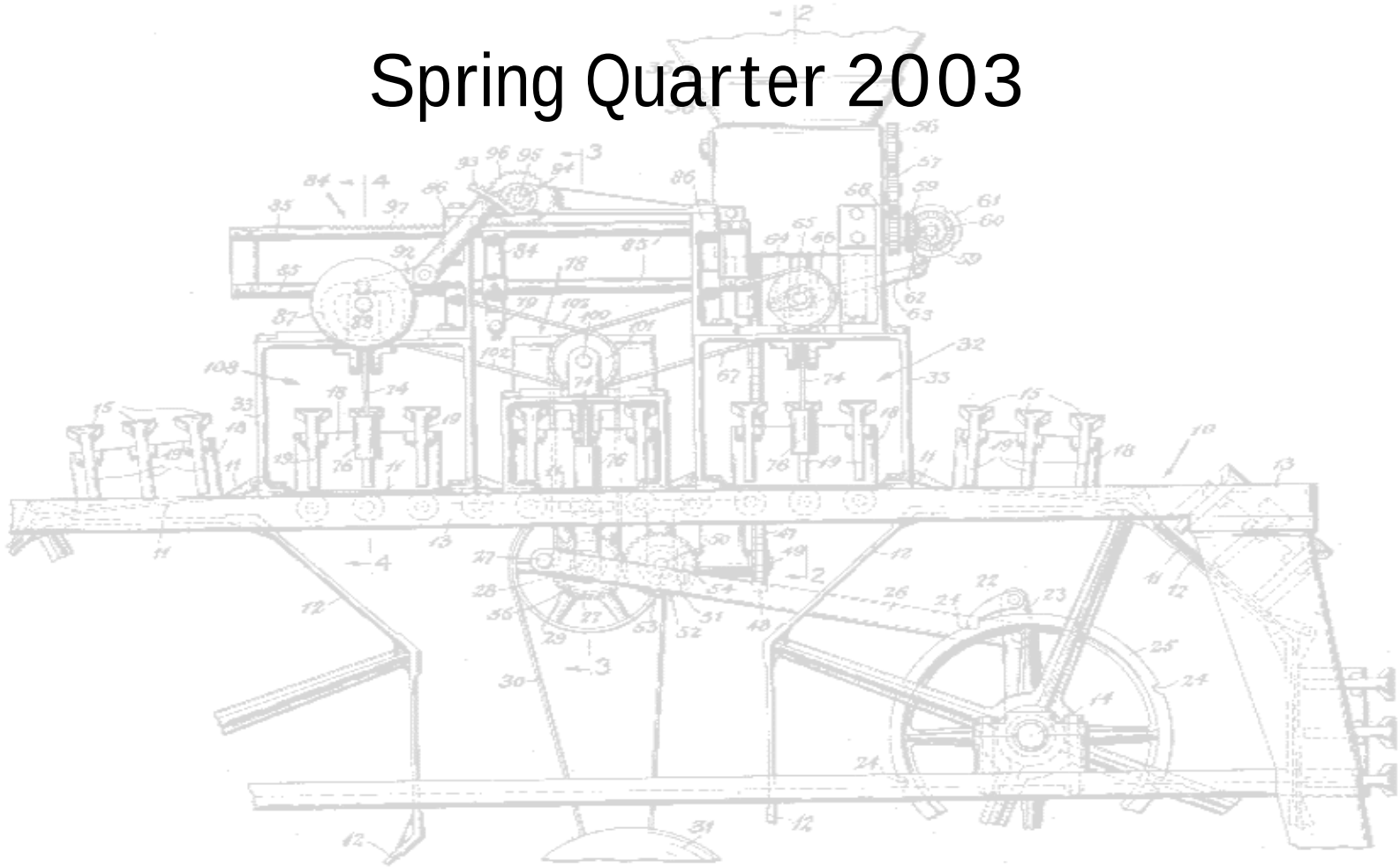
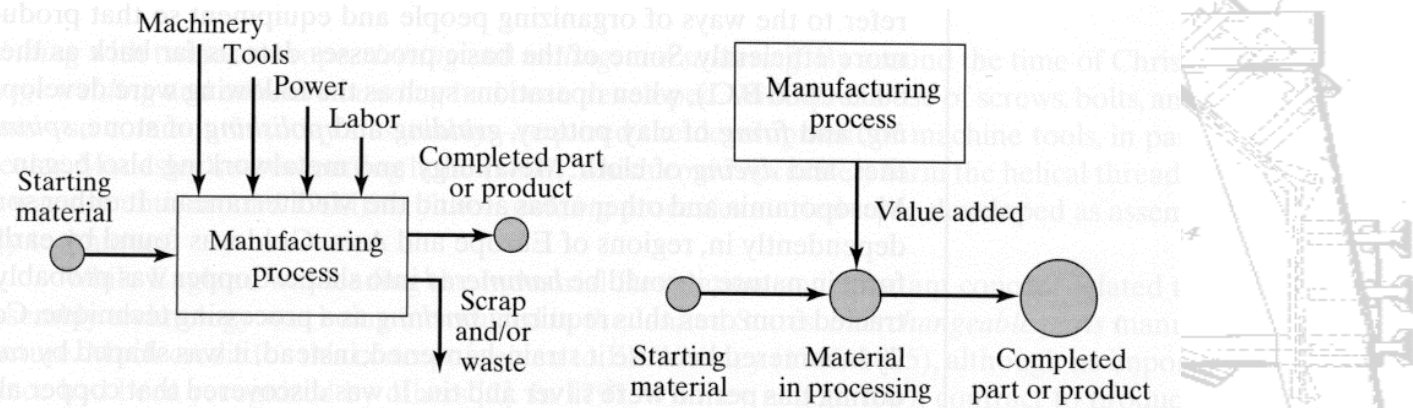
ENGR480 Manufacturing Systems

