From Concept to Design to Production
Integration of the DFMA Software in the LeCroy Design path

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Introduction:

LeCroy has been manufacturing Digital Sampling devices for over 40 years. For the longest time, ready-made enclosures were purchased to build the products. Although heavy design emphasis is put on the circuit assemblies, the oscilloscope is also a mechanical assembly.

As we moved forward, injection molded mechanical parts were used and then at a later point in the evolution of our product line, sheet metal replaced plastic parts in the structure. DFMA was never part of the design of any of the past systems.

A change in strategy and mentality were required to rethink how things were designed in order to improve costs of manufacturing and reduce cost in general. At a previous employer, one of our team members was exposed to the Boothroyd and Dewhurst (BDI) SW and philosophy. We took a look at the software and decided that DFMA could provide a benefit in our situation. We investigated further and attended our first DFMA conference in June 2005. We were energized to move forward and decided to apply this philosophy to our next platform designs. In several training sessions our manufacturing engineers, design engineers and product management functions were introduced to the BDI DFMA software and principles.

The introduction of the BDI DFMA software allowed LeCroy to get a head start on new techniques and innovative ideas to realize products with reduced costs and ease of assembly. This process facilitated and improved the very important cross-functional collaboration early in the design process where cost can still be influenced.

The first project for which the BDI DFMA software was used is code named “Eagle” project. We will discuss the steps taken from concept to realization on this project using the BDI tools.

Concept Phase:

During this phase, we defined the requirements and formulated them in form of design specifications for the new product.

Key requirements were:

- Overall form factor (ex. Large display, 19 inch rack mount compatible)
- Overall weight (bench top adapted)
- Material to be used for the chassis (availability, weight, cost, EMI)
- Cooling requirements (airflow, capacity, noise level)
- EMI requirement (Electromagnetic Interference, special shielding)
- RoHS/WEEE requirements (Environmentally compliant)
- Manufacturability (quality, cost, vendor selection flexibility)
- Serviceability (dis-assembly, re-assembly operation sequence)

The last two requirements were very difficult to quantify. Until now, there were very limited formal procedures in place to provide feedback on manufacturing and assembly issues, quality and serviceability issues observed from the field into new designs.

Comparison to a base line:

We used a current product designed without explicit use of the DFMA tool as a base line. The internal mechanical enclosure (chassis) is an assembly of different sheet metal parts, riveted together. This design does constrain physical access during subsequent higher level assembly operations of the electronic oscilloscope sub assemblies. (see Figure 1)

