product's total cost of ownership with the goal of providing a quicker time to – and longer successful time in – the market. Key topics include:

- The importance of designing for immediate fit, form and function, while also accounting for the longer term costs of LTCO
- Asking the right questions: how to discover the ideal design of a product to optimize LTCO given the environment in which it will be used
- Mastering beneficial collaboration between engineering disciplines, manufacturing, sourcing, supply chain and multiple stakeholder groups throughout the entire product development cycle
- Discovering the optimal stage of the design cycle for addressing a product's unit cost, regulatory compliance, electromagnetic compatibility, reliability, manufacturability, fulfillment, serviceability and sustainability
- Assisting product innovators to negotiate design and manufacturing contracts based on LTCO factors with the goal of complete transparency and discovered cost avoidance opportunities

Readers should take note: this paper covers many but not all facets of the Product Realization Value Stream as they relate to LTCO. Segregated from discussion are commercialization and manufacturing. This decision was made so that attention may be focused on the multiple overlapping layers of Design for Excellence (DFX) that can significantly influence LTCO during the design phase. Future publications will focus on testing, manufacturing assembly and fabrication as they relate to LTCO. Interestingly, the success of these downstream portions of the Product Realization Value Stream is all heavily dependent on the thoughtful and inclusive nature of the earliest phases of concept convergence. Let's start here.

The *Product Realization Value Stream* is a proven system of product development that seamlessly integrates product conceptualization, design, commercialization, manufacturing, fulfillment and sustaining services.

Designing starts with defining

> The goal of LTCO requires product innovators, designers and manufacturers to take the longest, broadest possible view of costs incurred over the lifetime of a product.

Designing for Excellence (DFX) is a group of best practice guidelines and skills acquired over decades of heavy linkage between engineering and manufacturing. Product innovators find this breadth and depth of experience invaluable because it takes a long, wide view of product innovation. DFX begins when seasoned project managers help product researchers and innovators to define their specific version of success; that is, how they seek to simultaneously achieve necessary performance and time-to-market requirements and LTCO.

The goal of LTCO requires product innovators, designers and manufacturers to take the longest, broadest possible view of costs incurred over the lifetime of a product, from cradle to recycling, so as to capitalize on both revenue-producing and cost-avoiding opportunities that arise over the long term. Cost reduction, a different term, must be recognized as a potential subset of cost avoidance. However, cost avoidance takes a holistic view of a project, whereas cost reduction is specific to only one phase of product development. Carefully consider the intention of each effort at cost reduction to ensure it results in cost avoidance over the long term.
A key element of the Product Realization Value Stream is concept convergence based on input from all stakeholders throughout the DFX process. Together, stakeholders come to understand the true product requirements over unnecessary enhancements. They identify the optimal place on the continuum that balances cost based on quantity produced. Via DFX, essential detailed questions will drive an effective customized plan that optimizes LTCO. From the very beginning, consider all possible:

- Stakeholder goals
- Applicable constraints
- Human factors
- Technology challenges
- Aesthetics
- Branding
- Cost drivers
- Business and intellectual property opportunities

Practiced project management facilitates DFX as a non-linear process

> A well-versed project manager knows of this complex mosaic and is trained to maximize inputs at the most opportune moments in the design process.

DFX and its vital LTCO component are not linear processes. The earliest definition of success will be revised several times as new factors arise, priorities are rearranged to accommodate them and stakeholders' comprehension grows. A well-versed project manager knows of this complex mosaic and is trained to maximize inputs at the most opportune moments in the design process, therefore proactively influencing design and minimizing disruption in the overall process.

Experienced project managers are skilled in analyzing trade-offs and driving difficult issues to closure, ensuring an optimal path for the success of your project. They are your single point of accountability for all facets of your project including technical, cost, schedule, quality and customer satisfaction. With a full value stream partner, the project manager continues playing a critical role as the final design transitions into manufacturing.

Working with all supporting stakeholders, the project manager remains the vital link between development and manufacturing until the customer and the manufacturing site team are in agreement that the transition objectives have been met.

