

Component Technology Case Studies

Planetary vs. Cycloidal Technology

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Today's Discussion will include:

- **Why Use a Gearbox?**
- **Understanding Planetary Gearbox Technology**
 - Principle of Operation
 - Advantages & Disadvantages
 - Commercial Variations
- **Understanding Cycloidal Technology**
 - Principle of Operation
 - Advantages & Disadvantages
 - Commercial Variations
- **Industries and Applications for Each Technology**
- **Practical Solutions from Three Industries**
 - Packaging
 - Robotics
 - Defense
- **Summary**
- **Q & A**

Why use a Gearbox?

- **Inertia matching**
- **Speed reduction**
- **Torque magnification**
- **Bearing support for application loads**

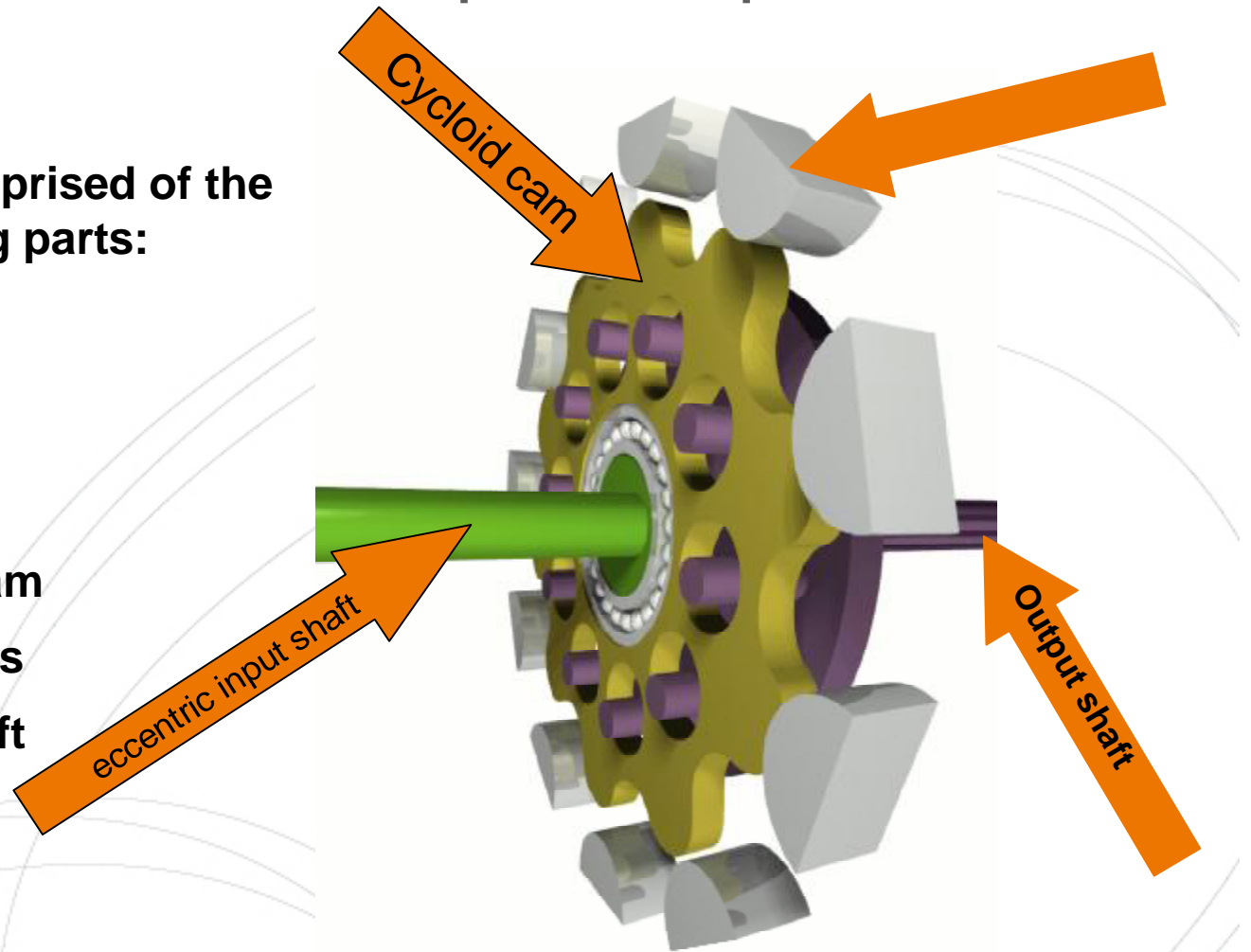
SERVO GEARBOX TECHNOLOGY

- **Planetary Gearbox**
 - **Single stage**
 - **Multi stage**
 - **Custom designs**
- **Cycloidal Gearbox**
 - **Single reduction**
 - **Compound reduction**
 - **Hybrid design**

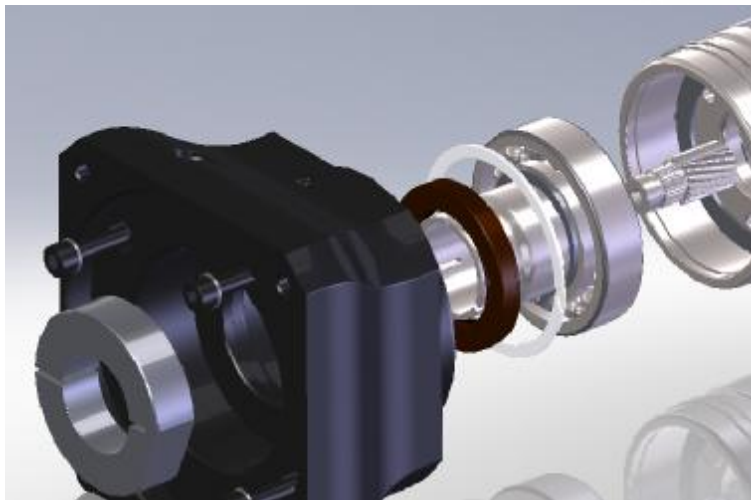
Cycloidal Basics – Principle of Operation

