Lecture #13

ERDM

Prof. John W. Sutherland

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The Product Design Process

- **Concept Design - System Design**
- **Module definition - Assemblies**
- **Detailed Product Design - Material Type & Features**
- **Detailed Product Design - Dimensions & Tolerances**
- **Prototyping and Testing**

So far....

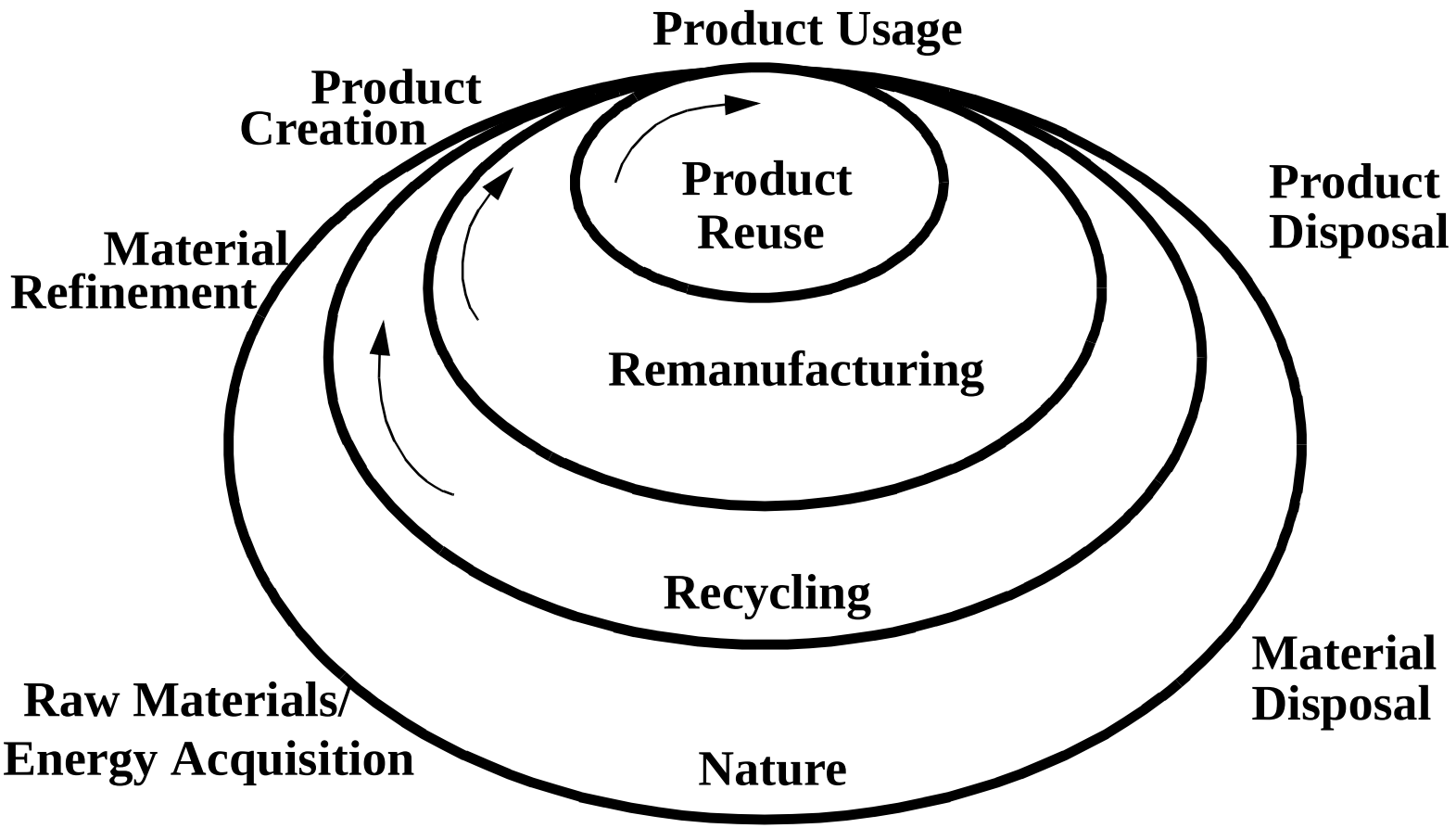
- **Want to understand how the characteristics of a product design impact the environment**

  - **Material selection issues**
    Mining & Metals processing, Plastics

  - **Concept design**
    QFD proposed as one way to “hear the voices”: customer and environment

Next: How does product design geometry influence recycling?

Product Life Cycle



Reuse?

- **What promotes it?**

- **What discourages it?**

Remanufacturing?

- **What promotes it?**

- **What discourages it?**

Recycling?

