E/ME/MedE 103
Management of Technology

Fall, 2017

Lecture 1 Introduction
Today’s Agenda

- Introduction of Course
- Structure of Course
- Expectations, grading, etc
- Special issues?
- Introduction of Students
<table>
<thead>
<tr>
<th>Name</th>
<th>Concentration/Department</th>
<th>Class</th>
<th>E-mail</th>
<th>Grade or P/F</th>
</tr>
</thead>
</table>

E 103 Management of Technology

Instructor: Ken Pickar
Visiting Professor of Mechanical and Medical Engineering

TA: Phillip An  Phillip@caltech.edu

Fall Quarter 2017
Tues, Thurs 2:30-3:55

Office Gates Thomas 208
Office hours: Ken - afternoons but best to e-mail ahead
Tel X 4185
E 103 Management of Technology

- Text (on reserve) Strategic Management of Technology and Innovation Dec 1, 2003
- by Robert A. Burgelman and Clayton M. Christensen

website [http:// www.pickar.caltech.edu/](http:// www.pickar.caltech.edu/)

Note: The copy-writed case material will be e-mailed to you. Please make only one copy for yourself. I will pay for each registered person in the class.
Ken Pickar

- PhD Low Temperature Physics, University of Pennsylvania
  - Thesis in Third Sound in Liquid Helium

- Bell Laboratories, Murray Hill, NJ 8 years
  - Member of the Technical Staff
  - Technical Area: Ion Implantation, Electron Beam Lithography, Plasma Etching, Thin Films, Semiconductor materials and devices
at Bell Labs

- The first ion implanted Charge Coupled Device,
- The first ion implanted picturephone targets,
- The first implanted damage gettering process
- Electron Beam Lithography
Ken Pickar

• Bell Northern Research, Ottawa, CA 5 years
  – Manager of new technologies
  – Technical Areas: ion implantation, electron beam lithography, plasma etching, Displays, Audio
At Bell Northern

- The first all-dry etching semiconductor process (no wet chemistry)
  - sub 2-micron
  - CMOS

Liquid Crystal Displays
Thin Film Keyboards
Ken Pickar

- Bell Northern Research, Ottawa, CA 5 years
  - Manager of new technologies
  - Technical Areas: ion implantation, electron beam lithography, plasma etching, Displays, Audio
Ken Pickar

- GE Corporate R&D 9 years
  - R&D manager Electronics Research Laboratories
  - Technical Areas: Medical Physics, MRI, Ultrasound, Digital X-ray, Locomotive, Radar, Lighting, VLSI, Power electronics, CAD, Manufacturing
At GE
The Industry-leading MRI
GE Lighting

- Discharge lamps
- Power electronics
- LED lighting
Ken Pickar

- AlliedSignal (Honeywell) Corporation 5 Years
  - Senior Vice President Engineering and Technology
At AlliedSignal Aerospace (now Honeywell)

- Engines
- Auxiliary power units
- Environmental control systems
- Avionics
- Wheels and brakes
- Managerial and technical services
- Repair and overhaul services
- Flight safety (EGPWS, TCAS, ice detection, wind shear)
- Sonar
- Space Station Power
Why am I telling you all this?

- I Had to make technical decisions
Why am I telling you all this?

- About Technical areas, I knew nothing about
What have I been doing lately. . .

- Caltech 19 years
  - ME/E 105 Design
  - ME/E 103 Technology
  - E 102 Entrepreneurship

- Also Tech Coast Angels (Angel Network)

- Board of Directors (Company)
  - Level One (sold to Intel 1999)
  - Neustar (IPO 2005) NYSE
  - Ness Technologies NASDAQ
  - H2Scan (Private)
  - Butterfli
Ken Pickar

• Board of Directors (non profit)
  – Los Angeles Cleantech Incubator (LACI)
  – LA Regional Foodbank
  – Intelligent Mobility International
  – Chamber Orchestra of the South Bay
  – South Coast Botanical Garden

• Academic
  – UCLA Anderson Adjunct Faculty (GAP Program(2005))
  – Monash University, Melbourne, Australia, (Visiting Professor (2010))
My Interests

• Products for the Developing World
• Design for Freedom from Disability
• Entrepreneurship Education
• Tech Transfer - Best way of transitioning tech from an academic environment to a business?
• Why do technologies succeed or fail?
  – Why do good products fail?
  – Why do good companies fail?
• Ethical considerations in Management and Eng.
Purpose of this Course

• To develop skills for critical technology judgment

• To study the management of technically-based companies
  – Market and customer realities
  – Corporate culture
  – Innovation processes

• To provide an introduction to business school case-based learning methodologies.

