THE LLENROC PLASTICS EXPERIENCE: STUDENT EVALUATIONS, 1993

Edited by

Peter L. Jackson

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STUDENT EVALUATIONS OF LLNROC PLASTICS

EDITOR: PETER L. JACKSON

COURSE BACKGROUND
Course: ORIE 416 / 515 Design of Manufacturing Systems
Credits: 4 Credits (Letter Grade Only)
Instructors: John A. Muckstadt and Peter L. Jackson
Semester: Fall 1993
Enrolment: 27 seniors in ORIE 416 (25 O.R. and I.E., 1 Computer Science, 1
Mechanical)
47 graduate students in ORIE 515 (26 O.R. and I.E., 10
Mechanical, 5 Electrical, 3 Chemical, 2 M.B.A., 1 Eng.
Mgmt.
Lectures: Fundamental concepts in production planning and inventory control
Guest Lectures: Group dynamics, Information Systems, Mfg. System Design,
Mass Customization
Laboratory Exercises: The Distribution Game, Cyclic Scheduling, Pull Systems
(The Cups Game)
Coursework: Manufacturing Operations Game (attendance credit only)
Llenroc Plastics Cases 1,3,4,5,6 (graded team project reports)

Evaluation Mechanisms: Surveys (Synthesis Coalition Questionnaires) and
Essays.

Students were required to write three one-page essays:

"Lessons Learned from the Manufacturing Operations Game"
"Three Lessons Learned from Llenroc Plastics Experience"
"Three Ways to Improve the Llenroc Plastics Experience"

The latter two essays were to be submitted with the student's name on a removeable
cover page to ensure anonymity. Some students signed the essay. An edited summary of
the first essay is entitled "Observations from Play of the Manufacturing Operations
Game," available under separate cover.

This report presents selected comments from the two student essays on the
Llenroc Plastics Experience. Comments were omitted if they might be used to identify
the student or if they were repetitious of other comments by the same student or if they
might reveal case solution ideas prematurely. Particular attention was paid to include
negative comments. Student comments have been rearranged by topic and edited
somewhat for grammar or clarity. Significant editorial changes are shown in square
brackets [ ]. Editorial comments are inserted in double square brackets [[ ]]. Edited by
Peter L. Jackson. Original essays (with names erased) are available to accreditation
personnel.
GENERAL APPRECIATION

Thank you for a great course. I really learned a lot.

I found the Llenroc Plastics Experience to be very educational.

I found the Llenroc Plastics experience to be very educational and very practical.

The great thing with this class is that it is a Socratic class where we learn by ourselves, led toward the important points.

I love doing this stuff! The project assignments really motivated me to work long and hard in order to do a really good job. The satisfaction came from the fact that what I got out of the course was how much I put into it. So I gave it all that I had.

OR 416 was one of the best educational experiences I have had at Cornell. It is the closest I have come in school to solving real-world problems. For each case, we used information provided by the company. We then had to be able to detect the problems faced by Llenroc Plastics. For people like me, who want to go into consulting, there is no better experience before entering into the business world.

I could really enjoy consulting as a career. I found the cases both interesting and challenging. I gained confidence in my technical knowledge and feel that I could help companies, especially manufacturing companies, with some problems.

The Llenroc Plastics Experience constitutes a very good approach to the type of work one can find in a consulting company. It makes a very good synthesis of all the skills we had to learn in other more specialized courses.

It was an excellent class that I really enjoyed.

This was one of the best, or the best course that I have taken so far. It was extremely educational, I made some great friends through the teamwork, and I believe I learned some lessons which will be useful for a very long time. Thanks.

I would like to thank you for your time and enthusiasm in providing a great learning experience for me in my last year at Cornell. I have learned a great deal not only conceptually, but socially as well. This is one course that will guide me in my future plans to expand [my family's business]...I was excited to find some of the same conceptual problems in our projects that I was exposed to in the family business. ...In individual cases and on the whole, this class has given me experience that I would not have been able to gain anywhere else with the experience I have or the age I am at...This class is great and I would recommend this elective to every senior, OR or not. This class also gives me something to "act like I know about" during my interviews.

Overall, this course, and maybe ORIE 410 [[Industrial Systems Analysis]], have been the most educational of my career here at Cornell. I felt like this was an excellent course to wrap up my ORIE undergraduate curriculum with. Teamwork skills and application of technical skills were both well-incorporated into the course content.
Overall, I really enjoyed the course. It was a great application of the principles and I would highly recommend the class to my fellow [major identified] [students].

Overall, the Llenroc Plastics experience was a positive one.

Overall, I think the Llenroc experience was valuable. It made OR416 the most interesting class I've taken in the department. I've thought of many positive experiences.

Overall, the class was an excellent exercise and allowed us as students to get an idea of what a real consulting job might entail.

Overall, the experience was very organized, educational, and challenging. All the improvements I have mentioned are very minor.

Overall, this class has presented me with a hands-on and comprehensive field experience. The ideas that were communicated through the lectures and case were of great value. I only wish that I had the opportunity to take this class before my first Co-op.

Overall, the course has been satisfying. I am excited to see the shift from theoretical lectures to hands-on case studies, and I hope it continues in the future.

I liked learning by doing - the "hands-on" aspect of the course. I found this to be very effective for most of the material covered in the course / cases. The course was very "real-world."

The hands-on experience provided by the cases provided a learning environment which emulated real life. Because of this, the problems faced and solutions discussed helped to create or reinforce skills students are more likely to see in their work experience.

In engineering, hands-on experience is extremely important, since each situation an engineer encounters is unique and must be handled as such. The Llenroc Plastics cases helped us to gain some of that much needed experience...Overall, the class was one of the most useful that I've taken here at Cornell. It allowed for group work, real-world experience (to an extent), and the chance to sharpen both written and verbal communication skills.

I very much do like team teaching!!

Discussions with Profs. Jackson and Muckstadt proved to be especially valuable, particularly for those interested and prepared. Maybe preparation should be a requirement of these.

The Llenroc Plastics experience was a good one. It was well planned and organized.

I can say that OR416 has been one of the most valuable and interesting classes that I have taken.

In general, my class experience was positive and I see no major flaws.... I believe the quality and worth of this class to be outstanding in benefit.

I really have no major recommendations for improvement. I thought the class was great and I have no complaints....Thank you Professor Muckstadt and Professor Jackson for an enjoyable class.
To suggest three ways the Llenroc Plastics experience could be improved would be difficult. I personally like the entire structure of the class. The workload was sufficient to promote learning with being overdemanding. The cases were written with clarity and the lab exercises were informative. Some students complained that there were too many oral presentations. I do not agree. Three presentations gave each member of the group a chance to speak formally. Overall, I enjoyed this class very much.

For me, the Llenroc Plastics case was a valuable experience. I worked hard, learned a lot, and had fun. These three things very seldom came together in my academic life.

ORIE 515 has been one of the best educational experiences I have ever had. I would like to begin this essay by congratulating both Professors Jackson and Muckstadt for taking the time to provide an excellent opportunity to learn.... I would like to underscore the fact that the Llenroc experience is an extremely interactive educational experience that provides students a great opportunity to learn. With several minor modifications, it could be even better.

Thanks for teaching such an interesting and beneficial class. This was one of the courses from which I will use what I learned in the workplace. Thanks. Great job!!

I feel that I have gained much knowledge and experience from each of the Llenroc Plastics' cases.

[This?] ORIE class is quite interesting and real-life (to a non-ORIE).

Although I did not need to take [this course], I opted to take OR416 because of its reputation, course content, and the professors who were teaching. In retrospect, I am happy with this decision because I have learned how to apply various theories which I have studied to specific company problems... Overall, this course tied together all the main points which my undergraduate curriculum covered by applying theories to a real problem. I feel that I have attained some closure with respect to my curriculum and that I have a clearer understanding of the knowledge and theories which I have studied at Cornell.

I found the Llenroc Plastics Experiences to be a very beneficial learning experience. One immediate benefit is that it allowed me to gain additional experience in working with groups and giving oral presentations. Strongly supporting the group interactions are the individual cases, which inspired creative thought due to the cases' real world scenarios.

The case studies were an effective teaching mode for ORIE 515 and provided me with valuable experience in report writing and giving oral presentations, introduced me to the scope of problems a plant must deal with (perhaps most importantly, the value of customer service), and gave me the opportunity to use common sense to solve production problems that had no one solution.

I enjoyed working in a team (this is what made the cases so interesting and what gave them a "real life" flavor) and the written and oral reports were good practice (these got easier as the semester progressed).
PROBLEM SOLVING

I learned how to turn an average company into one that is world class.

I found out that the problem isn’t obvious right away; to get to the top, you have to examine all manufacturing processes, all operational and communicational aspects and also determine the proper layout...

Since there was no "right" answer to these problems, my team and I were forced to come up with solutions on our own through brainstorming. This provided me with more insight into the problems and helped our team to function well together by communicating our ideas.

Don’t be carried away by buzzwords like kanban [or] JIT. Always think through the problems thoroughly and try to address the crux of the problem and not a side issue.

Most problems have very simple, easy and cost-effective solutions. One just has to apply common sense. Look beyond the surface. On the surface, things may appear very conflicting and complex.

Good solutions do not necessarily cost a lot.

Often the best solutions to a manufacturing problem are low cost. After examining the various cases, we saw [the] many ways Llenroc could improve had little to do with purchasing expensive equipment. Often the solutions were simply to look at the big picture and have confidence that a solution could be found.

Changes that may seem small, obvious and insignificant can produce big changes in yield and throughput.

Significant improvements can be made to a company through relatively simple and inexpensive changes. These changes often make common sense, but were never investigated [[by the company]] or tried out. So when trying to find the solution to a problem, a simple common sense solution is usually best.

The most important lesson I learned is that a simple change can have dramatic results. One must [look for] the potential for obvious and simple improvements.

I found that the fast and simple solutions are the ones that should be sought after the most. More often than not, there are operational improvements that can be implemented immediately at little or no cost. These operational improvements completely change the character of the company without large capital investments.

I realized how easy it was to make several simple improvements on the process without expending lots of money. And most of the time, these small improvements made in every place throughout the process caused a very significant improvement in the overall performance of the company. For example, the improvements achieved through the cyclic scheduling were really significant to achieving a better customer satisfaction by reducing the lead time drastically.

In all the cases, the option of buying new equipment was always there. However, it was never exercised. Always look for the most cost-effective solution, not the easiest. That
may sound trivial, but many companies will go out and buy without realizing that what they have already is plenty.

I learned that simple is better. By simplifying, we can more easily understand and control whatever system we are studying. For example, the warehouse distribution plan that was in place at Llenroc consisted of eight warehouses and a complex routing system. By eliminating warehouses, consolidating inventory, and simplifying routing, we were able to identify the true sources of lead time and poor customer service and eliminate them.

Some of the best solutions for the most complex problems were often the simplest and most inexpensive. This was very evident in the reduction of inventory and the implementation of a kanban system in the fabrication room.

Do not ignore the simple solutions. I think there is a tendency in industry to solve perceived problems by throwing technology at them. There were certainly instances in the Llenroc Plastics cases where our first thought was to use the technical solution. [A simple redesign] would probably have solved, or at least eased, the problem and at much less cost.

The small obvious changes make a huge difference. It just shows there is probably a lot of room for improvement in most factories.