- **What promotes it?**

- **What discourages it?**

Geometric Features

Focus on a single part (element of a larger product)

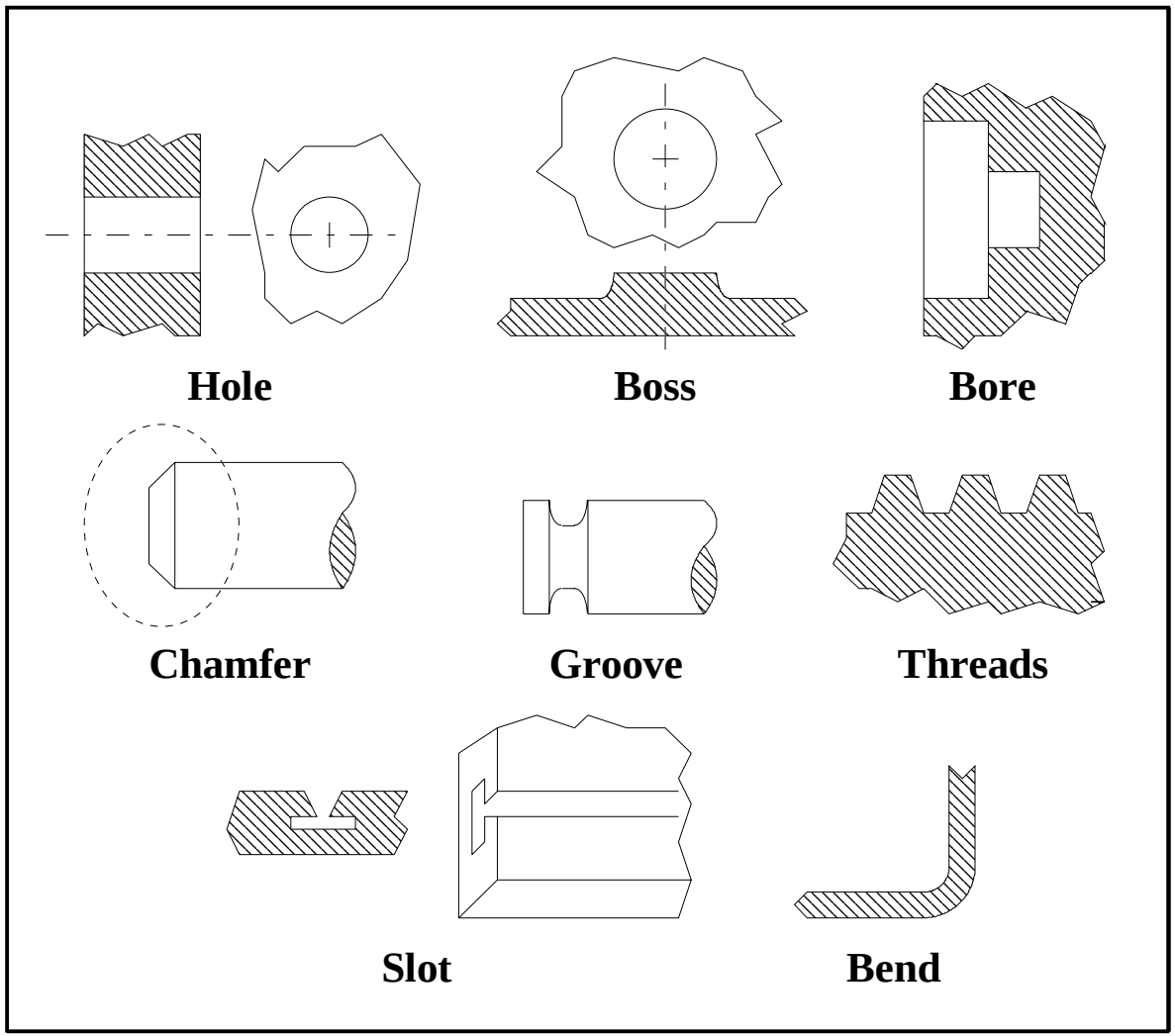
- **Holes**
- **Slots**
- **Threads**
- **Contours**

In general, the size and shape of a product.
How do these features influence the three R's??