• To help develop team skills.
Not the Purpose of Course

• To present an exhaustive set of principles

• To present an invariant set of principles good for the life of your careers

• To reliably predict the future development of technology
Reality VS Prediction

Adoption vs Time

Two lines representing reality and prediction, with the line for reality curving downwards.
What is it?

• A team-driven course
What is it?

• A management course for non-managers
  (Typically desirable to have “real world” experience prior to studying this subject)

• But E/ME 103 teachings useful for futures in
  – Academic research
  – Industry
  – Consulting
  – Business School
Why academia?

• Wouldn’t it be cool to have some inkling on how your field will develop?
Why academia?

• Wouldn’t it be cool to have some inkling on how your field will develop?
  – Delphi tools
Why academia?

- Wouldn’t it be cool to have some inkling on how your field will develop?
  - Effect of Support Technologies
    - Example: Big data computation - what new problems can it solve?
    - Is this a threat or an opportunity or a boondoggle?
What can a cheap smart device enable?
iBGStar Glucose Meter.

iPhoneECG Electrocardiogram.

Withings Blood Pressure Monitor.

ECEM Pulse Oximeter.

MobiUS SP1 Ultrasound Imaging Device.

Otoscope

Microscope

Dermatoscope (Skin scanner)

Ultrasound

PetriDish

Breathalyzer
How about your Research?

• What Technology is useful to your Group that was not available 5, 10 years ago?
Can you ride the wave?
Or Wipe-Out
Where would you rather be?

Technology Capability

Time

Here

Or Here
A different type of knowledge

A semi-quantitative exercise for quantitative people

– Technology management is 75% cultural and 25% quantitative.

– Input parameters don’t always lend themselves to rigorous mathematical analysis

– There is no unique “right” answer—context matters

• What is desired is consistency, insight and originality.

Scientific “truth” standards get relaxed?
Teaching Methodologies

- Cases
- Lectures
- Coaching
- References
- Invited Speakers
- Term Project (most important!)
What is a case?

• A real (or realistic) story that demonstrates a business challenge or challenges.
• Typically a short story for you to supply the ending.
• A teaching vehicle that enables the student to expand his/her experience base beyond what they personally have seen.
• A problem-solving platform.
Teaching (and learning) Cases

Four ways to teach cases

1. Lecturing a Case
   – Instructor leads class through case analysis

2. Theorizing a case
   – A vehicle for theoretical analysis

3. Illustrating a case
   – Case used as “war story” to illustrate a point

Issue: how much did the student learn?
4. Choreographing a case
   – Students analyze the case out of class and formulate “solution”
   – Instructors guide the students development of the case without prejudging the “correctness” of the students analysis
   – Inductive reasoning to form arguments and expose fallacies
   – Instructor ties together and establishes “backbone”
How to prepare a case

• Each team member
  – Skims it quickly to determine key issues
  – Reads it carefully, taking notes with questions
  – Puts themselves in the position of the protagonist-asking what would you do?
• Then discusses ideas with team
• Brainstorm “solutions”
• Formulate a consensus or agree to disagree
• If presenting, prepare (and rehearse) presentation
  \textit{and defense}
How will the cases be handled in class?

• Questions on each case to be answered by the team. Graded for consistency, thoughtfulness and ingenuity.
• One team will present the case to the rest of the class. (this team sends slides (ppt) plus pdf) Teams to present will be informed in advance
• There will be class discussions to develop the “answers”
• *Everyone* is obligated to contribute to the discussion. Part of grade depends on your contribution
How will the cases be handled in class?

