The Problem

• **Input:**
  – The set of components on the board
  – For each component, a set of alternative components, if any
  – For each component, a set of appropriate processes, including alternate processes, if any
  – Component characteristics: costs, defect rates
  – Process characteristics: yields, runtimes, setup times
  – The list of suppliers, the set of components supplied by each supplier
  – Supplier characteristics: lead times, quantity discount structures
  – Batch size, labor cost

• **Output:**
  – A set of solutions (designs) that are efficient with respect to five metrics - cost, yield, supplier lead time, number of suppliers, and quantity discounts
Assembly Data Model
Design and Manufacture of Microwave Modules

- Device Conceptualization and Architecture
- Individual Module Design
- Prototype Manufacturing
- Process Planning
- Module Manufacturing
- Module Testing & Tuning
- Module Design
  - Electrical
    - Schematic
    - Artwork
  - Mechanical
    - Component selection
- Substrate Design & Population
- Device Assembly

- areas we are addressing
Data Flow for Design Tradeoff

- Oracle Database
  - List of parts
  - List of alternative parts
  - List of <Part, Processes> (w/without precluded processes)
    - Alternative Designs
      - exclude precluded processes
      - include precluded processes
  - Files

- HTN planner
  - Files
  - Tradeoff Analysis
    - HTN planner

- Eesof
  - Suppliers
  - Parts
  - Process

- Viewing

Cost-Quality Tradeoff Curve for a Design

FILE containing the solution corresponding to the chosen point on the Cost-Quality curve:
Function Blocks, Assemblies, Parts, Processes.

Set of efficient solutions to problem $P$
Constraints

- For each component, choose exactly one among its alternatives \( \sum_{j \in v} x_{j} = 1 \) \( k \in v \)
- For each process related to a component, choose exactly one among its alternative \( \sum_{p \in P, j} x_{pj} = x_{j} \) \( \forall p, i \in Pj \)
- Selection of processes \( y_{p} \geq x_{pj} \) \( \forall p, j \)
- Selection of suppliers \( w_{i} \geq x_{j} \) \( \forall i \in S, j \in S \)
- Integrality \( y_{p}, x_{pj}, w_{s} \in \{0, 1\} \) \( \forall j, p, s \)

Performance metrics Expressions

Material cost: \( C_{m} = \sum_{i} n_{i} c_{i} x_{i} \)

Runtime cost: \( C_{r} = \ell \sum_{p, j} t_{pj} x_{pj} \)

Setup cost: \( C_{p} = \frac{\ell}{b} \sum_{p} t_{p} y_{p} \)

Total cost: \( C = C_{m} + C_{r} + C_{p} \)

Part Yield: \( Q = \prod_{r}^{P} (\beta_{p})^{r} \prod_{j}^{PARTS} (1 - \alpha_{j})^{x_{j}} \)
Objectives

• Develop a tool that integrates product and process design in a single system Environment.

• Support ‘Design-to-Cost’ through generation & evaluation of alternate designs

• Integration of heterogeneous databases (including legacy systems)

• Multi-objective Optimization for Tradeoff.

• Integration will provide designer with qualitative relationship between process/technology & quality/cost.