Maximizing inputs: The most opportune moments in DFX to achieve LTCO

> Documentation must tell a coherent story of the equipment's development and testing. Future upgrades can be more efficiently addressed when accurate and precise documentation has been prepared from the outset.

Opportunities for LTCO in Design Assurance

Design assurance is regulatory compliance engineering, including the documentation of analog, digital, mechanical and software systems for the purpose of efficacious agency testing and compliance. To ensure reliable, safe and compliant designs, design assurance must begin early in the design phase as the product is classified, considering issues such as:

- What is the product's intended use and what are its essential performance requirements?
- Which component selection and environmental concerns must be considered, as in California propositions or country-specific regulations?
- Will your design assurance team be dedicated to compliance and documentation, or is it an engineer with design assurance duties? If so, product innovators are missing out on a key benefit; that is, design assurance has a special role in melding analog, digital, mechanical and software engineers and ideas into a cohesive effort. They spot gaps and inconsistencies between these disciplines that can compromise functionality or delay agency approvals.

Product documentation must tell a coherent story of the equipment's development and testing. Future upgrades, and even challenges to a product's safety or efficacy, can be more efficiently addressed when accurate and precise documentation has been prepared from the outset. For example, adding a wireless component, an updated display or graphical user interface will be an add-on, not a start-over. Secondly, products with a 15-20 year life cycle will be more readily sustained with valuable documentation, as will the brand of a medical device manufacturer who may be faced with a U.S. Food and Drug Administration (FDA) Form 483 and is in need of admissible credentials.

Design assurance will play a vital role in ensuring that the design is reliable and robust and regulatory compliance is well defined and documented. A complete value stream partner will focus intently on the following design assurance factors and the impact they have on LTCO and time-to-market:

- Component services (environmental compliance) is checked to conform to applicable laws concerning regulated substances. The goal is to limit bill of materials (BOM) changes and the need for re-testing and re-certifications.

Real World Design Assurance

B/E Aerospace, the world's leading manufacturer of aircraft cabin interior products, sought support to manufacture Airbus A350 cabin switch panel assemblies that surpassed the look, feel and operation of traditional toggle switches. When Plexus proposed an I/O-C software driven platform that offered intelligence, recovery and scalability, the team was fully vested in achieving DO-178B compliance for avionics software.

- Plexus, B/E Aerospace, and a jointly engaged third-party quality assurance expert for avionics kicked off the project together with a listing of required equipment specifications.
- Plexus software engineers partnered with manufacturing experts, industrial designers, and the avionics quality assurance expert to program the I/O-C into a manufacturable prototype of the modular switch panel assembly.
- Plexus utilized its capabilities to design both hardware and software for hazards like lightning strikes, flammability, and toxicity and collaborated closely with Airbus laboratories to realistically test for these standards.
- The avionics software compliance review was successful. Careful documentation by the team, structured specifically for DO-178B compliance, addressed up to 255 different switch panel assembly variants.
- The resultant integrated software and hardware assembly is manufactured to order for all Airbus A350 galley switches, extraordinarily achieved in a single product development process.

- Bill of materials (BOM) optimization focuses on achieving dependable low cost alternatives, beneficial vendor relationships and/or preferred partnerships.
- Compliance services via Nationally Recognized Testing Laboratories (NRTLs) is expertise applied to avoid last minute changes, re-testing, re-certification or proposing cost effective mitigations based on proficient knowledge and understanding of certification methods.

Opportunities for LTCO in Electromagnetic Compatibility

Electromagnetic compatibility (EMC) is essential in all product manufacturing and experienced design and manufacturing firms have a toolbox from which to choose solutions. Grounding, metal shielding, reducing susceptibility and reducing emissions techniques can prevent extended product launch delays. Focus is on understanding the energy paths that cause disturbances to the product and those surrounding it, and designing circuit-level mitigations. Prioritize designing for EMC instead of testing for EMC. The former ensures a depth of understanding and lasting compliance.

Prioritize designing for EMC instead of testing for EMC. The former ensures a depth of understanding and lasting compliance.

