OPTIMAX®
Manufacturing the Future

Precision Freeforms at Optimax

Embracing Total Error

Presented By:
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OPTIMAX®

Headquarters **Ontario, NY**

Founded **1991**

In Operation **30yrs**

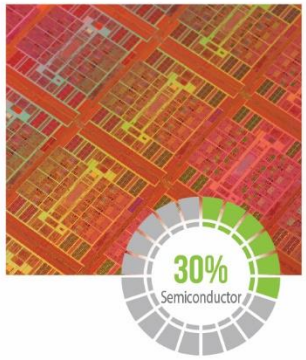
Privately Held Company — **Controlling Ownership in Perpetual Purpose Trust**

350 employees

50 engineers

120K sq foot facility

50,000 OPTICS shipped annually

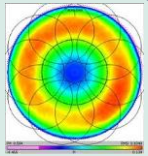


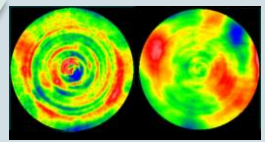
ENGINEERING THE SOLUTIONS OF TOMORROW

Enabling Customer Success and Employee Prosperity

Advancement of Precision Optics Manufacturing

Pre-1980	1990	2000	2010	2020	2030
Spherical lenses	**Aspheres**		**Freeform optics**	**Optical Integration**	
Traditional Grind & Polish Methods	Automated Spherical Processing Less Dependence on Artisans	Rotationally Symmetric Aspheres Deterministic Polishing Stitching Interferometry	Off-axis Aspheres and Freeforms Mid-Spatial Frequency Smoothing High Precision (λ/50) Rotationally Symmetric Aspheres	Freeforms Sub-Wave Freeform Positioning Error Machine Learning Autonomous Manufacturing	"Integrated" Freeform Optical and Mechanical Assemblies "Smart" Manufacturing





Complexity

Manufacturing Requirements

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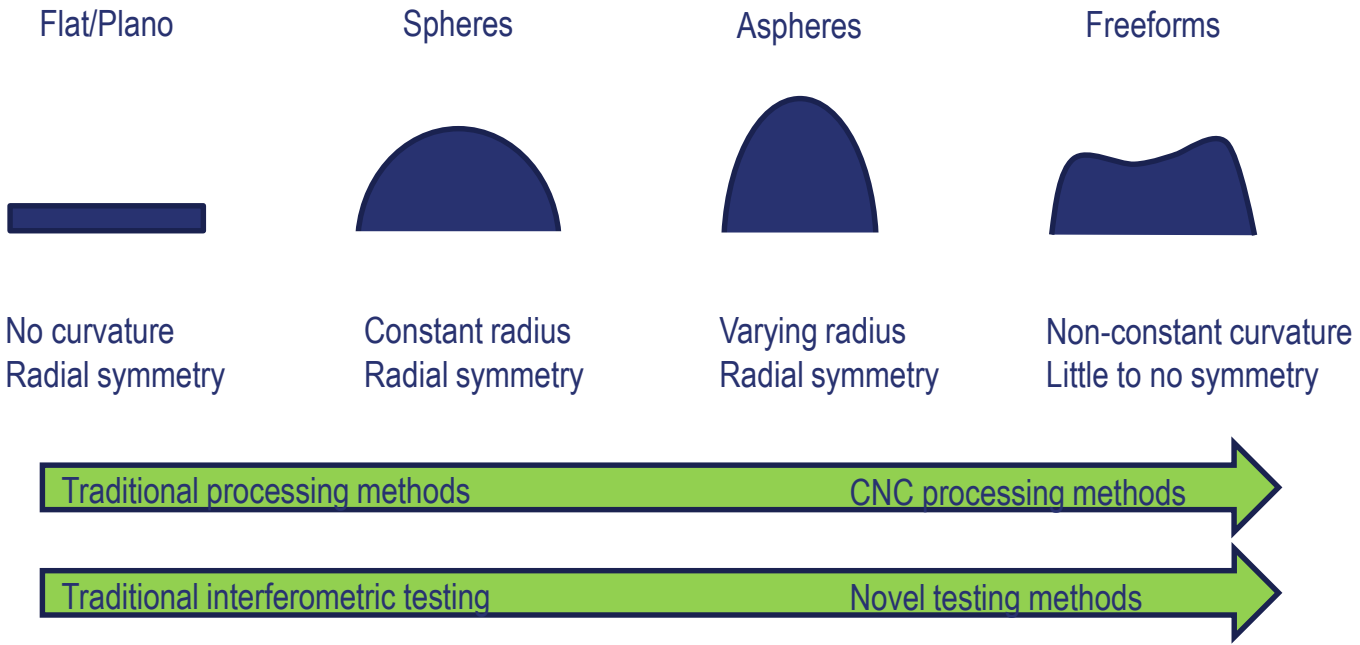
We define freeforms by their lack of symmetry and their fabrication method