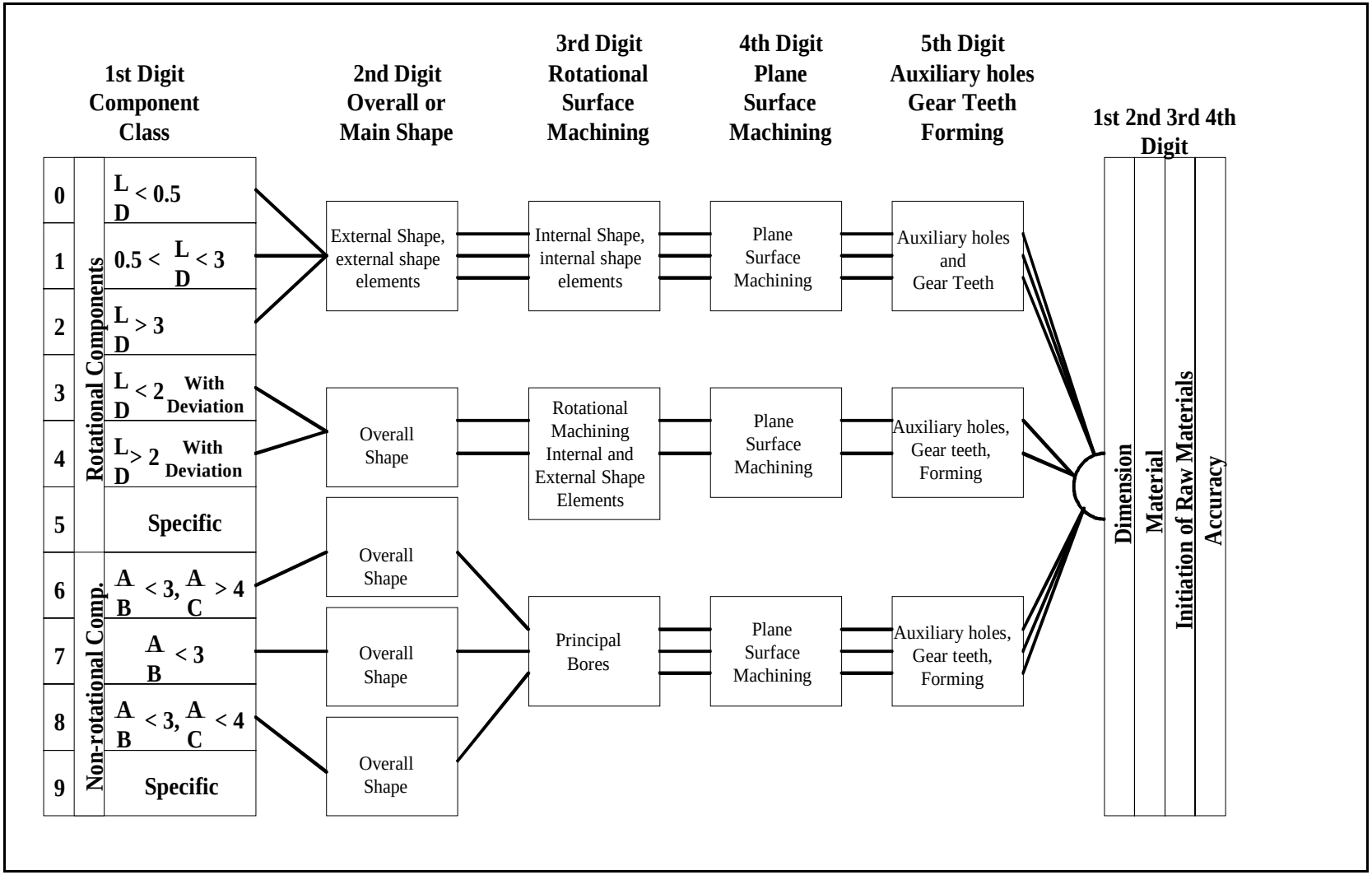
Role of Geometric Features

- **Large parts vs. small parts**
- **Large surface area vs. small**
- **Complex vs. simple**
- **Presence of mating / sliding surfaces**
- **Sections / features that experience high stress**