The mechanism is comprised of the following major moving parts:

- High speed input shaft
- Single or compound cam
- Cam followers or rollers
- Slow speed output shaft

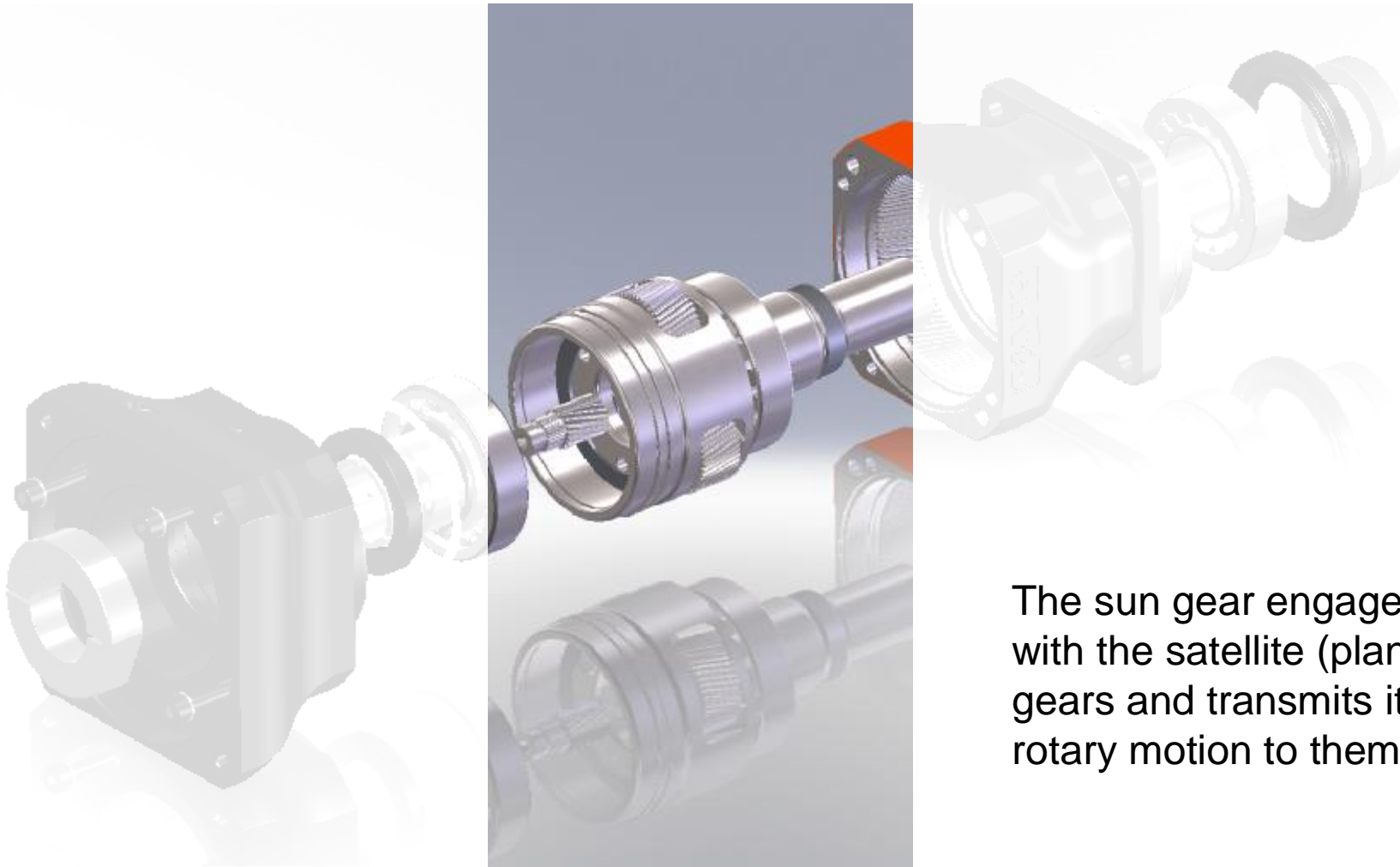


Planetary Technology – Principle of Operation



The sun gear is attached to the input shaft which connects directly to the servo motor.