Spring Quarter 2003



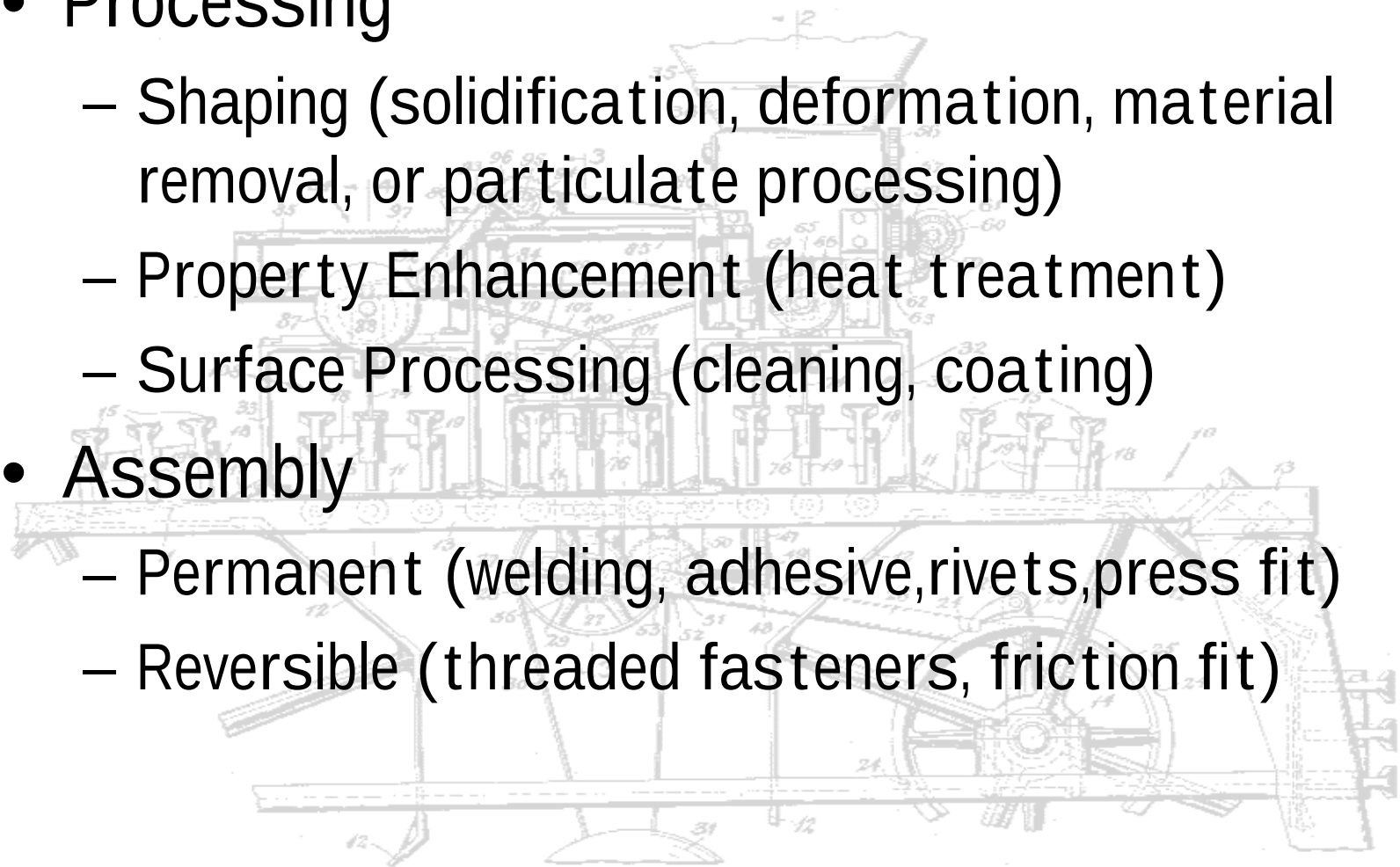
What is Manufacturing?