The opportune time to address EMC requirements is at the design level. Design for EMC is effectively addressed by functional engineers with added responsibility for EMC. Engineers who work across industry sectors can draw on their experience and expertise to:

- Treat EMC requirements like any functional requirement
- Define agency test approaches for all EMC modalities and apply this knowledge to product development (i.e. CE and UL standards)
- Identify potential receivers and transmitters. Minimize emissions and/or their frequency and potential interference from surrounding devices.
- Design mitigation into the first prototype (i.e. space for shields and enclosures)
- Properly route wires in a complex system to minimize EMC issues
- Utilize enclosures and blocking to route cabling harnesses
- Avoid unwieldy solutions that add weight, cost or lessen reliability
- Demonstrate cross-sector innovation, such as tapping expertise in sensitive telecommunications systems to advance the development of medical devices for home use, an environment rife with EMC concerns
- Capitalize on established relationships with regionally close certified labs by involving them during design-level reviews of preliminary electrical architecture design
- Learn how tests are interpreted by certified labs and identify and exploit these shared assumptions

Opportunities for LTCO in Design for Reliability

An electronic device can operate faultlessly until it finds its way into the hands of a user. Therefore, designing for optimum conditions of use is not enough, and reliability engineering addresses conditions of typical use and reasonable misuse. To be clear, reliability is not the same as durability, and Mean Time Between Failure (MTBF) is not a reflection of reliability. MTBF statistics only account for early life random failures, never wear-out. The value of confidence (reliability) testing lies in fewer product recalls, fewer problems in field and significant savings on service and repairs far into the future.

Reliability is uniquely defined by each customer, each project and their definition of success. The goal should be to help customers identify potential and reasonable misuse conditions so the new device withstands generally accepted perils. For example, a cell phone should be designed to withstand being dropped and operated across a wide range of temperatures.

A complete value stream partner will focus intently on the following reliability factors and the impact they have on LTCO and time-to-market:

- Properly designed experiments, including Highly Accelerated Lifetime Testing (HALT), that properly consider variables that cause or correlate to device

Real World Design for Reliability

A major U.S. military contractor contacted Plexus to complete the design and manufacture of a thermal weapons sight (TWS) to enable military rifles and equipment to detect heat. In particular, Plexus was charged with designing electronics which translate infrared energy from a focal plane array sensor chip into a coherent image. The electronics had to be designed for extreme conditions of use, including the perils of combat. It had to be small, powerful, durable in the midst of heat and shock, and impervious to water.

- The stack of printed circuit board assemblies (PCBAs) was particularly dense. It was a high density interconnect (HDI) design that included up to 14 layers of circuits on the four doubled-sided boards. This was achieved without resorting to newer, more expensive chip technologies.
- Using component re-rating analysis, components were designed to operate at no more than 50 percent of capacity to ensure robust operation in the field. Plexus analog tailored the power distribution architecture to maximize the power supply efficiency and battery life.
- Capacitors were oriented and polyester material was specified to minimize the shock wave impact of a 50-caliber long-range sniper rifle.
- The thermal weapons site was designed to operate between -55 and +85 degrees Celsius, from environments commonly found at fighter jet altitude up through host desert conditions.

success or failure

- How to achieve a reliable and robust design without added components, and if this is not possible, how to best realign priorities
- Identifying industry-specific definitions of success. For example, aerospace products are designed to meet reliability, Maintainability and Safety guidelines, medical devices are designed to be safe and effective in both intended use and reasonable misuse conditions, industrial equipment is designed to withstand harsh environments, and wireless/telecommunications projects typically incorporate layers of redundancies.
- Discovering the opportunities for mitigating risk and choosing the most appropriate solution.

> The goal should be to help customers identify potential and reasonable misuse so the new product withstands generally accepted perils.

> Unit cost determinations should be reviewed at nearly every stage of the value stream so that customers can make decisions affecting unit cost earlier, mitigating the risk of going back and starting over if unit cost is too high later on.

