GROUP TECHNOLOGY

Overview of Group Technology (GT)
- Parts in the medium production quantity range are usually made in batches
- Disadvantages of batch production:
  - Downtime for changeovers
  - High inventory carrying costs
- GT minimizes these disadvantages by recognizing that although the parts are different, there are groups of parts that possess similarities
- GT exploits the part similarities by utilizing similar processes and tooling to produce them
- GT can be implemented by manual or automated techniques
- When automated, the term flexible manufacturing system is often applied

Group Technology Defined
- An approach to manufacturing in which similar parts are identified and grouped together in order to take advantage of their similarities in design and production
- Similarities among parts permit them to be classified into part families
- In each part family, processing steps are similar
- The improvement is typically achieved by organizing the production facilities into manufacturing cells that specialize in production of certain part families

Part Family
- A group of parts that possess similarities in geometric shape and size, or in the processing steps used in their manufacture
- Part families are a central feature of group technology
- There are always differences among parts in a family
- But the similarities are close enough that the parts can be grouped into the same family

- Two parts that are identical in shape and size but quite different in manufacturing:
  (a) 1,000,000 units/yr, tolerance = ±0.010 inch, 1015 CR steel, nickel plate
  (b) 100/yr, tolerance = ±0.001 inch, 18-8 stainless steel
Ten parts that are different in size and shape, but quite similar in terms of manufacturing

All parts are machined from cylindrical stock by turning; some parts require drilling and/or milling

Ways to Identify Part Families
1. Visual inspection - using best judgment to group parts into appropriate families, based on the parts or photos of the parts
2. Production flow analysis - using information contained on route sheets to classify parts
3. Parts classification and coding - identifying similarities and differences among parts and relating them by means of a coding scheme

Parts Classification and Coding
Most classification and coding systems are one of the following:
- Systems based on part design attributes
- Systems based on part manufacturing attributes
- Systems based on both design and manufacturing attributes

Part Design Attributes
- Major dimensions
- Basic external shape
- Basic internal shape
- Length/diameter ratio
- Material type
- Part function
- Tolerances
- Surface finish

Part Manufacturing Attributes
- Major process
- Operation sequence
- Batch size
- Annual production
Three structures used in classification and coding schemes

- Hierarchical structure, known as a mono-code, in which the interpretation of each successive symbol depends on the value of the preceding symbols.
- Chain-type structure, known as a polycode, in which the interpretation of each symbol in the sequence is always the same; it does not depend on the value of preceding symbols.
- Mixed-mode structure, which is a hybrid of the two previous codes.

Some of the important systems

- Opitz Classification System — the University of Aachen in Germany, nonproprietary, Chain type.
- Brisich System — (Brisich-Barr Inc.)
- CODE (Manufacturing Data System, Inc.)
- CUTPLAN (Metcut Associates)
- DCLASS (Brigham Young University)
- MultiClass (OIR: Organization for Industrial Research), hierarchical or decision-tree coding structure
- Part Analog System (Lovelace, Lawrence & Co., Inc.)

Basic Structure of the Opitz Parts Classification and Coding System

<table>
<thead>
<tr>
<th>Digit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Part shape class: rotation versus nonrotational (Figure 22.1). Rotational parts are classified by length-to-diameter ratio. Nonrotational parts by length, width, and thickness.</td>
</tr>
<tr>
<td>2</td>
<td>External shape features; various types are distinguished.</td>
</tr>
<tr>
<td>3</td>
<td>Rotational machining. This digit applies to internal shape features (e.g., holes, threads) on rotational parts, and general rotational shape features for nonrotational parts.</td>
</tr>
<tr>
<td>4</td>
<td>Plane machined surfaces (e.g., flats, slots).</td>
</tr>
<tr>
<td>5</td>
<td>Auxiliary holes, gear teeth, and other features.</td>
</tr>
<tr>
<td>6</td>
<td>Dimensions—overall size.</td>
</tr>
<tr>
<td>7</td>
<td>Work material (e.g., steel, cast iron, aluminum).</td>
</tr>
<tr>
<td>8</td>
<td>Original shape of raw material.</td>
</tr>
<tr>
<td>9</td>
<td>Accuracy requirements.</td>
</tr>
</tbody>
</table>

Basic structure of the Opitz system of parts classification and coding.
Form code (digits 1-5) for rotational parts in the Opitz coding system

