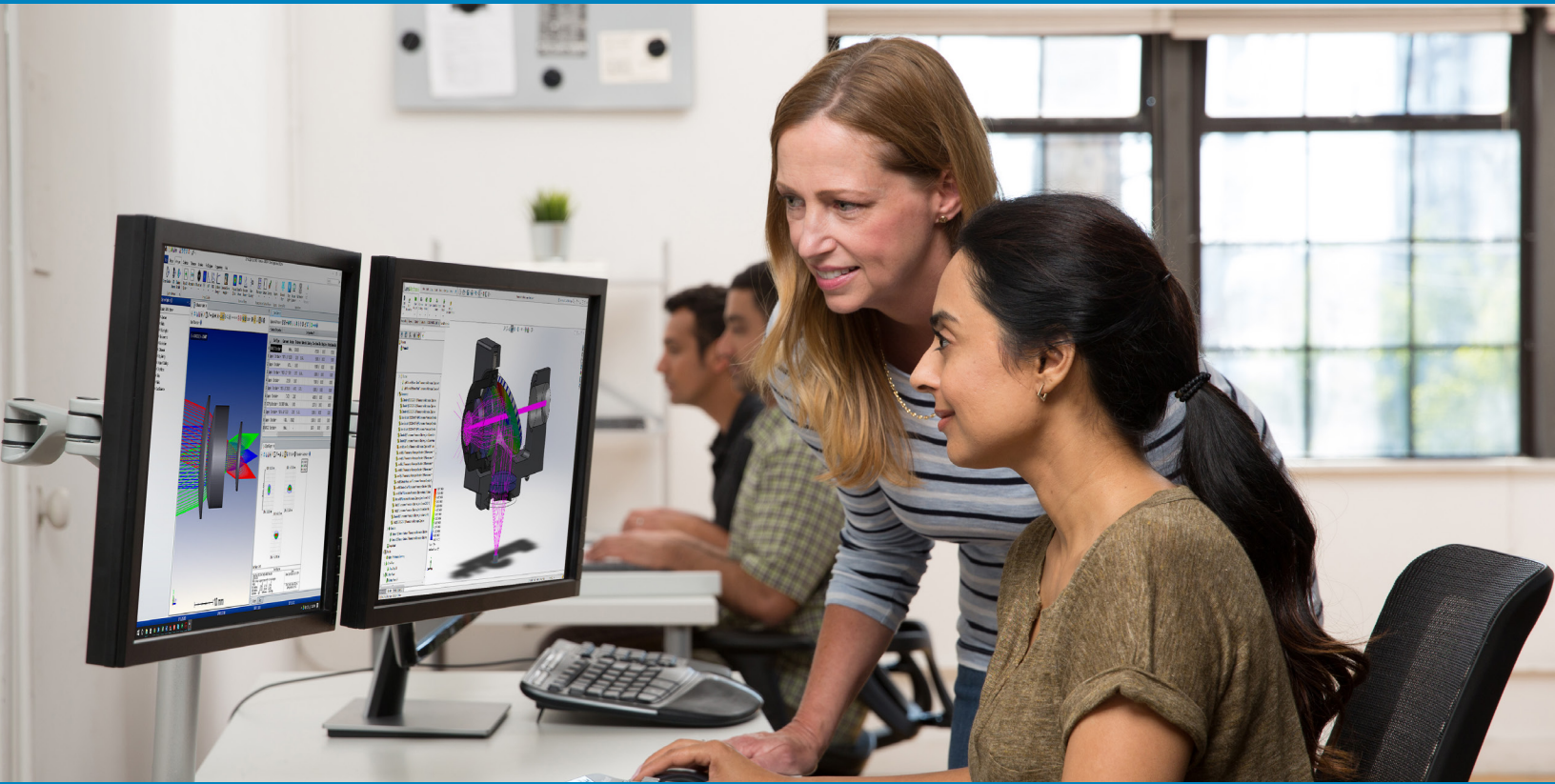


eGuide for engineering management

Six best practices for optical product design teams



By Mark Nicholson, CEO of Zemax

Zemax

Introduction

In their groundbreaking study *Six Myths of Product Development*,* Stefan Thomke and Donald Reinertsen (Harvard Business Review, May 2012) exposed common fallacies of product development and presented 12 best practices for overcoming them. This paper highlights how Zemax Virtual Prototyping applies six of these best practices—and what it means for the optical products you design.