Opportunities for LTCO in Design for Unit Cost

Unit cost data is heavily dependent on Total Landed Cost (TLC), or the total price of a product once it has arrived at a buyer's door, including the original price of the product, all transportation fees, customs, duties, taxes, insurance, currency conversion, crating, handling and payment fees.

An expert in reducing landed cost, and thus unit cost, will quote TLC from the earliest versions of the design through the life of the product based on preliminary labor, test and materials costs. These reiterations allow multiple consultations with the customer over trade-offs like features, design elements and tooling options. Unit cost determinations should be reviewed at nearly every stage of the value stream (conceptualization, design, commercialization, manufacturing, fulfillment and sustaining services) so that customers can make decisions affecting unit cost earlier, mitigating the risk of going back and starting over if unit cost is too high later on. The result is a faster product launch with a more confident and knowledgeable customer, one who is a true partner in device design and origination.

There are advantages to working with a design and manufacturing firm when it comes to designing for unit cost, because quotes are a direct result of their real-time partnership between engineering and manufacturing. Unit cost is therefore determined based on actual experience.

Opportunities for LTCO in Design for Serviceability

LTCO is by definition a transparent and comprehensive accounting of a product's complete life cycle. The ability (or inability) to efficiently service a high-tech product is a critical measure within LTCO. When the costs of service, repair and refurbishment are not accurately and precisely captured, they are often recorded as a warranty expense when in fact, they should be traced to their root design cause.

Numerous serviceability factors must be addressed in the product design phase to optimize LTCO, including:

- How a product is accessed in an environment from the point of view of a service person. Is this person a direct hire of the original product manufacturer or is this person a third party service provider?
- Location and ease of removal of access door(s)
- Defined Field Replacement Unit (FRU) strategy including ease of access removal, ease of replacement and consideration for hot swapability
- Can the device be brought to a depot for service?
- Design/layout of service manuals
- Use of self-locating features
- Use of self-fastening features

Real World Design for Reliability

A leader in defense electronics with distinctive strength in airborne mission-critical systems asked Plexus to develop and manufacture two separate electronic control modules for a new AESA radar system. The main control interface would facilitate communication with the aircraft's pilot-controlled electronics, and the front-end controller module was to emit electrical timing reference signals and manage the clock distribution for the antenna system within the radar. Both modules were part of an upgrade to replace a much more mechanical radar system that was less reliable.

Design for reliability was a top priority. The modules had to be suitable for use in a military jet fighter where space and weight is a major consideration and be able to cope with environmental extremes of temperature, vibration, and sudden shock from gunfire. Both units had to be compact, lightweight, and electromagnetically shielded to minimize noise amidst radar signals. Once integrated into the avionics of the plane, the boards would deliver high resolution radar at medium and long range. The Plexus team used the following techniques to maximize reliability:

- Component materials were carefully selected, including the consideration of thermal expansion properties and tin whisker growth. Tin whisker growth was further mitigated through careful PCB layout in relation to adjacent metal materials and with the addition of conformal coating.
- De-rating guidelines submitted by the customer were met against component specifications for voltage, power, frequency and thermal properties.
- Lightweight and reliable thermal relief techniques were used, including selective conduction cooling to a cool wall.
- Thermal analysis identified hot spots and drove revised PCB layout for the thermal relief and component de-rating.
- Mean Time Between Failures (MTBF) was calculated to military standard MIL-HDBK-217B.
- Failure Mode and Effects Analysis (FMEA) identified areas of reliability risk, leading to the design of protective circuits against threats like lightning strikes.
- Signal integrity optimization of critical high speed signals and slowing edges of certain signals reduced the noise in the radar antenna, improving the reliability of the critical reference clock distribution.
- Modules were manufactured to an IPC Class 3 standard using a SnPb process, with additional processes, such as conformal coating; edge sealing and corner bonding of ball grid arrays (BGAs); and reballing and hot solder dipping of components for tin whisker growth mitigation.
- Environmental Stress Screening (ESS) was successfully carried out by the customer to give confidence in the reliability, after which flight trials were successfully completed.