Planetary Technology – Principle of Operation

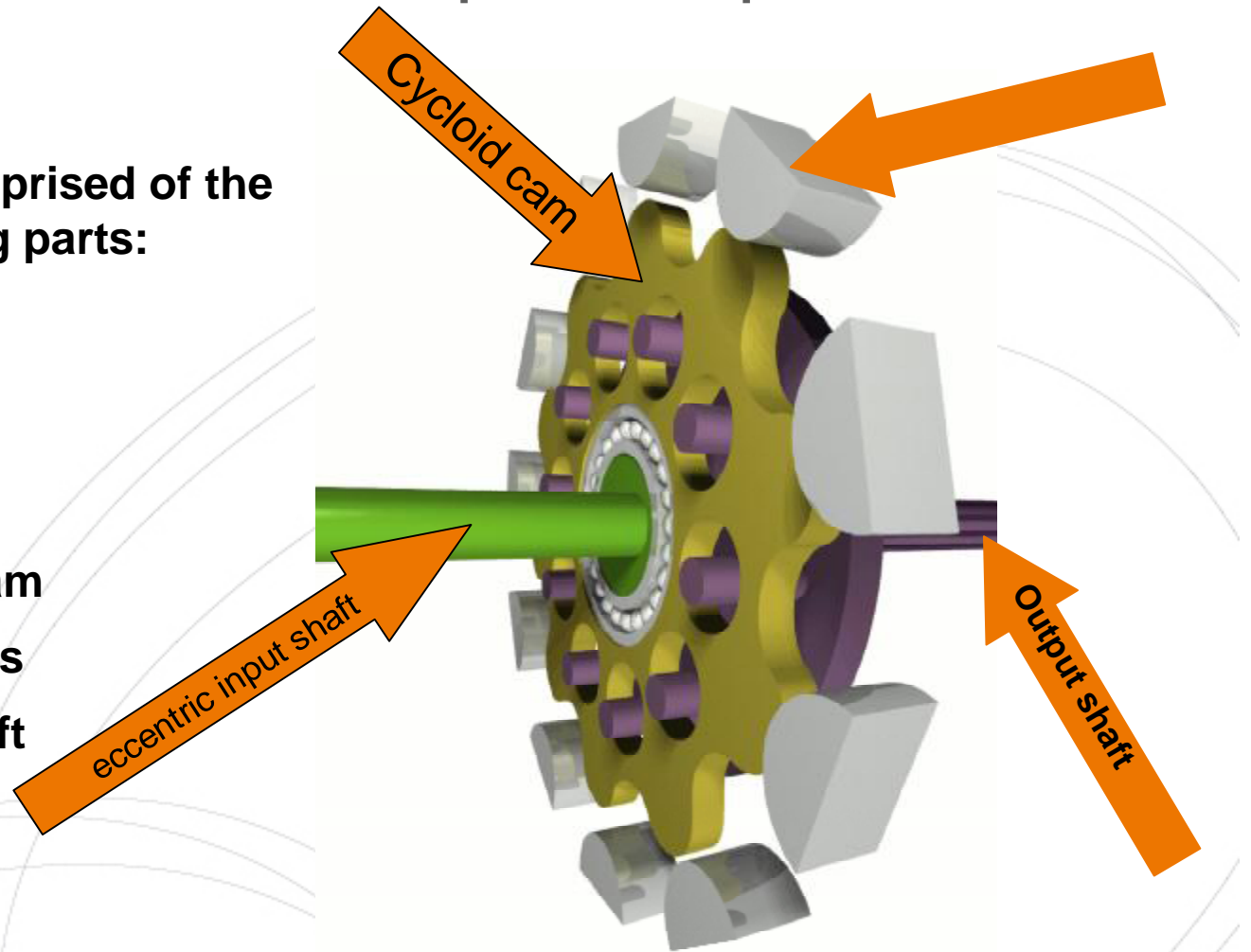


The sun gear engages with the satellite (planet) gears and transmits its rotary motion to them.

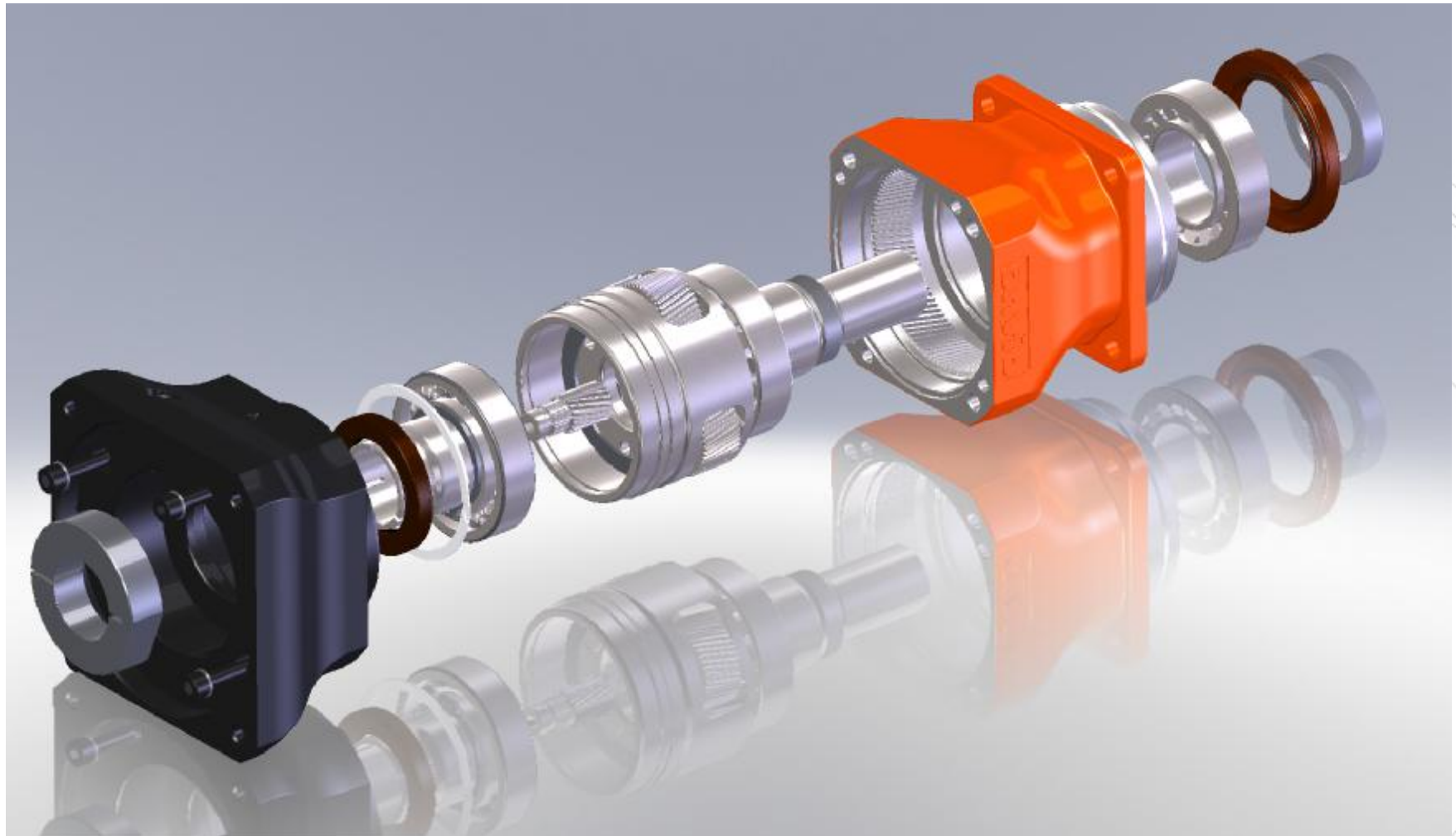
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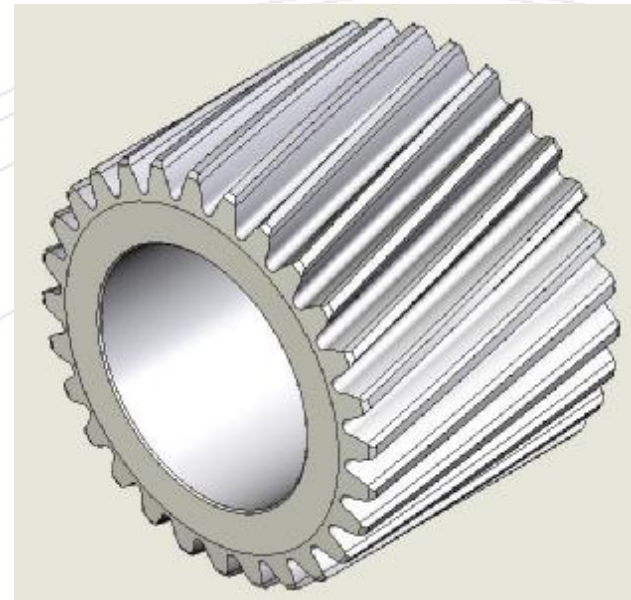