Simple actions can save a lot of money and improve drastically production quality.

Simple solutions to a problem can often be the most difficult to find. In our group attempts to solve Llenroc's various problems, the solutions were often complex and overthought. It is easy to get caught up on one point and overwork it, ignoring the obvious. It usually took one subtle suggestion to put our team back on track.

Working on these cases made me see engineering in a less technical light. I always felt at a disadvantage in college because I have a hard time with technical issues. Much of the work that we did on the Llenroc cases was not technical, it simply required one to think logically and creatively. For the first time, I began to defend my opinions in a group and not back down because I thought everyone else's answers were better or because they were smarter than me. I have gained confidence in my abilities as a thinker.

You cannot simply look at the delivery lead time, but you must look at the big picture; i.e. you must take both the manufacturing lead time and the delivery lead time [into consideration] when improving customer service. When all six cases are looked at together, a considerable improvement in customer service can be seen.

Be exhaustive in assessing all possible avenues in searching for [a solution]. It is not beneficial to tunnel in on one approach.

I enjoyed that the real problem was not always evident, that we really had to think to come up with solutions. Each case kept us mindful of the big picture and how each particular case related to the entire operations of the company.

Before performing an analysis of a system, one should observe it working. There were several instances when having seen the warehouse [[and factory?]] and its operations would have made our analysis a little easier.
Lessons Learned

No one's situation is so optimal that improvement is impossible. A company is always in a state of change and continual improvement. Even our solutions would probably no longer be optimal three months from implementation.

Optimization was always possible. In Llenroc, there were so many redundant operations. Some of [this] redundancy was not easy to see. This is why we need [collection] and analysis of data. Data collection is critical.

The most important lesson I learned from the Llenroc case studies was the importance of organizing and interpreting data. If the data are organized in an intelligent way (which is obviously not trivial) finding the main problem causes becomes much easier. All the cases had in common the need to read the given data in a logical way. Most of the improvements suggested by us on the reports were originated by interpreting the data, making a few assumptions and doing simple calculations with a spreadsheet.

The way in which data are arranged and presented can be a determining factor in finding optimal solutions for a problem.

One of the biggest lessons to be learned from the Llenroc Plastics cases is that if data are presented in a certain way, solutions to some problems can become obvious.

While many of the problems seemed to have intuitive solutions, the data presented always seems to have secrets hidden within it. For this reason, attention to the numbers became a valuable lesson learned. Instead of just using common sense, I can now see how "working the numbers" can also provide answers.

In order to get to the core of each case, we had to successfully study the data given to us and draw conclusions to get to the problem. That is, general data were given, but we were required to analyze, interpret, and infer meaning from it, eg. determining the bottleneck of the system, comparing rates of machinery, etc. This analytical ability is always valuable.

I learned that the numbers are not always right. For example, the numbers [led us to one decision in the warehouse location problem but it was not the solution chosen by the company.] The intangibles,..., had a lot of weight in the decision-making process, but their values could not be quantified.

Approach [every] problem with a systems view. Solutions are never isolated to just one problem. In addition, the most high technology solutions or the most expensive solutions are not necessarily the best solutions. Oftentimes, there are many quick and extremely simple solutions that are just as effective.

When trying to solve a particular problem, look at the system as a whole. Your actions will not only affect what you are working on, but other areas of concern [as well]. Make sure the overall effect is positive.

Sometimes it is necessary to step away from the problem area and look at the larger picture. In a couple of the cases, the tendency was to try to take care of everything in one area, when part of the problem was actually being caused by what was going on somewhere else. When we were looking at the pileup of inventory in the fabrication room, it took us a while to think to take into account the delivery of laminates from the
presses and to set up a system to account for that. The same was true in setting up press scheduling in Case 6: delays were caused in several areas, and we needed to look at all of them instead of focusing on just a few.

You must take all aspects of the company you are analyzing into account. When recommending a change, you must not only look at the short run effects but you must look at the long run effects. You can't only look at the dollar value and the numbers you calculate, you have to try and predict how it will affect the market, worker morale, etc.

I learned the importance of taking a systems approach in any problem solving situation. It is very important to understand that most problems that companies face nowadays are a consequence of losing touch with the big picture. Throughout the Llenroc experience I was able to fully comprehend how parts of one case interrelated with parts of other cases and the importance of noticing this. I learned that to be successful as a consultant, one needs to be exhaustive in the search for how changing something can affect everything else.


I learned that every large problem can be broken down into several little ones. These little problems can then be broken down into several smaller problems. All of these problems stem from one node, the main source of the problem. However, in order to reach this node, all of the other problems before it must be tackled first.

By looking from a different perspective, we can easily identify more problems to tackle. This opens up more opportunity for further investigation and analysis which is very important if we are planning on going to be in the consulting business in the future.

I learned how to look at situations from different perspectives. Often problems involve more than one issue of a current situation.

The most obvious solution to a problem is not necessarily the best solution. Many times in preparing the case studies, my team found that our initial solution could solve part of the problem, but would create other problems along the way. These other problems needed to be dealt with before the original problem can be considered "solved." Often, these issues were discovered when the final calculations were tallied. Then, we needed to go back and correct the problem, causing more work for ourselves. The lesson: make sure to examine how your decision affects the system as a whole.

I learned one must pay attention to small details. Our proposed plan of installing a conveyor system in handle the material flow from the sanders to the inspection area seemed like the perfect solution on the surface. When we analyzed our solution more carefully, however, we found that such a solution was nearly impossible. We concluded that it would not be realistic to expect humans to inspect the laminates as fast as we were asking.

Modeling real life is impossible, modeling a simplified view of it is feasible but dangerous. Deciding what things to consider and include in the model, and what things to exclude is as important as building the right model or using the right tool. I also realized that many times technology constrains the techniques we can use to solve a problem. We must develop heuristics that will provide a good solution.
It is crucial to know the company, to get involved with the people who make things happen, to understand the environment and the culture of the organization. When working on these cases, we lacked a lot of very important information about many aspects of the organization and we ended up making some unreasonable assumptions.

Many decisions made by intuition actually have a mathematical foundation. When used, this mathematical foundation sharpens the intuitive capabilities. The math is relatively simple and takes little time. However, most of the people I've worked with use their intuition and experience to solve problems, but probably do not know the mathematical foundations of their solutions. I enjoyed seeing how the mathematical foundations and intuition could merge to make a better whole.

Never start doing a project the night before. It is so much pain especially at the end of the semester when one does not have enough sleep.

Always [allow] at least one day to coordinate efforts. We all learned from Case 1 that simply putting together all the separate parts of a report and handing in the result was not good enough. There has to be at least a day's worth of time to edit the complete version and make sure it reads consistently.

TEAMWORK

Being part of a team and learning how to cope with members is an experience in itself.

At first, I resisted the team aspect of the case. I wanted to solve everything on my own, or at least solve a part of the case on my own. Initially, I felt this was the best method. As the study went on, I realized the value of having a group to work with. Often the group was stumped by a problem or headed on the wrong track, when one of the members would come up with a good idea. We often found our best solutions when two or more people were together.

Ensuring that you have a good working relationship with those that you work closest with is extremely important.

Working in a group of six for a whole semester was not an easy task. Getting everyone to do what we planned took a lot of energy and effort.

I learned the importance of organization, not only of yourself but of you as a group. I learned about working as a team to help achieve your group's objectives.

Working through the group dynamics was a meaningful lesson. Learning how to deal with group expectations, slackers, and overall leadership functions are invaluable lessons that will be used in the work place.

I learned a lot about group dynamics. I think our team worked very well together but it was sometimes hard to organize seven people. Everyone has different schedules and we had to learn to work around one another as well as with each other. We were forced to split up the work amongst ourselves and deliver quality since six other people were counting on each person. It was frustrating at times, but I know I learned a lot more with my group than I would have by myself. We had a lot of fun together during those late nights too.
The importance of teamwork ... may be the most beneficial lesson I learned from the course....Lack of motivation was the most difficult thing to encounter in people. Because our team was composed out of friendship, teamwork discipline was not the easiest thing to enforce.

I have become more adept a working in groups. The experience I gained is invaluable. Leadership, group dynamics, and planning are several of my skills which have improved because of OR 515.

As a team, the solutions reached were more creative and a lot more details were covered, even though the time to reach them was much more considerable. The division of tasks eased the work for everybody, creating an expert in every part of the problem. By working with the same group all the time, I got the opportunity to make 6 new friends. After sharing long nights and even almost all-nighters and also knowing every single person is doing a good job, you grow fond of each other.

I learned how to lead a team through a structured and organized discussion, while getting something accomplished, [and] how to delegate and hold people responsible for their tasks. I also learned the importance of becoming an expert in the part that I am responsible for and how this can help in a discussion. For example, in the first meeting, we usually brainstormed to get an idea of all the points we had to address in the report and assigned everyone a part of the case. After this, all the other discussions were much more productive because every person had done some special "homework," either getting some output from the computer or getting questions answered from the professor. When sharing the findings with the team, new ideas and problems were pointed out and discussed.

Working in a "multi-major" team for the whole semester helped me to acquire and improve several managerial skills that I will need in the business world. Among these were how to lead a discussion, how to delegate, how to negotiate (how to persuade and convince my partners that my idea was the best one), and how to give a good presentation.

Team decisions were usually better than individual decisions. I was amazed that the team could analyze so many more scenarios than most individuals could think of in about the same amount of time. Not only were more ideas examined, but the solutions reached by the team were usually better than any one individual's solution.

I enjoyed working as part of a "consulting team" throughout the cases. Of course, the incredible level of commitment and intellect on my team admittedly may have contributed [to this enjoyment].

I learned how to work in a team. Team projects require much more cooperation and planning as opposed to individual assignment. Often there are many ideas flowing around during discussions and learning how to compromise with others and to be able to present your own ideas in a very clear and persuasive fashion are very important.

I learned how to work productively in a team environment. My discipline (Electrical Engineering) has very few team-based projects.
One of the main things I gained was learning how to work in such a large group. It was a challenge to get everyone to agree. Certain personalities were harder to get along with than others. It also helped me learn how to work together with others in presenting a finished product. An effective division of labor scheme was needed, and compromises had to be made once a draft for the report was put together.

With so many different opinions it forced us to become organized. This was the first class I actually had to have an agenda at team meetings. This factor was also enhanced by our busy schedules. [[Each student was required to submit one report during the semester of a meeting which he or she had led. The report was to contain the agenda and the action items of the meeting, among other details.]]

In a group, it is necessary for people to be leaders. In our first case study, nobody really assumed the responsibility of leading the group and it showed. During the following cases, different people took control and the team was more focused and got tasks accomplished much quicker.

One of the main lessons learned includes managing meetings, working as a group to achieve specific goals, and dealing with differences among group members about such issues as how to attack a certain problem. The interactions with the groups are by far the most beneficial lessons learned from the cases.

The most important thing I learned was how to work in groups. Everyone [in our group] was willing to put in their share of work except for one member. It’s our fault for letting [this student] get away with shirking [his/her] responsibilities from the beginning. If we had acted more as co-workers rather than friends, this problem would have been easier to address.

It is so important to set goals, establish timelines, and ensure that each team member works towards accomplishing both.