* Stefan Thomke and Donald Reinertsen, "Six Myths of Product Development," <https://hbr.org/2012/05/six-myths-of-product-development>, May 2012.



ONE:

Remain open to an evolving development plan

Thomke and Reinertsen noted, “In all our consulting work and research, we’ve never come across a single product-development project whose requirements remained stable throughout the design process. Yet many organizations place inordinate faith in their plans. They attribute any deviations to poor management and execution and, to minimize them, carefully track every step against intermediate targets and milestones.”

Rather than rigidly adhering to original development plans, it’s more prudent to establish workflows that position you to quickly and easily make any adjustments needed during your design phase. With Zemax Virtual Prototyping, optical and mechanical engineers can share complete design data between OpticStudio® and LensMechanix®. This collaborative workflow accelerates optical product development by fostering an agile design process that simplifies rapid communication of design changes to everyone who needs them—without translation errors.

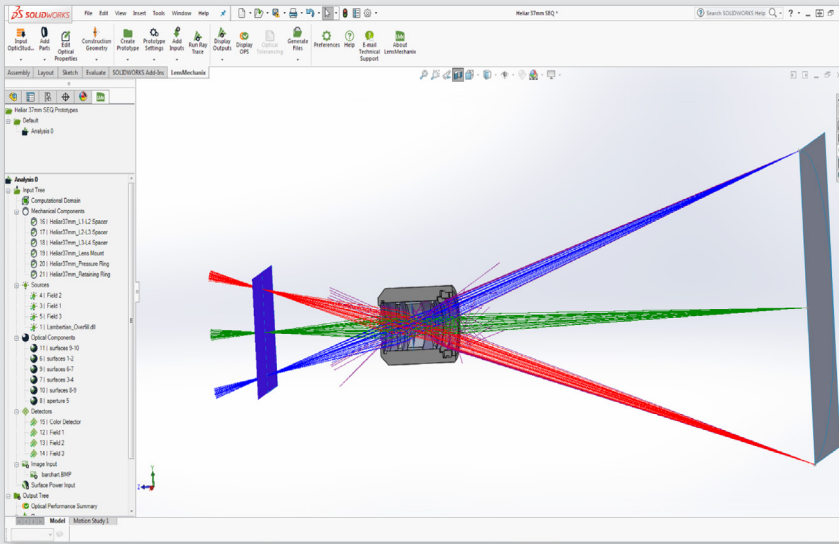
TWO:

Use iterative—not linear—design processes

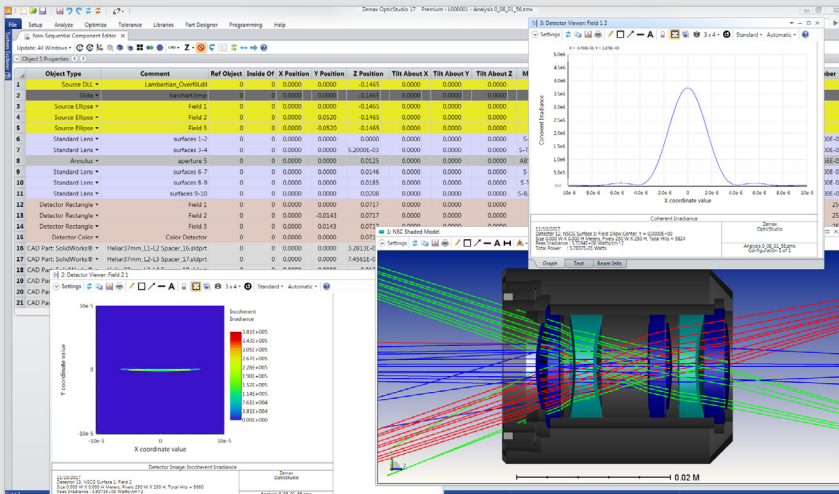
Before Zemax Virtual Prototyping, an optical engineer would design an optical system and then send a STEP or IGES file to a mechanical engineer, who would import it into a CAD program. These file formats lack the clear aperture location and other critical optical component data. The mechanical engineer had to then manually rebuild the optical components, which was a time-consuming, error-prone process that could take days or even weeks, depending on the complexity of the optical system.