- Placement of cables and connectors
- Power kill points including Electrostatic Discharge (ESD) concerns
- Board level diagnostics and test points
- Error logging and usage tracking
- Remote software diagnostics and upgradeability

Full value stream companies understand the need for customization of sustaining and aftermarket services based on customer preference and end-user convenience. Product innovators should seek an aftermarket service model that best meets these needs based on three general models:

1. Region of use repair– when lower logistical costs outweigh the labor savings of sending a product to its point of manufacture for service. The product is repaired in the region in which it is used.
2. Like product, like repair– a product is sent to a well-vetted facility that repairs similar

> Product innovators must be encouraged to stray from the script in commoditizing their product and find a partner who will analyze and get creative in crafting fulfillment solutions.

products, even if that facility does not actually manufacture the product in need of repair. The inherent benefit is a maturity curve that is achieved through working with products of similar operation and components.

3. Point of manufacture repair– when a repair house is not warranted or a regional test repair line is not economical and a product can be inexpensively shipped back to the manufacturer.

The drain of service issues can extend beyond current product offerings to inhibit future prospects. When resources must be deployed to address existing problems, research and development into new opportunities is curtailed or halted. Developers who wish to participate in new markets should take care to choose a value stream partner with experience in global serviceability standards.

Working with a full value stream partner means you will benefit from their engineers who can help upgrade or sustain a product's useful life in the marketplace with regional requirements input, while the manufacturing division has the ability to knowledgeably refurbish them.

Opportunities for LTCO in Fulfillment

The process for shipping products to end-users possesses nearly as much opportunity for customer satisfaction as the product itself. Shipping cost, timing and responsiveness are all important factors in the introduction of a finely crafted invention. Product innovators must be encouraged to stray from the script in commoditizing their product and find a partner who will analyze and get creative in crafting fulfillment solutions. The alternative would be to ignore real costs associated with LTCO or ignore the logistical risks, let them happen and fight it out later.

From the beginning of the design process, where these issues can be addressed most effectively, be prepared to discuss the market sector characteristics with your fulfillment provider. Topics should include:

- The impact of sector-specific requirements on fulfillment options. High-volume, low-tech production varies significantly in scope from low-volume, high-tech products.
- Consideration of reshoring, where the product is manufactured within 12 hours of its end-use customer. Shipping by ground, not air saves costs and may involve a trade-off for higher labor costs.
- How is your design and manufacturing value stream partner configured to produce your product most efficiently? Seek out a flexible and agile partner if you need high-tech and mid-to-low volumes. Other companies are configured for higher volumes of less complex or variable products.

To achieve the goal of LTCO, seek out a full value stream partner who can help realize:

- Quicker time-to-market
- Optimized shipping costs

- Mitigation of risks through transparency of duties and taxes
- Volume/size/weight implications
- Ideal mode of transport
- Optimum date of transit
- Reduced inventory carrying costs
- Importer of Record (IOR) expertise

Direct Order Fulfillment (DOF) is an excellent alternative to third-party warehousing and distribution. Benefits include:

- Significantly more rapid delivery and time-to-market. Whereas a warehousing distribution method could take up to 16 weeks for delivery, DOF takes an average of five days from factory to end user.
- A third party logistics company is not predisposed to finding faster, cheaper and more direct methods of transport, whereas a full value stream partner has a unique perspective for discovering these opportunities.

Strengthening your LTCO procurement practices

Designing and manufacturing for LTCO requires commitment, deep thought, a willingness to accept suggestions and critique and confidence in one's total value stream partner.

Be a Good LTCO Customer

Not every product innovator is prepared to invest in designing and manufacturing for LTCO. Such effort requires commitment, deep thought, a willingness to accept suggestions and critique and confidence in one's total value stream partner. Time taken in the concept convergence phase will result in confidence in the product's design, performance and life cycle. You will know the supply chain is sound, the design is reliable and robust, regulatory compliance is well defined and documented and knowledgeable engineering support is proactively deployed to resolve issues that would interrupt manufacturing. Ask the following questions of yourself and your team before pursuing a genuine LTCO partner for your next product innovation and consider whether your organization values these traits.