During the first project we started to work on all the sections as a group rather than delegating certain sections to members of the group. The night before the due date, we realized how much time we had wasted and finally separated the project into sections. After staying up all night to complete the project, we all quickly learned that each member of the group needs to take responsibility for a certain aspect of the project in the future.

As a group, we tended to do the assignments together rather than splitting them up. We could have been more efficient if we had split the assignments up from the beginning.

Make sure you set clear agendas for what each group member should be working on and what the group is working on as a whole. It is very easy to get lost in either direction. You don’t want everyone doing the same thing so that work becomes redundant, and also you want to make sure people know what the end result of their efforts should be so they don’t waste time on trivial areas.

The diversity of major fields and the differences in schedules of the team members forced us to be effective in our meetings. By the end of the semester we had developed a program of meetings for each case. For instance, everybody had to read the case and think about the solution before the first meeting. Then, during the first meeting, the case was
extensively discussed by all the members of the team to assure that everyone had a good understanding of the goal of that case. Generally, during the second meeting, the strategy to follow was developed and if possible, tasks were assigned by pairs. Thus, during the rest of the meetings for that case, all the members of the team were on the same track and working for the same goal. I believe this was essential to our success as a team and I consider this experience very important because the same problems we faced getting together here will occur between members of different departments in every company.

It is important that the consultants [team players] get their act together. First, get organized. Then, study all the information and client objectives. Then, see if the data you have will let you answer all the pertinent questions. Last but not least, think systematically. Never forget that each aspect of the case being worked on is related to other operating and people systems All need to function together.

Use the resources of all the group members. Just because you think you have the right ideas, make sure the entire group is allowed their input. Different people look at the same problem from different angles, and a group that works efficiently together can accomplish much more than individuals.

It is very beneficial to have a mix of students from the different engineering majors in the same group. I was very surprised at the amount of knowledge I was able to gain from the ORIE students. I did not expect the students from the other areas to take the time to explain how to do certain things that pertained to their field. For example, the ORIE students in my group took a whole meeting and explained the ideas associated with the future value of an annuity and some of the tax implications. It was a new way of learning and I was surprised at how well I was able to retain the information when taught by another student instead of a professor.

With so many ideas and open-ended questions, brainstorming became a valuable tool in case study proposed solutions. Working in teams proved most useful in implementing this technique. I learned the value of other people's opinions. By combining ideas and different expertise's, we could come up with better solutions than those reached by working separately.

The divergence of team members in expertise and interest are beneficial to the success of each project.

This has been the first time I had to work in a team for such a long period. This experience showed very well the increase in performance one can get by making people work together instead of just adding their individual works.

The fact that we stayed in one group the whole time gave the projects a sense of teamwork.

Probably the most important lesson to me was how to function in a dysfunctional group. From the very beginning of the semester our group could not work together. Unfortunately, by the end of the semester the situation was no better. The group situation did not get resolved during the semester. It is only in retrospect that I see how things could have worked better and how I could have encouraged more participation. These cases taught me just how differently people function when placed in a group. Some students want to do all the work and others don't want to do anything. I am glad I had a
chance to experience a group like this for the first time in college instead of at my first job.

In the beginning, I believed that my team would blend just fine. All the members from the OR department knew and respected each other. The other members, who came from outside the OR department, ... were only present at the meetings just observing what was going on. I do not say that these members did not help in the writing of the cases or they did not do their assignments. I just do not believe that they deserved the grades the team got because they did not give us any sign that they understood what was going on. After thinking about this experience, I believe that as a team we made two mistakes: first, nobody told them that their participation was inadequate and second, we did not have any kind of leader so as to tell these members what the view of the rest of the team was.

A major issue and potential source for problems is the fact that different team members may have very different standards and priorities for the course. This was the case in our team and we discovered three main behaviors that can really improve team relations: (a) be sincere about your feelings; let everyone know how you feel. Encourage the same behavior from other members and provide constructive rather than destructive feedback. (b) Set performance standards for the team. When the expected results are known by all team members, they have to perform or else they will feel the pressure from others to improve. (c) Everyone deserves the chance to lead something; give everyone a chance to be a leader and set the pace. Chances are he/she will perform much better than expected.

Working on the cases with other people also made me realize how many solutions there are to a single problem. It always seemed the minute we thought of all the possibilities there were ten more to consider. One must always keep an open mind and keep brainstorming until he or she finds what is really the best solution. That solution is not always hard to find either; sometimes the answer is very simple and right in front of your eyes.

I am totally confident in the fact that diversity is one of the main [strengths] of a team. None of us had all the skills and I think we would never have done it without putting our abilities together.

In our team, everybody was coming from different countries, and therefore different cultures with a different way of working. At first, this gave a lot of difficulties... but later became one of our biggest strengths once we managed to understand each other and once we learned to know each other's abilities.

Certain people are better in certain types of jobs. In my team, we had two people who were very good in doing the algorithms and all the mathematical programming required. We also had one member who was an expert with Word, Excel packages and with formatting the whole report so as to make it more presentable. If we had the roles reversed, then we would not have been a very successful team.

Sometimes it is very efficient and necessary to work in a team [but] it can also make you lose a lot of time: a team has more inertia that a sole person. I think that we know better [how] to get organized more efficiently. I have learned which behaviors to avoid to prevent tensions in a group.
Working in a group does not necessarily ensure the quickest processing time of a problem, but more ideas are thrown out at the beginning. I know that if I had done the cases by myself, I would not have thought of most of the solutions that my team proposed in our cases. Also, the team keeps you in check by making sure that you are not cutting corners to get to the end result. This was the first class that the team insisted that the end result be of the best quality that we could make it. As a result, I believe that our case write-ups were very good.

Working in a group is far better than working alone. Through the group meeting, I learned that there are many approaches to the solutions. Analyzing these approaches, we found pros and cons with each one, and then found the best solution among them.

I learned the importance of coordination of team members. On our first project, we divided up the assignments, then stapled the finished parts together. As the semester progressed, we changed this format, and maintained communication between team members throughout the duration of the case.

Time management [is important]. Our group consisted of members on very different time schedules. One member woke up by 7 a.m. every day... Other members ... rarely [woke] before noon. We learned to balance each of our time schedules and find meeting times which were suitable to everyone.

Teamwork is a good way to get a job done. But, in order to be successful, all the members of the team must have the same goals and similar ways of achieving the goals.

At times, engineering is more an art than a science. I had never been involved with such a group of talented individuals; this was a great challenge in itself. It was usually never the case that we would all agree on a subject. It took leadership and persuasiveness to coordinate the efforts of all these people. I learned that the best way to assume a leadership position is to impress your colleagues through your performance. After you have earned your peers' respect, it is much easier to [steer] the direction of the group. I also learned that solving the problem is not always the hardest part of the assignment. Rather, it was dealing with the people aspect that posed the problem. Overall, this was a great learning experience.

Make sure to build on the strengths of the team members. By allowing people who are experts in certain areas to do the work in those areas, everyone learns more and benefits. Once our team figured out who was good at doing what types of things, we all learned a good deal more by letting that person teach the rest of us.

I received much practice in giving feedback to others. This included feedback on technical performance, writing style, and presentation style.

If at all possible, choose your group members carefully. Fortunately, we did this, and it worked well. However, I saw some groups struggling due to certain team members.
PRESENTATION SKILLS

I learned about the methods used to convey your findings to a client. I learned about the correct use of proposals and presentations as a way of effectively showing your ideas to a client and most importantly, convincing them to implement your proposed changes.

I learned how to present a proposal to management. We learned what to emphasize when presenting ideas to management. We also learned how to handle various questions that management may have about different issues and how to convince management that your proposal is beneficial to the company.

The oral presentations were very valuable:... one of the more valuable lessons I will have acquired from the class.

The experience of presenting your ideas in front of a group is invaluable.

I felt the reports and presentations were an excellent idea to give students practice in communicating in the business world and will be a big help in the future.

A good consultant is good at both analytical and communication skills. Sure, people had [more of] one than the other, but that should foster people teaching each other and learning from one another.

No matter how good your idea may be, if you cannot convey your idea clearly and persuasively, no one will understand you and your idea will be hidden in the dark.

I have discovered that my best ideas are practically useless unless I can convince others that they are valuable. This is true both when working with the client (professor) and when working with my fellow team members. I found that it was often a struggle to get anyone else to support and develop my ideas. It seems that the power of persuasion plays an important role if one is to be part of any change process.

Developing your ideas and coming up with final recommendations are one thing. But selling your ideas and the implementation of your recommendations is another. The presentation style is important in order to sell your ideas. Your ideas are worthless if you can't communicate them.

It is a good thing to present in front of another group and to have it presenting in front of us. It allows us to compare and to see what an [audience can expect] from a presentation. [Oral presentations were made by two teams per session to one or both of the faculty members. All teams gave oral presentations of cases 1, 5, and 6.]

The opportunity for us to orally present our case analysis was a plus. This gives me a chance to practice speaking in front of people. I usually do not have that many chances because I am an Electrical Engineer.

The more I did [presentations], the more comfortable and fluid I became. From observing other groups, I had a basis of comparison against myself, and could pinpoint weaknesses for improvement. This skill is important because I see many presentations in my future, whatever the job.

[The Llenroc case studies] helped improve communication skills through oral and written presentations.
Throughout this project, we were compelled to generate reports that would be read by management. Most of these assignments made use of complex management science tools beyond the scope of most managers. It was a challenge to explain these in a language accessible to managers. We were forced to come down from the O.R. cloud and explain things in a less esoteric language.

Another important skill I acquired which will be beneficial in the future is how to write an effective Executive Summary. For the first case, our group gave too much detail about the problem itself and ended up with a two page Executive Summary. Throughout the semester, this section of our projects improved tremendously and, with the practice, I have been able to write them quickly and concisely.

I learned far more in the group settings during presentations and the discussion that followed than in any other part of the course.

**Manufacturing and Distribution**

This class was my first exposure to the world of manufacturing and distribution. The concepts of safety stock, cycle stock or any other stock were completely foreign. However, over the course of the semester, I learned the terminology and developed an appreciation for the fundamental issues. While the lectures served as a source of learning, the Llenroc Case Studies offered a "real-life" view of manufacturing, a perspective often missing in the engineering curriculum.

The most significant lesson I learned was the importance of full scale integration of manufacturing, distribution and sales.

A lot of the problems facing different industries are basically the same; they just take on slightly different forms. The problems usually boil down to a few variations on old themes: inventory is not being well managed, there are quality problems that are not being addressed, machines are not being utilized effectively, etc. It is easy to see how a small group of individuals could have success dealing with the problems of a great many companies engaged in completely different manufacturing activities.

Llenroc provided me with insight into some typical problems facing many companies. Although the details of the cases may not be the same, the principle is there. Now I can know better what types of problems to expect and tackle if, say, I became a consultant.

There are many ways to increase efficiency in a plant.

Keep in mind that changes to one part of a company will have positive and negative effects on other parts of the company. Remember the big picture.

Everything that a company does is interrelated. Making a small change in the press room of Llenroc Plastics, for example, has a serious effect on the rest of the factory, including the paper treating operation, the trimming and sanding operations, and the inventory stocking function.

Little adjustments in processes can lead to enormous benefits in productivity, customer response, inventory levels, etc. Often no additional investment in hardware is necessary. For example, just by implementing a simple kanban system in the fabrication and inspection room, we were able to save over half a million dollars and improve throughput
and lead times considerably. No new forklifts, conveyor lines or visual recognition devices were necessary.