<table>
<thead>
<tr>
<th>Digit 1</th>
<th>Digit 2</th>
<th>Digit 3</th>
<th>Digit 4</th>
<th>Digit 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part class</td>
<td>External shape, external shape elements</td>
<td>Internal shape, internal shape elements</td>
<td>Plane surface machining</td>
<td>Auxiliary holes and gear teeth</td>
</tr>
<tr>
<td>0</td>
<td>L/D ≤ 0.5</td>
<td>Smooth, no shape elements</td>
<td>No hole, no breakthrough</td>
<td>No auxiliary hole</td>
</tr>
<tr>
<td>1</td>
<td>0.5 &lt; L/D &lt; 3</td>
<td>No shape elements</td>
<td>No shape elements</td>
<td>Axial, net on pitch circle diameter</td>
</tr>
<tr>
<td>2</td>
<td>L/D ≥ 3</td>
<td>Thread</td>
<td>Thread</td>
<td>Axial on pitch circle diameter</td>
</tr>
<tr>
<td>3</td>
<td>Stepped to one end</td>
<td>Functional groove</td>
<td>Functional groove</td>
<td>Axial and/or radial and/or other direction</td>
</tr>
<tr>
<td>4</td>
<td>No shape elements</td>
<td>No shape elements</td>
<td>External plane surface related by graduation around the circle</td>
<td>Axial and/or radial and/or other direction</td>
</tr>
<tr>
<td>5</td>
<td>Thread</td>
<td>Thread</td>
<td>External groove and/or slot</td>
<td>Axial and/or radial and/or other direction</td>
</tr>
<tr>
<td>6</td>
<td>Functional groove</td>
<td>Functional groove</td>
<td>External spline (polygon)</td>
<td>Axial and/or radial and/or other direction</td>
</tr>
<tr>
<td>7</td>
<td>Functional cone</td>
<td>Functional cone</td>
<td>Internal spline (polygon)</td>
<td>Spur gear teeth</td>
</tr>
<tr>
<td>8</td>
<td>Operating thread</td>
<td>Operating thread</td>
<td>Internal and external polygon, groove and/or slot</td>
<td>Bevel gear teeth</td>
</tr>
<tr>
<td>9</td>
<td>All others</td>
<td>All others</td>
<td>All others</td>
<td>Other gear teeth</td>
</tr>
</tbody>
</table>

Example 1: A part coded 20801
- 2 - Parts has L/D ratio >= 3
- 0 - No shape element (external shape elements)
- 8 - Operating thread
- 0 - No surface machining
- 1 - Part is axial

Example 2: given the part design shown define the "form code" using the Opitz system

Step 1: The total length of the part is 1.75, overall diameter 1.25,
L/D = 1.4 (code 1)

Step 2: External shape - a rotational part that is stepped on both with one thread (code 5)

Step 3: Internal shape - a through hole (code 1)

Step 4: By examining the drawing of the part (code 0)

Step 5: No auxiliary holes and gear teeth (code 0)

Code: 15100

MultiClass – developed by the Organization for Industrial Research (OIR)

- First 10 digits of the MultiClass Classification and Coding System
MultiClass Coding System example – the rotational part design

MultiClass code number for the rotational part
Possible ambiguity with a coding system

Benefits of a Well-Designed Classification and Coding System

- Facilitates formation of part families
- Permits quick retrieval of part design drawings
- Reduces design duplication
- Promotes design standardization
- Improves cost estimating and cost accounting
Facilitates NC part programming by allowing new parts to use the same part program as existing parts in the same family

Computer-aided process planning (CAPP) becomes feasible

**Composite Part Concept**

- A *composite part* for a given family is a hypothetical part that includes all of the design and manufacturing attributes of the family.
- In general, an individual part in the family will have some of the features of the family, but not all of them.
- A production cell for the part family would consist of those machines required to make the composite part.
- Such a cell would be able to produce any family member, by omitting operations corresponding to features not possessed by that part.

**Composite Part Features and Corresponding Manufacturing Operations**

<table>
<thead>
<tr>
<th>Design feature</th>
<th>Corresponding operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. External cylinder</td>
<td>Turning</td>
</tr>
<tr>
<td>2. Face of cylinder</td>
<td>Facing</td>
</tr>
<tr>
<td>3. Cylindrical step</td>
<td>Turning</td>
</tr>
<tr>
<td>4. Smooth surface</td>
<td>External cylindrical grinding</td>
</tr>
<tr>
<td>5. Axial hole</td>
<td>Drilling</td>
</tr>
<tr>
<td>6. Counterbore</td>
<td>Counterboring</td>
</tr>
<tr>
<td>7. Internal threads</td>
<td>Tapping</td>
</tr>
</tbody>
</table>

**Machine Cell Designs (Types of GT cells):**

(a) Single machine
(b) Multiple machines with manual handling
(c) Multiple machines with mechanized handling
(d) Flexible manufacturing cell
(e) Flexible manufacturing system
Benefits of Group Technology

- Standardization of tooling, fixtures, and setups is encouraged
- Material handling is reduced
  - Parts are moved within a machine cell rather than entire factory
- Process planning and production scheduling are simplified
- Work-in-process and manufacturing lead time are reduced
- Improved worker satisfaction in a GT cell
- Higher quality work

Problems in Group Technology

- Identifying the part families (the biggest problem)
  - If the plant makes 10,000 different parts, reviewing all of the part drawings and grouping the parts into families is a substantial task
- Rearranging production machines in the plant into the appropriate machine cells
  - It takes time to plan and accomplish this rearrangement, and the machines are not producing during the changeover