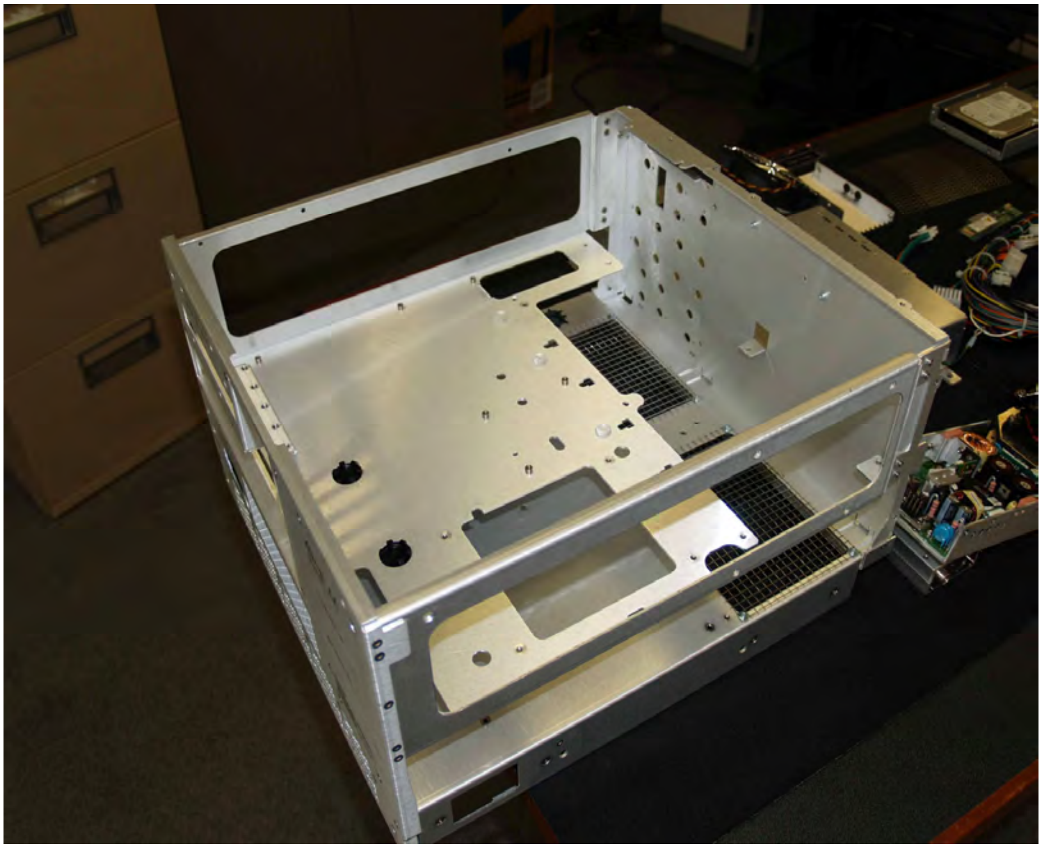

Figure 1: Oscilloscope Enclosure

The PC peripheral components and dedicated interface boards make up our Top Box sub assembly. The part count of 194 piece parts is broken down into:

Cables in the top box assembly: 23
Fasteners: 103 (7 different types)
Other parts that compose the top box assembly: 68

These are shown in Figure 2.

Figure 2: Top Box piece parts

The model tells us that the DFA index for our Top Box is 3.4.

Using this feedback and putting the requirements together, the DFMA team who attended training sessions at BDI in Rhode Island got together and started to work on a totally new design with a new perspective.

Design Phase:

After going through our concept phase and re-affirming that we wanted to reduce the number of parts, fasteners and cables, we started our DFM/DFA sessions.

The Mechanical Design Team comprised of the Mechanical Engineers, Sr. Manufacturing Engineers and Lead Project Engineer met on a weekly basis to come up with ideas and review them using the DFMA tool. Many new ideas stemmed from these sessions and everyone was very enthusiastic about the achievements made from these meetings.

The DFM/DFA tool was of great help as we could objectively measure in real time the effects of small changes such as the type of fasteners. It helped us re-think on how we designed the enclosures and how to reduce the count of parts, cables and fasteners. Manufacturability and serviceability were greatly improved during this design phase.

Results of the DFM/DFA study show that:

- By making the right decisions we could reduce the number of parts.
- We could design a system that was easy to phase into production and that would be easier to assemble.
- This resulted in a system that is easier to service.
- The sheet metal parts manufacturing costs were reduced.
- Several of these concepts can be used in future design projects.

New Design: The chassis is now comprised of 3 separate sheet metal parts. The total Top Box piece part count is reduced from 194 to 67 (see Figure 3).