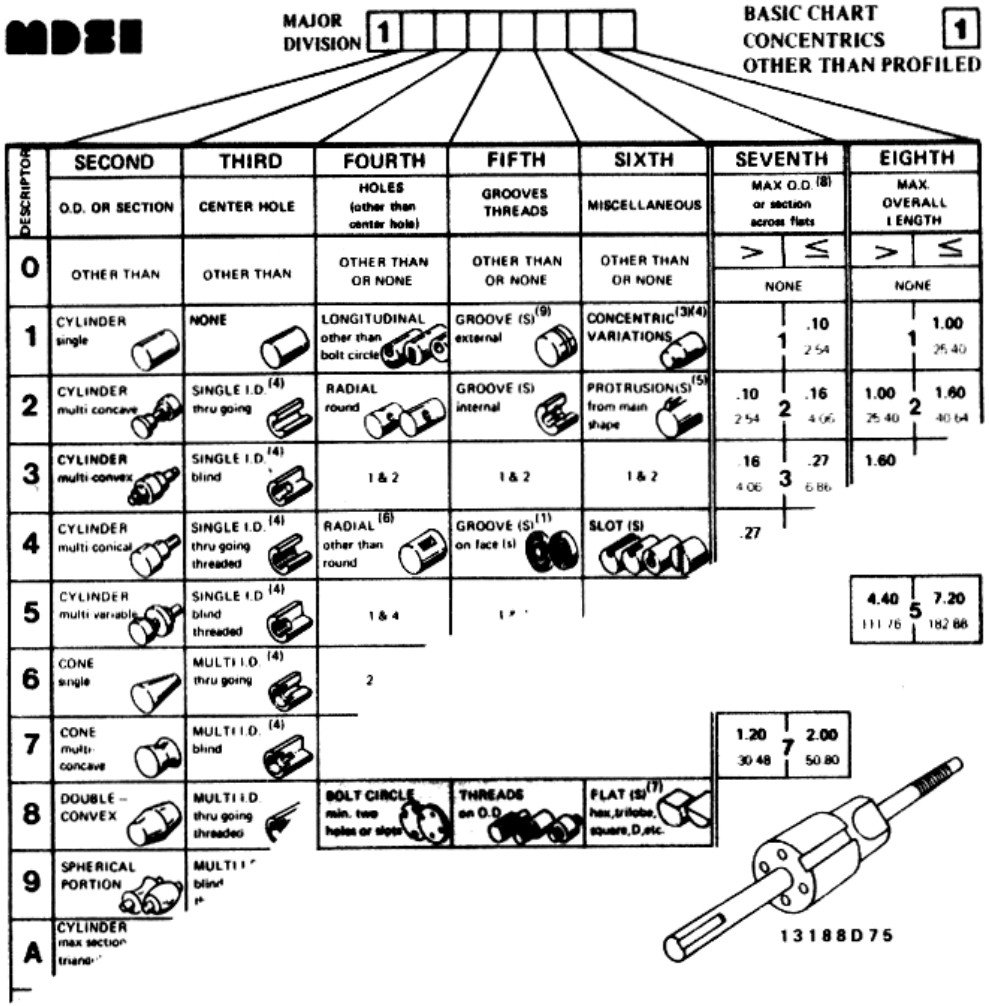
Product Features



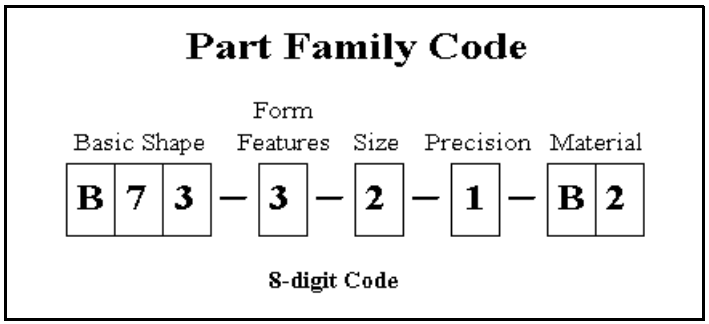
Opitz Classification Code

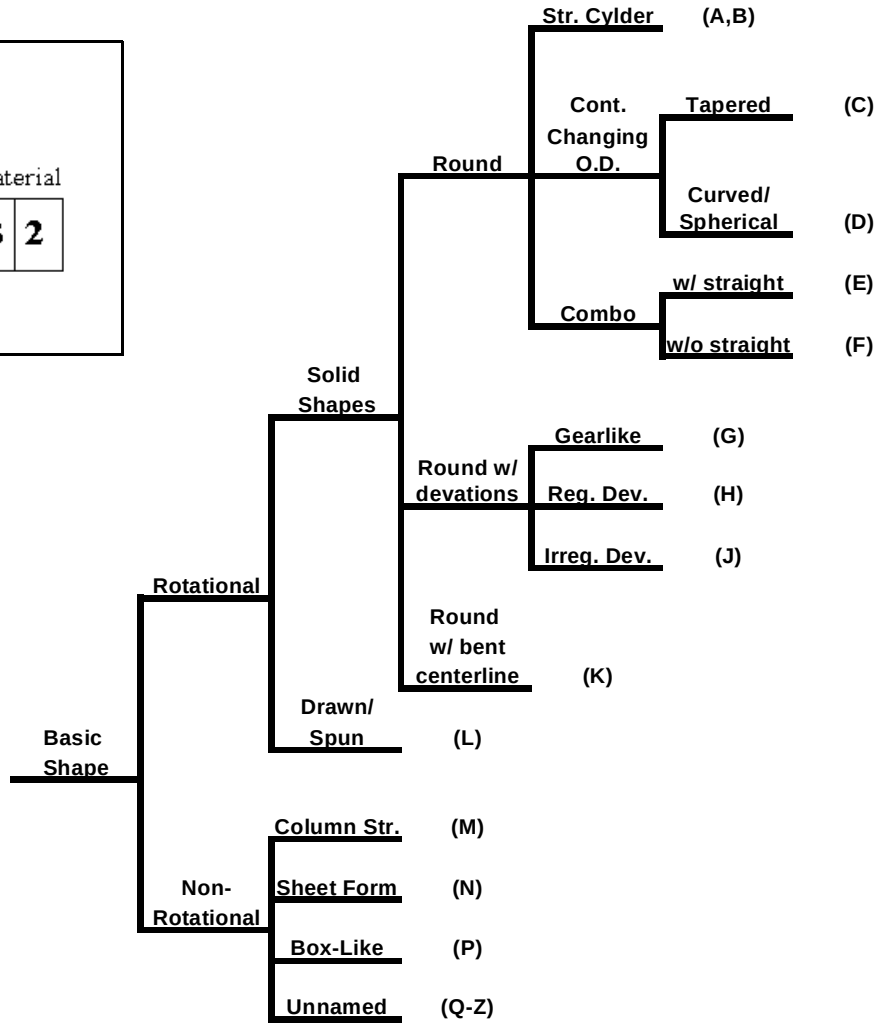


MDSI Code (Manf. Data Sys., Inc.)

