OPTI 421/521 – Introductory Optomechanical Engineering

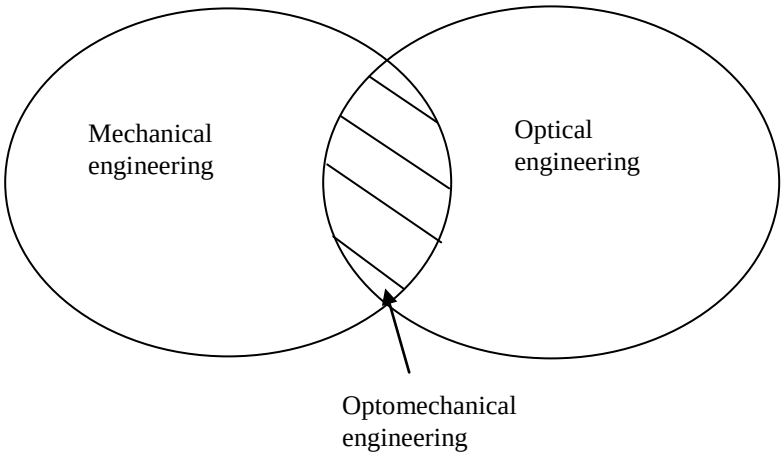
1 Introduction

What is opto-mechanical engineering?

Optical engineering – Design and characterization of systems that use or manipulate light. The optical engineer uses mathematics and computer simulation to predict how the light will behave.

Mechanical design engineering – design and analysis of things mechanical. The mechanical engineer uses mathematics and computer simulations to apply knowledge from materials science and engineering mechanics.

Optomechanical engineering – the field of engineering dealing with mechanical aspects of optical systems



Examples of optomechanical engineering tasks:
- Design of mounts for optical elements
- Design of a system that allows precision adjustments
- Analysis of distortion of an optical instrument with orientation, and thermal environment

Examples of optical engineering tasks that require some optomechanics
- Tolerancing of optical systems
- Fabrication of optics
- Optical alignment
- Analysis of optical systems including mounting effects

How important is optomechanical engineering?

First of all, in most cases, industry hires optical engineers because they want to build systems using optics (rather than just design and study them, creating only paper and computer files). To build anything, the optical engineer must deal with mechanical aspects of the system.

Engineering design is driven by analysis. This requires good command of analytical and computer models and access to test data. Analysis is critical for design for two reasons:

1. It allows you to make trade-offs so your system is efficient. To improve performance only to the level required by the system. If it is far better than required, the added performance does not justify the increased cost.
2. It is the only way to know that the system will meet the requirements without building and testing.

The goal of a system designer is always optimization. You can always make something better, but it would cost more. Here are two extremes for design optimization for optical systems:

- Optimize entirely for performance. Fabrication limitations dominate. Optical designer must work closely with mechanical and fabrication engineers to take advantage of state of the art technologies.
- Optimize entirely for cost. Production limitations dominate. Optics cannot be ignored, but the emphasis is on good mechanical engineering and setting up an efficient production process.

So the bottom line is that the success of the optical system (thus the optical engineer) depends on good optomechanical engineering.

The optical designer and the mechanical designer should be in close communication so they can fully exploit the system tradeoffs in the design, such as modifying the optical design to loosen a difficult tolerance. If these people are separate, the optical designer may not know that the tolerance is too tight, or the mechanical designer may not know that a design modification can ease the tolerance. Of course, the best situation is an optical designer with a solid understanding of the mechanical and fabrication issues.