- 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 make



Manufacturing Operations

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



Short History of Manufacturing

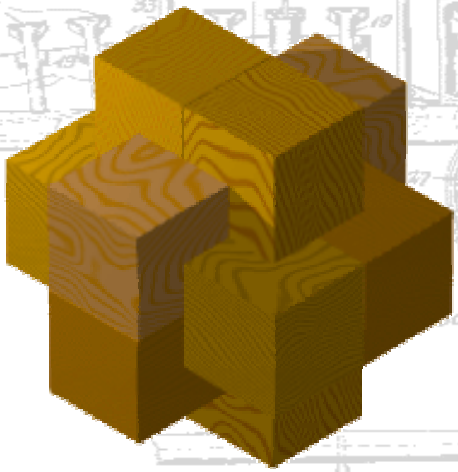
- 3000BC: Egyptian and Korean sand casting
- 1000BC: Iron age began
- 26BC: Egyptian lathe turning
- 1770AD: Steam engine, industrial revolution
- 1801: Interchangeable parts
- 1911: F.W.Taylor's "Principles of Scientific Management", Henry Ford's mass production
- 1980's: Concurrent engineering and TQM
- 2000: Virtual corporations & global commerce

Our Manufacturing Company

- You thought this was a class – it is really a manufacturing company

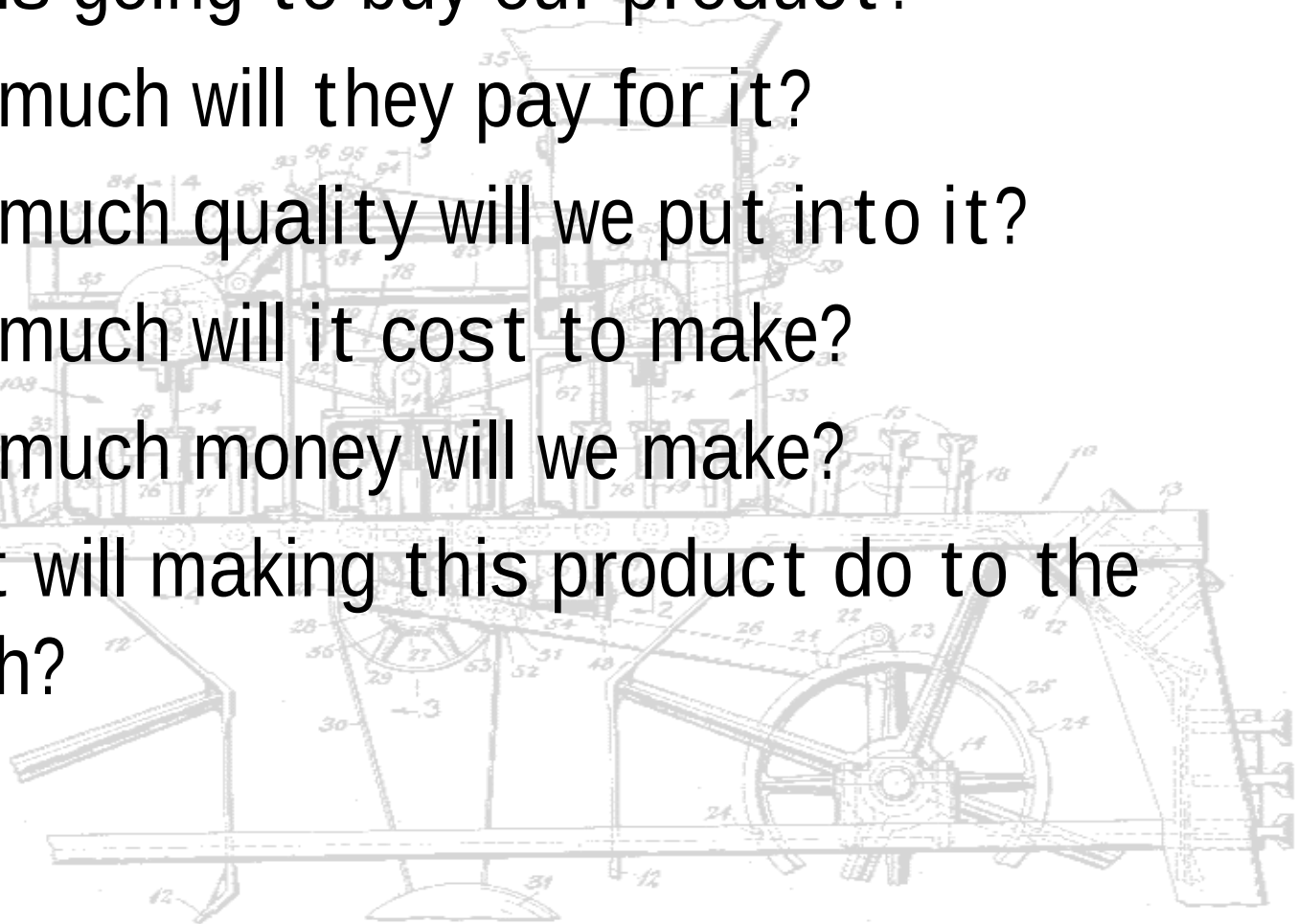
  (we'll call it *Puzzazzle Inc*)

- Our products are six-piece wooden puzzles



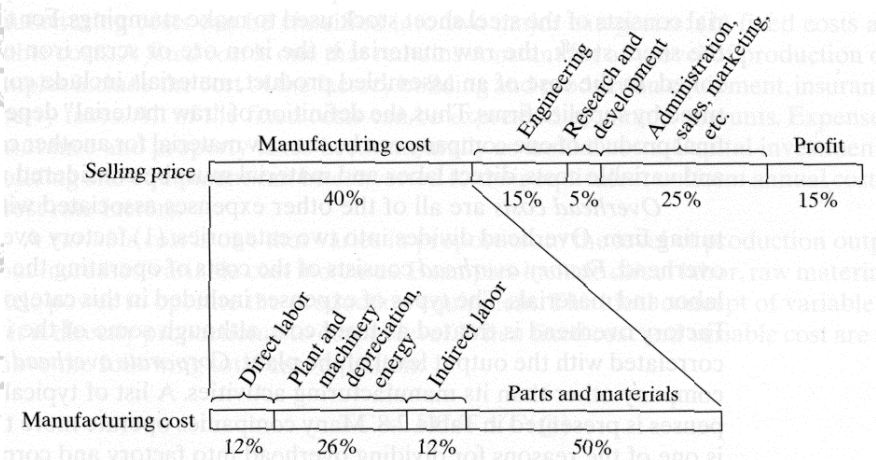
Some Questions a Mfg'r Needs Answered

- 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 Earth?



