THINKING OF YOUR CAREER AS A PHYSICIST: SCIENTIFIC RESEARCH IN INDUSTRY

Dr. Frank L. Lederman – October 17, 2012
Leading Assumption

You want to make a significant change in the world.

Significant change requires leadership.
Every Leader Must Have a Vision and Communicate it Well to Build and Inspire a Following.

Set goals that are SMART:

- Stretch
- Measurable
- Achievable
- Realistic (with available resources)
- Time-limited
What is the **Strategy** to Achieve Your Vision?

What are the independent variables?

You’ve learned how to design an experiment. Use your physics training to design your career.

What is in your control and what isn’t?
Scientific Research in Industry

Questions for Today:

● How does it differ from academic research?
● What’s it like to work there?
● What does it take to succeed?
● Why do some people fail?
● Who should consider such a career?
● Why haven’t your science professors told you more about it?

– Seeking depth in their field ⇒ lack of familiarity with industry
– Reputation among academic peers ⇒ encourage careers in academia
**Questions to Ask Yourself**

- **What motivates you?**
  - Understanding the universe for the sake of knowledge
  - Seeing your creations being used in society

- **Do you tend to seek more depth or more breadth?**
  - Are you interested in developing non-technical skills?

- **How do you feel about change?**

- **How strong are your political convictions?**
Key Differences between Research in Academia and Industry

1. Motivation for research
   - Achieve understanding at a fundamental level, for the sake of knowledge
   - Innovate to achieve corporate vision

2. Strategy
   - Generally bottom-up, based on ideas of principal investigator
   - Top-down, starting with corp. vision and customer needs. Create / maintain competitive advantage

3. Structure
   - Loose & weak
     More opportunity – and responsibility to do it all yourself
   - You have a boss
Key Differences between Research in Academia and Industry

4. Career paths
   - Usually only a few research areas per career
   - For career guidance, you’re generally on your own
   - Wide spectrum from few to many areas
   - Generally have lots of support for guiding your career

5. Rewards
   - Reputation, publications, tenure
   - Dual ladder: technical and management

6. Decisions and money
   - Slow, pedantic bureaucratic decision processes
     - Resources for new projects harder to get
     - Confrontations and tension are generally avoided
   - Dynamic, faster decisions, constructive confrontation
     - Start-up resources more readily available
     - A great deal of support
Key Differences between Research in Academia and Industry

7. Social contract
   - Tenure-based social contract
   - New social contract: Level playing field
     Loyalty not expected – and no guaranteed employment

8. How you are measured
   - Subjective, if at all
   - Varies, but a formal review
     - Fixed salary budget plus merit-based differentiation
       ⇒ forced ranking!

9. Personal competencies
   - Primarily technical
   - Both technical and personal skills – and can be measured
Work Environment in Industry

● Start-up is easy for new employees
  – Few funding worries to start
  – Excellent facilities
  – Lots of support

● Social environment can be similar to that in academia

● Opportunity to work with excellent colleagues doing real science

● Still have seminars, colloquia
## Four-Stage Career Model

<table>
<thead>
<tr>
<th>Stage I</th>
<th>Stage II</th>
<th>Stage III</th>
<th>Stage IV</th>
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</thead>
<tbody>
<tr>
<td><strong>Depending on Others</strong></td>
<td><strong>Contributing Independently</strong></td>
<td><strong>Contributing through Others</strong></td>
<td><strong>Organizational Leadership</strong></td>
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<tr>
<td>- Willingly accepts supervision and direction</td>
<td>- Demonstrates technical competence, credibility, and a reputation for good work</td>
<td>- Demonstrates a breadth of business or technical understanding and insight</td>
<td>- Shapes the direction of the organization</td>
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<td>- Demonstrates competence in a portion of a larger project or activity overseen by more senior staff</td>
<td>- Works independently and produces results</td>
<td>- Develops and influences others: as an idea leader, an internal consultant, a mentor to more junior staff, a manager, etc.</td>
<td>- Effectively exercises power for the benefit of the organization by initiating actions, influencing key decisions, obtaining important resources</td>
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<td>- Effectively performs detailed and routine work</td>
<td>- Assumes responsibility for a definable portion of the project, area, or clients</td>
<td>- Builds a strong network of organizational and industry relationships</td>
<td>- Uses the tools of the organization to obtain organization commitment and results</td>
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<td>- Shows “directed” creativity and initiative</td>
<td>- Relies less on the supervisor or mentor, developing his or her own resources to solve problems</td>
<td>- Deals with the outside on behalf of those inside the work group (e.g., with other work groups, clients, industry associations, upper management, etc.)</td>
<td>- Sponsors promising individuals to test and prepare them for key roles in the org.</td>
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<td>- Builds collegial relations with coworkers</td>
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<td>- Represents the organization both internally and externally</td>
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Personal Competencies in Industry