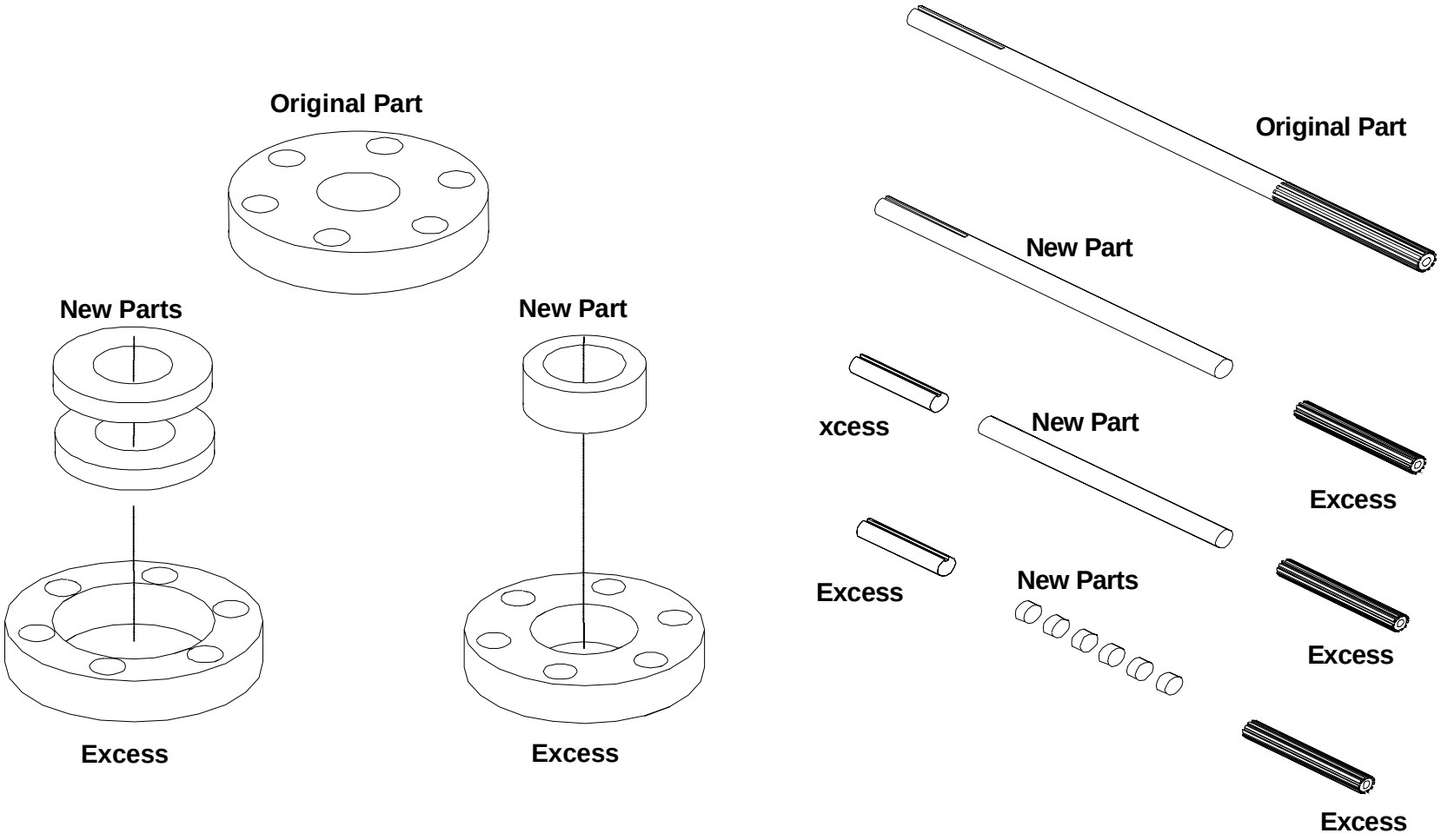


D-Class Code

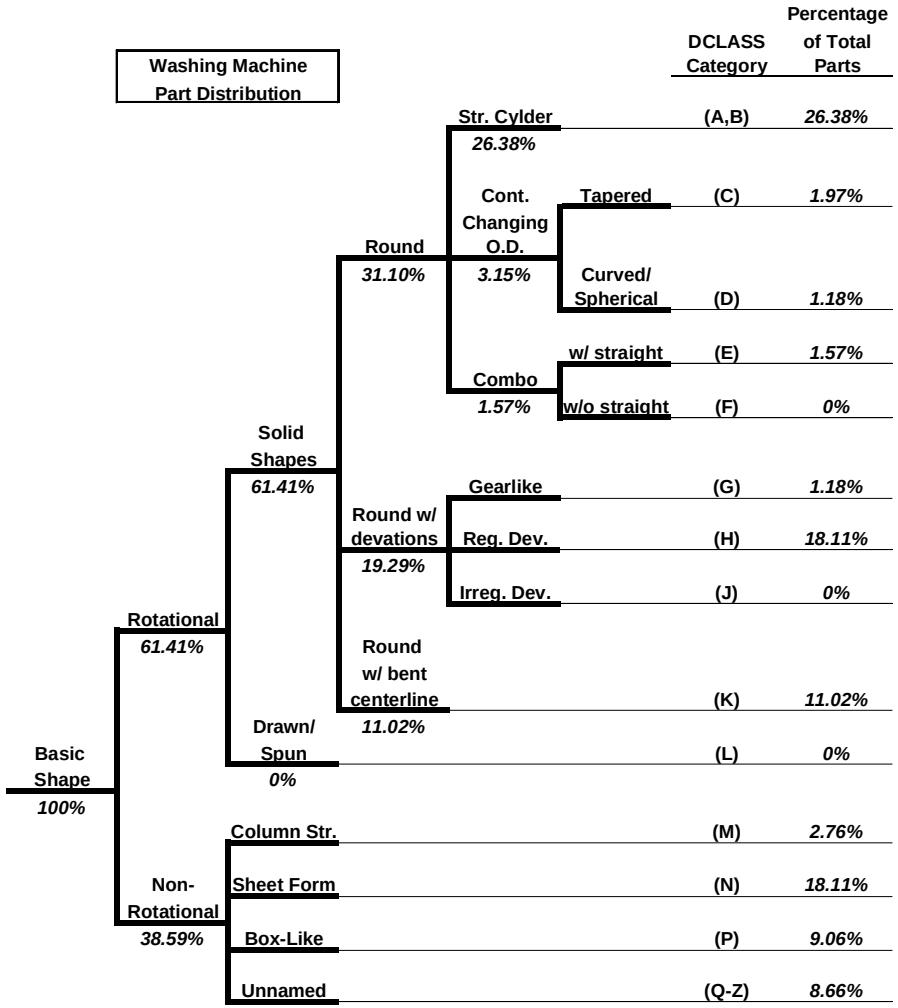




Post-use Alternatives



Washing Machine



RPI - Reprocessability Index System (Wentland)

Focus on Rotational Parts

Product	Number of Parts	Rotational Parts %
Washing Mach.	254	61%
Cordless Drill	53	60%
Automotive Jack	122	80%
Electric Drill	79	68%
Utility Engine	188	68%

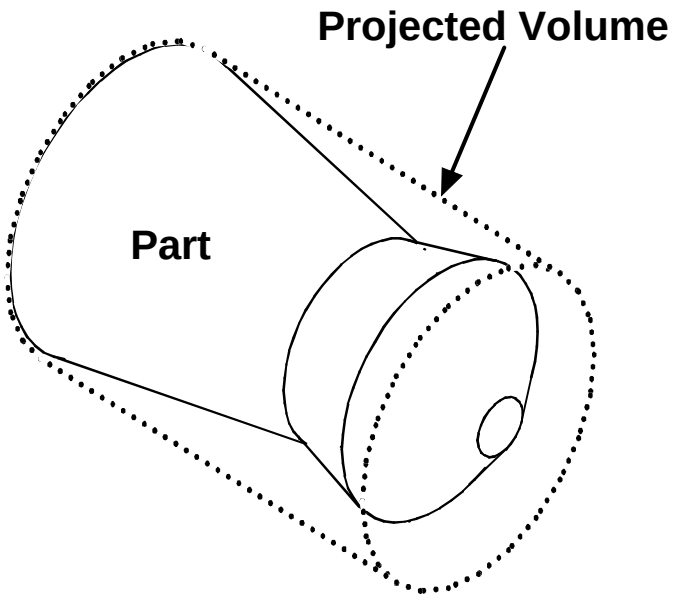
RPI Philosophy

Define metrics that, when small, are more likely result in product post-use. Metrics for the following

- **Part complexity (more complex is bad)**