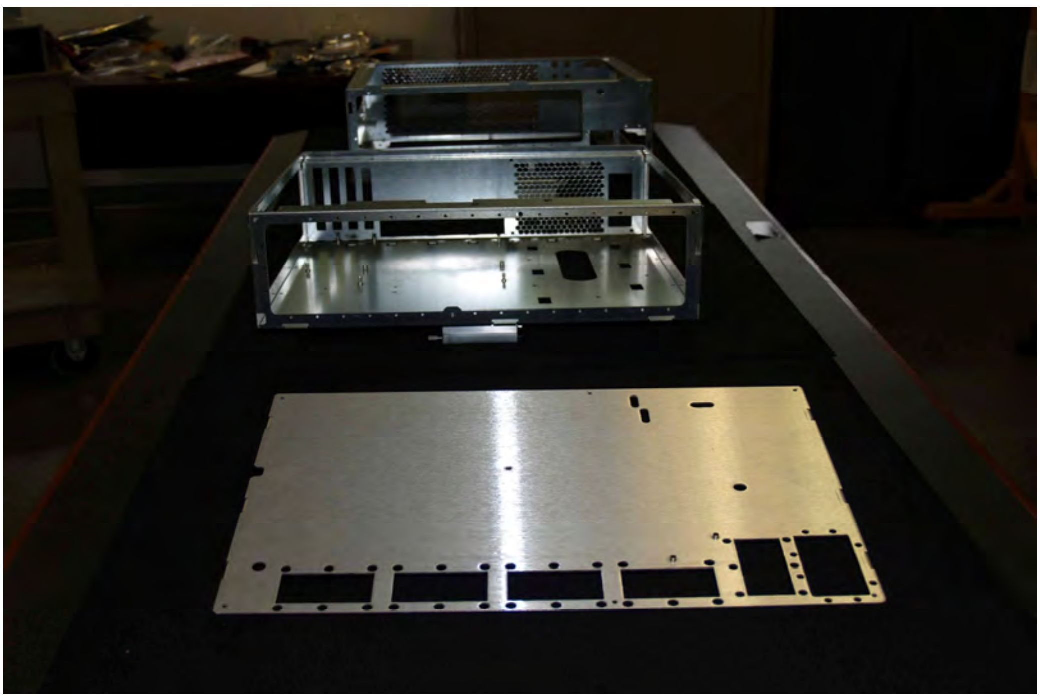

Figure 3: New Top Box prototype after DFMA Study

Reduced part count from 68 to 22, cable count went from to 23 to 1 cable plus 2 other cable harnesses (USB cables and Video Cables), the count dropped from 103 to 42 (see Figure 4).

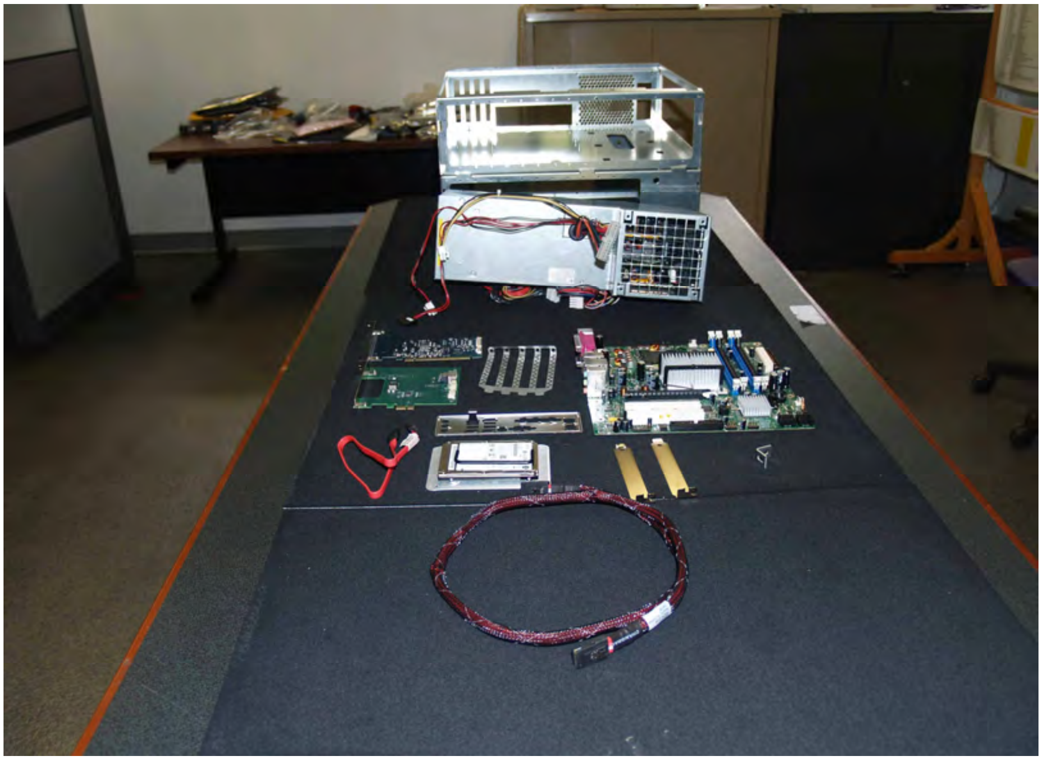

Figure 4: New Top Box piece parts

This new concept/design allowed us to reduce the amount of cables by replacing them by harnesses. Another advantage of this design is that harnesses reduce multiple single cable attachments.

With all of these changes, the DFA index of the new design has increased from 3.4 to 23.3 for the Top Box assembly. For a visual comparison refer to Figure 5 and Figure 6.

Key Improvements:

- We can clearly notice that the wiring is better routed in the new design.
- All components are easily accessible.
- Removing and re-installing components is facilitated in all aspects.

This new "Top Box" is designed to slide onto the "Lower Box" and is guided by features in the metal work. Because we could see the DFA index change in a real time, we could make the best decisions to improve the overall design of the product. This is something that couldn't be done without this valuable tool.