Levels of just-noticeable differences in behavior

**Impact and Influence**

1. States intentions but takes no specific actions
2. Uses direct persuasion in presentation or argument
3. Carefully prepares actions or presentation to persuade
4. Calculates impact of one’s action or words
5. Anticipates and prepares for others’ reactions

**Team Leadership**

1. Manages meetings
2. Informs people
3. Promotes team effectiveness (morale and productivity)
4. Takes care of the group
5. Ensures others buy into leader’s mission & goals
6. Communicates a compelling vision and generates enthusiasm & commitment
Where is R&D Done?

- Governance
  - Finance
  - Counsel
  - H. R.
  - EHS

CEO

B. U. #1
- Marketing
- Sales
- Service
- R D & E
- Manufacturing

B. U. #2
- Marketing
- Sales
- Service
- R D & E
- Manufacturing

Central R&D
Matrix Management

Program Mgmt. Org.

Functional Mgmt. Org.

Software Dev.
  - Person D
  - Person E
  - Person F
  - Person G
  - Person H
  - Person I
  - Person P
  - Person J

Hardware Dev.
  - Person K
  - Person L
  - Person M
  - Person N
  - Person O
  - Person Q

Project A

Project B

Project C
Understanding What it Takes

3000 raw ideas .03%

300 submitted ideas .3%

125 beginning projects .8%

1.7 launches 60%

4 major developments 25%

9 large developments 11%

1 commercial success
A gate review meeting after every stage:

- Pre-arranged review team
- Measure progress against predetermined goals
- Go – no-go decision
- Define goals for next stage and review team for next gate meeting
# Generations of R & D

<table>
<thead>
<tr>
<th>No. 1: Technology as the Asset</th>
<th>No. 2: Project as the Asset</th>
<th>No. 3: Enterprise as the Asset</th>
<th>No. 4: Customer as the Asset</th>
<th>No. 5: Knowledge as the Asset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Strategy</td>
<td></td>
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<tr>
<td>R&amp;D in isolation</td>
<td>Link to business</td>
<td>Technology / business integration</td>
<td>Integration with customer R&amp;D</td>
<td>Collaborative innovation system</td>
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<tr>
<td>Performance</td>
<td></td>
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<tr>
<td>R&amp;D as overhead</td>
<td>Cost-sharing</td>
<td>Balancing risk / reward</td>
<td>Productivity paradox</td>
<td>Intellectual capacity / impact</td>
</tr>
<tr>
<td>People</td>
<td></td>
<td></td>
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<tr>
<td>We / they competition</td>
<td>Proactive cooperation</td>
<td>Structured collaboration</td>
<td>Focus on values and capability</td>
<td>Self-managing knowledge workers</td>
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<tr>
<td>Process</td>
<td></td>
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<tr>
<td>Minimal communication</td>
<td>Project-to-project basis</td>
<td>Purposeful R&amp;D portfolio</td>
<td>Feedback loops and information persistence</td>
<td>Cross-boundary learning and knowledge flow</td>
</tr>
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From Debra M. Amidon Rogers
Open Innovation Paradigm

● Old model was “closed” vertically-integrated value chain, with all parts in the same company
  – Knowledge is scarce
  – Technical talent has limited mobility

● New model is “open” horizontal supply chain
  – Different pieces of value from different companies
  – Knowledge is open and abundant
  – Technical talent is mobile
  – Venture capital is available

People in Industry Often Fail to:

- Communicate and persuade (have impact)
- Be proactive rather than passive-aggressive
- Work in teams – in a virtual environment
- Learn and share across disciplines
- Integrate knowledge of others
- Take calculated risks and show self-confidence
- Be flexible and mobile (take advantage of opportunities to develop and contribute)

People rarely fail from technical shortcomings
What Good is Your Physics Education?

- Fundamental math. & computational ability
- Comfort with theoretical & experimental approaches
- Experience in dealing with complex systems
- Comfort with non-linear thinking
- Decision making
  - Capacity to break down complex problems to discrete parts and understand root causes
  - Willingness to invite support from other disciplines
  - Comfort with taking the risk of making & owning a decision
So What are the Independent Variables for You?