- **Part size (smaller parts are bad)**
- **Removable features (preferred)**
- **Relative stress level (low stress -- less damage?)**
- **Amount of mating (moving) contact areas (minimize)**

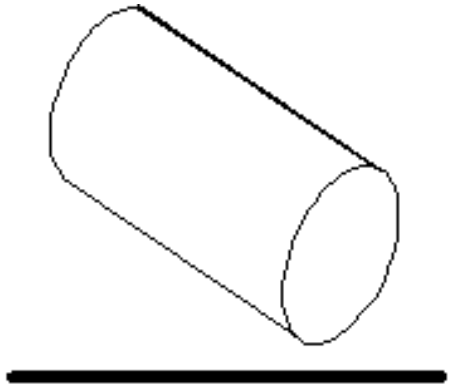
Definition of RPI Terms

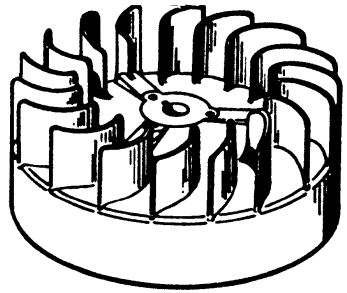
$$R_1 = \frac{\text{Volume of Bounding Volume}}{\text{Part Volume}} = \frac{V_{BV}}{V}$$

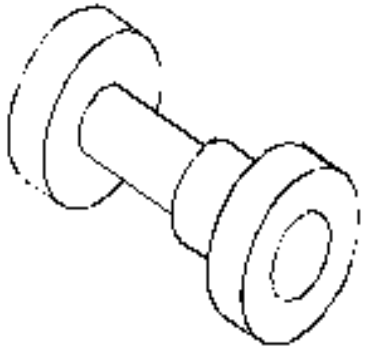


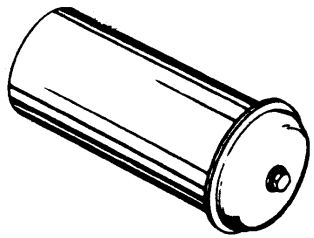
RPI Terms - 2

$$R_2 = \frac{\text{Surface Area}}{\text{Surface Area of Bounding Volume}} = \frac{SA}{SA_{BV}}$$