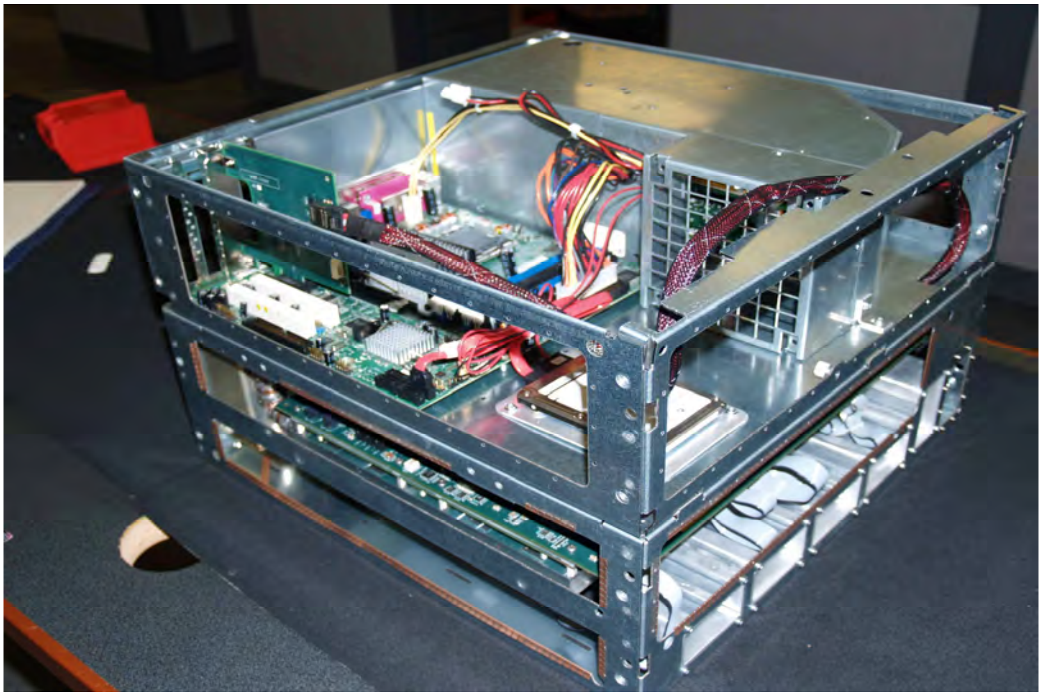

Figure 5: New Top Box Assembly (DFA index 23.3)

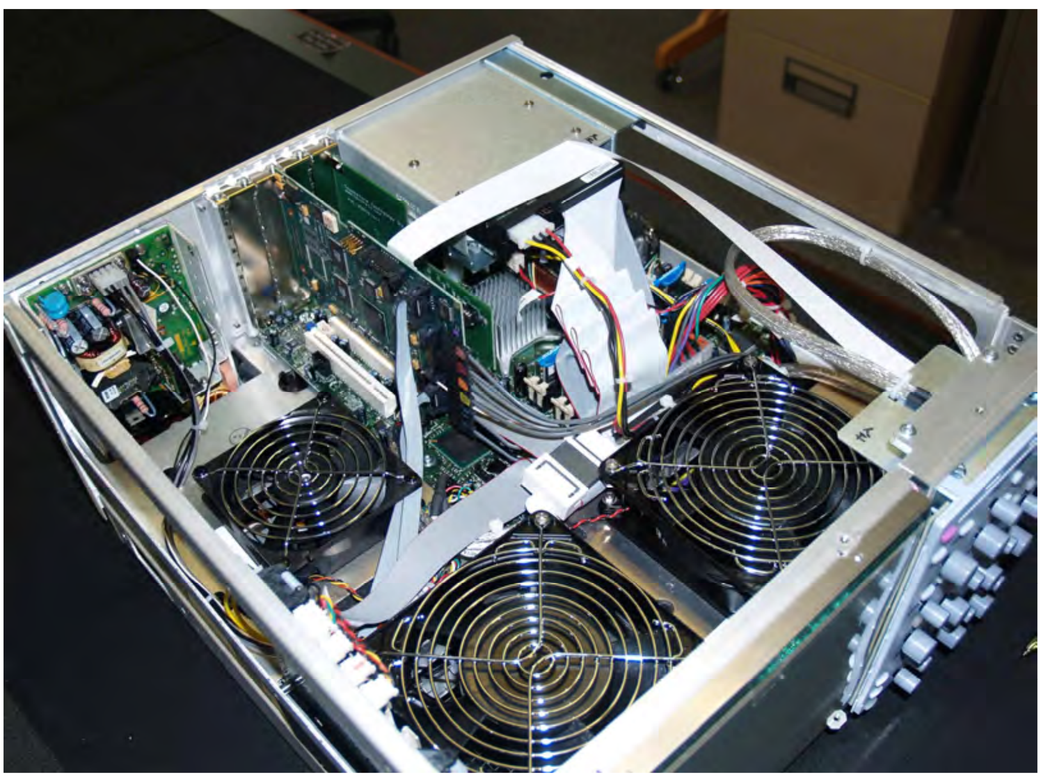

Figure 6: Old Top Box Assembly (DFA index 3.4)

Further reduction of fasteners was achieved through a revised method of interconnecting sheet metal piece parts. An example is shown in Figure 7 and Figure 8 for slots and finger interconnect system.