Serenity Prayer
(from theologian Reinhold Neibuhr, 1943)

God, grant me the serenity to accept the things I cannot change,
Courage to change the things I can,
And wisdom to know the difference.
So What are the Independent Variables for You?

- What produces superior results?
- What makes you special?
Frightful ride:
y in chaos

The foreign exchange
and savvy investors

Your clients last week as European interest rates and exchange rates went wild. It's true that the European monetary union is shattered. The Bank of England abandoned the EC's mechanism for setting currency prices and increased its key lending rate from 10% to 12% and then to 15% in the space of a few hours. The Germans lowered interest rates a smidgeon and the Swedes hiked their overnight money-market rate (open only to institutions, no individuals need apply) to 500% in a feeble attempt to protect the krona. Canadian bonds reeled and the loony plunged to a four-year low.

"It was panic and fear all over the Street," says Hank Cunnin-

CONTINUED ON PAGE 6

g new values

der group

Sure, forest products are in the tank. Real estate still stinks. And Hees-Edper is heavy into both. But its energy stocks look great. Calgary-based North Canadian Oils Ltd. is up 99% from the 1992 low, and Norcen Energy Resources Ltd., also of Calgary, is up 15% and has great potential overseas. Mining also shines — the group's Westmin Resources Ltd. of Van-

INSIDE STORY

Mining intelligence

Noranda Inc.'s technology centre, headed by Frank Lederman (above), shows Canadian industry how to spend R&D money wisely and make sure it pays off commercially

SEE PAGE 14
Gathering the Data for Your Career Decision

● Career advice is just data
  – Welcome it – but you decide what to do with it

● Interviews are critical – you are both measuring each other, looking for a possible fit
  – You cannot over-prepare
  – Have your “elevator talk” ready and make sure they hear you
  – Give examples of your leadership and higher-level behaviors
  – Everything matters (attitude, energy, grammar)

● Remember your physics background
  – Make sure you understand their vision and culture
  – You can quickly infer what they need and envision how you can add value better than others they may be considering
  – Make sure they hear your vision
Profiles in Versatility

A Leading Lederman in Industry

By Alanna G. Levine

Editor’s Note: This is the second in a series of articles profiling people trained in physics who have gone on to make their mark in a variety of careers. The first article appeared in the April APS News.

Looking back on a successful and intellectually-stimulating career in research management and technology development spanning more than 30 years, Frank Lederman, former chief technology officer and vice president at Alcoa, doesn’t question his decision to choose industry over academia. “After all,” he chuckles, “nobodyLederman won the Nobel Prize in my field.” He had heard Fermilab physicist Leon Lederman were not related and have never met. But the non-collusion of them and Frank never dismissed the latter Lederman from pursuing his great love of physics.

Yet, when he graduated with his Ph.D. in both theoretical and experimental solid state physics (he had two thesis advisors) from the University of Illinois at Urbana-Champaign, he turned down a job at the National Bureau of Standards and decided to go into industry. “I went into industry, partly because I didn’t want to be a professor. I didn’t want to teach. I wanted to do something else,” he says.

He was eventually promoted, and Frank’s interests and skills made him an excellent leader at GE. He had a passion for pursuing the best solution for a problem. “I never change, of course, which is now a billion-dollar business for GE.”

In 1988, Frank left GE for Canada-based Nortel, where he was with AT&T. As president of Nortel, and then for Alcoa, the world’s leading producer of aluminum and its products, he served as the Vice President and Chief Technical Officer for six years.

Frank notes his physics Ph.D. was always associated with novel technology. When he started research going, he says, “a Ph.D. gives you credibility with recruiting, with directing research, and with government and universities, especially when getting funding.”

And as a manager in industry, expertise in physics is almost a strategic necessity. “A physics background gives you experience in solving complex problems and breaking them down into bite-sized pieces. And you have to recognize what you have done already,” Frank says. “You need to look at the toughest parts of a project, and the rest of it will fall into place.”

As a member of Alcoa’s executive team, Frank participated in the business decision of the company. Again, his physics came in handy, as it taught him what questions to ask in order to identify the underlying problem driving a particular situation.

His greatest moment of satisfaction at UTC came when he convinced the CEO and key business managers that they had to stop all the good ideas. “If we don’t do it, who will?”

Frank is now an executive at a venture capital firm focused on technology and energy. As a member of Alcoa’s executive team, Frank participated in the business decision of the company. Again, his physics came in handy, as it taught him what questions to ask in order to identify the underlying problem driving a particular situation.

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