RPI Terms - 3

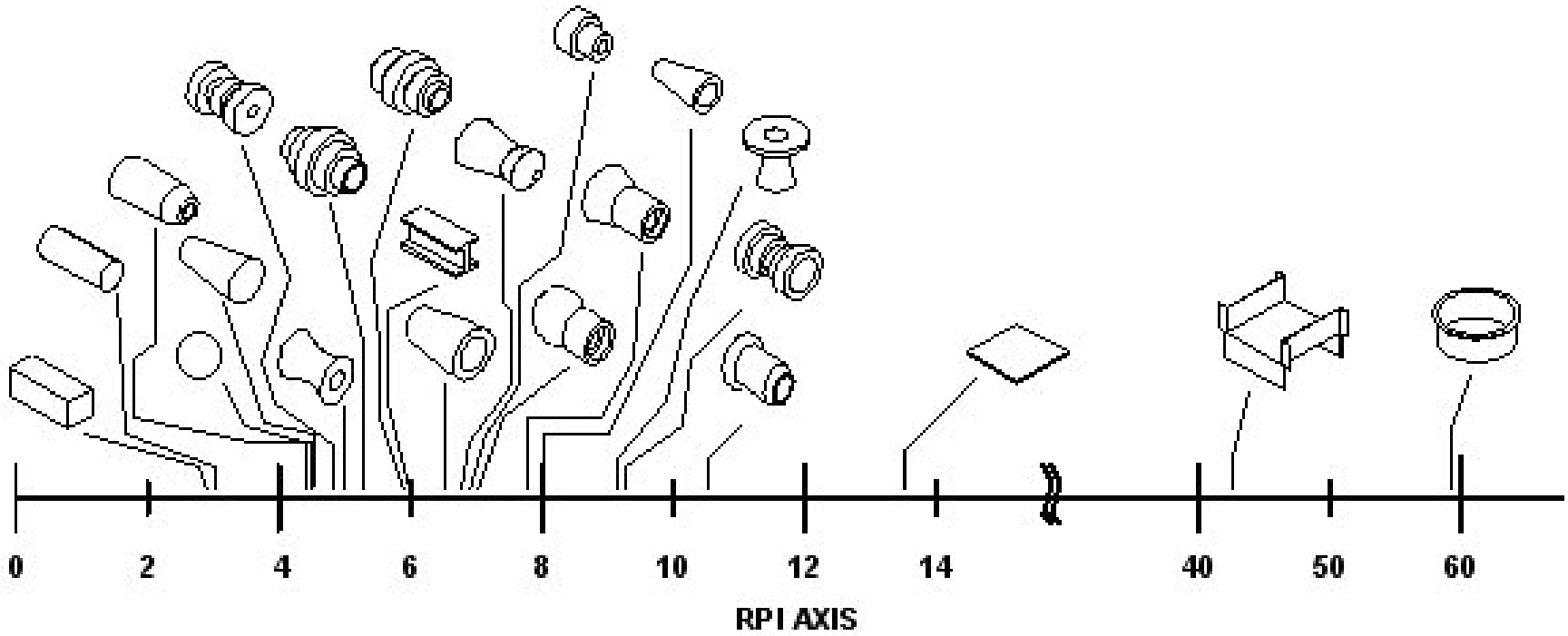
4 other terms to consider other factors

$$RPI = \sum R_i$$

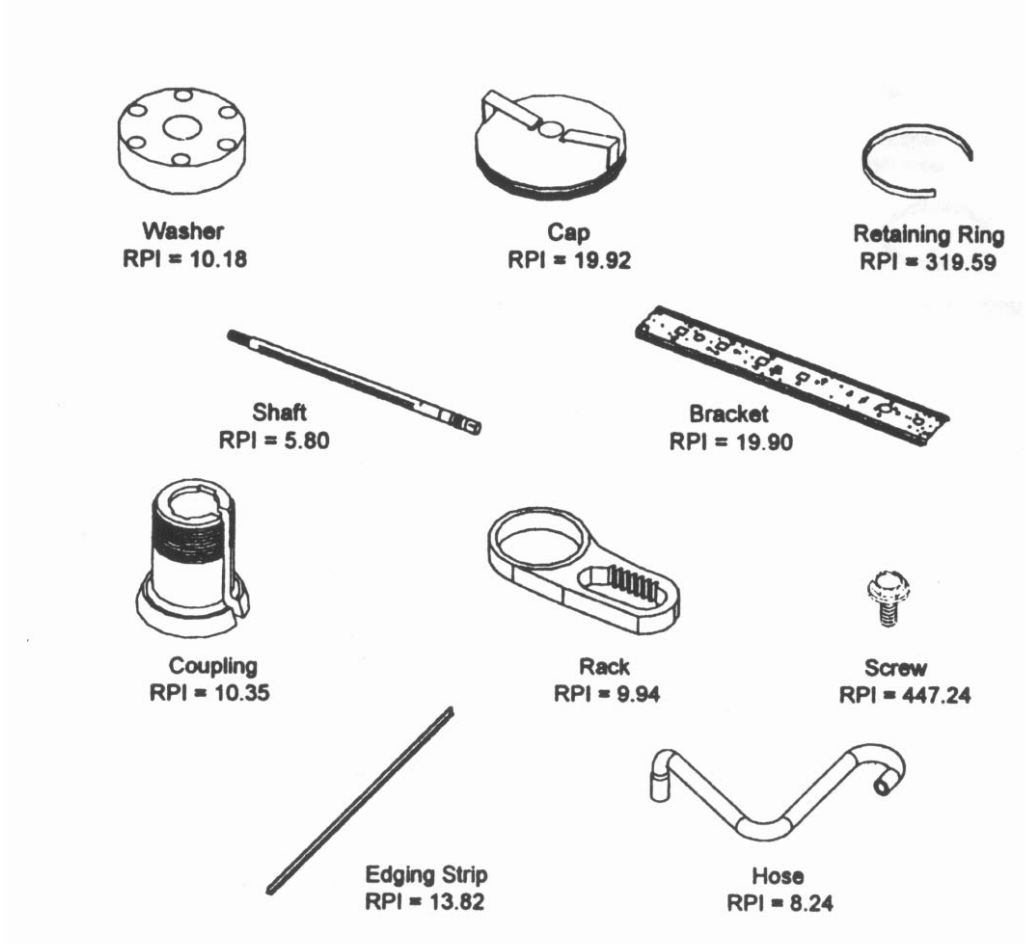
Want to minimize RPI