If the mechanical engineer added a fold mirror to change the direction of the light, she had to start over with a new design from the optical engineer.

Further, without tools to assess the impact of the mechanical design on optical performance, the mechanical engineer had to build physical prototypes or export the design to the optical engineer to validate. This cycle of prototype and redesign was often repeated many times before the optomechanical design was finalized. The linear workflow and repeated design iterations increased costs, delayed time to market, and caused stress on the design team.



After running a ray trace, the mechanical engineer uses the analysis tools in LensMechanix to identify and correct stray light and other problems caused by the mechanical geometry—before building a physical prototype or sending the design to the optical engineer to review.



This ZAR file was created in LensMechanix and loaded into OpticStudio. The file contains the optical design, mechanical components, and scatter profiles of the mechanical components.

Zemax Virtual Prototyping changed all this by streamlining the workflow and communication between optical and mechanical engineers, so teams get to a qualified design more quickly.

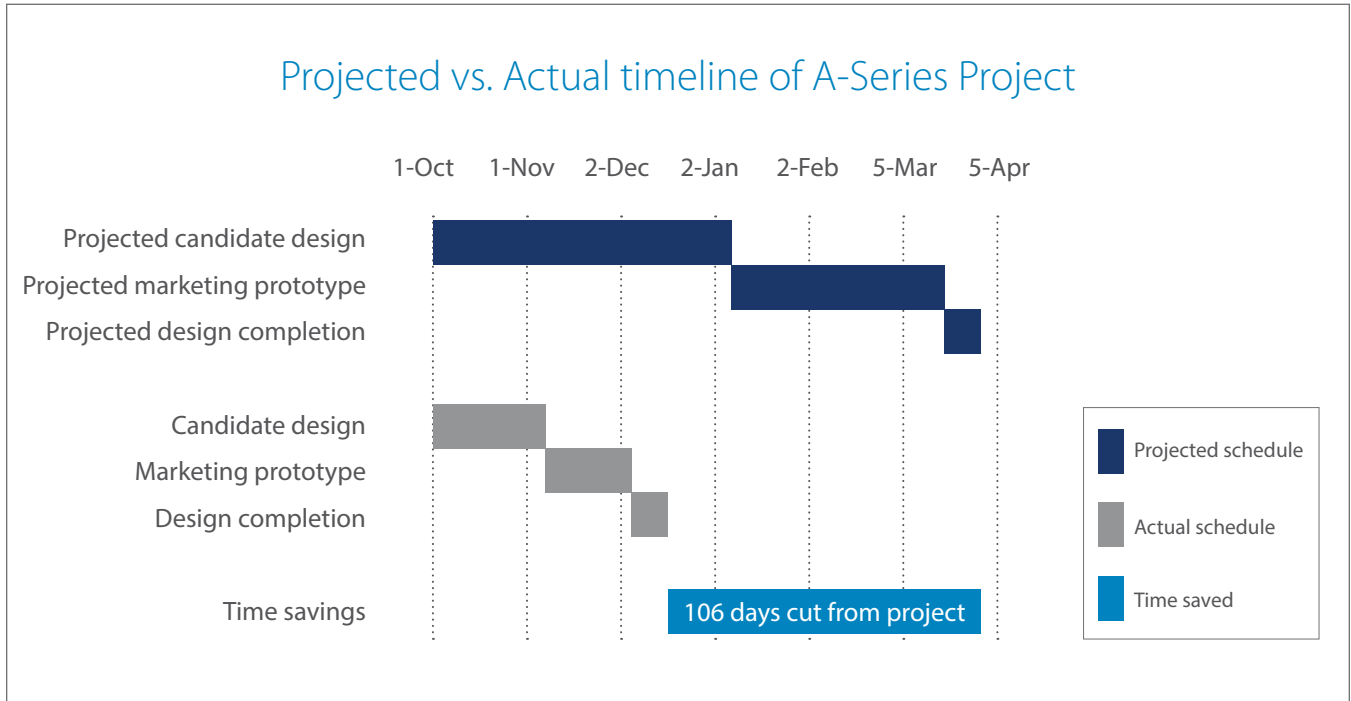
- After an optical engineer designs an optical system in OpticStudio, the mechanical engineer loads the OpticStudio file into SOLIDWORKS or Creo. The file includes the optical components, materials, coatings, surface radii, edges, wavelengths, clear aperture location, sources, and detectors.
- LensMechanix automatically creates the optical component parts as native SOLIDWORKS parts with the exact lens dimensions. This eliminates the need for STEP and IGES files.