1. Do you possess the philosophy and commitment to positively influence your designs? To achieve success, you must do the right thing at the right time within critical time slots. Customers who display a lack of commitment miss a finite window of opportunity to influence design.
2. Is it within your company culture to take a thoughtful approach to each step of the design phase to achieve LTCO?

Prepare to avoid problems that will harm DFX, and thus LTCO, including:

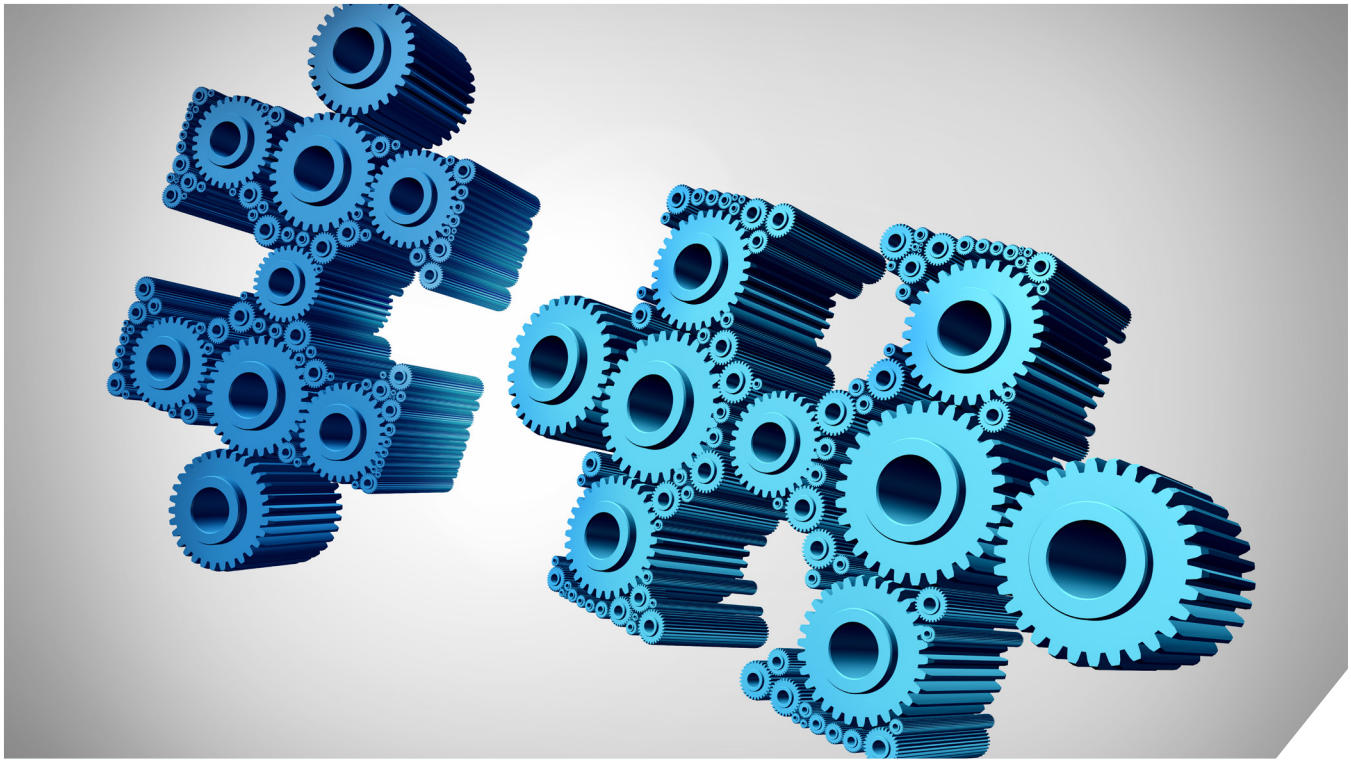
- Decisions made with narrow view, without a long-term view of the ripple effect, and their effect on downstream issues.
- Push back, and questions like "Why do I have to pay for DFX?" You should seek to realize the cost avoidance achieved through genuine DFX. It is difficult to quantify cost avoidance because it is intangible by nature but look at historical data and extrapolate your savings potential. Do your best work.
- Skepticism that DFX slows down the design process, when in fact it ensures timely and successful product launch with fewer performance and life cycle issues down the road.
- Rewarding employee success only by measuring "now" costs, not future/total costs, because an organization only understands cost reduction, not cost avoidance.
- DFX in the eleventh hour are changes made only for show-stoppers. Customers who understand the value and cadence of DFX do it early. Reacting instead of collaborating on the full process of DFX.