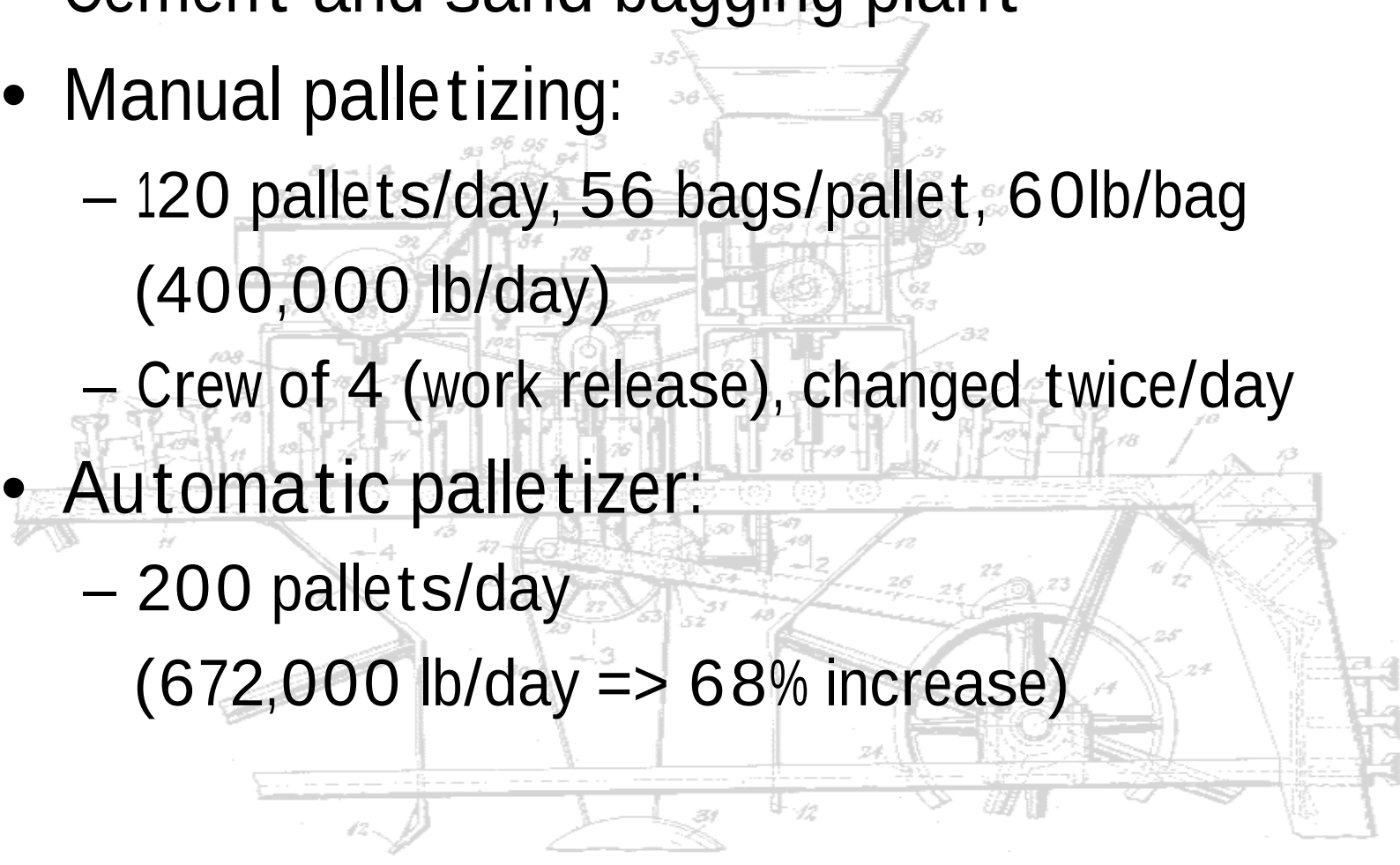
The Next Questions

- Will we make 1 or 1,000,000 units?
- Is this a "consumable" or a major asset?
- How long a development time can we afford?
- How much should we invest in production efficiency for this product?