- Within minutes, the mechanical engineer can start building mechanical geometry, compare the optical performance in SOLIDWORKS or Creo with the original output, and then analyze and validate the optomechanical system by running fully multithreaded ray traces.
- The mechanical engineer can then save an OpticStudio archive file (ZAR file) in LensMechanix for the optical engineer to load into OpticStudio. The file contains the optical design, the mechanical components, and the scatter profiles of the mechanical components.

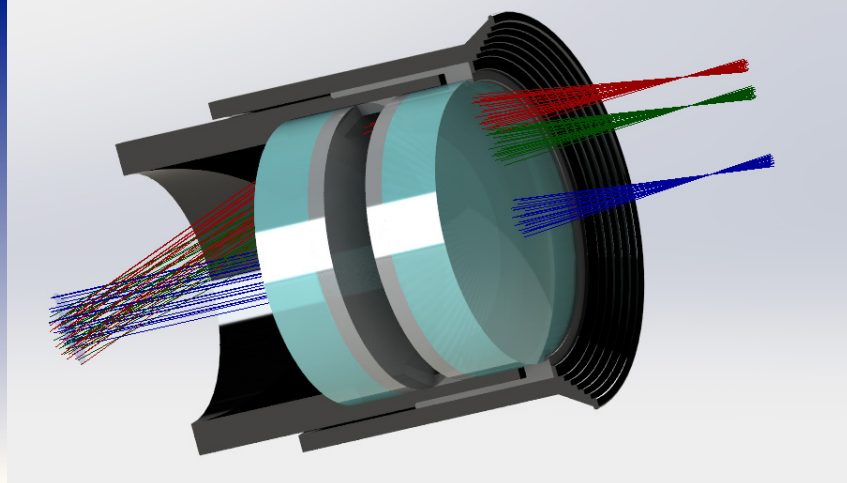
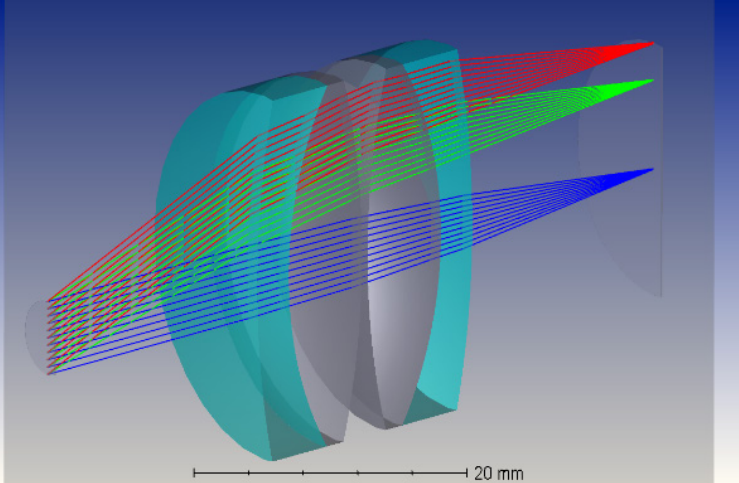
Preserving the integrity of optical data when transitioning from optical to mechanical designs reduces the number of design iterations and physical prototypes needed to create a successful product.

“By using OpticStudio and LensMechanix, we honed in very quickly on one design. We had a high-quality optical and mechanical design candidate in one week. In time savings, we knocked this project out of the park. Zemax tools enabled us to complete prototypes before our CAD time budget was spent. We got to start working on the next design project early.”