Planetary Technology – Principle of Operation



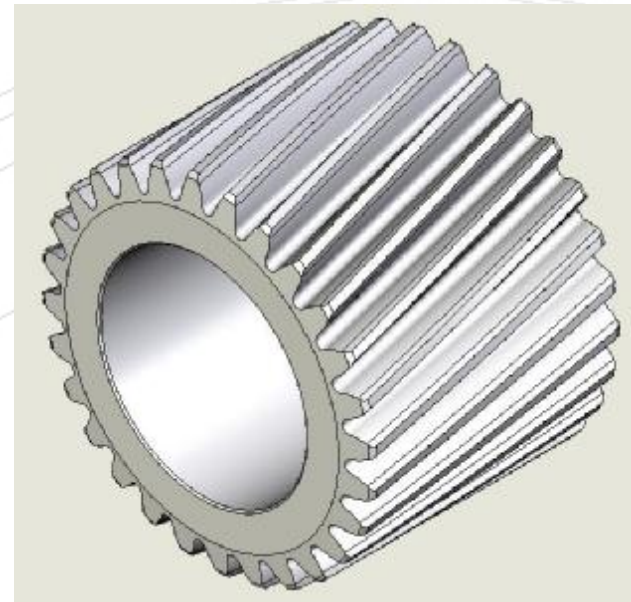
Planetary Technology – Advantages

- **High torque density**
- **Load distribution and sharing between planet gears**
- **Smooth transmission**
- **High efficiency**
- **Low input inertia**
- **Low backlash**
- **Low cost**



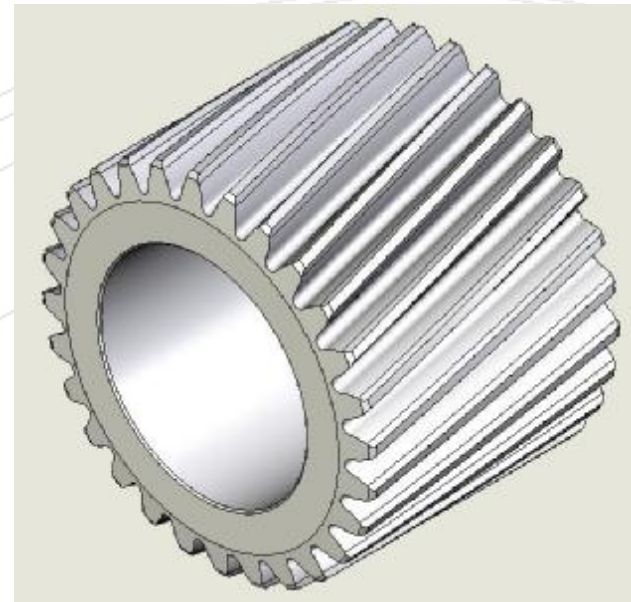
Planetary Technology – Disadvantages

- **Necessary backlash increases with wear**
- **Maximum practical single stage reduction ratios 10:1**
- **> 100:1 requires 3 stages**
- **Through holes are not practical**