Always look for the Herbie [[the bottleneck process]]! Every process needs to be analyzed to determine where the bottleneck is located. Once the bottleneck is found, anything that will help ease the bottleneck should be considered. If a process is not a bottleneck, it should not run like one. Non-bottleneck processes should be idle at times.

I learned the importance of a bottleneck in a manufacturing system.

I found it intriguing that a department that was perceived as a bottleneck only needed an alternative schedule in order to have ample capacity. At one of my internships, I remember a manufacturing support group trying to install a second curing oven in order to increase the department's capacity. Now, after these cases, I wonder if it is really a bottleneck or just a matter of altering their scheduling procedures.

I learned, beyond my control, the details of making laminates. I learned the different steps involved in making them and the raw materials required. This part was very enjoyable for me because I am a very industrial type of person. I like to see what things are made of and how they are produced. I feel that every consultant must feel this way, otherwise they will not be dedicated to who they are trying to help.

Savings that result from an efficient manufacturing system can quickly be lost without an equally efficient distribution system. Therefore, designing and implementing an effective distribution system is just as important as designing an implementing an effective manufacturing system.

Designing a distribution system entails many steps. First, you have to compare the cost of various shipping strategies, such as purchasing a fleet of trucks, hiring a contract carrier or a common carrier, or using UPS, etc. It is also important to consider the additional requirements associated with each of these alternatives. For example, purchasing a fleet of trucks requires creating routes and scheduling trucks (solving the "dispatcher problem").

The system should minimize the number of distribution echelons and thereby minimize inventory. It is important not to abandon the customer though. Therefore, the warehouse location should be partially driven by the consideration of the customer.

The information system at each echelon should indicate [see?] the inventory levels at all the echelons below it.

Case 3, the Warehouse Location Problem, provided insight into the types of variables which go into warehouse and distribution decisions. I will remember that it is better to hold stock at one location because it reduces the standard deviation [of demand].

When you work, you think of yourself as [both] a customer and a producer and as a single link in a long chain of producers and customers.

I learned much about how different aspects of manufacturing affect various levels of the production chain. Many of the situations we encountered in the cases are present in actual manufacturing lines, and the strategies we used to tackle the problems are viable...
I really understand the concepts of JIT manufacturing and Kanban systems now. These are terms I have heard before in other courses but never understood completely. I think it is just as important to learn where these concepts cannot be applied as it is to gloss over the terms and talk about their advantages. Specifically, in Case 5, those ideas were important in rearranging the floor layout and redesigning the fabrication operation. I also think the lecture we had on Kanban systems was very informative and when the class operated it's own "Kanban" [[The Cup Game]], the point really became clear.

I learned the value of a kanban system in improving material flow and reducing the work in process. It was also beneficial in improving quality as smaller amounts of material flowed through the system and, therefore, could be controlled more efficiently.

I learned how a cyclic schedule could be used in improving the operation of a plant. A cyclic schedule allows for better production planning.

Cases 4 and 5 demonstrated that with some minor investment and plant layout changes, production can increase significantly.

From our presentation to Bill Hudson [[president of AMP, who sat in on presentations of Case 6]], I learned that improving a company's competitive position must be factored into your analysis. His point about increasing market share causing capacity problems was a very good observation that had not occurred to me.

I learned the importance of implementation. When making changes or proposing solutions, it is always necessary to ensure feasibility. This means testing a solution with real data, rather than projected or hypothesized data. This also includes looking at the big picture, which includes factors such as the workers and their capabilities, the market position, and the effect on the position of the firm in the future.

The work you perform in one area of the company can have a serious [impact] on another area. Although this is an obvious point that most people would just assume is true, this is the first course that actually made an effort to demonstrate this point.

I learned how the manufacturing process works in great detail. I saw how inefficiency in one area of production causes problems in other areas. From the lectures and from other group members' experiences, I learned how to apply different operations research techniques to solve these problems, leading to improved efficiency and reductions in costs.

**APPLICATION OF TECHNICAL KNOWLEDGE**

I learned how to apply all the technical knowledge that I have gained during the past three years to practical applications. Concepts, from linear programming to financial statements to computer applications were finally put to use in a way where I was able to see the relevance of all the engineering courses I have been put through.

Coming from a purely theoretical background, I was amazed by the practicality of this course. In each case, we looked at a new aspect of how different parts of a manufacturing company operate. This course did not just teach me new terms such as pipeline stock or cycle stock, rather it showed me how to think in terms of optimizing the performance of the manufacturing systems in a company. I do not wish to infer that I have all the
Lessons Learned

answers for all the problems. This course gave me, nevertheless, the tools to cope with different situations.

I saw how to evaluate whether an improvement is worth it using a net present value analysis. [But] there are other factors that must be considered... such as how long the process will be down [to implement a change], how the missing throughput will be [made up], and how much inventory must be built up before the shutdown occurs.

I learned the importance of an ABC analysis when determining an optimal inventory policy.

One of the most efficient ways to [read the data] is using Pareto analysis: determine which are the most important clients, what are the products that give the biggest percentage of the revenues. In our case, we were able to reduce drastically the inventory levels due to ABC classification. Knowing which were our important clients allowed us to know what should be the transportation system changes in order to improve customer service.

Techniques of safety stock, pipeline stock, cycle stock, and re-ordering points were learned and utilized in keeping inventories and lead times down while at the same time satisfying demands with their variations. Computer simulations and spreadsheets were utilized as the tools in decision making processes.

This class is an occasion to use the tools we learn in other classes, such as simulation, statistics, or economical analysis. Above all, it is the discovery that common sense seems to be the best tool.

I learned a lot in that one section where we simulated a factory assembling cups. You do not realize it by theory the difference little policy [changes] make; when you get to physically compare two procedures for assembling cups, you see the difference in production. [The Cups Game is not part of the Llenroc Plastics Cases.] I am very competitive and games like that interest me. I wish there were more of them.

I have a better understanding of JIT.

The concepts in the video on Continuous Flow Manufacturing were directly applied to Case 5. Note that a high utilization rate can be misleading, especially if a PUSH system is being used. Ideally, we should try to implement a JIT system.

To better control the work in process inventory, kanban loops could be instituted.

Though this course, I noticed that the materials (tools) I learned before or am learning now are useful. Throughout this course, we used tools such as simulation, inventory theory, scheduling, and economic analysis to study the cases.

My OR/IE degree will probably have some benefit when I go to work in a manufacturing plant. In working with students from other disciplines within the engineering school, I became aware that the OR/IE degree has some benefit over, say, a mechanical engineering degree when examining the logistics of the situation. The other members of my group were key to our success, but some issues they had not been trained on. I’m glad that I had the opportunity to take a course broad enough to use all the issues [techniques?] that I have studied so far.
Case 6 taught me how to allot idle time in a schedule to provide sufficient excess capacity to guarantee variation in demand was met. It was helpful and interesting to apply scheduling techniques which I have learned in ORIE 525 [[Scheduling Theory]] to another situation.

SOFTWARE

The use of computer software to help us analyze the case studies was definitely a plus. I cannot imagine how we would do some of our case analysis without the computer software.

Seeing and using some of the simulation packages was interesting. This helped me understand the limits of what is being used today.

I learned that computers are powerful tools in visualizing, analyzing, and testing manufacturing systems. Many programs we used in class contained bugs and weren't very user friendly but they turned out to be very useful. For example, we experimented with the distribution system using the software package [[Warehouse Location Software]] trying to find more efficient routes and the optimum number of trucks per route. I enjoyed using XCELL+ for Press 7 simulations and was amazed by the number of input variables such as downtime and maintenance.

CUSTOMER FOCUS / BUSINESS ANALYSIS

I learned the importance of customer satisfaction and total quality management and their roles in determining your market position.

It is necessary to know and to understand your customer. Sometimes this is merely a case of understanding what the customer is asking for and sometimes it is a case of convincing the customer that the real problem is not the one he actually sees but something else altogether.

It is important to know the customers very well and to be able to see differences among them. They are not all waiting for the same service, they do not have the same needs, and they do not have the same importance. This is really relevant for the production scheduling, the computation of safety stock, and the problems of distribution and transportation.

The Llenroc Plastics case did an excellent job of emphasizing that it is important to [identify] what business the company is in.

Llenroc Plastics needed to determine and understand what business it wanted to be in.

Knowing the customer is vital for any company. Companies must define quality, products, services, plant layout, etc. according to their customers. While designing the distribution system, many times we sacrificed profit [in order to reduce] customer wait time. Reducing customer wait time was our ultimate goal in other cases as well.

Be sure the company is focusing on the business that it wants to be in. This was brought to light in the first few cases.
VARIABILITY

Variability is the major driving factor in the ability to establish an effective system. Variables like capacity and worker hours seemed to be easy to deal with. Variability, however, created great difficulties in the ability to plan production and satisfy customer demand inexpensively. This course drove home the point that if you can reduce variability, the system becomes more effective and more efficient.

Variability is evil. This course drilled home the point that variability in the individual components can have an adverse effect on the whole system. In Llenroc, we learned that the variability in the distribution and manufacturing functions added up to make the lead time for the products unpredictable and long. By reducing each function's variability, we reduced the lead time to produce laminates and also made the lead time more predictable.

Variation is the enemy. This message was known to me before, but the cases reinforced this notion. The reduction of variability should be a major goal in any analysis.

Variability kills!!

Variability is definitely THE ENEMY. One must accommodate for change by designing a system that is robust enough to handle variation.

I learned the need to reduce variability in all stages of production and distribution. By working to minimize demand variability, we are able to better predict production and inventory requirements. This will serve to lower inventory costs and allow us to create the most efficient production process possible. By minimizing variability in production we can easily create an efficient cyclic schedule that will maximize utilization. We can also create an accurate MRP system that will be able to schedule reorder times and quantities accurately.

Demand variability is a major problem in industry. Businesses should try to work closely with their customers and suppliers to analyze demand patterns. They should look for ways to smooth demand in a schedule that satisfies both parties. The economic benefits of an optimally operated business are worth trying to achieve.

The point was driven home that VARIABILITY IS THE ENEMY. In all of the cases, there were times when a small amount of variability in something made a tremendous difference in the way things worked out.

Variability is the main evil. It was the variability in the demand pattern (especially related to the so-called C items) that created needs for safety stock. We should also note that in Case 5, we had variability in the batch size, creating inventory problems downstream (which should not have been our bottleneck).

Variability kills you. Variability makes ... the reality very different from the theory. For example, the theoretical capacity of the Press Room has nothing to do with the real [capacity].

The negative effects of variability tend to increase as a system becomes more complex.
One important weapon against variability is to be able to aggregate the data. This reduces dramatically the variability, and often allows [one] to discern a pattern. It is thanks to aggregation that the cyclic schedule in case 6 is possible.

Variability is the enemy. Aggregation reduces variability. The "No B/C Stock Strategy" is useful. Reducing cycle time is usually the key for everything.

The cyclic schedule in case 6 demonstrated that "variability is the enemy." Without variability, a schedule is straight-forward... However, variability in demand forces one to (i) determine factors that will reduce variability to manageable levels and (ii) understand the trade-offs associated with reducing variability in demand.

It is ESSENTIAL to understand a company's variability. Variability in demand, as well as variability in the processes needs to be well understood and managed.