Robert Mentzer, Optical Engineer at Global Surgical Corporation



The original project was expected to take six months. Instead, the first prototypes were completed three months ahead of the initial target date, improving the overall project timeline.



The left image shows ray trace results in OpticStudio for a doublet optical design. On the right, the same design is packaged in LensMechanix and then analyzed by running a ray trace.

THREE:

Experiment with smaller batches for faster feedback

This best practice gets to the heart of Zemax Virtual Prototyping. We've seen optical designs with 10-20 new components turned into physical prototypes. The chances of creating a successful physical prototype on the first attempt are slim. The chance of isolating a problematic component in a physical prototype is even slimmer. Zemax Virtual Prototyping makes it possible to isolate each change made, so that the impact can be seen across the entire product.

Consider this example: Should a design include a cemented doublet or an air-spaced doublet? An air-spaced doublet is better for optical design because having four surfaces helps control aberrations. If you cement those lenses together, you have only three effective surfaces for aberration control. So, the optical designer prefers air gaps.

But aligning two singlets to make an air-spaced doublet poses a trickier problem for the mechanical engineer, who needs a new mounting method and must also analyze the optomechanical system for stray light, beam clipping, and other issues. Now add a new glass choice and an aspheric surface. By creating a virtual prototype, you can evaluate the impact of each design choice independently, cumulatively, or in any combination. With physical prototyping, you must manufacture separate physical prototypes to evaluate the effect of each design change—which is more difficult, expensive, and time-intensive than using a single virtual prototype.

FOUR:

Quantify the cost of delays and factor it into your decisions

It is important to quantify delay costs and build those costs into your decisions and schedules. But what if you could eliminate the sources of many delays altogether? The combination of OpticStudio and LensMechanix eliminates design delays. For example:

- Bringing the exact optical design into SOLIDWORKS or Creo enables mechanical engineers to quickly expose the features they need, such as the optical axis or clear aperture, and know exactly where to place the mechanical components. "It used to be difficult to get all the design data we needed. The package of data I have in a single design file is far superior to the 20 plus drawings I had to rely on before LensMechanix," said mechanical engineer Tim Stiefferman at Global Surgical.
- By seeing how rays interact with the optical and mechanical components, mechanical engineers gain clarity on how their designs impact optical performance.
- Optical engineers no longer deal with inconsistent global coordinate systems and lost design fidelity, or having to manually locate mechanical components to recreate the assembly that a mechanical engineer created in a CAD platform.

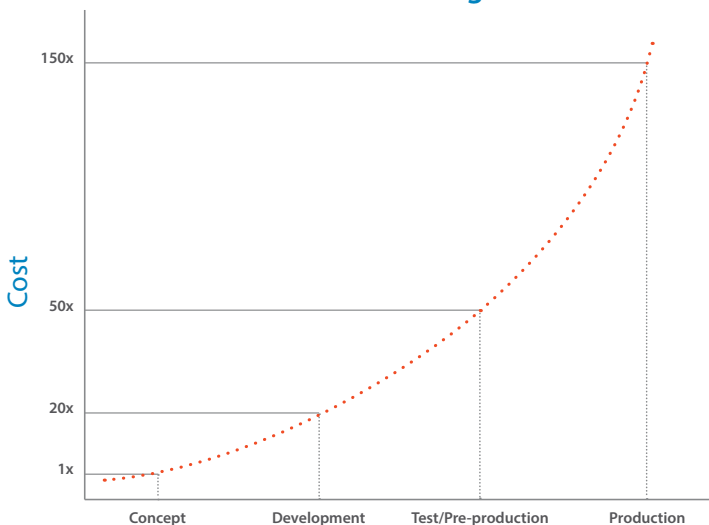
FIVE:

Experiment early, rapidly, and frequently

You've probably heard the expression "fail early, fail often." Design changes become exponentially more expensive the further you get into the design process. With Zemax Virtual Prototyping, engineers can make changes early in the design process, and validate the change within the virtual environment. They can also rapidly experiment with new ideas at a very low cost. As Thomas Edison once said, "The real measure of success is the number of experiments that can be crowded into 24 hours."