Planetary Technology – Commercial Variations

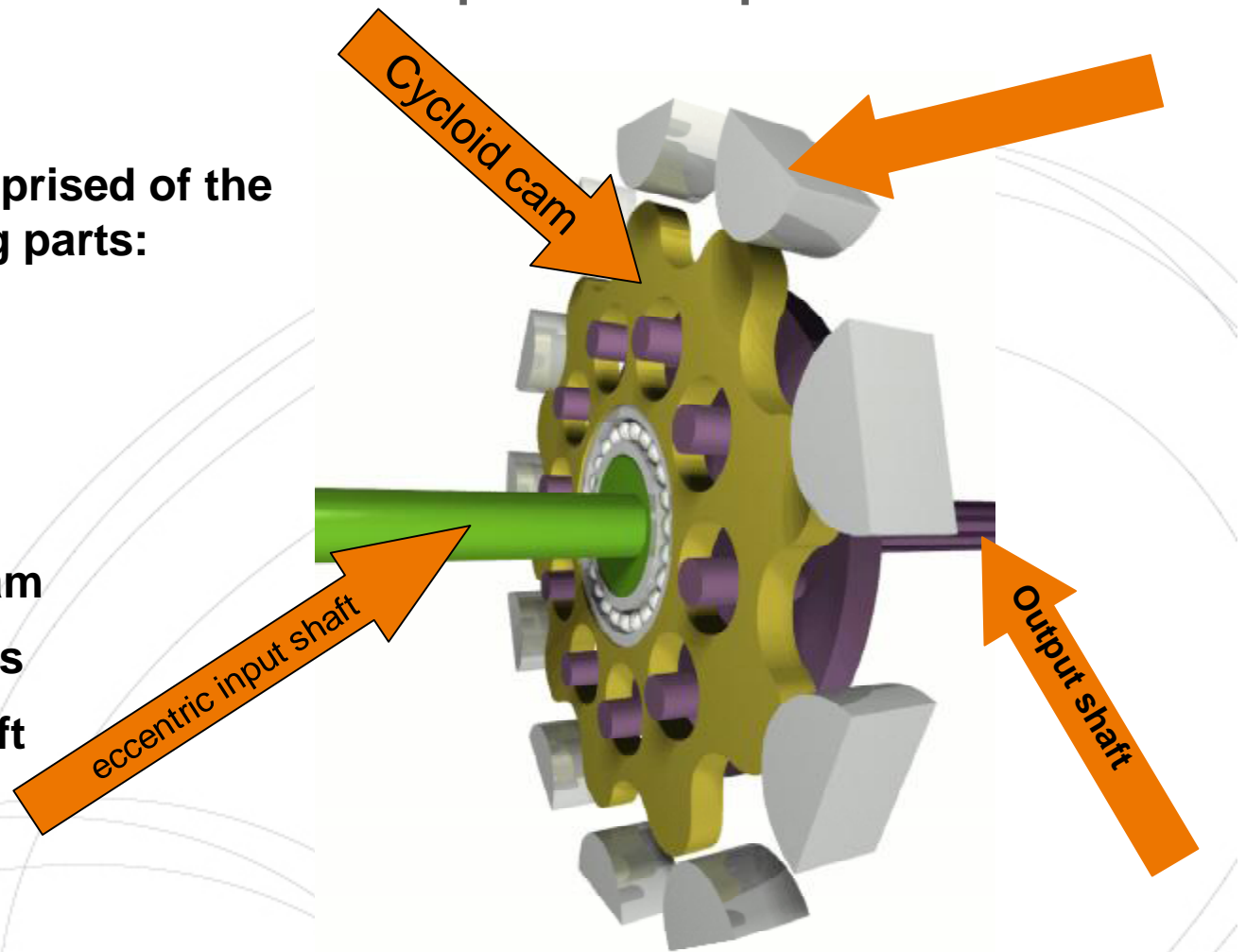
- **Gear Tooth Design**
 - Straight teeth
 - Helical teeth
- **Gear Finishing Process and Precision**
 - Hobbing
 - Skiving/carbide re-hobbing
 - Honing
 - Grinding
- **Heat Treating Methods**
 - Carburizing
 - Plasma/ion or gas nitriding
 - Through hardening
 - Carbonitriding
- **Output Shaft Bearing Support**
 - Deep groove ball bearings
 - Angular contact ball bearings
 - Taper roller bearings
- **Satellite Carrier Design**
 - Straddled gear support
 - Cantilevered gear support