One of the lessons is that "variation is the enemy."

INVENTORY

Case 3 demonstrated the importance of safety stock and the costs it incurs in the company. We had learned about safety stock in class, but Case 3 forced us to apply it to a realistic situation and optimize the [customer service?] while minimizing the cost.

The importance of inventory was taught to me. Too much is bad because certain equipment cannot cope with the speed from the previous operation. Thus, a pull-system should be implemented to stop WIP buildup.

I had always thought of inventory as just storage and that it had no effect on the business. I now realize that inventory is a resource and the money that is "tied up" in that resource could be used for something else.

Inventory is not necessarily evil. In fact, some amount is required to buffer against variability.

[Knowing] the amount of inventory in the system is irrelevant without knowing the production rate. Inventory poses an additional burden too. Inventory not only created additional holding costs for the company, but it also created confusion which led to misplaced items on the shop floor.

I saw how having many distribution centers will lead to higher overall safety stock levels. I also say how inventory costs more than the amount of capital that it ties up. In the factory, it also led to damaged product from forklifts, long lead times and time wasted looking for misplaced laminates.

Both too high and too low inventory levels degrade the effectiveness and efficiency of manufacturing processes. Long and varying lead time causes problems in [scheduling and distribution] from manufacturing down to end customers. The common cause of these inventory and lead time problems is the lack of knowledge in handling variations in demand and processes.

An interesting point I learned this semester was the effectiveness of doing nothing. The concept of sitting idle, as opposed to producing inventory, was counter-intuitive.
Lessons Learned

Before taking this class, I had never studied warehouse inventory theory or work-in-process concepts. I believe that the class provided excellent experience in the recitations and discussions on many different inventory concepts and control systems. I believe this is valuable knowledge that enhances my capabilities as an employee.

[I learned] the importance of managing safety stock inventory adequately. We saw how safety stock can help us overcome the variation of the system, thus preventing the lead time from increasing. Also, I learned how safety stock could be optimized using A,B,C categorization; consequently reducing the investment required to maintain the inventory levels.

An important point stressed in a few cases was the inventory policy. The tradeoff between stock levels and customer satisfaction and cost was a very important concept that I didn't [know previously].

I became familiar with the way Pareto analysis was used in determining priority for certain items.

Inventories must be reduced to reduce production costs. This can be done by aggregating demand [using] policies such as the No B/C Stock policy (or Almost No B/C).

I learned an important concept from the warehouse location case study [[case 3]]. By separating the safety stock into several different locations, the overall variability increases. Although I probably could have figured this out, I had never thought about this before. I think this is an important concept that I will probably have to reapply to a future situation.

Probably most importantly, I learned that aggregation of inventory is important. A good example of aggregation is the consolidation of Llenroc's warehouses. Another good example of how aggregation can be useful is in [the storing of treated paper in rolls rather than in cut sheets]...

I learned the importance of aggregation. You're better off keeping inventories aggregated as long as possible to reduce variation or misallocation. This point was excellently demonstrated in the cases.

INFORMATION SYSTEMS

There was not a case in which we did not mention an implementation of information technology to improve customer service. By looking at the order patterns and consumption [rates] of our customers, Llenroc can optimize its manufacturing patterns... A central information system [for distribution] will result in significantly reduced inventories, improved customer service, and reduced number of emergency orders.

The importance of relevant data was emphasized. Case 6 introduced the importance of having [relevant] data before any calculations and decisions can be made effectively.

The success of a well-integrated manufacturing system hinges on the availability of information and the development of information systems. Understanding what data are critical for operations is of vital importance. Most of the recommendations we generated were a direct result of the information afforded to us. If Llenroc had had this information
readily available, they could have conducted the analysis. The importance of information cannot be underestimated.

An endless amount of data is worthless, unless it is filtered into quality information. Information is the sword used to slay the variability dragon and get closer to the treasure. Remember, "VARIABILITY IS THE ENEMY!"

World class performance requires a world class information system. Therefore, it is essential that an information system exist in all areas of the operation, from distribution to manufacturing to sales and marketing and that it integrates all these areas. I learned a lot about information flow (or lack thereof) within a large company like Llenroc. In all of the cases, one of the major problems was the communications mixup between different departments... I do not know how to make sure Llenroc's computer system has accurate information (scheduling, inventory levels, routings, etc.) at all times.

**EMPLOYEE RELATIONS**

Continuous training of employees is very important. Most of my group's case solutions involved training of employees, in one way or another, to perform additional tasks.

Much of the variability we get can happen due to the unpredictability of labor. First, labor is a significant expense, especially if we have to resort to overtime. Several considerations must be taken into account when designing a system: the scheduled breaks; the low utilization of labor; and even the behavior of labor.
TEAM SIZE AND COMPOSITION

The groups were too big. The ideal size is 4 people. Because the cases did not require the full energy of 6 people, I believe that this may have caused some people to be slackers.

Make the teams smaller (4, maybe 5, people).

Groups sized four or less would be more productive.

Make the groups smaller. With six members in our group, we found it very difficult to coordinate our efforts and it was also hard to split the various cases up to be worked on separately... As an aside, I know six members is not an unusually large team for industry, but usually those team members don't have a thousand other things to worry about, as college students with other classwork do.

Six persons in a group might be too [many]. I know that some groups divided into two [groups]. They took turns for projects. In my group, everyone met together for each assignment. [We] wasted a lot of time in waiting, discussing and reporting.

In our team, we were only 5 and sometimes were really thinking that we were maybe a little too [big]. On the other hand, the purpose is also to learn how to work in a team, to coordinate and dispatch work.

With groups as large as 6 or 7 people it was sometimes very difficult to allocate individual work to each person. There were times when every group member was not utilized.

It is very difficult for six people to work together on one case. Generally only two or three students worked effectively on each case. The only case where it was possible to divide the work in a balanced way was case 1, where we had a few assignments that were independent from each other. If this cannot be done with the other cases, I suggest decreasing the group sizes. If this increases too much the reading work for the professors and TAs, I suggest reducing the number of cases. Then all students can really get deep into all the cases and there will be a similar number of reports that the professors and TAs will have to grade.

The teams are too large. It is difficult to schedule meeting times between two Cornell engineers. It is impossible to schedule meeting times between six. Once everyone did get together, we could not get everyone to agree on anything. Major discussions seemed to drag on forever. It seems that four would be a much better team size.

Having teams of six or seven proved to be cumbersome at times. It was sometimes difficult to find enough time where everyone could meet. In many cases, at meeting not all group members' time was used to efficiency since there may have been only two computers; or not enough different tasks to be accomplished at the time. I feel reducing team sizes to three or four with maybe fewer cases to accomplish might have made the learning experience better for all.
The teams should not be so large. Many times, only two or three people completed most of the work for the case, and then felt obligated to include the other people in the group. Often times, it took longer to try to explain what had been done than to have just done it ourselves. Groups of about four would be much better.

The individual efforts and contribution within a team weren't equally distributed, overburdening some members. Some changes which might help improve this situation are: reducing the group sizes; having constant peer evaluation forms; and assigning which members should present, so that all of them get involved.

Make the group project individual work.

Require each group to contain at least three ORIE majors out of the six members. The balance is very important. While diversity is good, it is essential for some members to have the ORIE background in manufacturing.

Groups should be assigned by professors. It is important to learn to work with people you don't know, and with people you don't like working with. In the real world, you are seldom able to choose who you want to work with.

I would make the groups random, rather than letting the students choose. My rationale is that out in the real world, your partners on a project are usually chosen for you. Although I did have a lot of fun working with my friends on the Llenroc cases and it does minimize group conflicts, I feel that if you are trying to give us a taste of the consulting atmosphere, you should pick the groups for us.

It is important that every member of the group have a different background. Although this was one of the requirements for our class, most groups didn't follow the requirement.

In the way this course is organized now, only four in the team [were needed to do] the work. The team size should be reduced or the amount of work increased (but this will not be very popular).

Smaller teams! We often found that the group worked very well when the entire group was not meeting together. When the entire group met, we often did not get much done. We began delegating the writing of the assignments to two people per case. Often those people would do more work for the case than the rest of the group. This situation made giving presentations quite difficult. A team size of four would be ideal.

Maybe the teams should be limited to five members. Any more than five and it is hard to get organized where everyone can make the meetings and be significantly involved.

Smaller groups in future classes would be beneficial. It seemed as though a group of seven was too large for the scope of these projects. Often time was wasted explaining different aspects of the projects to all the members of the group. In addition, it is very difficult to find convenient times for all seven group members to meet. A smaller group would allow all group members to gain more out of each case study and would be more manageable.

The team size made division of efforts difficult. Most of the case studies could easily be broken into four parts, but were difficult to break into six parts. This resulted in some
team members working much harder than others and seemed to encourage slothfulness because there were plenty of team members to pick up the slack.

I found the size of teams (6 members) to be too large and distracting. There are too many people to account for and much time was wasted just waiting for late arrivals or filling other members in on what happened.

Have a smaller number of people in each group. It was inevitable that three or four people did most of the work for each case. I feel that groups no larger than five would be easier to work in.

It would be good to work in two different teams before having to choose the permanent members for the rest of the [semester]. In my case, the dynamics of the first team [[for the Manufacturing Operations Game]] was a little strange and I wanted to try something different. Unfortunately, the second team also had some trouble. If permanent selections were made after the second case [[meaning, case 1 of Llenroc?]], then a better choice of team members could be made because we would know more people. Finally, the second report [[case 1 of Llenroc?]] is worth a high percentage of the grade and is difficult to complete if your team members changed from the first case. The emphasis forces the team to perform quickly, which is very strenuous on the members. There was much other homework due around the same time and the diversification of majors made meetings time difficult.

Swap groups midway through the semester. While it is good to have a consistent group to work with, it is also good to learn how to work in different groupings. We became very set in roles with our group, and I don't see that as particularly good.

Having teams of both seniors and graduate students is another idea to think about. You might think that grad students could end up doing most of the work, but I honestly do not think so. The advantage of this type of grouping comes to play when grad students take higher level courses or have more industry experience, two aspects which can contribute new ideas to the discussions. [[Teams were separated into undergraduate and graduate teams. However, oral presentations were often made by both type of teams during the same session.]]

Any ways that you can think of to facilitate meeting classmates and finding team members would be helpful. The Manufacturing Operations Game was good, but I was put in a section with Seniors instead of M.Eng.'s. Then, when I went to form a team, I hadn't met any M.Eng.'s. Also, make it clear when teams need to be formed. I felt like I was scrambling at the last minute to find teammates.

**INTERDISCIPLINARY NATURE**

Because of the different [disciplines] or because this course is really too Operations Research oriented, [the members from other disciplines] could never express themselves and provide their share of the work. In building our team for this course, we should have looked for people who could really bring something.

Unfortunately, we could not really incorporate or use the skills of two team members coming from [other] fields. [In spite of] leadership and encouragement from the other team members, loss of interest and [understanding] from these two members increased
Ways to Improve

with time. Before an interdisciplinary team is formed the interdisciplinary problems have to be identified and confirmed.

