This talk explores deterministic p-period f-facility supply networks with production and storage costs that are additive and exhibit either economies of scale (concavity), diseconomies of scale (convexity) or both (linearity), and without backorders or lost sales. Each facility produces a single product for which there is known nonnegative integer (resp., real) exogenous demand in each period, unit production of the product in a period consumes fixed integer (resp., real) amounts of the outputs of other facilities in the period or prior ones, and there is no circuit of facilities each of which consumes the output of its predecessor in a period. This formulation captures assembly and distribution networks as well as time lags in delivery. The goals are to understand how the assumptions about the cost functions influence the structure of the optimal, i.e., minimum cost, or near optimal (production and inventory) supply policy, and how it can be computed efficiently.

For the case of linear costs and no upper bounds on production or storage at any facility, the optimal supply policy is integer (resp., real) and linear in exogenous demands, and can be computed in time proportional to f^2p. Also, the optimal amount to produce at a facility in a period is positive only if there is no entering inventory at the facility in the period.

For the case of concave costs and no upper bounds on production or storage at any facility, the properties of the optimal supply policy remain the same as for the case of linear costs above except that linearity is lost because of the economies of scale. For the case of serial facilities, the problem is solvable in time proportional to fp^4. For general supply networks, all known algorithms run in exponential time. For the case of the stationary (costs and real demands) continuous-time infinite-horizon variant of the problem in which there is a setup production cost and a linear storage cost at each facility, there is a remarkable heuristic that is guaranteed to produce a supply policy whose average cost is no more than about 2% above the lowest possible average cost. The heuristic is fast in most practical problems. For example, in one-warehouse multi-retailer and in assembly networks, the heuristic runs in time proportional to $f \ln f$.

For the case of convex costs, assume the cost of producing x at any facility j in any period i equals $d_i c^j(\frac{x}{d_i})$ for some positive constant d_i. One interpretation is that d_i is the number of hours allocated to production at j in i and $c^j(\frac{x}{d_i})$ is the hourly cost of producing at the hourly rate $\frac{x}{d_i}$ at j in i. Assume there are no direct storage costs, the integrality options in the first paragraph are dropped, and the demand vectors at different facilities are proportional to eachother. Then the optimal supply policies at different facilities are proportional to eachother and are independent of the c^j. Moreover, if there is no exogenous demand at facility j, it is optimal to carry no inventories at j, i.e., *just-in-time* production is optimal at j. Further, the optimal supply policy can be found graphically and in time proportional to $f(f+p)$.

This talk draws primarily on work of Willard Zangwill, Robin Roundy and the Speaker