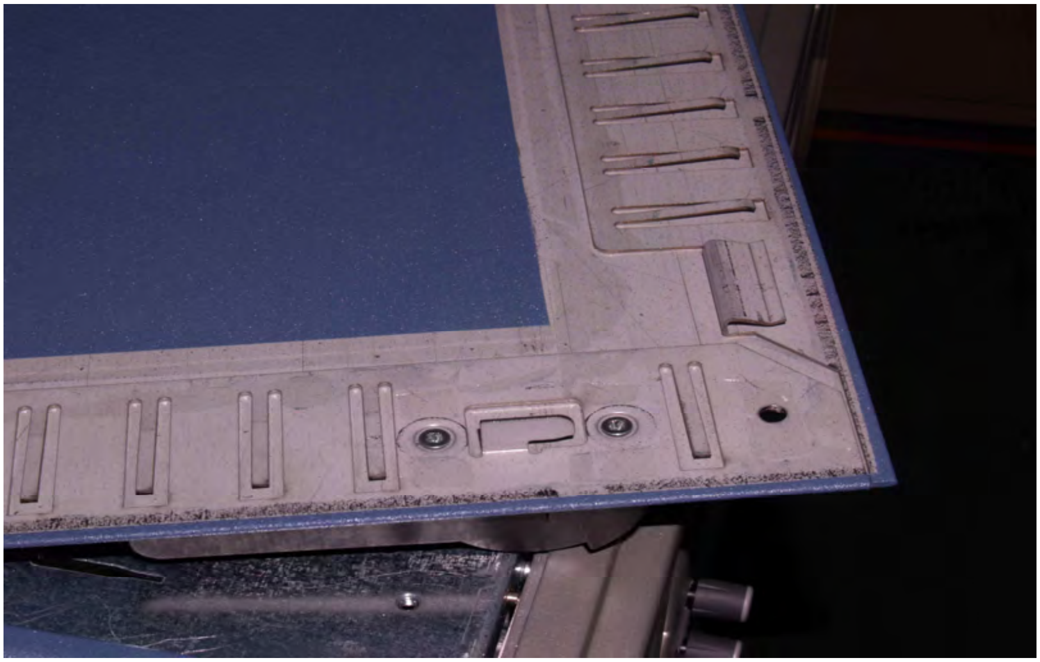

Figure 7: Lower Cover with fingers

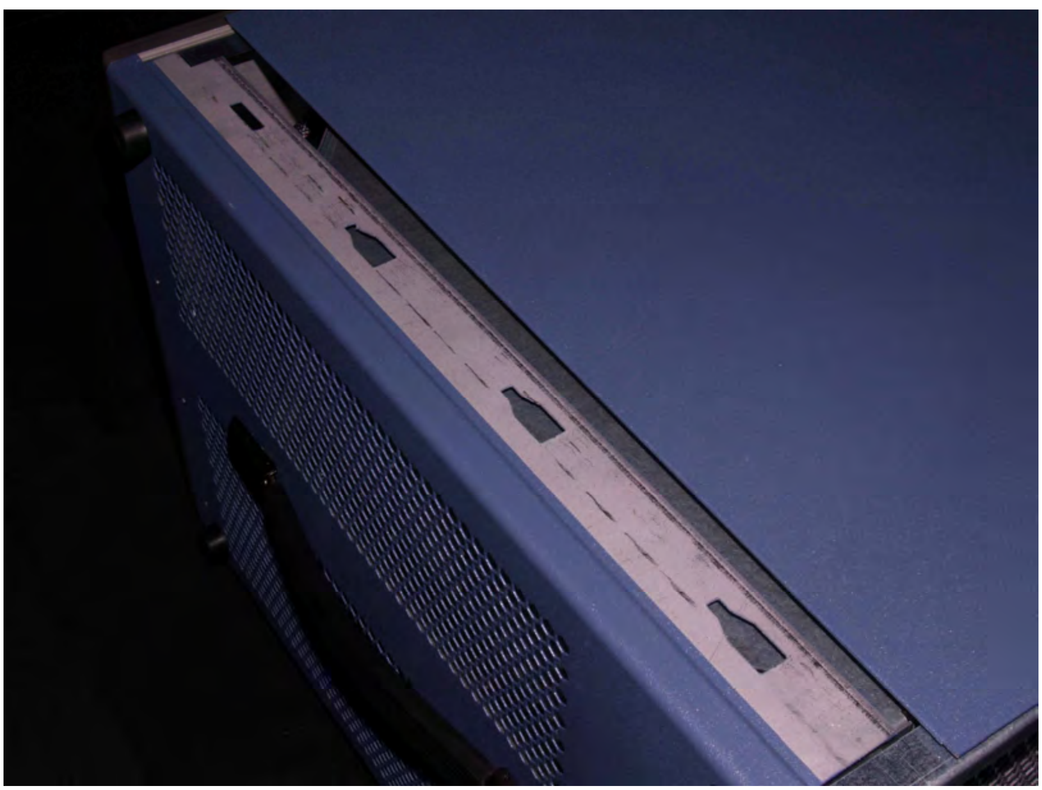

Figure 8: Side Panel with interconnecting slots

Table 1: Comparison of Piece Part Count and DFA indices

	Parts	Cables	Fasteners	DFA Index
Current Design	68	23	103	3.4
New Design	22	3	42	23.3

Conclusion:

Application of DFMA principles is a key to the successful realization of competitive product offerings. It provides a method and a focal point for the cross functional design team to meet aggressive cost and innovation goals. This process requires thinking ‘out of the box’ and leads to new ideas that could differentiate the product.

The earlier the DFMA tool is applied in the NPD process, the better the cost can be controlled and the more innovative solutions can be discovered and implemented.

In our case, analyzing the current generation of products has brought LeCroy a new way of thinking and designing products. We have found ways to both improve manufacturability and keep cost within target range. As LeCroy continues to develop and design new products, the DFMA software will be one of the most valuable tools in the cross functional design teams.

About the authors of this document:

Pamela J. Wiseman is currently the Vice President of Worldwide Operations for LeCroy Corporation; the corporate headquarters is located in Chestnut Ridge, NY. LeCroy Corporation, a public company listed on the NASDAQ (LCRY) designs, distributes and manufactures a broad range of Digital Storage Oscilloscopes and other test equipment worldwide. Pam has held positions in Engineering, Sales and Operations at several high tech companies over the past 19 years. Pam worked at AT&T Bell Laboratories in Whippany, NJ and The MITRE Corporation in Bedford, MA both as a Member of the Technical Staff. She also held various management positions at United Technologies Sikorsky Aircraft in Stratford, CT