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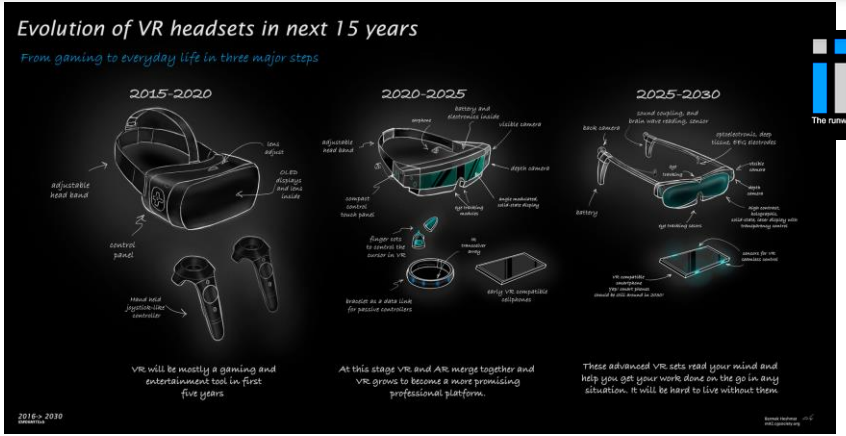
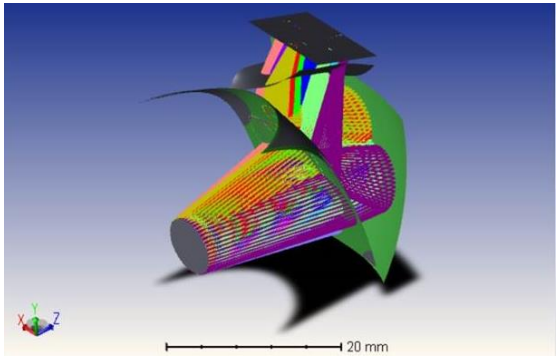
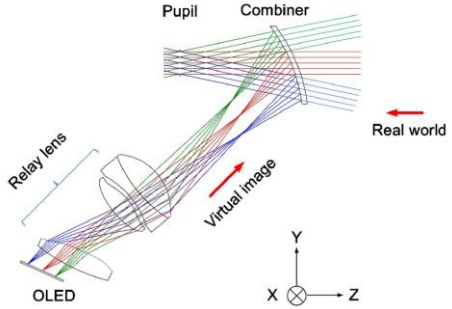
Why would you use a freeform optical surface?

A few examples:

- Reducing size
- Off-axis optical designs
- Beam shaping
- Conformal shapes



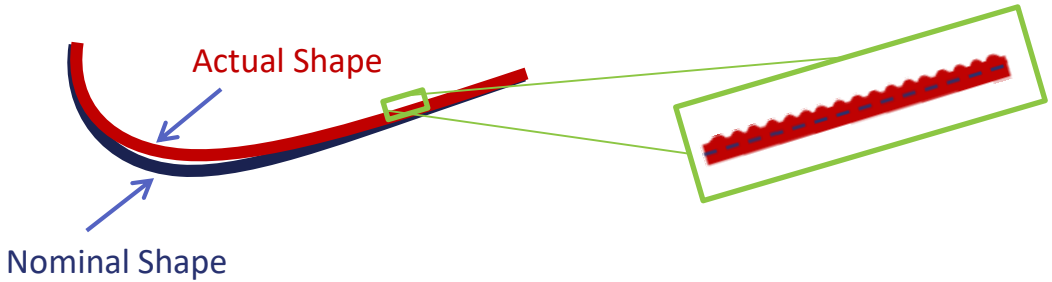


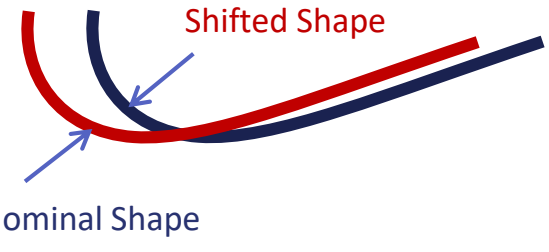


Lidong Wei, et al., Opt. Express **26,** 8550-8565 (2018);