RPI calculation linked to AutoCAD

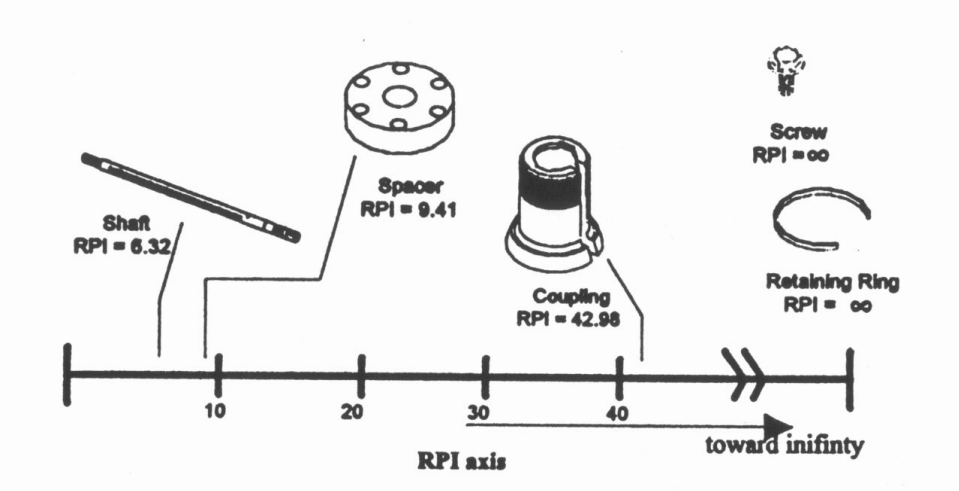
D-Class Parts

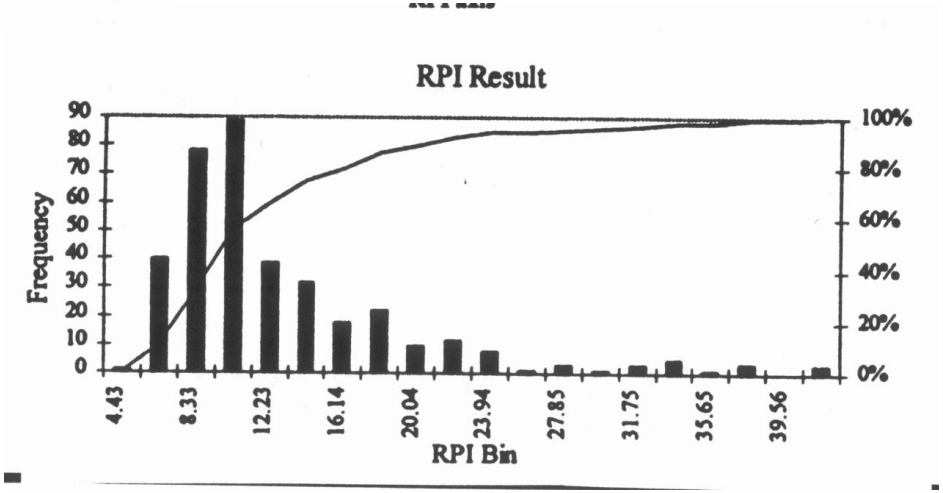


Washing Machine Parts



Washing Machine Parts - 2





Another Example