

#### ENGR480 Manufacturing Systems

- MWF 12:00, Lab Tue 2:00
- Read Syllabus for other info



## What is Manufacturing?

- Man-u-fac-ture: To make or process a raw material into a finished product, esp. by means of a large-scale industrial operation.
- From Latin manu + factus: by hand, to



## Manufacturing Operations

- Processing
  - Shaping (solidification, deformation, material removal, or particulate processing)
  - Property Enhancement (heat treatment)
  - Surface Processing (cleaning, coating)
- Assembly
   Permanent (welding, adhesive, rivets, presshit)
  - Reversible (threaded fasteners, friction fit)

## Short History of Manufacturing

- 3000BC: Egyptian and Korean sand casting
- 1000BC: Iron age began
- 26BC: Egyptian lathe turning
- 1770AD: Steam engine, industrial revolution
- 1801: Interchangeable parts
- 1911: F.W.Taylor's "Principles of Scientific Management", Henry Ford's mass production
- 1965: Toyota Production System, single-piece flow
- 2000: Virtual corporations, global manufacturing

#### **Our Manufacturing Company**

- You thought this was a class it's really a manufacturing company (we'll call it Puzzazzle Inc)
- Our products are six-piece wooden puzzles

Automated Wood Block Puzzle Cutter

Designed and Fabricated by:

Jonathan Knoll Paul Robertson Collin Stevens

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12-11

## Some Questions a Manufacturer Needs Answered

- Who is going to buy our product?
- How much will they pay for it?
- How much quality will we put into it?
- How much will it cost to make?
- How much money will we make?
  What will making this product do to the Farth?

## The Next Questions

- Will we make 1 or 1,000,000 units?
- Should this product be durable or disposable?
- What will be our production schedule?
- How long can development take?
- How much should we invest in production efficiency for this product?



#### Case History: Forge Industrial

- Cement and sand bagging plant
- Manual palletizing:
  - 120 pallets/day, 56 bags/pallet, 60 lb/bag = 400,000 lb/day
  - Crew of 4 (work release), changed twice/day

Automatic palletizer

- 200 pallets/day (672,000 lb/day, 68% increase

## Analyzing the Product



# Analyzing the Stapler



## Stapler Example



## Stapler Example

• Liaison Diagram with Key Characteristics



## Our Product

- Six-piece Wooden "Burr" Puzzles
- Production Rate Goal of 1 puzzle/min
- Raw material is 3/4"x3/4" hardwood, with lengths of 2-1/4".

## Solid and General Burrs

- Solid burr
  - no internal voids
  - Last piece inserted has no notches
  - First piece out takes one step
  - 314 solvable solid puzzles possible
  - General burr – One or more internal voids
    - Multiple steps to remove first piece
    - 74,086 solvable puzzles that take 5 steps to remove first piece!

## Notchable, Machinable, and General Pieces



- We only need to produce notchable pieces
- There are 59 notchable pieces, of which 25 are needed to make all possible solid burrs
- IBM Research Burr Puzzles site: http://www.research.ibm.com/BurrPuzzles