C&O 370
RESEARCH PROJECT
WINTER 1995

General: In groups of three or less, you are to solve one of the attached problems. You may use any resources as aids, provided you reference them carefully. You may consult with instructors/tutors concerning your planned approach and to obtain limited technical help. Projects should be clearly written self-contained reports with the narrative parts typed in English.

Guidelines: The project problems tend to be open-ended and are unlikely to have unique solutions. It is a good idea to solve completely a restricted, or core, version of your problem and then to do what you can with each of a progression of harder versions, or extensions, obtained by relaxing the assumptions.

Your project will be assessed primarily in terms of how well you communicate your knowledge of both the problem and your model. Accordingly, make your analysis as thorough as possible, and make certain that your model is an appropriate one.

Format:
The format should be similar to that of the case studies, with the added components of a detailed model critique and analyses of core problem extensions. The report structure should include:

title page/table of contents/summary of results/main body/reference/appendices.

Include, as a separate enclosure, a reproduction of presentation materials which you would use for a 15 minute oral presentation of your work.

Project Due Date: Friday, March 24, 1995, in class.

Presentation Dates: Wednesday, March 29/Friday, March 31.

1. **Coal Tipple Operations**
   The Aspen-Boulder Coal Company runs a loading facility consisting of a single large coal tipple. When coal trains arrive, they are loaded from the tipple. The standard train takes 3 hours to load and the tipple's capacity is 1-1/2 standard trainloads of coal. Each day, the railroad sends three standard trains to the loading facility and they arrive any time between 5 AM and 8 PM local time. Each of these trains has three engines. If a train arrives and sits idle while waiting to be loaded, the railroad charges a special fee, called a *demurrage*. The fee is $5000 per engine per hour. In addition, a high capacity train arrives once a week every Thursday between 11AM and 1 PM. This special train has five engines and holds twice as much coal as a standard train. An empty tipple can be loaded directly from the mine to its capacity in 6 hours by a single loading crew. This crew (and its associated equipment) costs $9000 per hour. A second crew can be called to increase the loading rate by conducting an additional tipple-loading operation at the cost of $12,000 per hour. Because of safety requirements, during tipple loading, no trains can be loaded. Whenever train loading is interrupted to load the tipple, demurrage charges are in effect.

   The management of the Coal Company has asked you to determine the expected annual costs of this tipple's loading operations. Your analysis should include the following considerations:

   (a) How often should the second crew be called out?

   (b) What are the expected monthly demurrage costs?

   (c) If the standard trains could be scheduled to arrive at precise times, what daily schedule would minimize loading costs?

   (d) Can this tipple support a fourth standard train every day?

2. **Designing a Parking Lot**
   Develop a model for determining an "optimum" parking layout of a given rectangular paved lot. That is, determine the widths of access lanes and how the lines are to be painted (both subject to existing regulations) so as to accommodate as many cars as possible. In particular, show how Parking Lot B on the UW campus can be redesigned so as to accommodate more cars.

3. **Courier Service**

Loomis Couriers of Mississauga is a company with a mandate to deliver parcels anywhere in Canada in an economical and QUICK manner. One of the most unstructured delivery routes in Canada is that of Toronto's downtown core. The driver can not simply park on the side of the road as is done for all other routes. He would block traffic and get parking tickets. Besides, this method would be much too slow.

The current solution is to have four "walkers" who are roughly stationed at the four corners of downtown. The driver comes down off the freeway and chooses a walker to go see. He drops the first batch of parcels to that walker and then makes a decision as to whom he should see next. He continues until all parcels are delivered.

Develop a model by which the driver can minimize his total delivery time.

In general, the following information must be supplied to the model:

1) A map labelled with the times required for the driver to get from corner to corner
2) The number of parcels that each walker has to deliver
3) The time required for the walkers to deliver a parcel and for the driver to deliver parcels to the walkers
4) The number of parcels that one walker can can carry at a time.

Test your model using the following data:

Walker	Intersection	Parcels to deliver
A	York & Wellington	49
B	York & Queen	31
C	Younge & Shuter	43
D	Younge & King	22

4. **File Transfers**

In your company, information is shared among departments on a daily basis. This information includes the previous day's sales statistics and current production guidance. It is important to get this information out as quicly as possible.

Suppose a communications network is to be used to transfer blocks of data (files) from one computer to another. As an example, consider the following graph model:

Figure 1. Example of a file transfer network.

Vertices $V_1, V_2, \ldots, V_m$ represents computers, edges $e_1, e_2, \ldots, e_n$ represents files to be transferred (between computers represented by edge endpoints). $T(e_x)$ is the time it takes to transfer file e_x and $C(V_y)$ is the capacity of the computer represnted by V_y to simultaneously transfer files. A file transfer involves the engagement of both computers for the entire time it takes to transfer the file. $C(V_y) = 1$;means that computer V_y can only be involved in one transfer at a time.

We are interested in scheduling the transfers in an optimal way to minimize the total time it takes to complete them all. This minimum total time is called the *makespan.*

Your corporation has 28 departments. Each department has a computer, each of which is represented by a vertex in Figure 2. Each day, 27 files must be transferred, represented by the edges in Figure 2. For this network, $T(e_x) = 1$ and $C(V_y) = 1$ for all x and y. Find an optimal schedule and the makespan for the given network.

Figure 2. Network for your corporation.

Find an optimal schedule and the makespan for the same network but with the following transfer times:

$x =$	1	2	3	4	5	6	7	8	9	10	11	12	13	14
$T(e_x)$	3.0	4.1	4.0	7.0	1.0	8.0	3.2	2.4	5.0	8.0	1.0	4.4	9.0	3.2
$x =$	15	16	17	18	19	20	21	22	23	24	25	26	27	
$T(e_x)$	2.1	8.0	3.6	4.5	7.0	7.0	9.0	4.2	4.4	5.0	7.0	9.0	1.2	

5. **Selecting a Gymnastics Team**

In women's gymnastics competition there are four events: vault, uneven bars, balance beam and floor exercise. Each team can enter up to six gymnasts in each of these events. The top five scores from the six entrants are included in the team score. A major constraint in selecting the six entrants for each event is that there must be at least four "all-arounders" who must compete in all four events.

Develop a model for assisting the coach in selecting the entrants for each event so as to maximize the expected total team score. Test your model using the following data:

	Events			
Gymnast	Vault	Bars	Beam	Floor
1	9.80	9.10	9.15	8.90
2	9.00	8.90	9.10	8.50
3	8.50	8.30	9.20	9.00
4	7.00	9.00	8.30	8.65
5	9.40	8.30	9.00	8.50
6	8.90	8.80	7.90	9.00
7	8.50	8.90	8.80	8.10
8	9.10	9.20	8.50	8.20
9	7.90	7.30	8.00	8.80
10	8.90	8.80	9.10	8.70

Table: Scores (0 to 10 in each event) Expected by the Coach for each Gymnast in each Event.

6. **Operational Analysis**

Select a local business, and determine in what ways it might benefit from some sort of operational analysis.

If you have contacted a business and formulated a plan of analysis, then see your instructor for approval to do this project <u>before</u> proceeding.