

Case Study: Incorporating Toxics Use Reduction into Lean Manufacturing and Six Sigma at Ophir Optics

1. Overview

Ophir Optics designs and produces a full range of high performance Infra-red (IR) optical lenses and elements. Its products are used in electro-optical systems for military, homeland security, commercial and industrial applications, ranging from Night Vision equipment to industrial metal processing. Ophir Optics has successfully utilized Lean Manufacturing and Six Sigma tools and methodologies for a variety of projects, including toxics use reduction, at their manufacturing facility located in North Andover, Massachusetts. **As a result of this work, Ophir has reduced its use of toxic chemicals and generation of hazardous waste, and increased the energy efficiency of its manufacturing operations.**

Ophir's 40,000 ft² facility can produce large quantities of optics quickly and cost-effectively. All manufacturing is done in-house, using automated machining with precision diamond cutting; spherical, aspherical and diffractive optical components; mirrors and metallic optics. Because the company has been expanding production, it anticipated being faced with increased management costs associated with environmental byproducts, and planned proactive measures to address them.



35mm f/1.4 athermalized lens



15-300mm, f/4 continuous zoom cooled lens

2. Implementation of Lean Manufacturing and Six Sigma at Ophir Optics

Ophir started their journey towards a more sustainable operation in early 2009 when it conducted internal training and implemented continuous flow in its manufacturing areas. This process was accelerated in 2010 when Ophir received a work force training grant from the Commonwealth of Massachusetts to undertake training in Lean Manufacturing, Six Sigma, and management methodologies designed to create a more efficient overall manufacturing process. Ophir teamed with a non-profit Lean Manufacturing consulting organization, Greater Boston Manufacturing Partnership (GBMP), to provide the training.

Lean Production

A method of eliminating waste through employee involvement

During this same time period, Ophir contacted the Massachusetts Office of Technical Assistance (OTA) for ideas and assistance in reducing its generation of hazardous waste. OTA engineers evaluated the processes that use toxic chemicals and create hazardous waste, and provided a number of suggestions for reducing toxics use and hazardous waste generation. Based on OTA's recommendations Ophir embarked on a series of continuous improvement projects, using the Six Sigma process where appropriate.

The basic concept of Six Sigma is that processes have characteristics that can be measured, analyzed, improved and controlled. The Six Sigma approach is implemented through a group effort that motivates commitment from the entire organization to achieve sustained quality improvement.

Six Sigma
An approach to improving the quality of production by identifying and removing the causes of defects (errors) and increasing standardization in business processes

Ophir used Six Sigma tools to implement a suggestion by OTA that it could decrease the use and emissions of mineral spirits, a toxic and volatile organic compound (VOC) used as a coolant in their diamond turning manufacturing process. Anticipating an increase in production, Ophir was concerned about increased costs associated with compliance with air emissions regulations. Ophir evaluated the technical performance of three alternative coolants identified with OTA's assistance. Ophir investigated nonvolatile water-based coolants and determined that substitution could provide higher quality results, but Ophir would need to fully design a fluid capture and solids removal system to implement the change. Therefore, as a short term solution, Ophir investigated methods for increasing the efficiency of its use of volatile organic compounds in the diamond cutting process.

Ophir reduced VOCs by 70%, saving \$15,000 annually

After closely monitoring the use of mineral spirits at each machine and measuring product quality, Ophir determined that even with significant reductions in the use of mineral spirit there was no diminution in lens functioning. The careful identification

of key factors and measurement and control of operating parameters that is a hallmark of the Six Sigma process brought about even further reductions in mineral spirit usage in the machines with the lowest use rates. Each cutting machine operator was then instructed to set the flow controls for delivery of mineral spirits to the cutting site within a tight set of application parameters.

Mineral spirit consumption had increased along with production from 2008 to 2009. However, even though production held steady in 2010, with the implementation of these changes, Ophir was able to reduce its mineral spirit consumption by 3,872 pounds (70%). The total estimated annual savings for the VOC project is \$15,000. In addition, the careful measurement and evaluation of the diamond turning process has enhanced overall production quality, with fewer adjustments necessary during production. Ophir will also save on time and air permitting costs by avoiding the increase in emissions.