Total Error is important for freeforms

Total Error = (Surface Irregularity + Surface Texture + Positioning) errors





Surface Irregularity
Low order surface form errors

Surface Texture
Surface Roughness and
Mid-Spatial Frequency (MSF) Errors

Positioning
Position relative to global coordinate system

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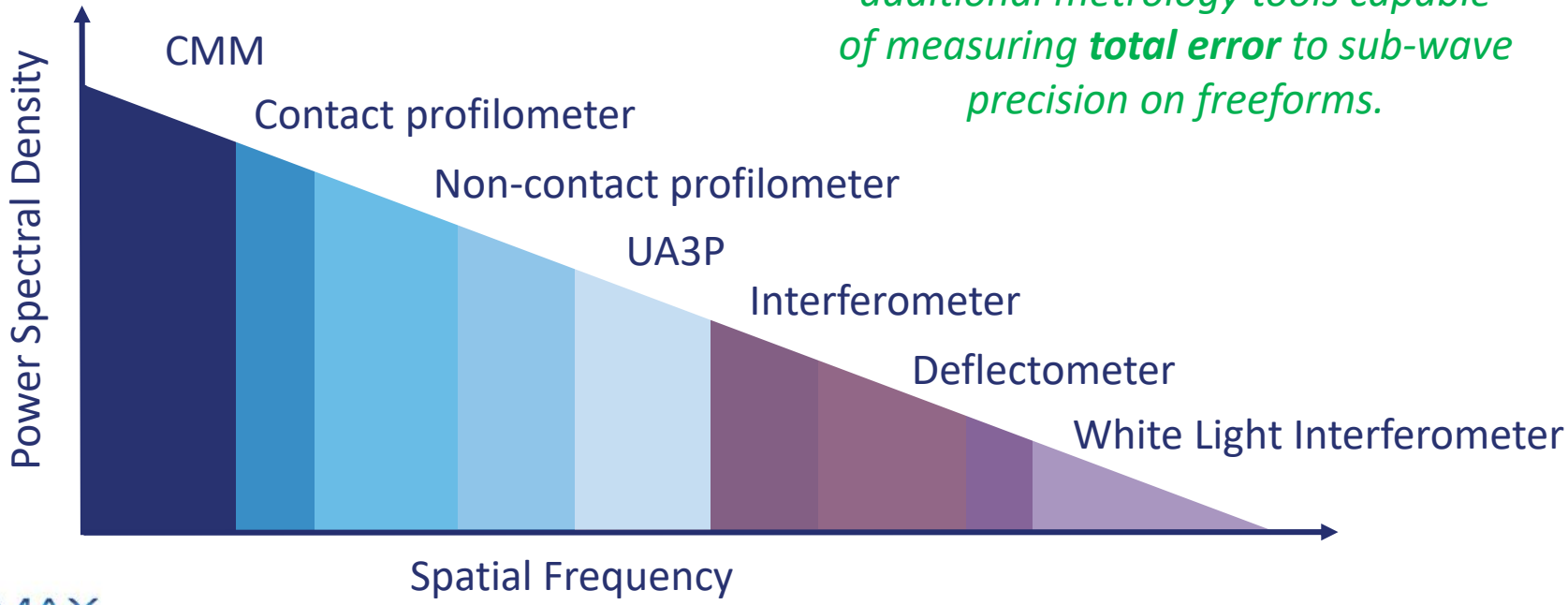
Multiple instruments required for full spatial frequency measurement coverage for freeforms

Every method has pros and cons

*We continuously search for additional metrology tools capable of measuring **total error** to sub-wave precision on freeforms.*



