

Third Term Spring 2008 (3, 0, 6) Graded or Pass/Fail

Class hours: Tuesday, Thursday Times 2:30-4:00 PM Thomas 306

Revisions: Course Schedule, and Project Timetable now moved to separate document E103 Schedule. Available under Syllabus tab of website.

E 103 – Management of Technology

Course Objectives:

- To study the management of technically-based companies in the context of industry norms, market realities and corporate culture. Technology is defined in the broadest sense and will include the management of technical people, manufacturing issues, software and hardware as well as product technology.
- To develop skills for critical technology judgment and provide the student with the principles and the tools for technology management. These tools will be integrated into the case analyses and the term assignment. We will explore how these tools are employed in several industry segments. We will examine cases from some of the following industries: Semiconductor, Materials, Medical Devices, Aerospace and Biotech
- To provide an introduction to Business School case-based learning methodologies. We will use Harvard Business School Cases as well as cases created with guest lecturers developed exclusively for this class.
- To develop team skills. Team processes emulate how technology is actually developed in business today.

This course is different from most Caltech courses:

1. The Course is Case-based

Although there will be expository lecture material and reading assignments, most of the learning will occur through your reading, analyzing and discussing cases. These cases are real examples from real companies which present problems for the students to solve. Unlike your other classes, there are no "correct" or "incorrect" answers. There are, however, answers which are well thought-through or are superficially or illogically argued.

2. The Course is Team-based

To address these cases and to work the term assignment, we will be divided into groups of three people. The teams' members will behave interactively and cooperatively to improve the results of any single member. To participate in this Class, you must take these teams very seriously. You are obligated to attend team meetings and bear your share of the burden. Each team member will receive an identical grade for efforts produced by the team. The first week of classes will be devoted to forming these teams. At each class a case will be presented by one or on occasion by two teams, depending on the number of students registered. This will require the members of the teams to read the case, answer the analysis question, write out your analysis and present the results to the rest of the class.

All other members of the class who are *not* presenting are also required to read the case, answer the questions and be prepared to comment on the ideas presented by the two teams. Whether you present or not, your grade ("HW") will be based on your written analysis submitted to me. After

the case is presented in class, we will all analyze and critique the suggested approaches and contribute to synthesizing an acceptable answer. Everyone must be prepared. I will moderate the discussion and perhaps present some expository material if required. This discussion simulates how business is actually conducted; most business information is transmitted orally. Therefore, I will require all students to contribute. I know some students are not comfortable with this and I will make some allowances. However, I do want all to join in and 15% of the grade will be dependent upon this participation. Attendance, of course, is required. You can't contribute if you are not there!

The above only works if the "Teams" work as teams with everybody contributing. No free rides. The Caltech honor code applies here. There will be a rating process where members score each other on team behaviors. In the extreme, non-performing members can be voted off the Team. If there are team issues, please address early. The TA and I are available to help.

Remember, everyone in the class, presenting or not, reads the case in advance and attends team meetings to discuss and prepare the case. Everyone attends each class, *showing up on time*. If you have to unavoidably miss a class, I would like an e-mail or telephone message in advance informing me of the fact. This is the kind of learning where looking up lectures on the web will not suffice. You will only *own* the information if you follow the arguments made and participate in arriving at an acceptable conclusion. The journey in getting there is part of the learning experience. The formula is as follows:

Learning = f{(team effectiveness + team preparation + rest-of-class preparation) X (class attendance)}

Term Assignment

Do *either* A or B

A. Write a Technology Assessment and projection.

- Choose a Technology
- Show the history of development of this technology with key breakthroughs indicated
- Show the characteristics of how this technology was advanced (industrial breakthroughs, product demands, University research, military spin-off, etc.)
- Show where the capability of the technology is heading (1-5 year projection). Justify your assumptions and conclusions.
- Who will develop (and how will this technology be fully exploited) through the time period in question, i.e. what are the drivers? Hint: look at what's in the laboratory or conceptual stage now. Most importantly, look also carefully at market forces. Is there really a discernible demand from potential customers? There are great technologies, producing seemingly cool products which no one wants to buy. Furthermore, early adopter acceptance does not guarantee popular success.
- Apply critical reasoning; distinguish hype from reality. This is key! Don't fall into the common pitfall in accepting unsupported (and often hyperbolic) assertions. These exaggerations can take the form of over-optimism in assessing the readiness of the technology for exploitation or in misjudging the market acceptance of products deriving from this technology. Scientists and engineers can enthusiastically promote technologies like pitchmen promote products on late-night TV. Don't fall for it! Be critical. As for the Technology itself, you can get as deep into it as you want but I am looking for an analysis not a technical paper.