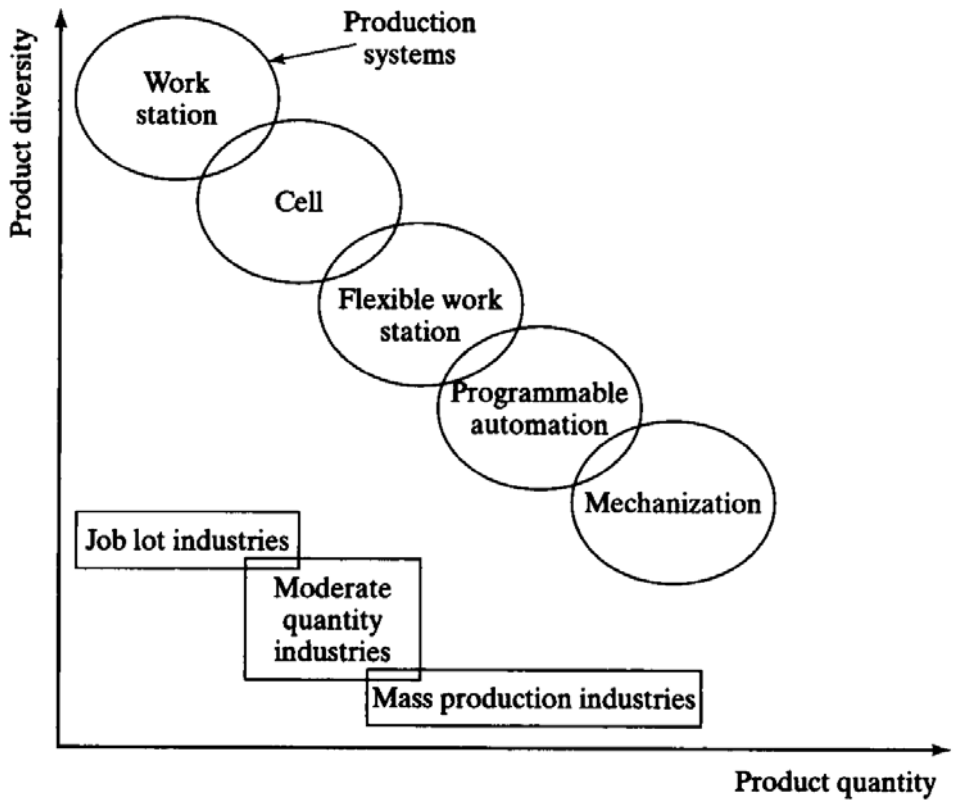
Case History: Forge Industrial

- Cement and sand bagging plant
- Manual palletizing:
  - 120 pallets/day, 56 bags/pallet, 60lb/bag (400,000 lb/day)
  - Crew of 4 (work release), changed twice/day
- Automatic palletizer:
  - 200 pallets/day (672,000 lb/day => 68% increase)