The Llenroc Plastics cases deal mostly with inventory, distribution, demand variation, and lead time. I did not see any problems concerning electrical or mechanical aspects of manufacturing. The reason I took this course is the course title "Design for Effective Manufacturing" implies interdisciplinary subjects in manufacturing which should include operations research, electrical, mechanical, chemical, economics, laws and regulations, and even political [factors] such as NAFTA. I believe this class can be enriched by inviting outside speakers not only from manufacturing but also from law firms, political agencies, or even labor relations. Frankly, I do not believe that operations research alone can create an effective manufacturing [system].

We had some troubles with people from other departments who could not provide their share of the work. I had the feeling that this was due to the fact that ORIE 515 is too Operations Research-oriented and that the ORIE students were teaching what they know to EE and MAE students when we could not take advantage of their knowledge. This could be improved by adding, if possible, some questions involving some electrical or mechanical knowledge.

**WORKLOAD**

The cases were overwhelming in terms of work and time and a one week deadline causes me to neglect my other courses.

I don't think there was enough [work required for the course]; we should have done case 7 as well.

Assign one less case and spread the extra time to ease the other cases' deadlines. If ORIE 416/515 is to remain a 4 credit course, the workload must be more manageable. I spent a huge amount of time working with my group, more time than I have ever spent on any 4 credit course at Cornell. The intensity may be good, but a couple of extra days to finish the reports might have enabled me to better concentrate on my other classes.

Either reduce the number of cases or combine a couple. By the end of the semester, it became extremely tedious to write up cases every week, especially as other major projects became due.

A reduction of the number of cases might be nice. We completed five cases, all with written reports and three with oral reports. Perhaps if two cases could be combined so that there were a total of four cases, that would be good. It wasn't that bad, but sometimes, we would finish one case and the next one would be due a week later which made them a little rushed.

Reduce the number of cases and make them more in-depth. I wound up getting a lot out of the Llenroc Plastics case studies, but I think I would have gotten even more with a smaller number of more in-depth cases. As it was, our group often spent more time writing up the reports and putting together the presentations than we did on the actual cases. I would have liked to see cases dealing with more issues, or perhaps a case in which the problem was not quite so laid out and which would have involved analysis to
Ways to Improve

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determine exactly what was wrong. Someone said in lecture that consultants spend far more time and effort finding out what the problems are than in fixing them.

Drop the workload a bit. As a Masters student taking 20 credit hours, I often found myself buried by this class and unable to work on anything else. Perhaps if the cases did not have quite so many assignments, or if several of the cases were treated as less formal assignments, this would lessen the burden.

Communicate with the other professors in the Manufacturing Option and limit the amount of group work being done in all classes. Group work is fine and is something that should be learned in school, however, the large number of group projects/papers/presentations that were part of all classes made it nearly impossible to get something out of every project. Work ends up getting divided up and only a few people do the majority of work on any one project. Group projects in each course should be scheduled NOT to coincide with projects in another class.

Try to work with the other departments in the engineering college to find out when other major projects and exams are scheduled and assign the appropriate due date for the next case. The benefit is that then the students can apportion a fair amount of time to the case as well as their other classes.

There should have been a wider space of time between the end of one case and the beginning of the next. Toward the end, I got tired of working with the same people without a break because it seemed as if we were always working together.

If we can be given more time I believe the quality of the reports can be further improved.

The more interesting and time consuming cases came towards the end of the semester (cases 4-6). By pushing the cases earlier in the semester, I think we’ll have more time to analyze the cases.

The end of the semester is very busy for most students, especially grad students. Therefore, the only portion of the course that I would suggest changing is starting Case 1 earlier in the semester so that the last few cases were spread out in the end.

Case 6 is really being crammed into the final week which is already a very hectic time. I wish we had started Case 1 earlier in the term. I think we were allotted enough time for each case, but I felt like the class didn't really start until about three weeks into the semester. [[The Manufacturing Operations Game and most of the lectures for the course were scheduled in the first three weeks.]] If we had started the Llenroc work earlier, I think we could have had this last case due before [[Thanksgiving?]] break and just wrapped up with Case 7 after the break. The timing could have been much better.

The class might start earlier on the cases and spread the work out even more throughout the semester. The oral progress sessions, however, were helpful in that they eased much of the added work. [[In the Case 6 oral progress report, the faculty directed the students to limit their analysis to very specific questions.]]

If we could have started Case 1 earlier than we did, and ended Case 6 during study week [[period before final exams]] it would have taken a lot of pressure off us. Some of the cases were to be completed in only one week.
SOFTWARE

I hope that the software is improved. The bugs in the programs caused severe headaches at times as well as wasted a lot of time (the programs [[TRUCKS?]] didn't allow us to save [our data] which made us redo the entire [[truck schedule?]]).

Remove the bugs in the software.

Have the software as "bug-free" as possible before using it in class. I'm sorry, but this got royally frustrating at times. Our group eventually gave up on the various pieces of software (which refused to save our results, or would not open files in which results had been saved, or would just plain eat the data we put in) and used the spreadsheets. I appreciate the programmers' efforts in trying to come up with something easier to use than the spreadsheets, but a little more debugging, or testing, or something, was needed.

Software in this course should be fully tested / debugged or just rewrite the whole thing. (I heard these programs are written in Basic. Why not C?)

The software must be tested more thoroughly before springing it on the students. The software packages for cases 1 and 3 [[TRUCKS and the Warehouse Location Software]] would crash several times. This is inconvenient seeing as it is hard enough to organize a group meeting where everyone can attend. If the software then crashes, the meeting becomes unproductive. Overall, the software was effective. The only problems I felt were with "random crashing" and the speed of some of the programs.

There are several fatal "bugs" in the [graphical] software used for Cases 1 and 3. The software [[TRUCKS?]] sometimes saved the wrong demand and supply data. Even worse, the software sometimes kicks the user out of the program. The nice graphical [[warehousing software]] takes a lot of processing time and so takes a lot of our time unnecessarily.

There were many bugs still in some of the initial computer packages that caused extensive delays in project completions. These should be worked out for next year. [[Llenroc Plastics is used in alternate years in the curriculum.]]

Work the bugs out of the new programs before turning them over to students. The new graphic style programs were much nicer to use than the spreadsheets, but the bugs in the programs really detracted from them. It added a lot of time to each project when the programs crashed halfway through the exercise. Fixing the programs would make the projects much easier to deal with and would reduce the amount of fumbling around that you have to do with each case.

The software that was given to us in the first few cases could be improved. Most of the time it did not work the way it was supposed to.

It is understandable that some of the new software have some problems since they are still being developed (but were still very useful). For example, the spreadsheet SAFETY.WK1 used for Case 3 had some theoretical mistakes; also some of the totals given by the spreadsheet [[WHOUSE.WK1]] differed from the totals given by the graphical software.
Debug the software for distribution cases [[warehouse location software]]. We tried many different distribution patterns to reduce the number of trucks. In the end, we came up with an efficient schedule. Feeling very happy, we went home. The next day, when we sat down to write the report, we couldn't retrieve our file.

The computers in the MEng. lab are too slow. [[IBM 386 SX.]] This caused a lot of frustration [[The warehouse location graphical software was slow, even on a 486 machine.]]

The software was not only not very interactive, it ran very slowly on most computers. A manual of how to operate the software should be included in the course packet. The recitations [[laboratory sections]] do not satisfy the needs of everyone due to differences in computer skills.

Use a totally different program for trucking schedules. The one we used for case #1 [[TRUCKS]] was not very user-friendly.

I think this problem has been solved, but the computers could have been a little faster for the TRUCKS software and the route software (Case 1).

An obvious [area to improve] is the software for the first cases. It is not vital but it would be nice to have smoothly running software.

In the beginning there was plenty of software to assist us in our calculations. Towards the end, however, we had to create our own. There were other items taking up our time that made creating software very time-consuming. [[Cases 5 and 6 have no software associated with them. Students are expected to create a spreadsheet to solve Case 6.]]

Have available software for each case. This software should be usable in other areas or in the real world. We could also have used some lectures in how software packages for industry are designed.

Allowing the students to develop more of the tools needed to solve the cases might be interesting. This would provide a more realistic experience about the difficulty of solving these kind of problems in real life.

One of the things that could be improved in the Llenroc Plastics Experience is the amount of utilization of the software created by Prof. Jackson. [[The student is probably referring to CGANNT, the software for cyclic scheduling. This was used in one recitation to illustrate the concepts of cyclic scheduling but was not used in any of the Llenroc cases for detailed analysis. It is an integral part of a different design experience, The Manufacturing System Development Game.]] I believe [it] could be a useful tool in reaching optimum solutions to the cases. The cases could be adapted in order to use the available software or vice versa. I think that all the time and effort Prof. Jackson put into writing the software should not be wasted.
CASE TEXT

Clarify the cases, because sometimes what was written didn't make sense.

The readings would be [improved] with a clearer statement of objectives and requirements. I found the case readings to be rather vague, and it was easy to get bogged down by minor details.

At times, the data / text were unclear and we often had to make assumptions [we were unsure of].

The data were ambiguous. There should also be more information on the physical aspects of the operations.

A more detailed diagram of the Fabrication room could have been helpful. This diagram would show how material flows in and out of the MJs and sanders, and it would show what [material handling] devices [[scissors lifts]] are located at the entrance and [exits] of the machines.

Appendix F is a little confusing. I had trouble following how to make the safety stock calculations. For example, on page F4 no subscripts are needed on any of the alphas if I understand them correctly.

It should be specified how to make the divisions into the A/B/C categorizations. Say that the A items make up 80% of the demand, etc. This is important because it is used later in the other cases.

Make corrections to the cases that were realized this time around. For example, we had a problem with case 6 because the numbers we used came from a calculation that the case suggested but wasn't quite right.

There was so much information presented in the Case Studies that not all of it was relevant.

I would review the text for the class. Most of it was clear and easy to understand, but some of the tables were slightly confusing, and without a better understanding of the process, it was hard to tell exactly what the numbers meant. The text should be written assuming no understanding at all of the process. For the most part, it was. There were just a few confusing parts.

If we are given a clearer picture of the current situation with Llenroc Plastics we will be able to perform a better job on the assignments. Sometimes, I felt that the information was not enough and it was unclear. This created some difficulties for us.

Improve the description of the cases as much as possible. Also it would be a good idea to have a reference file or book or even video tape where we can consult for details about the actual situation of certain operations. Throughout the semester, we lost a lot of time making incorrect assumptions. It is sometimes not possible to ask a professor or a teaching assistant at the time the questions arise. Moreover, sometimes, we cannot wait until the next available day. That is why a common reference will be extremely helpful.

Sometimes I got the feeling that we were missing data that would have been useful in evaluating different alternatives. For example, in cases 5 and 6 we had production time
and demand very well specified, but nothing on costs. Maybe cost is not a major issue
here, but it can definitely tip the scales between two possible solutions.

There was something strange [about] case 3 and I can't really put my finger on precisely
what. I think it was either too broad or too early in the semester. I was going through it
just now and the issues did not seem too complicated, but I remember that we had about
4 meetings for that case where the first question was "OK, what do we have to do for
this?" I remember we did not know how to start so we lost a lot of time. I would guess
that this is why in the end most groups ended up only playing with the software, without
doing any further analysis.

**VISUAL AIDS / PLANT TRIPS**

It would have been great to do a live plant tour. It seems ironic that I will graduate from
Cornell, having spent the bulk of my time preparing for work in manufacturing, and
never even have been to a plant as part of my coursework. A plant trip would not even
have to relate to the Llenroc cases, it would just be nice to have the opportunity to visit
any facility with my professors on hand to comment and answer questions.

