Review of 1st half of course

- A thumbnail outline of major elements
- Intended as a study guide
- Emphasis on key points to be mastered

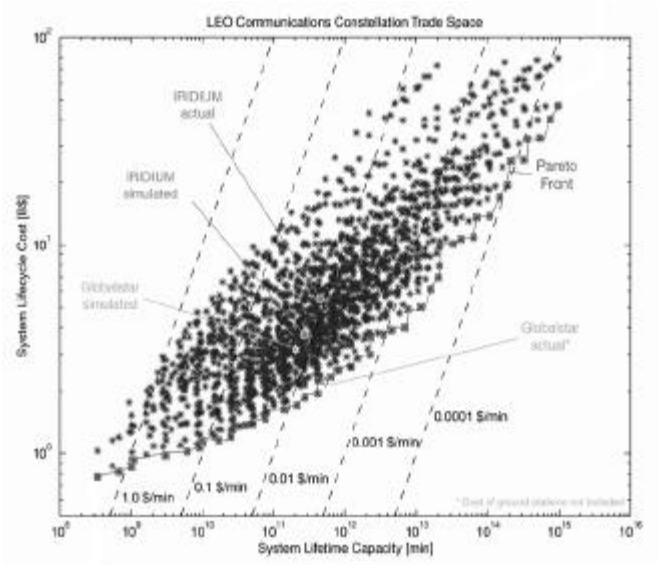
Major Elements Covered

- Modeling of production possibilities
- Valuation Issues
  - over time
  - evaluation criteria
- Optimization of production and cost
  - marginal analysis
  - constrained optimization
  - linear programming
- Sensitivity Analysis
- Use of Excel, LP programs (not on mid-term)

Modeling of Production Possibilities

- **Basic Concept: Production Function**
  - **locus of technical efficiency**
  - **defined in terms of technology only**
- **Characteristics**
  - **marginal products, marginal rates of substitution**
  - **isoquants -- loci of equal production**
  - **returns to scale (≠ economies of scale!)**
  - **convexity of feasible region? Know when!**
- **Generally defined by systems models that define possibilities (eg: satellite systems)**

Trade Space



Valuation Issues -- over time

- Resources have value over time
  - Discount rate (DR) , r %/period
  - Formulas; e^{rt} for continuous compounding
- Choice of discount rate defined by best alternatives, at the margin
- DR ~ 10% or more -- long term benefits beyond 20 years have little consequence
- Money may change value via inflation
- Make sure you are comparing like with like

Valutation issues-- criteria

- Many types -- none best for all cases
  - Net Present value -- no measure of scale
  - Benefit/ Cost -- sensitive to recurring costs
  - Cost / Effectiveness -- no notion of value
  - Internal Rate of Return -- ambiguity, does not reflect actual time value of money
  - Pay-Back Period -- omits later returns
- Choose according to situation (if allowed)
- In practice, people may use several criteria

Optimization -- Marginal Analysis

- Economic efficiency merges technical opportunities (Prod. Fcn) and Values (Costs)
- For continuous functions, convex feasible region in domain of isoquants
  - Optimum when MP/MC ratios all equal
  - Expansion path is locus of resources that define optimal designs
  - Cost function: Cost = f(Optimum Production)
  - Economies of Scale ($\neq$ increasing returns to scale)
- Good Concepts, often not applicable in detail

Optimization -- Dealing with Constraints

- Equality Constraints:
  - Lagrangean Equation
  - Lagrangean multipliers = shadow prices
- Inequality Constraints
  - Kuhn-Tucker conditions
  - Shadow prices or slack = zero (complementary slackness)

Optimization -- LP

- Standard Form
- Conditions
  - linearity of Objective function
  - additivity; non-negativity
- Formulation issues
  - Activities
  - Non-linearities (approximations valid only for convex feasible regions)
  - “fixed charge” problems
- Solution cost = f(number of constraints)

Typical Formulations: "Transportation" Problem

Objective = Minimize cost of moving a single commodity from sources "i" to uses "j"

$= \Sigma C_{ij} X_{ij}$

Subject to:

Amount shipped ≤ Amount available $\Sigma_j X_{ij} \leq S_i$

Amount delivered ≥ Uses $\Sigma_i X_{ij} \geq S_j$

Note: Matrix of constraint coefficients are all 0's and 1's ==> Particularly efficient solutions

Typical Formulations: "Blending" or "Diet" Problems

Objective = Minimize cost of materials

$= \Sigma C_i X_i$

Subject to:

Limits on availability $X_i \leq$ **Amounts given**

Maxima or minima on impurities, trace elements, nutritional requirements, etc... $\Sigma_i a_{ij} X_i \leq = \geq b_j$

Example:

– **Minimize cost of steel alloy when only so much scrap is available, subject to limitations on carbon content, trace elements, etc.**

Typical Formulations: "Activity" Problems

Objective = Minimize cost of production

$\Sigma C_i X$

$_i$ **represent "activities", that is, specific ways or fixed ratios of using resources**

$\Sigma_i a_{ij} \leq = \geq$

Example

– **Minimize cost of delivering cargo where each "activity" represents the use of a different size of ship, each with own limitations on the use of crew, fuel, etc.**

Sensitivity Analysis

- Key part of analysis -- because parameters never known exactly, need to explore solution
- Two main concepts:
  - Shadow prices = Change in Objective Function per unit change in constraint
  - Opportunity cost = Change in OF per unit use of non-optimal decision variable
- Shadow prices typically given with ranges
  - Notice that SP decrease as constraints relaxed or feasible space increased (floors dropped, roofs raised)

Computer Programs

- Excel -- a basic too
  - Economic valuations
  - Cost models (as in Exercise 1)
  - Sensitivity analysis (via Data Tables)
  - Basic optimimization
- LP Suites
  - What's Best, etc
  - Sensitivity information

Good Luck!

The teachers really hope you will do excellently!

(and make us look good!)