Cycloidal Basics – Principle of Operation

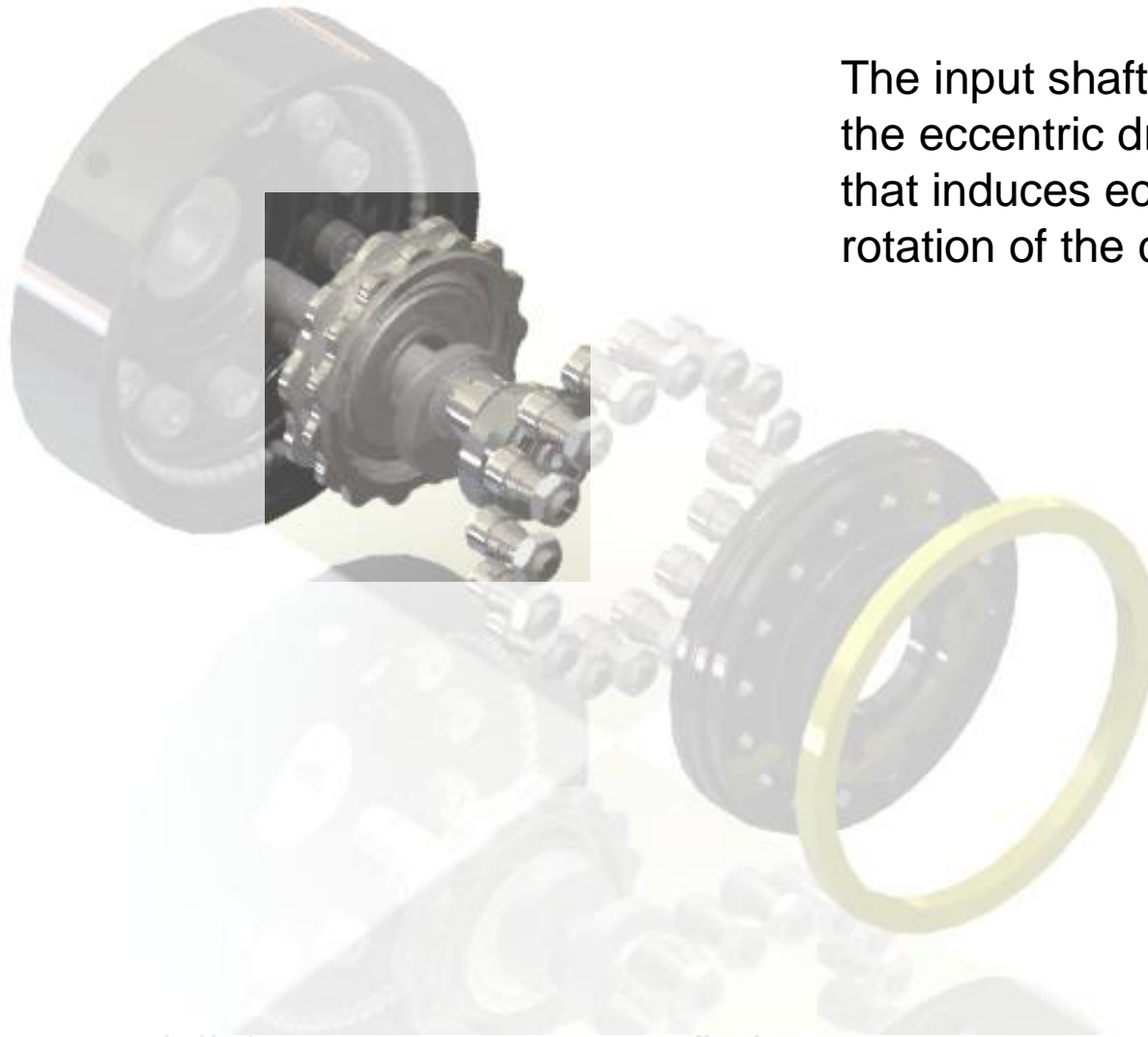
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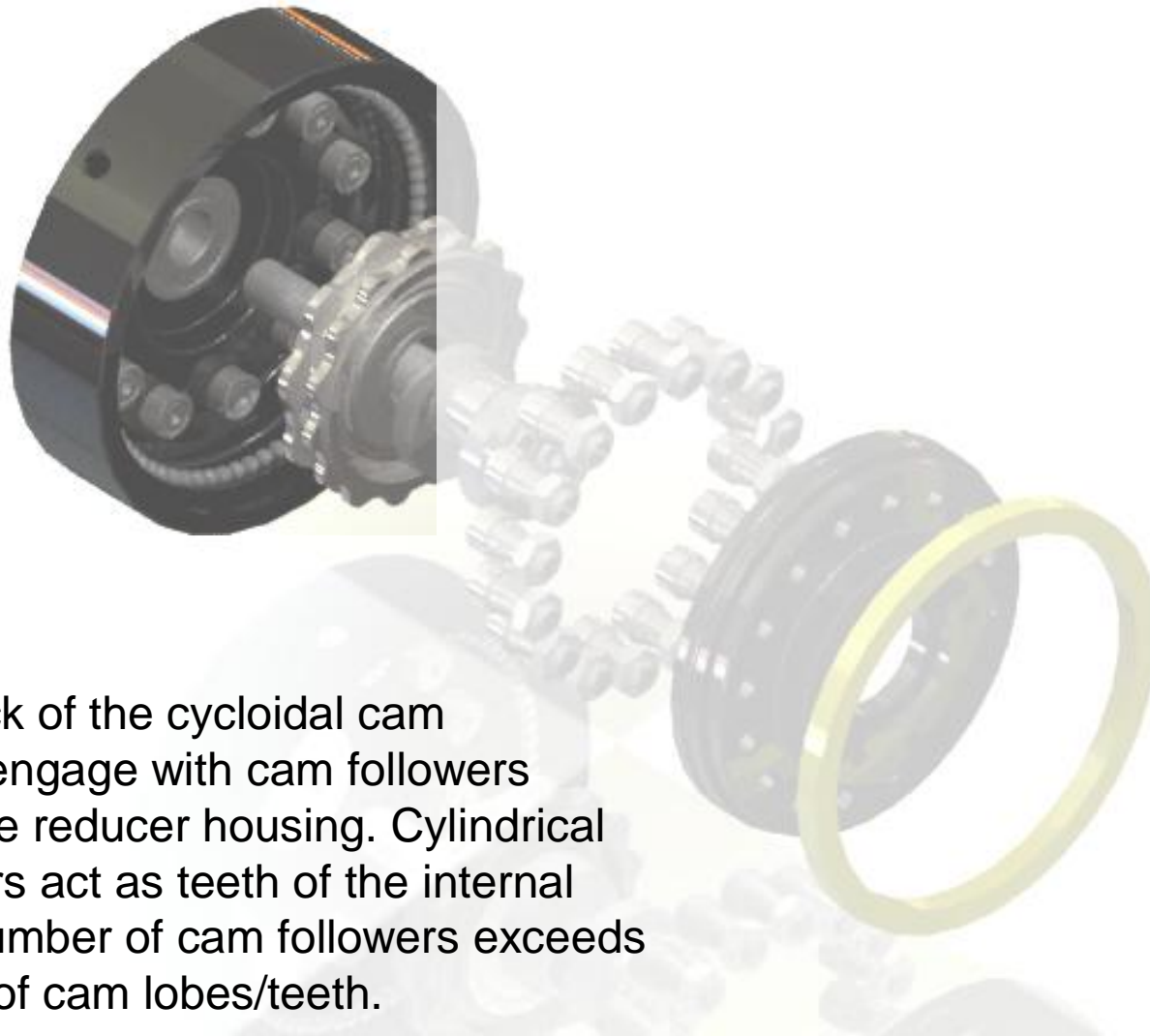


Cycloidal Technology – Principle of Operation

The input shaft is attached to the eccentric drive member that induces eccentric rotation of the cycloidal cam



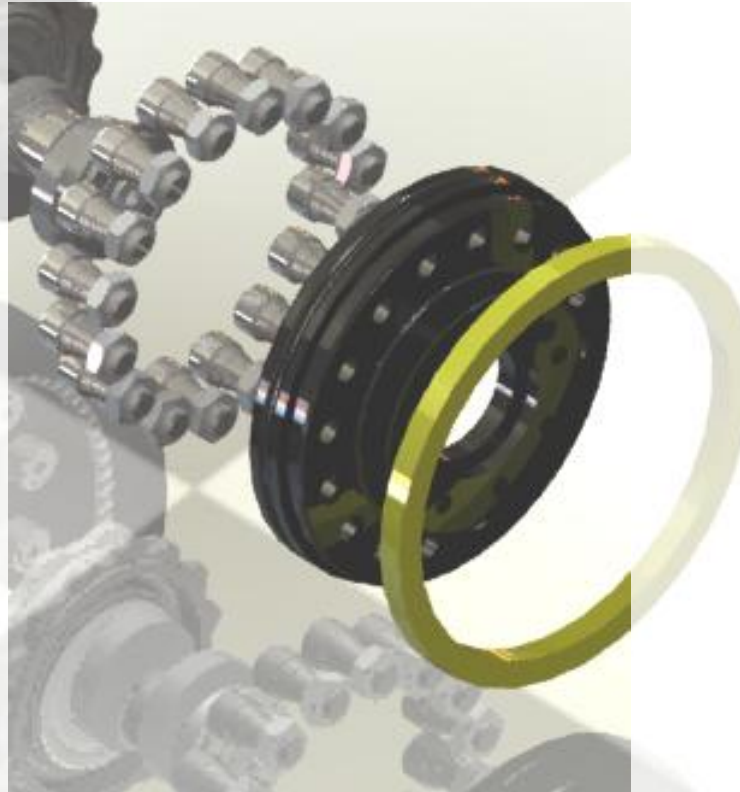
Cycloidal Technology – Principle of Operation