A real plant tour would be nice but probably not feasible. It was sometimes difficult to
get the true nature of the problems from the text but you explained everything in class as
well as it could have been without actually seeing it.

If a new case is developed in the following years which involves a factory nearby,
arrange a trip to that factory. Students will be able to come up with better solutions if
they have the opportunity to observe what is going on.

Take one or more field trips to different manufacturing companies. It would have been
very useful if we had been able to go to "Llenroc" to see the facilities themselves. I
would certainly recommend that in the future, students visit the company before they
start working on the cases.

It would have been helpful to have a visual introduction to the case at the beginning of
the course, rather than in the middle. [[Faculty conducted a "plant tour" with the aid of
35 mm slides before Case 4. Also, a prototype multimedia video tour was briefly
demonstrated.]}} There is much more you can understand from a situation when you see
it.

I wish I had seen more videos of Llenroc Plastics because early on, I had no idea what
the factory or warehouse looked like. The ideal situation would be for us to visit the
company but maybe the first class should have been a video about the warehouse, factory
operations, and an overview of the whole company, especially since the entire course is
focused around Llenroc. I didn't even have a firm grasp of what our product looked like
(and the handling problems associated with it) until we saw the video for Case 4.

I would suggest that more videos and audiovisual equipment be used to give us a taste of
what is going on in reality. This was done for once and it was great. [[A prototype of
interactive multimedia factory tour was demonstrated.]}} I know that it would probably be
very hard to get more of these videos at this time, but I just wanted to point out their
great value. Having more of them would be great.
Ways to Improve

Making recommendations for a production plant that we have not been able to even take a tour of is very difficult. I think it is integral to be able to visualize the current production process before making any recommendations for change. This is why I think more visual slides such the ones given during the one [plant tour] lecture should be given. This can even serve as an introduction to the class during the first week or two. Once you can visualize what is going wrong in the plant, it is easier to see what steps need to be taken for improvement.

I would try to give the students more of a picture of what the plant looks like. The video clips (or slides) were somewhat helpful, but I think each part of the process should be visually defined before assigning the project. In this way, we can better understand a process which most of us have never seen.

LABORATORY EXERCISES

Only half of [the lab periods] were effective.

I found I learned more from the simple examples in class than from the computer models used in lab. While the computer models were powerful, I found I often was applying them without understanding their fundamental principles.

LECTURES / PREPARATION

I understand this course requires us to spend a large part of our time on the case studies. I also understand you don't want to repeat material the grads have seen. But I would have benefitted from additional formal teaching. I am a senior, and I haven't learned everything yet.

Assign several short homeworks to reinforce how to perform calculations such as WIP, throughput, and inventory stock requirements. The lecture and recitation covered it, but some people are not comfortable doing these calculations by themselves.

If you were not an ORIE major (ie. never taken a class in this material before), then I feel that you tend to get less out of the cases. The amount that you learn is dependent on your own motivational level. For example, I never had to understand some of the financial analysis and scheduling that was done, as the ORIE's did it themselves. I had to constantly ask what was happening in order to keep up and contribute. Perhaps a basic optional text could be made available?

If you are not an ORIE student or if you do not have any background in statistics or economics, you are at a severe disadvantage. More common sense stuff should be taught instead of learning all that theory (statistics equations, standard deviation, etc.). Not all theory should not be learned, however.

More formal training is necessary prior to any one case as often we didn't understand the concepts we were applying. Furthermore, a class of review after each case would help to more firmly implant the knowledge.

Some of the cases called for knowledge some of us simply didn't have. Not having taken OR 451 [[Economic Analysis of Engineering Systems]], I could not build the economic model the case requested and had to leave it up to other members of the group. If this happens frequently, then the members will not be contributing equally.
I was unhappy with a few things in the case studies, most importantly the fact that if you were not an OR/IE student you had to have one in your group. There were many tools that I had never heard of before and still do not fully understand. The ORIE students in our group wound up doing all of the Pareto analyses and all of the economic analyses, so that the end result was that non-ORIE students did most of the simulations and number crunching of data while the ORIE's did all the inventory and cost calculations.

As a CME student [[Manufacturing Option Program]] who is not an OR major, I must recognize the shortcomings in course preparedness. I was fortunate to have taken several OR classes as a Cornell undergrad, but many of the people in this class were not so fortunate. It places some strain on the team as the common sense solutions to the problems are evaluated by all members, but the tools of evaluation are often possessed by only the OR majors. Perhaps more attention should be paid to the course readings, but I would suggest an optional text that covers the general tools required so that the interested non-OR's can learn more of the fundamentals.

It could be improved if non-ORIE's gained some finance experience prior to enrolling in ORIE 515. Perhaps NBA 553 [[Economics and Accounting for Manufacturing]] could be offered concurrently with ORIE 515. It was frustrating, I am sure, for ORIE's to have to bring the non-majors up to speed. However, this was important for group dynamics.

Explain the basics of OR theory more completely for the benefit of non-ORIE students.

Students with a solid background in operations research and industrial engineering had to teach many basic principles to the non-ORIE majors. For example, topics such as engineering economy, inventory theory, and cyclic scheduling were clearly understood by ORIE majors. However, we then had to teach these principles to the non-OR's before progress could be made on the cases. A possible suggestion would be to go over some basics in Engineering Economy and Inventory Theory in optional lectures for non-OR's.

Often, the OR's on the team had to explain all the necessary tools to the other students from the CME [[Cornell Center for Manufacturing Enterprise]] program before doing a case. Perhaps some guest lectures could be prepared where attendance is optional for the OR majors. Some examples would include "What is Simulation?" by Prof. Schruben, "Applications of Mathematical Programming" by Prof. Trotter or Todd, "Introduction to Engineering Economics" by Prof. Jackson, etc. This would give the CME students the necessary background to contribute more to the cases.

Make the lectures optional for OR students. The lectures should be mandatory for non-OR students. The lectures should then provide background in such areas as simulation, economic analysis, etc., so that the OR students in the group are not left with the teaching responsibilities.

I recommend that we have fewer lectures. More office hours in place of lectures would be beneficial.

I don't think quite so much information about the different kinds of inventory was needed at the beginning of the course. If some of this was eliminated, the cases could get started earlier.
Lecture material should be more structured around the labs or cases. For example, talk about production scheduling towards the end of the course [[when case 6 is studied]]. Describe demand aggregation, reduction of variability, the No B/C Stock policy with slightly more math. emphasis, or maybe closer to the cases where those ideas will be applied. This was especially true in the beginning of the course when we covered a lot of material that we then used two months later (thus some of those ideas got lost in time!).

I felt like we learned many of the tools too far in advance of when they were needed in the course. This was not a big issue, but it might have provided more continuity.

The classes used for explaining the types of inventory should be placed between [case 1 and case 3?]!. That is, it will be more useful for us to analyze the types of inventory in class when [case 3] is being analyzed. This arises from the fact that when [case 3] is being done, a lot of questions arise about the types of inventory and how they [behave?] (!?

The lectures were usually boring and uninteresting. I think the lecturers need to have more energy and enthusiasm when presenting the lectures. The material covered in the lectures was interesting, it was just the manner in which it was presented that made the material to also seem boring.

Teams were left in the dark to some extent when it came to problem solving methodology. From the IBM Manufacturing Consulting people [[guest lecturers]], I learned that most consulting groups have a clearly defined methodology that they follow. I am not saying that a methodology should have been forced upon us. However, it would have been productive to look at some of the more successful methodologies at the start of the course.

You could have a lecture (or two) about how to manage groups and working together as a group. This could include how to run meetings, prepare meeting agendas, prepare meeting reports as a group, and how to make a group presentation. [[One of the guest lectures was entitled Group Dynamics and addressed some of these topics.]]

GUEST LECTURES

Encourage the guest speakers (some of them) to interact more with the class.

I think the guest speakers we had this year were not very inspiring. I think the material on which they lectured is vital to our coursework and the manufacturing program (since guests can be more educational than our class material) but I found the men from GE and IBM (not John Jenner) to be uninteresting. Perhaps it was due to the time (right after lunch!) and/or the length of the class, but instead of getting excited about the "real-life" applications of our studies, I found myself yawning. However, I thought our guest from Avon was enthusiastic and interesting. Also, I would like to see a woman engineer come and speak as a guest lecturer.

Eliminate the guest lectures from the curriculum. I felt that the issues that were being covered in these lectures were good overall manufacturing topics. However, they seemed to have little direct relevance to the cases. Topics such as these were covered in ORIE 410, and we have the tools to use them already when taking the course. Also, some of these lecturers were the same speakers as in our seminar later on that day. [[M.Eng.
students are required to attend a 1 credit colloquium on Manufacturing Engineering.]]

Often, material was repeated from 515 during the seminar.

Spending more time on the case material in lecture would be more helpful than mandatory lectures with guest speakers.

Invite as many guest speakers as possible. The knowledge and experience they bring is invaluable. It might be interesting and enlightening to invite speakers who just graduated from Cornell and don't have much work experience. Listening to the problems these people faced when they started work could help us prepare better for work.

Bring more people from industry to talk about their experiences. It could be very useful if the people from the company on which the cases are based could see our work and come and talk with us.

Include some of the people working in the laminate company in question during the lectures. It would have been of great value to get an appreciation for how some of the people that worked for the company viewed the problems that it faced.

TEACHING ASSISTANTS

I recommend that the Teaching Assistants become more involved in the course. The few times I tried to talk to a T.A., he/she seemed to know less about the case than I did. Their involvement in the first few cases was strong but gradually deteriorated throughout the semester. [[The faculty did not involve the T.A.'s in cases 5 and 6.]] Late night questions are normally directed towards a T.A. because calling a professor at night at home seems unprofessional. We were unable to do so this semester.

Since most of the time the T.A.s did not know what the cases were about, we could not count on them to answer our questions. This is why you, the professors, ending up answering our questions all the time. Usually, TA's are easier to catch than the professors. Also, I believe that TA's should be willing to understand and see all the possible points of view when grading the cases. [[The TA's graded case 4 reports.]] They should not grade only according to what they think is the best solution but also taking into consideration the assumptions and line of thinking of the students.

ORAL PROGRESS REPORTS

There was little incentive to come prepared for the oral progress reports, since most of the time, they were just Prof. Muckstadt and Prof. Jackson giving more information on the case. If we could be required to come prepared with the discussion questions, as we did in case 1, I feel that the sessions would be more beneficial.

[Perhaps, there should be] more oral progress reports, though not necessarily so long. Perhaps a short in-class discussion (15-20 minutes) for those cases where we don't have oral progress reports. (This is just an off-the-top-of -the-head idea; overall, I thought the way you handled the cases was very effective.)

I would like you to provide more oral progress reports to make sure that the groups are heading in the right directions and there is a lot more time for questions. In this way, serious errors on the cases will be minimized and the results will be more detailed. Basically, the groups will have a better idea of what you are looking for in a solution.
Ways to Improve

On some cases, we began to work very early, and we lost a lot of time, because we were working with the wrong assumptions, trying to do things that are not demanded, or with constraints that have changed.[[The faculty used the oral progress report meetings as a time to clarify the objectives of the case.]] This means that the cases need a better description, and a more precise indication of the assumptions that are made.