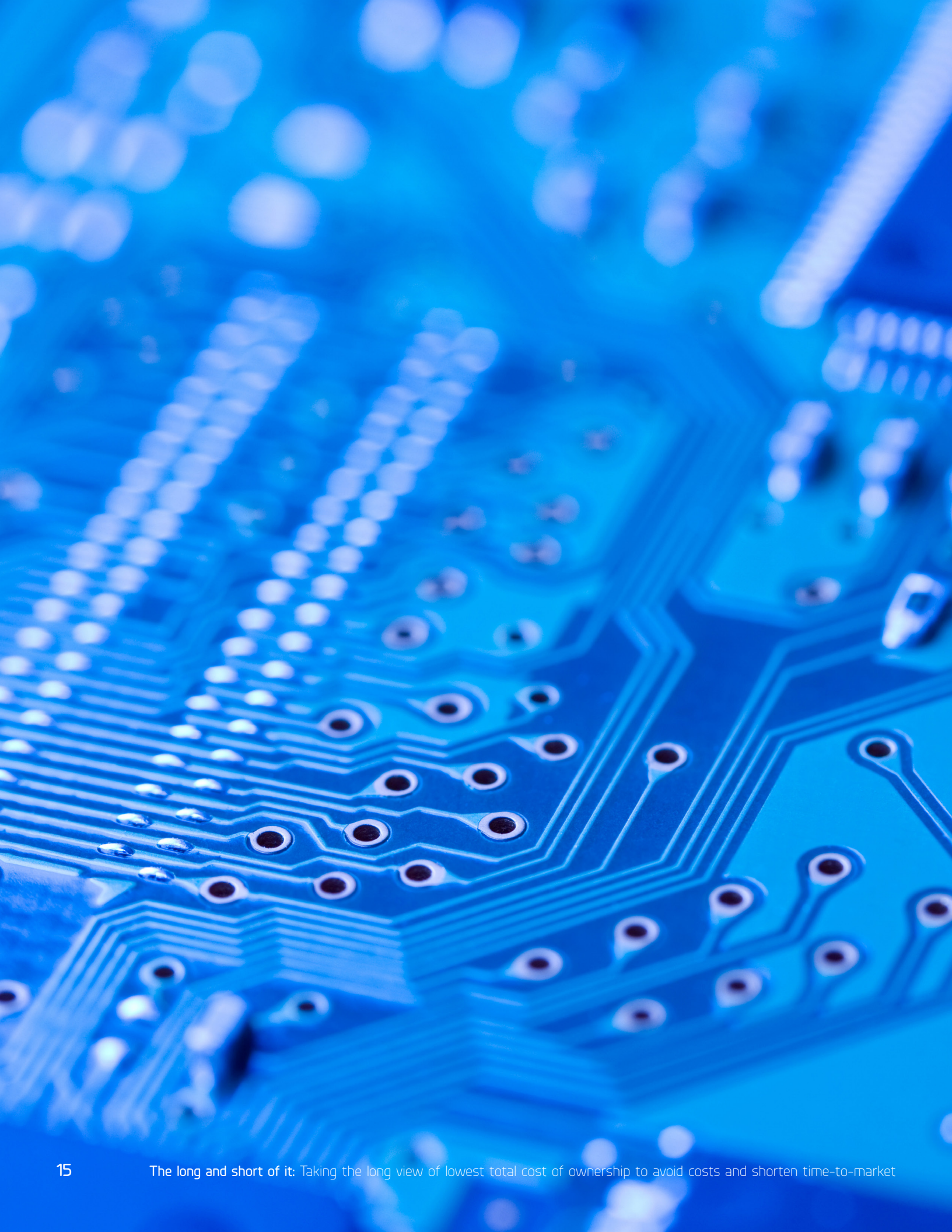
Find a Strong LTCO Partner

Ask these questions of a full value stream partner to ensure their DFX and thus, LTCO competency:

- Does the company own the analysis tools for each step of DFX?
- Does the partner have dedicated experts in DFX, not just staff with DFX responsibilities?
- Are the functional engineers working across market sectors to discover synergies between product designs?
- Are you getting sector-specific expertise that recognizes appropriate success indicators and the predictable useful life of the product?
- Are functional engineers working in small groups on individual product components to facilitate time-to-market? Consider four teams of 12 engineers, each on their own product component versus 50 engineers working on one large project. Small teams can generate and vet cross-pollinated ideas quicker, decreasing cost and shortening time-to-market.
- Are you going to receive regular, frequent updates on unit cost throughout all design phases?
- Does the company have a vested interest in getting your product to market? Full Product Realization Value Stream companies have the benefit of both design and manufacturing services and value equally both phases of development.

Plexus Corp. 2015





Contributors

Aaron Berken
Functional/Project Manager
Plexus Corp.
aaron.berken@plexus.com

Brian Ballweg
Principal Engineer
Plexus Corp.
brian.ballweg@plexus.com

Calum Fraser
Software Engineer II
Plexus Corp.
calum.fraser@plexus.com

Dale Lee
Process Engineer
Plexus Corp.
dale.lee@plexus.com

Douglas McGregor
Functional/Project Manager