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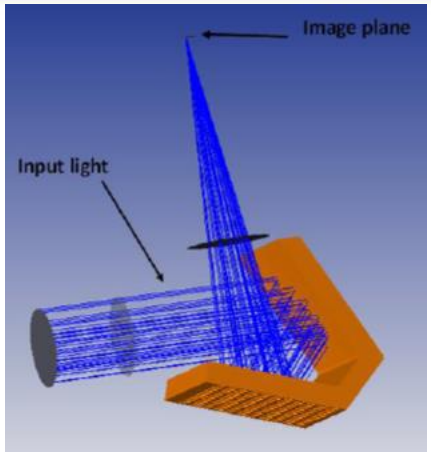
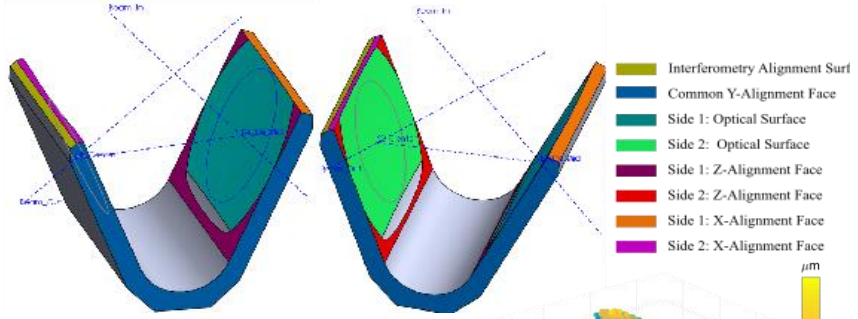
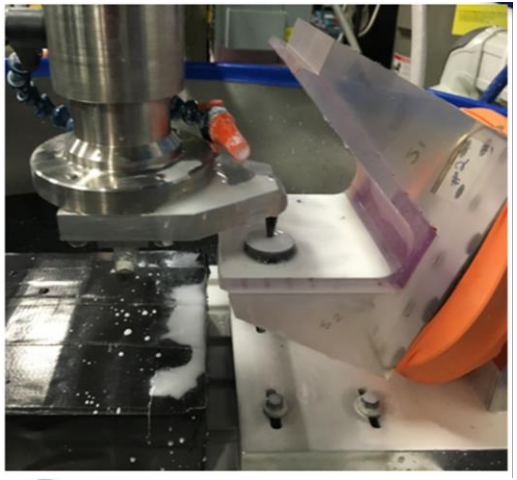
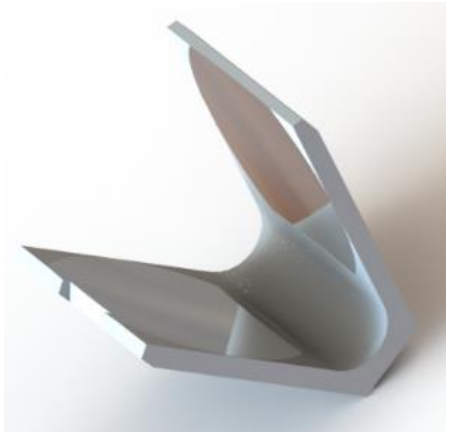
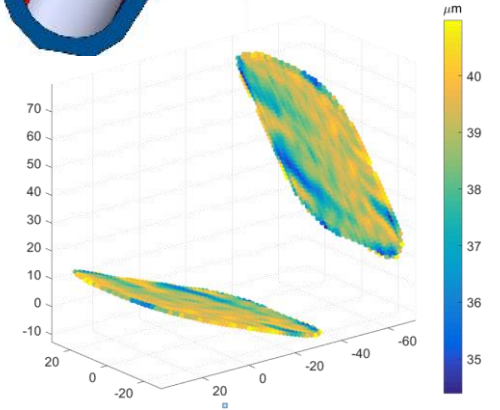
Monolithic freeform telescope example

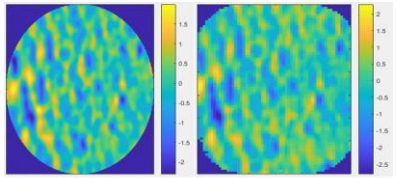












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Freeforms continue to be the future

Trending towards higher precision and more extreme surfaces

Freeforms are being used to reduce system size, off-axis design, conformal windows and beam correction

- Freeform designs and manufacturing methods continue to evolve
- Total error (surface form + surface texture + position) is important for freeform system performance
  - Freeforms are subject to complicated alignment errors and MSF errors

Experience leads to breakthroughs

- Collaborations driving toward more extreme surfaces
- Interested in partnering with universities, research institutes and industry to create more manufacturable low ***total error*** freeform systems

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and now for the famous EPIC questions!

What can Optimax do for you?

- We will partner with you to manufacture custom optical components to help you achieve your desired system performance.
- Our value contribution includes expertise in manufacturing, testing and coating optics of all forms, including freeforms!

How can you help Optimax?

- New ways to measure freeform surfaces
- Collaboration for better ways to specify and tolerance freeform surfaces
- Partner for new applications for freeform optics

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