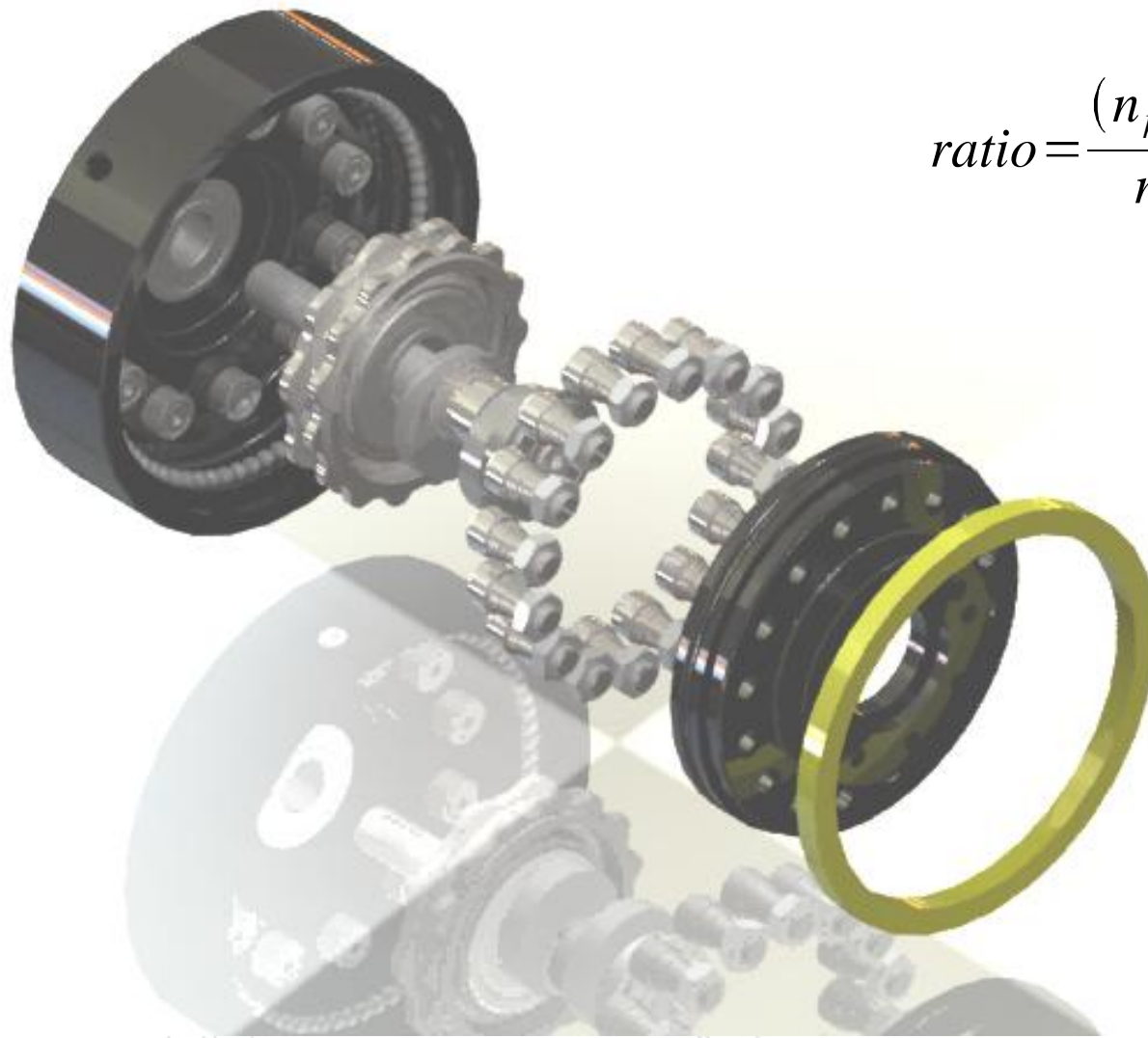
The first track of the cycloidal cam lobes/teeth engage with cam followers located in the reducer housing. Cylindrical cam followers act as teeth of the internal gear. The number of cam followers exceeds the number of cam lobes/teeth.

Cycloidal Technology – Principle of Operation

The second track of the cam lobes/teeth engages with the cam followers on the output shaft and transforms eccentric rotation of the cam into concentric rotation of the output shaft producing increased torque and reduced speed