Plexus Corp.
douglas.mcgregor@plexus.com

Jason Anderson
Sr. Engineering Project Manager
Plexus Corp.
jason.anderson@plexus.com

Jeffrey Newhouse
Sr. Quality Engineer
Plexus Corp.
jeffrey.newhouse@plexus.com

Jerry Hanson
Director of Engineering Solutions
Plexus Corp.
jerry.hanson@plexus.com

John Simpson
Sr. Engineering Project Manager
Plexus Corp.
john.simpson@plexus.com

Jon Gayhart
Functional/Project Manager
Plexus Corp.
jon.gayhart@plexus.com

Martin Schleicher
Manager of Engineering Solutions
Plexus Corp.
martin.schleicher@plexus.com

Michael Febo
Manager of Engineering Solutions
Plexus Corp.
michael.febo@plexus.com

Michael Orrico
Manager of Engineering Solutions
Plexus Corp.
michael.orrico@plexus.com

Michael Schmitt
Principal Engineer
Plexus Corp.
michael.schmitt@plexus.com

Mike Collins
Manager of Engineering Solutions
Plexus Corp.
mike.collins@plexus.com

Mike Hale
Manager of Engineering Solutions
Plexus Corp.
mike.hale@plexus.com

Paul Cahill
Functional/Project Manager
Plexus Corp.
paul.cahill@plexus.com

Steven Alsbro
Director of Global Logistics
Plexus Corp.
steven.alsbro@plexus.com

Thomas Ray
Manager of Engineering Solutions
Plexus Corp.
thomas.ray@plexus.com

Tom Radle
Staff Hardware Design Engineer
Plexus Corp.
tom.radle@plexus.com

William Sobkowicz
Manager of Engineering Solutions
Plexus Corp.
william.sobkowicz@plexus.com

AMERICAS
+1 877 733 7260

EUROPE
+44 (0)1506 637 997

ASIA PACIFIC
+604 632 5252

PLEXUS.COM

©2017 PLEXUS CORP. | Plexus and the Plexus logo are registered trademarks of Plexus Corp., Neenah, WI, USA. | APR 2015

Publication date: APR 2015