Sometimes, too much help was given in the oral progress reports. It would have been more educational, and more creative solutions would be generated if fewer hints were given. This was particularly true in case 6, where most groups' solutions were nearly the same. There is something to be said for letting a group struggle through the problem determination.

It would have helped if we received more guidance on each case. Perhaps, in lecture, [you could] define some key issues on which we should focus.

More effort should be spent in class to prepare for the cases. I felt overwhelmed every time a new case began. There was an overload of information, making it difficult to sort through what was important and what was not. Although the oral progress reports helped, not enough time was spent discussing the case at hand.

I would somehow try to meet in smaller groups more often. The large lectures were much less useful than were the small progress report meetings. In the small meetings, the one-on-one interaction allowed for more questions and an open discussion of any misunderstandings the students might have.

The discussions during the oral progress reports were crucial to successfully doing the cases. Several important concepts and the specific aspects to be focused on in the case were given to us during the meetings (especially for cases 3 and 5). The only problem is that we usually came with lots of questions, and so ended up not having time to address them all. So, maybe these discussion sessions could be increased in duration (such as having one big discussion session during lecture).

During progress report meeting have [only] one team present. [[Typically, two teams were present for each progress report meeting.]] I noticed that most teams did not participate as much in the meeting because they didn't want to share their ideas with the other team.

**ORAL PRESENTATIONS**

It would be helpful if all of the students, or at least the M.Eng.'s had to do oral presentations twice. A few people in my group who were not comfortable speaking in front of others made it clear that they would not participate in [the last] presentation. Therefore, the people who needed the most practice did not get it.

If we could have four cases where [oral] presentation is required it will be very beneficial.

Have a presentation for all of the cases. The more we present, the better we get.

You may need to require students to participate in at least two presentations instead of only one.
Make the written report something like homework and forget about [oral] presentation.

Eliminate some of the written case studies (eg. Case 5) and just do oral presentations.

The teams should make their presentations to larger groups of people. I understand time constraints, but for grading consistency, both instructors should have a say in every group's grade for every case. In addition, the group members would doubly benefit from the comments of two instructors.

During the presentations, I disliked that occasionally the professor would incite debate between the groups presenting. This made it very personal between the groups. This is too confrontational and potentially embarrassing for a weaker team.

All students should be led to the proper resources which can maximize the aesthetics of their projects. Teams whose members have access to color slides and laser printers have a distinct advantage over those who don't. The advantages, if not eliminated, should be compensated for in the grading.

Maybe it is just my ignorance of ORIE classes in general, but it seems to me that the "dog and pony show" aspects of the reports and presentations were weighted too heavily over content.

I was disappointed in the flowery nature of most of the ORIE students and the fact that they all seemed to be putting on a show. They would dress as if they were going to an interview and then throw a bunch of garbage into reports and presentations. Maybe it goes with being an ORIE student, but some of the reports written by the ORIE's in my group were thinner than the paper they were written on.

An interesting idea would be to have random presentations. All the group members would prepare it and then at the actual presentation you could randomly pick people to present certain parts. While the presentation would not be as refined, it would ensure that everyone in the group, not just the presenters of that section, understood each section of the project.

I would organize and adhere to a more strict presentation schedule. A lot of time, these presentations do not occur during our normal OR 416 lecture hours. For this reason, most of the class members have to schedule their days around their presentations. If the presentation does not start on time or goes on longer than expected, a student's entire plan for the rest of the day could be altered. This problem has happened to me and it is a tremendous inconvenience. An improvement is definitely needed in this area.

In a course about improving U.S. manufacturing I think it's important to show that schedules, ie. meeting times, should be adhered to.
CASE REVIEW / FEEDBACK

Go over the cases more extensively once they have been handed in. What solutions did Llenroc actually implement? What were the results? What would Llenroc say to the suggestions that we came up with? It seemed that once the case was finished, the next case would be started immediately without discussing what Llenroc actually did.

It would be nice to see more of what Llenroc really did, particularly after we finish each respective case. Lecture time could be used more to support the case. For instance, class time could be used to go over what happened in each case and what the real issues were (after the fact).

It might be of interest to many of the students to have some writeup of the actual solutions to these problems. Hearing about them was fine, but if they were presented in some written form after each case as a baseline solution, it might give the groups some ideas to work from. (But I suppose it could also stifle creativity.)

A discussion of each case should be followed after each case is due. Discussion should include the good and bad points of reports.

The professors [should] address some good solutions and points from some nicely done reports.

Provide an example of what you considered an "A" written report after each case. This would help students realize what is important, what is NOT important, and give students an idea of how a report could be organized. Of course, this would only be a pseudo-example, and there would be many other formats that could represent an "A" report.

Sample cases should be provided to allow students an idea of what is expected. Sample cases could include actual cases presented to Llenroc or cases from previous years.

There is good feedback from the written reports, but the feedback from oral presentations were also important for us. If we could receive a critique about how well or how [poorly] our presentations were and what we could improve, then we can learn more and continuously improve our presentation ability.

There is a lack of feedback on the oral and written presentations. Actually, the written reports contain a lot of annotations, and that helps a lot. It may be interesting to get some kind of correction at the end of each case. For the oral report, I wish we had more comments on what was wrong, and how to improve it. Sometimes, from the comments we had, we thought we did a good presentation, but the corresponding grade was not as good as expected.

Put more emphasis on improving the style and form of the writing and oral presentations.

The feedback that we received for the written and the oral reports was poor. Sometimes we made the same mistake because we did not understand what you were expecting. In addition, sometimes we had questions about the grading policy and about some of the comments written on the reports. I think that a 15 minute feedback session per team, per case, will help us improve the reports.
Ways to Improve

It is hard to present in front of Professor Muckstadt because he puts you on the defensive. It is especially hard the first time because his tactics totally blow your concentration. I am not saying that what he does is bad; actually, it is good. However, you may want to tell the students that the reason that you do this is so that they will be prepared when a [client] does it to them, so the students don't end up thinking that you are ripping them to shreds because they can't do anything right.

I would strongly suggest much more feedback on the evaluation portion of the class. At times, I did not have a clear impression on what we could do to improve both our oral and written presentations. I suggest that more time be scheduled so that either the professors of the T.A.s can give more feedback. This would make the learning experience much better.

Provide more feedback about student presentation skills so that they could be improved upon for future presentations.

The cases should be integrated from the start, with students aware of all the eventual necessary improvements at the beginning of the semester. In addition, lectures taught immediately after cases are graded should relate to what was good and bad about each of the students' solutions. The major emphasis should be on why certain wrong solutions are not viable.

At times I felt that a case was not covered as completely as I would have liked. Maybe if there were fewer cases with more attention to each case, the student would learn more about certain areas instead of a little bit of all areas.

I understand that there are many right answers to problems such as this, but in many cases, I was curious as to what the most correct answer was. More attention to this could have been made after each case was finished.

**Peer Evaluations**

[[Students were required to hand in confidential evaluations of the contributions of their team members. One peer evaluation was submitted after case 3; the second after case 6.]]

Make students fill out the peer evaluation forms more frequently, perhaps after each case is completed. This way, you are able to spot sooner people who might be slacking off, and alert them of the situation before more drastic measures are needed. Having only two peer evaluations is not enough...

Make the peer evaluations COUNT for more. That way the lazies will work.

There should be some way to deal with students that are not necessarily doing their share of the work. As it stands, it was left to the groups to deal with the internal dynamics and task assignments. If there was a student that did not have a grasp of the material, then the rest of the group was required to do more work. (This was not a major problem for my group, but I know it was a problem for many of the groups.)

Find a way to make sure that everyone is carrying their own weight in the team. This was a common problem in most of the teams. For the most part, two people did the work throughout the cases.
Ways to Improve

Try to incorporate some more individual performance into the final grade. I think more frequent [peer] evaluations are needed. These can be used to detect poor performers or potential problems within the teams. Also, during the discussions and presentations, the faculty could ask questions to specific individuals to get a flavor of their knowledge about the case, which could indirectly reflect their level of effort and participation in the teamwork.

One of the great lessons of this class was the one learned from working with other people. This lesson could be amplified by having intra-group evaluations after every case. In these forms, students could give students feedback on all aspects of their work and interpersonal skills. This would give every student an added incentive to perform and it would also create a mechanism to progressively improve the team skills of everyone.

ADDITIONAL CASES / MISSING FEATURES

An interesting case [to include] might be a marketing oriented case.

Ask students to do Case 7 and give a presentation on it. This would help put all the other cases [into] perspective.

Case 7 would have been a useful exercise to do. However, the workload for this course is enough already. Maybe you could require all groups to do case 7, and allow them to skip one of the previous cases. That way, if the group has a busy week, they can choose to not do the 515 case that week. All groups would also get the benefit of tying everything together in case 7.

Try and fit case 7 in. Even if it is a shortened version, I think it would be effective.

Talking with Prof. Muckstadt during the last presentation got us going in that direction because he asked us to tell him in which order we would implement the changes we recommended throughout the cases.

One or some of the projects should include techniques in effective data collection.

I missed the data research aspect which is, I am totally aware, very difficult to put in place. This could, perhaps, be done by only giving the data during the progress meetings when the teams would have thought of which data they are going to need.

It would make it more interesting and realistic to let the students figure out what data are needed for each case. For example, all the information needed for the cases could be put together into a big appendix, not in sequential order relative to the cases. Another approach could be to provide the information upon request from the students.

As an ORIE major, there are a few topics I haven’t learned anything about, such as sales and marketing, product design, financing various proposed changes, and mission statement / corporate strategy... I know these topics might go beyond the scope of the course, but maybe it would be worthwhile to think about how these areas may affect manufacturing. For example, how can sales and marketing work together to provide customers with the best quality product and the shortest waiting time? What incentive is there for the salesman to understand and consider the manufacturing process? Can the product be designed better? What changes would have to be made in the manufacturing equipment? What is happening in the market for this good? Do trends exist in the data?
Ways to Improve

To add a proactive perspective to the case study, a complete analysis should be conducted on the recommendations made by the teams. For instance, when we stated that the customer service will improve, the president of AMP suggested we predict how much market share will increase because of the improvement. And, accordingly, determine if we will have the capacity to handle the increased market share. This approach will help understand the ramifications of our conclusions. [[Bill Hudson sat in on oral presentations of case 6 and indicated that this market share prediction is the type of analysis he requires of his planners.]]

FACILITIES

Get a better lecture room next semester.

Most of the time, Professor Muckstadt and the student answering a questions were very difficult to hear. Maybe more should be written on the board so that we can keep track of these important points.

Faster computers [[existing computers were 386SX]] in the ORIE lab and more printer paper would have been very useful.

Arrange for additional hours in any computer lab during the day or two before projects are due. We worked in Hollister [[general undergraduate PC computing facility]] until midnight many nights and were then forced to return to someone's apartment to work. This significantly slowed our progress since in the computer lab, we worked on many computers at once. In our teammate's apartment, we wasted many hours waiting for our turn to use the computer.

Another difficulty we faced was finding space to utilize the software given for some of the cases. There is a minimal number of computers in Hollister [[general undergraduate PC computing facility]] and many of them are very slow (especially when using the software for the [warehouse location] case study). This problem may be overcome if the students could have more access to the [ORIE] computer lab in the Theory Center. [[This is a teaching lab that is not generally open on evenings or weekends. Access was increased later in the semester.]]