• Everyone must come to class
  – if you cannot make the commitment, don’t take class
  – if you must be absent let Phillip and I know before class by phone or e-mail

• You must come to class on time

• No computer “multi-tasking” (computers, cell phones or tablets etc.)

• Cases must be prepared and submitted prior to class by all teams. (Please e-mail pdf document to Phillip and myself by noon)
How will the cases be handled in class?

• You are expected to be prepared!
• You can be called upon for an “answer”
Cases and Copyright

- Cases will be e-mailed
- Cases are original or from Harvard Business School Publishing
  - Do not make more than one copy per student for Harvard cases as I am paying Harvard Business School Publishing
What are some of the negatives of the case methodology?
What are some of the negatives of the case methodology?

- Based on past
- Highly subjective
- You are not experts
- Over-simplify
• Lots of Stuff to talk about
Subjects Covered

Introduction, Purpose and objectives. Technology as a growth agent. Industry Life cycle, Product Development Pipeline
Financial implications of Technology Management
Innovation
Predicting Technologies
Limitations, Inflection Points, Disruption
Trends, Scenarios, Projections
Science Vs Engineering
Managing Technology programs
Integration of Technology Development with the Product Development Process
Determining core technologies, enabling technologies, make/buy
Portfolio Management Models and Decision Criteria, Gatekeeping
Management of Scientific and Engineering Resources
Motivation, Rewards and Recognition
Outsourcing and Joint Venturing
Globalization of Technology Capability
Intellectual property
Subjects Covered

Overriding theme

Innovation
E/ME 103
Matrix of Innovation

It’s not all technology!!
Some major non-technical innovations in the last 10 years

• Manufacturing
Some major non-technical innovations in the last 10 years

• Marketing
Some major non-technical innovations in the last 10 years

• Sales
Some major non-technical innovations in the last 10 years

• Finance
# Previous Guest Lecturers

(still being scheduled)

<table>
<thead>
<tr>
<th>Name</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>David Baltimore</td>
<td>Drug Delivery (Medical)</td>
</tr>
<tr>
<td>Kent Kresa</td>
<td>Aerospace/Automotive</td>
</tr>
<tr>
<td>Steve Streit</td>
<td>Cash Cards</td>
</tr>
<tr>
<td>Henry Kressel</td>
<td>Warburg Pincus Electronics</td>
</tr>
<tr>
<td>Andy Downard</td>
<td>Analytics</td>
</tr>
<tr>
<td>Rob Manning</td>
<td>JPL Mars landing</td>
</tr>
<tr>
<td>Bill Gross</td>
<td>Idealab</td>
</tr>
<tr>
<td>Erik Antonnson</td>
<td>Northrup Grumman</td>
</tr>
<tr>
<td>Andy Lin</td>
<td>Rehabilitation (Rancho Los Amigos)</td>
</tr>
<tr>
<td>Josh Botkin</td>
<td>U Michigan Strategy</td>
</tr>
<tr>
<td>Barry Lieberman</td>
<td>Intel Semiconductor Lithography</td>
</tr>
</tbody>
</table>
Term Assignment

Do either A or B

A. Write a Technology Assessment and projection.

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 assumptions and conclusions.
Term Assignment

Do either A or B

A. (cont.)

Who will develop (or how) will this technology be fully exploited, i.e., what are the drivers?

Hint: look at what’s in the laboratory or conceptual stage now, look at market forces. Look at response of “conventional” technology being “displaced”

Apply critical reasoning, distinguish hype from reality. You can get as deep into the Technology as you want but I am looking for an analysis not a technical paper
Term Assignment

A. Continued
Use two or more of the following techniques
1. S-curve analysis
2. Delphi (consulting “wise people”)
3. Trend extrapolation
4. Corollary Technology Development
5. Problems that need solving
6. Scenario
7. Reasoning from analogy (the experience of similar technology innovations in similar markets)
8. Comparing with technology development models and norms
9. Your own techniques
Term Assignment

Show the strengths and weaknesses in your choice of methodologies

Show all references

Cf. Burgleman, Maidique, Wheelwright, pp135-154 (on reserve)
Term Assignment

A. Continued

Use *Primary* Research (Interviews most important!)

and

*Secondary* research (published material, web sites, consultant reports)
Which Technology should you choose?