In addition to the VOC reduction project, Ophir also looked into OTA's recommendation that, as good general practice, processes should be redesigned to avoid mixing together germanium and selenium waste streams. Implementing this suggestion was not difficult for Ophir, and during 2010 the facility reduced the quantity of hazardous waste shipped by about two-thirds. Whereas during the first half of the year the company was a large quantity generator of hazardous waste (the threshold is one thousand kilograms per month), during the second half of the year Ophir was able to reclassify itself as a small quantity hazardous waste generator, with shipments

well below 1,000 kilograms of hazardous waste per month. Associated training, hazardous waste management and reporting requirements were also reduced.

Other Lean Manufacturing and Six Sigma projects implemented at the facility that have made Ophir's production process more efficient include:

- Cellular Layout of Ophir's lens fabrication which facilitated the switch from batch manufacturing to continuous flow production. This reduced work in process inventory, labor, and overall lead time to produce the product.
- Total Productive Maintenance (TPM) in several departments, including daily checks of equipment and visuals which allow operators to easily confirm that equipment is within proper operating parameters.
- 5S methods (sort, straighten, shine, standardize, and sustain) throughout the plant. This is a method of organization that reduces wastes such as searching for tools. Supplies and tools are now stored at point of use and organized in a standardized way that facilitates operator/technician use.
- Recognition programs to motivate participation by employees including both team rewards and individual employee awards. For example, teams were recognized in a variety of ways including plaques, gift cards, and shirts.
- Standardized work projects, which help balance the production flow and eliminate waste and manufacturing bottlenecks.
- Scrap reduction projects utilizing the Six Sigma process DMAIC (Define, Measure, Analyze, Improve, and Control).



3. Results Achieved

The results achieved by Ophir Optics' implementation of Lean Manufacturing and Six Sigma improvement projects include:

More than
\$1,000,000 in
efficiency
improvements
achieved

- More than **\$1,000,000** in efficiency improvements was achieved from implementing Lean Manufacturing and Six Sigma projects. The majority of this was achieved through the implementation of continuous flow cells and standardized work.
- Ophir also achieved more than **\$100,000** in projected scrap reductions from Six Sigma projects.

- Savings associated with hazardous waste reductions in excess of **\$60,000**.
- Less facility space (saved 1400 ft²) and capital equipment required, also better manufacturing throughput with a fixed amount of resources.
- An overall reduction of **70%** in the time to manufacture lens elements.
- New business opportunities generated through reduced cost and new products. Ophir was able to offer products at lower cost and designed new coatings using the Six Sigma process.

Ophir is continuing with research and experimentation with water based coolant alternatives, with the goal of complete elimination of mineral spirits.

4. Summary

Ophir has been very successful in using Lean Manufacturing and Six Sigma techniques to reduce their use of resources such as facility space, production equipment, and energy. In addition, Ophir's implementation of continuous improvement projects has been successful in reducing Ophir's hazardous waste. Ophir also used Six Sigma to pursue OTA's recommendation to reduce use of VOCs (mineral spirits) while improving an already well controlled production process.

In conclusion, the application of Lean Manufacturing and Six Sigma strategies and tools has facilitated many "green" initiatives, including toxics use reduction and resource conservation, in a manner that is consistent with other Ophir business goals including quality, cost, and delivery.

To learn more about the products of Ophir Optics, LLC or to discuss how your facility might be able to implement similar techniques to maximize your toxics use reduction potential, contact Tim Petter, Production Manager, at 978-657-6410 or Tim.Petter@ophiroptics.com

For more information about the Toxics Use Reduction Institute Cleaner Technology Demonstration Site Matching Grants, contact Pam Eliason, Industry Research Program Manger, at 978-934-3142 or pam@turi.org, or Greg Morose, Research Manager, at 978-934-2954 or Gregory_Morose@uml.edu

For more information about the on-site confidential technical assistance services provided by OTA, contact Bill McGowan, Technical Services Chief, at 617-626-1078 or william.mcgowan@state.ma.us