One of our customers changed the angle of a baffle to reduce the amount of stray light in a system. Using LensMechanix, he quickly identified which surface was reflecting rays along an unintended path. He was able to detect the problem in the virtual prototype, implement a change, and verify that the change resolved the stray light problem.

Cost of change

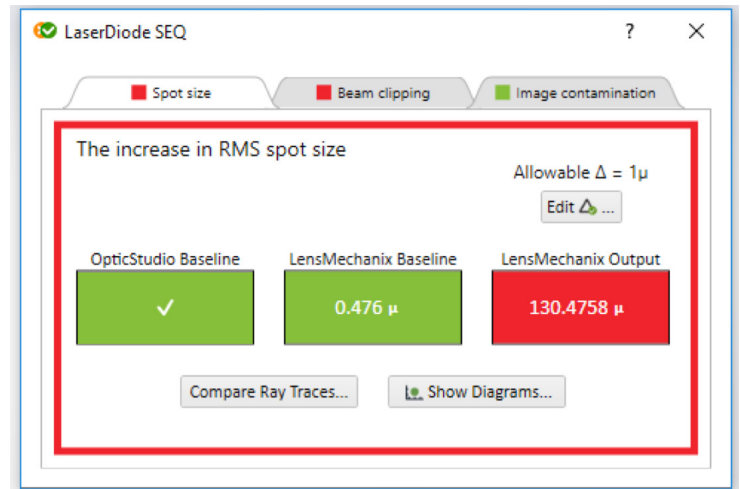


New product development phases

Correct design problems early when changes are much less costly. (Source: QualityInspection.org)

SIX:

Make information flows visible



In product development, it's often difficult to communicate critical information across different roles and teams. An effective approach to combating this challenge in any cross-functional team is providing greater visibility into key data.

When mechanical engineers open an OpticStudio file in SOLIDWORKS or Creo, LensMechanix runs an OpticStudio baseline ray trace to ensure that the optical system in LensMechanix is the same as it is in OpticStudio. After designing the mechanical components, mechanical engineers can easily identify and correct errors in the mechanical geometry by running a ray trace and then using the Optical Performance Summary, which exposes performance data of the mechanical components for spot size, beam clipping, and image contamination. A simple chart indicates pass/fail for these measurements.

Detailed data about the results is also stored so that mechanical engineers can troubleshoot the design or gather additional insights. These results give the optical engineer and mechanical engineer confidence that their optical system will work as expected when physical prototypes are built, or they'll have clear insight into where problems exist.

Conclusion

Companies developing cutting-edge optical products—from virtual reality to autonomous vehicles—can gain an enormous competitive advantage by following best practices in product development.

With Zemax Virtual Prototyping, you can improve optical performance, cut your product development

time dramatically, and reduce costs by creating a virtual prototype of a complete optomechanical assembly.

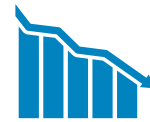
Optical and mechanical engineers can arrive at a high confidence design candidate quickly, catch and correct errors early in the design process when changes are cheaper and easier, and reduce time and costs by creating fewer physical prototypes.



IMPROVE OPTICAL
PERFORMANCE



SHORTEN
TIME TO MARKET



REDUCE COSTS



Mark Nicholson

Chief Executive Officer

Mark has been with Zemax for more than 20 years and holds a PhD in plasma spectroscopy from Imperial College, University of London and a bachelor's degree in physics, also from Imperial College. When he's not testing the latest beta or working on business strategy, he's playing his guitar or riding his motorcycle through the countryside.

About Zemax

Zemax's industry-leading optical product design software, OpticStudio and LensMechanix, helps optical and mechanical engineering teams turn their ideas into reality. Standardizing on Zemax software reduces design iterations and repeated prototypes, speeding time to market and reducing development costs.

We touch nearly every optical system manufactured today, including virtual reality systems, cell phone cameras, autonomous-vehicle sensor systems, and intraocular lenses—even imaging systems for the Mars Rover. By listening to our customers, we deliver unmatched value and have the largest, most passionate user base in the industry.

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