- Technology subjects can be already moving
  - Lab on a chip
  - Smart phone in Medicine
  - Next Generation Social Networking
  - Green Energy (Focus on one alternative)
  - Green Food
  - Power Transmission Wireless / Smart Grid etc.
  - Hybrid or Electric Cars/IC
  - Cellphones beyond I-phone
  - Stem Cell
Which Technology should you choose?

- Technology can be already moving (cont.)
  - Virtual Reality Glasses
  - Next Gen Video Games
  - Personalized Medicine
  - Cloud Computing
  - Cashless society
  - Big Data
  - Cybersecurity
  - Graphene
Which Technology should you choose?

– Next Gen Rapid Transit
– Auto Traffic Management
– Autonomous Vehicles
– Space travel
– Beyond Moore’s Law computing
  • Quantum Computing
– Predictive weather/climate models
– Earthquake prediction
– Cancer “cure”
How about your Technologies?
Which Technology should you choose?

- Something not on the list which
  - Is useful to you
  - Intrigues you
  - Interests you
  - You care about

Each team should choose one technology plus one alternate
• You can choose a technology where the experts are accessible. (e.g., Caltech) or you have some access or pre-knowledge.

• Something you know nothing about and know no one who does
Basically, what I want to know by the end of the quarter

- How will this technology develop in the next ~ 5 years?

- Why? Drivers and inhibitors
OR
B Do an Innovative Capabilities Audit of a technology-oriented company

- Choose a small stand-alone business 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. Remember 6 degrees of separation

- You are ultimately responsible for making this choice. Phillip and I will advise.
B Do an Innovative Capabilities Audit of a technology-oriented company

• Develop a conceptual framework to perform an audit. You want to examine what in the firm augments or discourages innovation

  – The textbook provides some good ideas,
  – Information on approaches from cases and lectures studied in class
  – You might want to figure out your own methodologies.
B continued

- Use the framework you have developed to gather data. You should use public information, *personal interviews*, internal documents.

- Analyze
  - Understand process on how ideas get translated into products. What aids the process and what retards the process?

- Make recommendations
  - How can the firm’s capabilities can be improved.

- Write a Final Report. Prepare a presentation.

- Present to Class. Present to company.

- cf. Burgleman, Maidique, Wheelwright pp. 7-10 (BMW 9-13)
Choice B

• Biggest issue is finding the company and getting their attention.
  – Network! Relatives OK!
  – Sell as free consulting
  – Minimally invasive
• Best to start at top
• A learning experience for a consulting career or for any career in product development
Another Choice

• There are 17 new start-up incubators that have been set up in the last couple of years in Southern California
  – Why?
  – What do they do?
  – What is the record of incubators in general?
  – Critique the model
  – Critique a few of the incubators in depth
  – Critique some of the resident companies
Timetable for A or B

Teams formed and topic chosen October 3 with Initial Plan of Action

- Presentation of Accomplishments to date and Research Plan: Schedule, Responsible person
- Midcourse correction private discussions
- Midterm Exam Presentation and 5 page paper
- Private Discussions
- Final Presentation
- Final Paper Due
• Final Report maximum 15-20 pages double spaced.
• Final Class Presentation should take about 20 minutes (~ 15 slides) with 10 minutes for discussion

Phillip and I are available continuously for counseling on this and all assignments. Please feel free to call on us.
Marking

• 25%  Case preparation and HW
• 10%  Midterm Presentation
• 15%  Class participation (includes showing up!) and teamwork
• 50%  Term Assignment and Final presentation
Exercise

• Who are you?
• Why are you taking this course?
• One unusual thing about yourself. . .
For Thursday, September 28

- Think whom you would like to work with
- Work on Forming Team! 2-3-4 people
  – How many have worked on Teams?
- Think (even choose) Term project
- Have a few alternatives
For Tuesday, October 3

• Have Team
• Have Term project
• Why did you choose this project?
• Have a few alternatives