- Use two or more of the following techniques
 1. S-curve analysis
 2. Delphi (consulting “wise people”)
 3. Trend extrapolation
 4. Scenario development
 5. Reasoning from analogy (the experience of similar technology innovations in similar markets)
 6. comparing with technology development models and norms.
 7. Your own techniques
- Although much of this can be found on the web, a google paper is not what we are looking for. You must interview people including industry insiders, analysts, reporters, consultants, professors, researchers, etc. From this data, show the strengths and weaknesses in your choice of methodologies. Market Research reports from Consultancies can be helpful.
- Show all references including web references.
- See for example, Donnelly, <http://www.hfac.uh.edu/MediaFutures/forecasting.html#1> plus your own ingenuity.

Or

B. Do an Innovative Capabilities Audit of a technology-oriented company

- Choose a firm. The firm can be large or small, or a business within a larger firm. This will generally require the permission of the firm if you want to do internal interviews. Caltech alumni could be helpful on this. It is your responsibility to find the firm.
- Develop a conceptual framework to perform an audit. You will get a lot of information on approaches from the cases studied in class but you might want to figure out your own methodologies. You want to examine what aspects of the firm’s capabilities and culture augment or discourage innovative development. A good approach is to begin with 2-3 hypotheses and prove or disprove them through your research.
- Do your homework! Use the framework you have developed to gather data. You may use public information, personal interviews, and internal documents. Look particularly for inconsistencies, unrealistic expectations, neglect of key success factors, poor execution, etc. A common shortfall is lack of critical consideration of market acceptability.
- Analyze the data
- Make recommendations on how the firm's capabilities can be improved.
- Write a Final Report. Prepare a presentation. You may get invited to present to the Firm you review as well.

Note: If you have some thoughts of becoming a management consultant, this project could give you a valuable apprenticeship.

- cf. Burgelman, Christensen, Wheelwright pp. 7-12 plus any other appropriate reference plus your own ingenuity.

We are available continuously for counseling on this assignment.

Please feel free to call on us for any questions, including questions on team effectiveness. I find that teams that consult us do better than teams that do not.

A word on web research

Superficially, search engines offer an effective means of discovering data with a minimum effort. The problem, of course, is the quality of that data. I would look for “triangulation” or getting data from multiple sources. I would look at the reputability of the source. I would look at the plausibility of the data. I would follow-up with phone calls and e-mail to help qualify the data. Thus the search engine offers an entry point to discovery rather than an end in itself. Primary Research is key!

A word on timing

The sooner the better. You will run into snags and, in fact, could even decide to change topics mid-stream. The most difficult barrier to overcome is the difficulty in reaching busy people and scheduling interviews. If everything is left even to the middle of the quarter, it will be difficult to deliver a quality report.

Course References

On reserve is Burgelman, Christensen, and Wheelwright, (called BMW in syllabus) Strategic Management of Technology and Innovation, fourth edition, Irwin, 1996. I will distribute additional Cases and Supplementary readings as required.

Grades

40% HW (Case Write-Ups), 35% Term Assignment and Final Presentation, 10% Midterm Presentation, and 15% Class and Team Participation

Auditing

Although auditors are welcome, it is clear from the above that the amount of learning accomplished is directly proportional to the effort expended. Of course this is true of anything you would want to learn. In this course, merely perusing notes or lecture slides after the fact is particularly useless unless you have a position of knowledge of what the discussion is all about. Winging it doesn't work. Passive listening doesn't do much either. Thus, at the minimum, I suggest that auditors read the cases carefully in advance. Auditors might consider forming teams with other auditors.