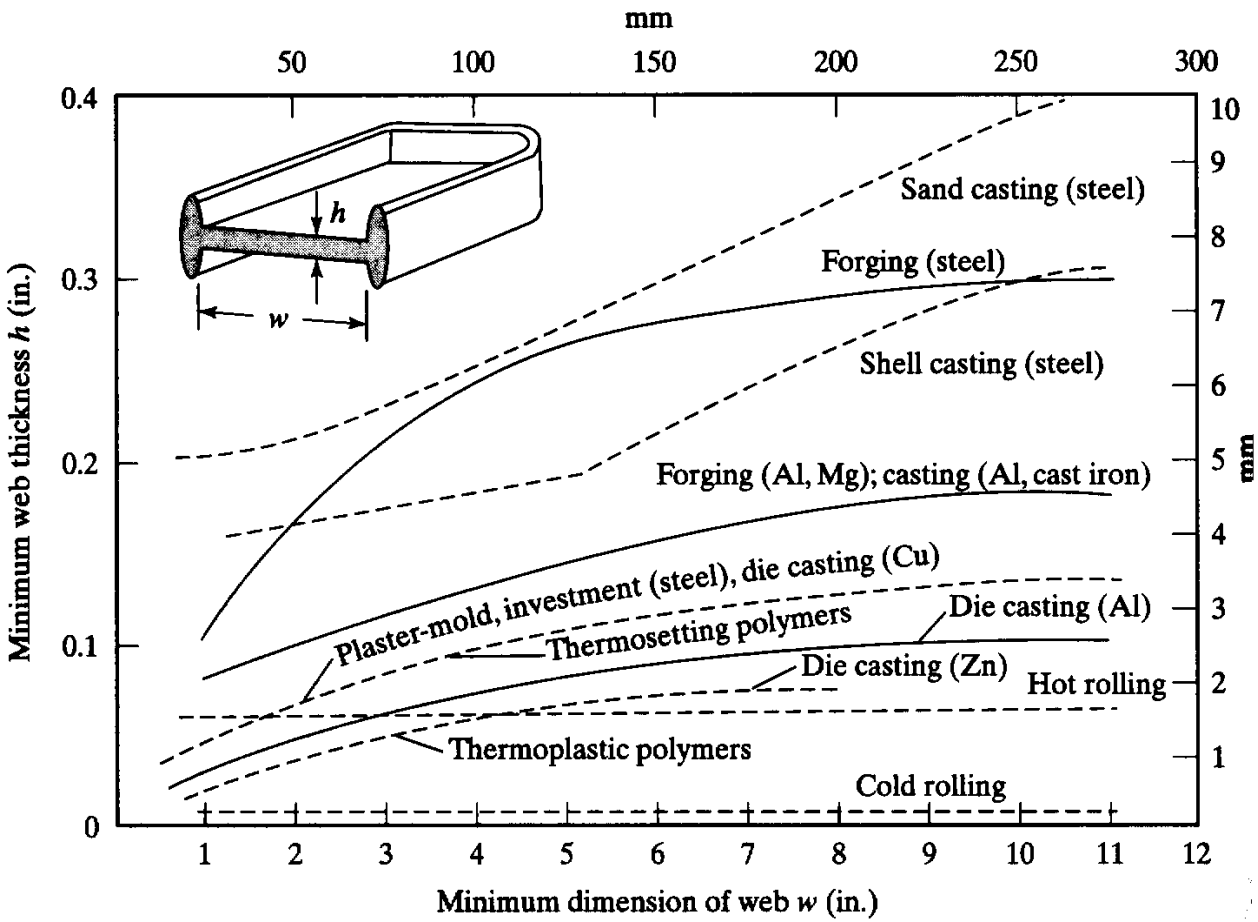
Analyzing the Product

- What is the required production rate?



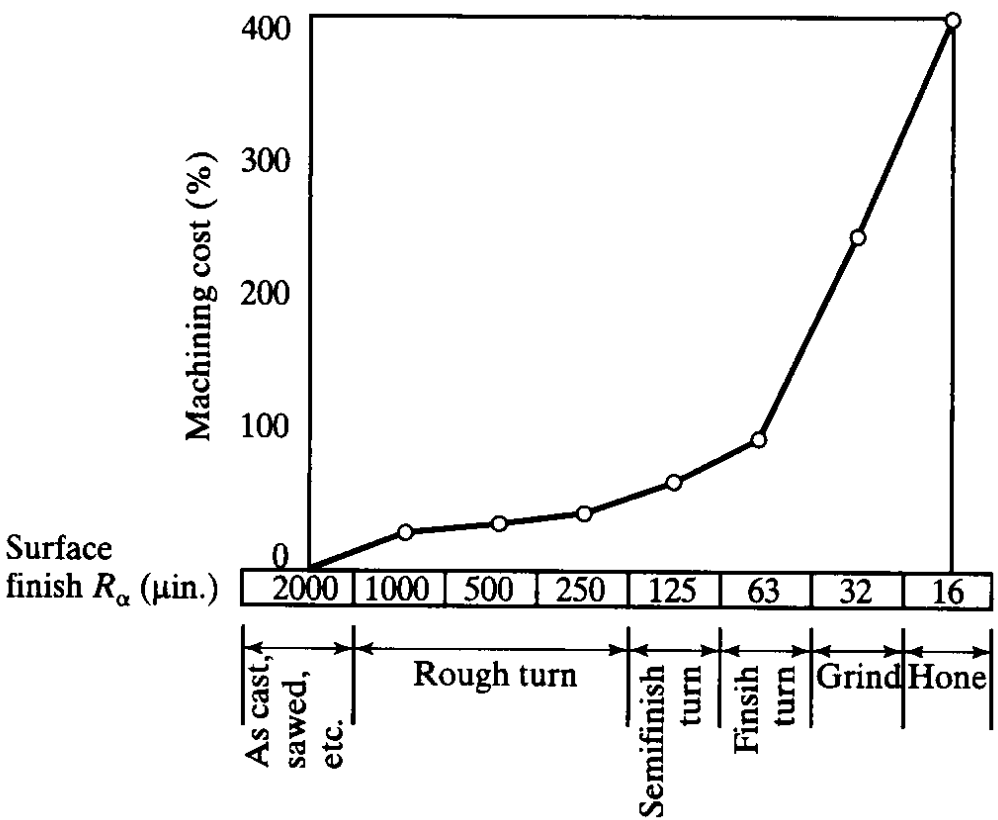
Analyzing the Product

- What are the materials and dimensions?