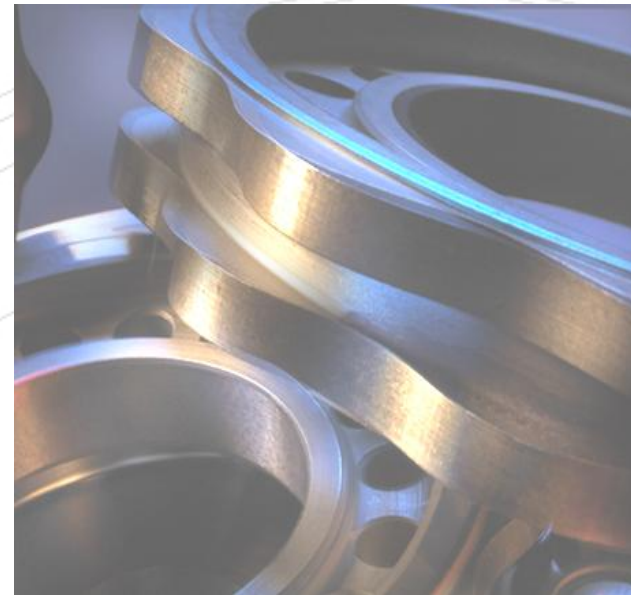
Cycloidal Technology – Principle of Operation



$$ratio = \frac{(n_{hsg} - 1) \cdot n_{ops}}{n_{hsg} - n_{ops}}$$

Cycloidal Technology – Advantages

- **Zero or very low backlash stays relatively constant through life**
- **Rolling vs. sliding contact**
- **Very low wear**
- **High shock load capacity**
- **High torsional stiffness**
- **Flat, pancake design**
- **Ratios in excess of 200:1 in the same package size are possible**
- **Quiet operation**



Cycloidal Technology – Disadvantages

- **Low reduction ratios (below 25:1) impractical**
- **Lower efficiency**
- **Large diameter**
- **Weight**
- **Higher input inertia**
- **Smoothness**



Cycloidal Technology – Commercial Variations

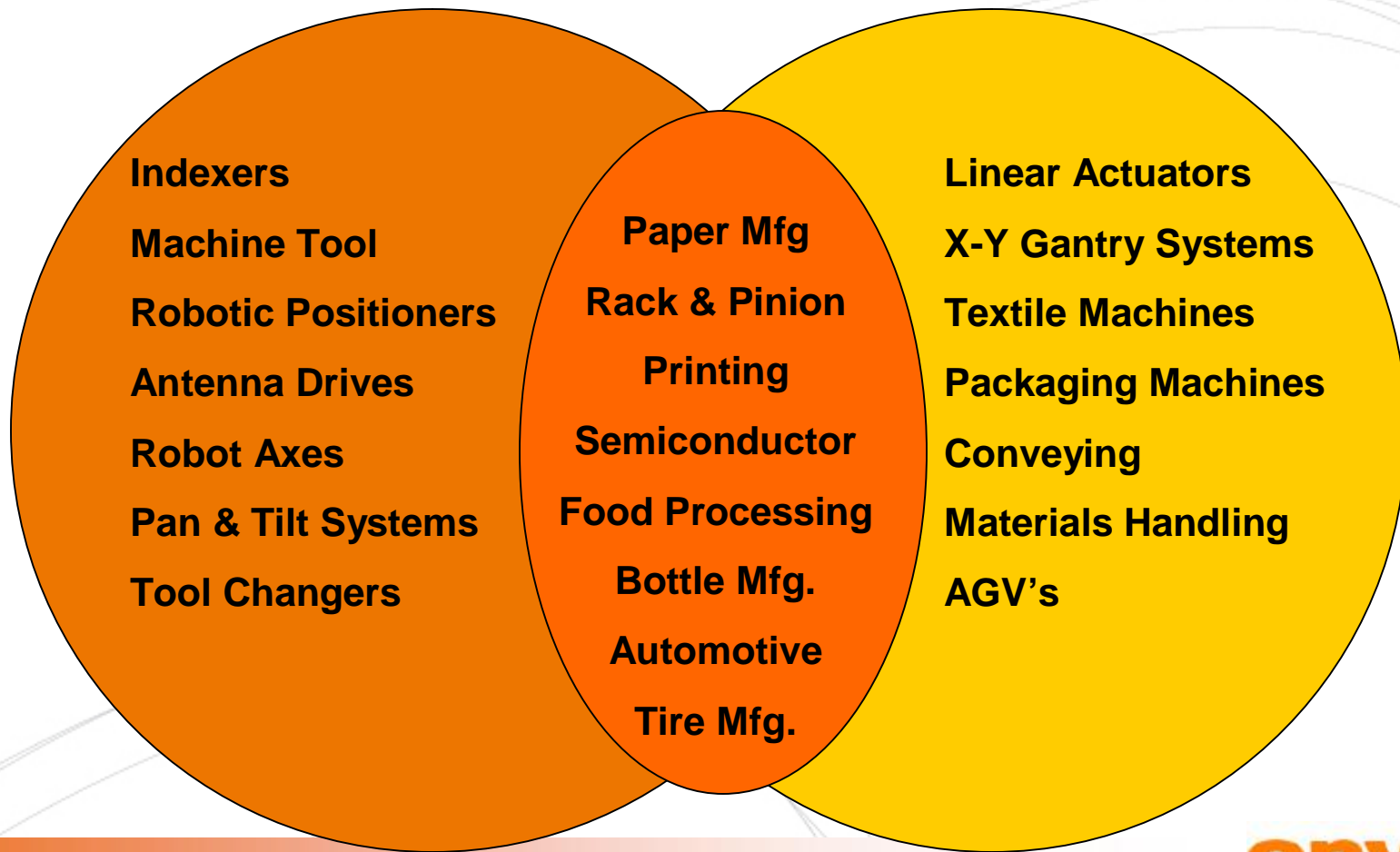
- **Single vs. compound cycloidal stage speed reduction**
- **Rollers vs. cam followers**
- **Cantilevered vs. fully supported rollers/cam followers**
- **Single, dual and triple cam arrangements**
- **Cross roller vs. angular contact ball bearing support of loads**
- **Large diameter thru-holes**



Applications by Technology

- Cycloidal Applications

- Planetary Applications



Summary

- **Two common technologies for use in servo applications**
 - **Planetary offers**
 - **Low ratios**
 - **Low backlash**
 - **High torque density**
 - **High efficiency**
 - **Cycloidal applications**
 - **High ratios**
 - **Lowest backlash**
 - **Compact design**
 - **High capacity output bearings**
- **Principle of operation of both technologies**
- **Broad applications for use with servo motors**

Questions

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THANK YOU!



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