6bi. Agriculture and forestry: Operations Research is for optimization of processes or a set of constraints. Operations Research has been applied to Agricultural processes and constraints already, where it can be used to optimize crop yields, use of resources, and managing constraints.

Airline Crew Scheduling: operation research has been applied to Airline Crew Scheduling by creating schedule designs which defining which markets to serve and with what frequency, and how to schedule flights to meet these frequencies,fleet assigning which specifies what size aircraft to assign to each flight, aircraft mantenance routing which determines how to route aircraft to ensure satisfaction of maintenance requirements.

Bii) Production Planning at Harris Corporation - Semiconductor Section: For our first application [1], we look at an area that is readily appreciated by every industrial engineer - production planning and due date quotation. The semiconductor section of Harris Corporation was for a number of years a fairly small business catering to a niche market in the aerospace and defense industries where the competition was minimal. However, in 1988 a strategic decision was made to acquire General Electric's semiconductor product lines and manufacturing facilities. This immediately increased the size of Harris Semiconductor's operations and product lines by roughly three times, and more importantly, catapulted Harris into commercial market areas such as automobiles and telecommunications where the competition was stiff. Given the new diversity of product lines and the tremendous increase in the complexity of production planning, Harris was having a hard time meeting delivery schedules and in staying competitive from a financial perspective; clearly, a better system was required.

In the orientation phase it was determined that the MRP type systems used by a number of its competitors would not be a satisfactory answer and a decision was made to develop a planning system that would meet Harris' unique needs - the final result was IMPReSS, an automated production planning and delivery quotation system for the entire production network. The system is an impressive combination of heuristics as well as optimization-based techniques. It works by breaking up the overall problem into smaller, more manageable problems by using a heuristic decomposition approach. Mathematical models within the problem are solved using linear programming along with concepts from material requirements planning. The entire system interfaces with sophisticated databases allowing for forecasting, quotation and order entry, materials and dynamic information on capacities. Harris estimates that this system has increased on-time deliveries from 75% to 95% with no increase in inventories, helped it move from $75 million in losses to $40 million in profits annually, and allowed it to plan its capital investments more efficiently.

Gasoline Blending at Texaco: For another application to production planning, but this time in a continuous as opposed to discrete production environment, we look at a system in use at Texaco [2]. One of the major applications of O.R. is in the area of gasoline blending at petroleum refineries, and virtually all major oil companies use sophisticated optimization models in this area. At Texaco the system is called StarBlend and runs on networked microcomputers. As some background, the distillation of crude petroleum produces a number of different products at different distillation temperatures. Each of these may be further refined through cracking (where complex hydrocarbons are broken into simpler ones) and recombination. These various output streams are then blended together to form end-products such as different grades of gasoline (leaded, unleaded, super-unleaded etc.), jet fuel, diesel and heating oil. The planning problem is very complex, since different grades of crude yield different concentrations of output streams and incur different costs, and since different end-products fetch different revenues and use different amounts of refinery resources. Considering just one product - gasoline - there are various properties that constrain the blends produced. These include the octane number, lead and sulfur content, volatilities and Reid vapor pressure, to name a few. In addition, regulatory constraints impose certain restrictions as well.

As an initial response to this complex problem, in the early to mid 1980's Texaco developed a system called OMEGA. At the heart of this was a nonlinear optimization model which supported an interactive decision support system for optimally blending gasoline; this system alone was estimated to have saved Texaco about $30 million annually. StarBlend is an extension of OMEGA to a multi-period planning environment where optimal decisions could be made over a longer planning horizon as opposed to a single period. In addition to blend quality constraints, the optimization model also incorporates inventory and material balance constraints for each period in the planning horizon. The optimizer uses an algebraic modeling language called GAMS and a nonlinear solver called MINOS, along with a relational database system for managing data. The whole system resides within a user-friendly interface and in addition to immediate blend planning it can also be used to analyze various "what-if" scenarios for the future and for long-term planning.