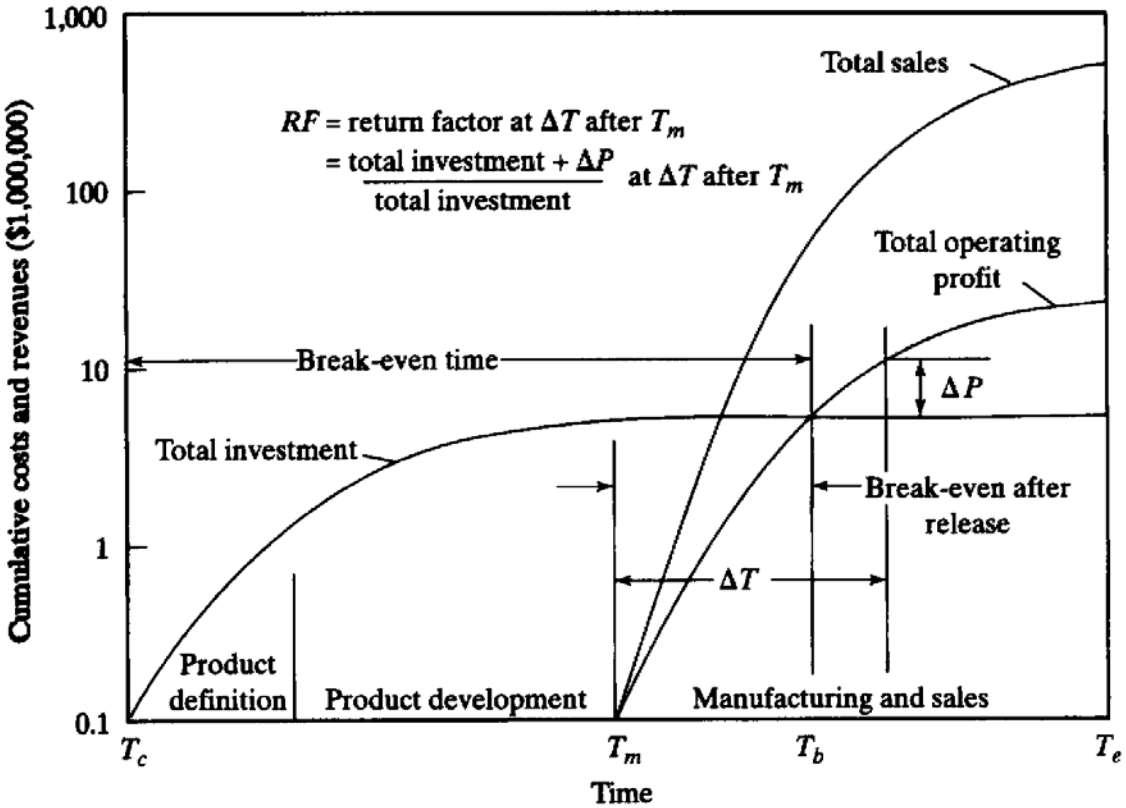


Analyzing the Product

- What are the required tolerances?

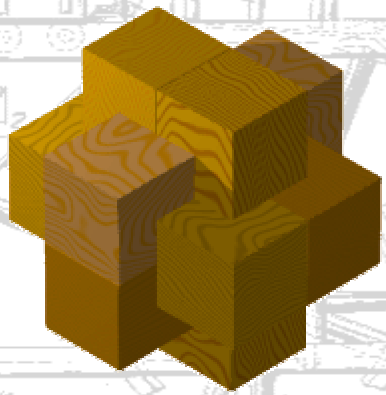


Profit Potential



Our Product

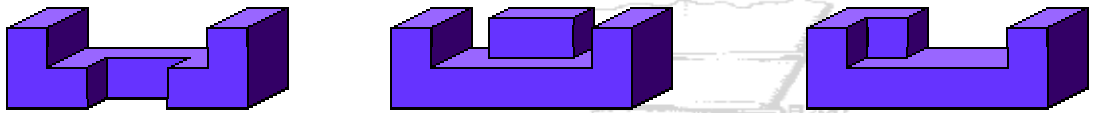
- Six-piece Wooden “Burr” Puzzle
- Production Rate of One Puzzle/minute (batches of fifteen puzzles)
- Raw material is 3/4”x3/4” hardwood strips, lengths of 2.25”, 3”, 3.75”, or 4.5” (6,8,10,or 12 units)



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
  - 74,085 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 solid burrs.
- IBM Research – Buzz Puzzles site:

  http://www.research.ibm.com/BurrPuzzles/