KAP Lecture Subjects

Technology as a Process
Technology Life Cycle
Disruptive Technology

Predicting the Future
Theory of Dominant Design
Managing Technical People
Methodologies for evaluating new technologies
Engineering Economics
Ethical Concerns

Potential Cases

Claire McCloud
Airbus
Kittyhawk
Northrop Grumman
Nova
Genzyme
Medtronic

Guest Speakers/Coupled cases

David Baltimore, Caltech/Biotech (Board decision making)
Henry Kressel, Warburg Pincus (Technical Investment)
Satyam Cherukuri, Sarnoff Laboratories (Independent R&D)
Kent Kresa Aerospace Rob Manning (Leadership)

Student Presentations

All Cases
Midterm
Final

Case Write-Up Guidelines

Most importantly, we look for each answer to be well-supported by reasoning and analysis. When you answer each question, think of the "why?" Why did you select this option over others? Why is this factor important? Why do you think this particular course of action is better than others? The answers may be obvious to you, but we want to see what your reasoning is, so make sure write to be explicit. We can generally get a feel of whether or not you put effort into a question by examining the quality and depth of analysis.

For questions where you are asked to choose a course of action over other options, we expect an analysis of not just why this one is the best, but also why the other ones are not. Analyzing the advantages and disadvantages of all choices and coming up with a cohesive conclusion is a good way to do it, though of course is not the only way.

We would not deduct more than few points for the "correctness" of the answers. You will most likely get full credit even if we disagree with your answers as long as it's well supported. The only time we may deduct points is if we feel that you have missed an important point crucial to understanding of the issues presented in the case, but the deductions will be small if you provide good supporting analysis.

Format – bullet point responses or tables are fine for case write ups.

Case Questions

Claire McCloud

Primary objective: To determine what qualities and skills are necessary to manage a High Technology firm.

There are many questions going through Claire's mind? I would like you to address the following:

1. What issues should Claire be considering in her decision to accept or decline the General Manager's position?
2. What are the possible consequences to Claire of saying no? What are the possible consequences of saying yes?
3. What does Claire need to know about the technology to do her job effectively?
4. What are OWS's strengths and weaknesses?
5. What are Claire's strengths and weaknesses?
6. What are the most immediate long and short-term issues Claire should address?
7. Should Claire take the job?

Airbus

Primary objective: To understand the considerations in making a major strategic decision

1. If you were Airbus, would you commit to launch the A3XX? Why? (Make sure to write a well-supported conclusion)
 - a. Consider Financial return
 - b. Consider strategic position
 - c. Consider risk
2. If you were Boeing and Airbus decides to build the A3XX, what would you do? Why? (Make sure to write a well-supported conclusion)
 - a. Consider strategic position
 - b. Consider risk

The Flight of the Kittyhawk (HBS 9-697-060)

Primary objective: To show how a great company can anticipate a disruptive technology, do their marketing homework, form an appropriate partnership, follow the rules of product development and still not produce a successful product.

1. What would you rate as the strengths and weaknesses of the way HP structured and supported the Kittyhawk Development team?
2. What do you think of the way the team set out to find a market for the Kittyhawk? What correct turns and wrong turns did they make?
3. What are the root causes of failure of the Kittyhawk program? Show by an Ishikawa diagram.
4. What should HP have done in hindsight?

Medtronic (HBS 9-698-004) Cf. also Wheelwright et al "Creating Project Plans to Focus Product Development", Harvard Business Review, March-April, 1992, pp.70-82)

Primary Objective: To discover some of the organizational principles to successfully perform R&D. Because you were a great company in the past does not guarantee future success. It is easier to lose the "edge" than retain it.

1. Show in an Ishikawa diagram the root causes of how Medtronic lost its edge in the 70s and 80s.
2. Which of the improvements that Medtronic initiated were most instrumental in turning the company around?
3. What do the concepts of "product line architecture" and "train schedule" mean in the pacemaker business? How generally applicable are these concepts?
4. What are the most crucial elements of the Medtronic's System that require senior management attention? What can be delegated?

Genzyme

Primary Objective: To show how successful companies have to continually refine their strategies to account for marketplace changes.

1. Describe the key factors in Genzyme's success to date.
2. Does the Drug Development process have to be so long? Why or why not? How do you think the process can be improved?
3. What is a better business model - a cure or a treatment. Why?
4. The products in the pipeline are addressing rarer and rarer diseases. At the same time, genomics is showing that targeted therapies that address smaller populations might be a more effective approach to more common diseases. Are these important changes in the environment? If so, how would you address this if you were Genzyme?

Nova

Questions to be included in the handout.