supporting the manufacture of helicopters. More recently, Pam held management positions at Dover Corporation's Universal Instruments Corporation in Binghamton, NY managing Manufacturing Operations and Field Service Operations related to automated Printed Circuit Board assembly equipment. Pam graduated from Brown University with a Sc.B. in Geology/Physics/Mathematics. She also holds an MSEE from the University of Rhode Island and an MBA from the University of Chicago Graduate School of Business.

Jörg Richstein joined LeCroy in Sept 1989 as a Manufacturing Engineer in the European Headquarters in Geneva, Switzerland. Subsequently, his role extended into Manufacturing Management. In 1999 he transferred into the Corporate Headquarters located in Chestnut Ridge, NY. There he served in positions as Sr. Manufacturing Engineer, Factory Service Manager and later Micro Circuit Manufacturing Manager. As Director of New Product Process Development he assumes dedicated NPI responsibilities from conceptual design to production ramp-up in various manufacturing locations. He also manages the Manufacturing Engineering and Factory Service Teams.

He is a member of SME, has participated in APICS training and holds a PhD in High Energy Particle Physics from the University of Dortmund, Germany.

Toni Inserra joined LeCroy in 1995 as a Service Engineer in the European headquarters in Geneva, Switzerland. In 1998 he transferred to the Tokyo, Japan division of LeCroy as a Senior Service Engineer and as an ISO 9001 coordinator. In 2004 he transferred to the corporate headquarters located in Chestnut Ridge, NY. There he has joined the Manufacturing Engineering department in the Operations group. With the introduction of the BDI DFMA software he has taken a leading role to work with the Design team for all projects designed and built in NY.

He is a member of SME and AIG (Geneva Engineers Association, Geneva, Switzerland)