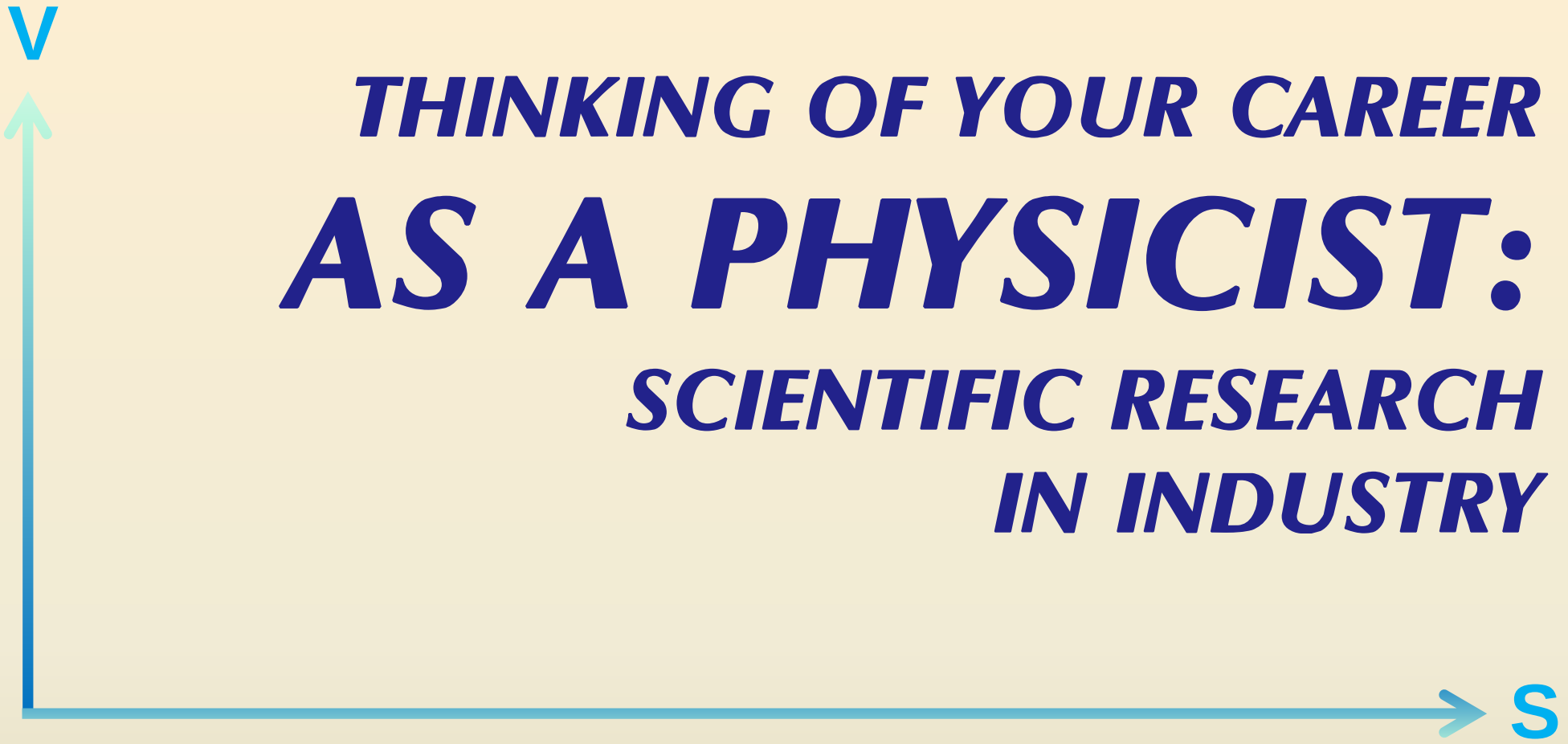

THINKING OF YOUR CAREER AS A PHYSICIST:

SCIENTIFIC RESEARCH IN INDUSTRY

Dr. Frank L. Lederman – October 17, 2012


imagination at work


noranda


ALCOA


CRAY
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BLASCH
PRECISION CERAMICS

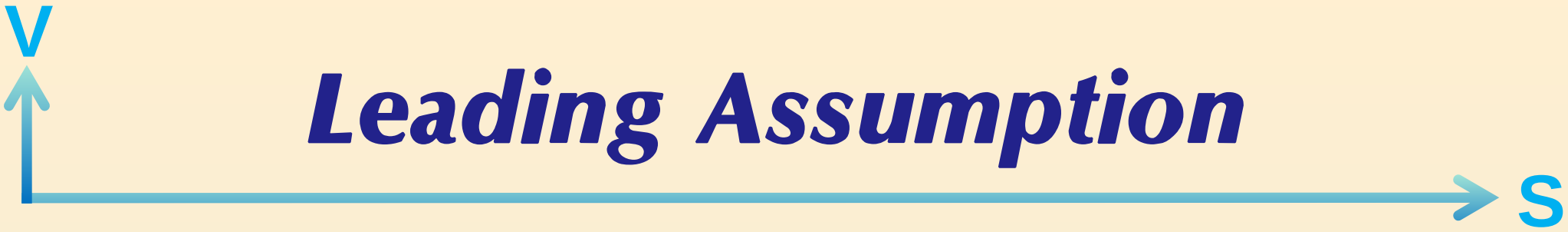

ARIZONA


PITT


UT DALLAS


CARNEGIE MELLON UNIVERSITY
PITTSBURGH PENNSYLVANIA 1900


ILLINOIS



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.

V

Set goals that are SMART:

- **S**tretch
- **M**easurable
- **A**chievable
- **R**ealistic (with available resources)
- **T**ime-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

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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

Depending on Others

- Willingly accepts supervision and direction
- Demonstrates competence in a portion of a larger project or activity overseen by more senior staff
- Effectively performs detailed and routine work
- Shows “directed” creativity and initiative

Stage I

Contributing Independently

- Demonstrates technical competence, credibility, and a reputation for good work
- Works independently and produces results
- Assumes responsibility for a definable portion of the project, area, or clients
- Relies less on the supervisor or mentor, developing his or her own resources to solve problems
- Builds collegial relations with coworkers

Stage II

Contributing through Others

- Demonstrates a breadth of business or technical understanding and insight
- Develops and influences others: as an idea leader, an internal consultant, a mentor to more junior staff, a manager, etc.
- Builds a strong network of organizational and industry relationships
- Deals with the outside on behalf of those inside the work group (e.g., with other work groups, clients, industry associations, upper management, etc.)

Stage III

Organizational Leadership

- Shapes the direction of the organization
- Effectively exercises power for the benefit of the organization by initiating actions, influencing key decisions, obtaining important resources
- Uses the tools of the organization to obtain organization commitment and results
- Sponsors promising individuals to test and prepare them for key roles in the org.
- Represents the organization both internally and externally

Stage IV

Personal Competencies in Industry

Levels of just-noticeable differences in behavior

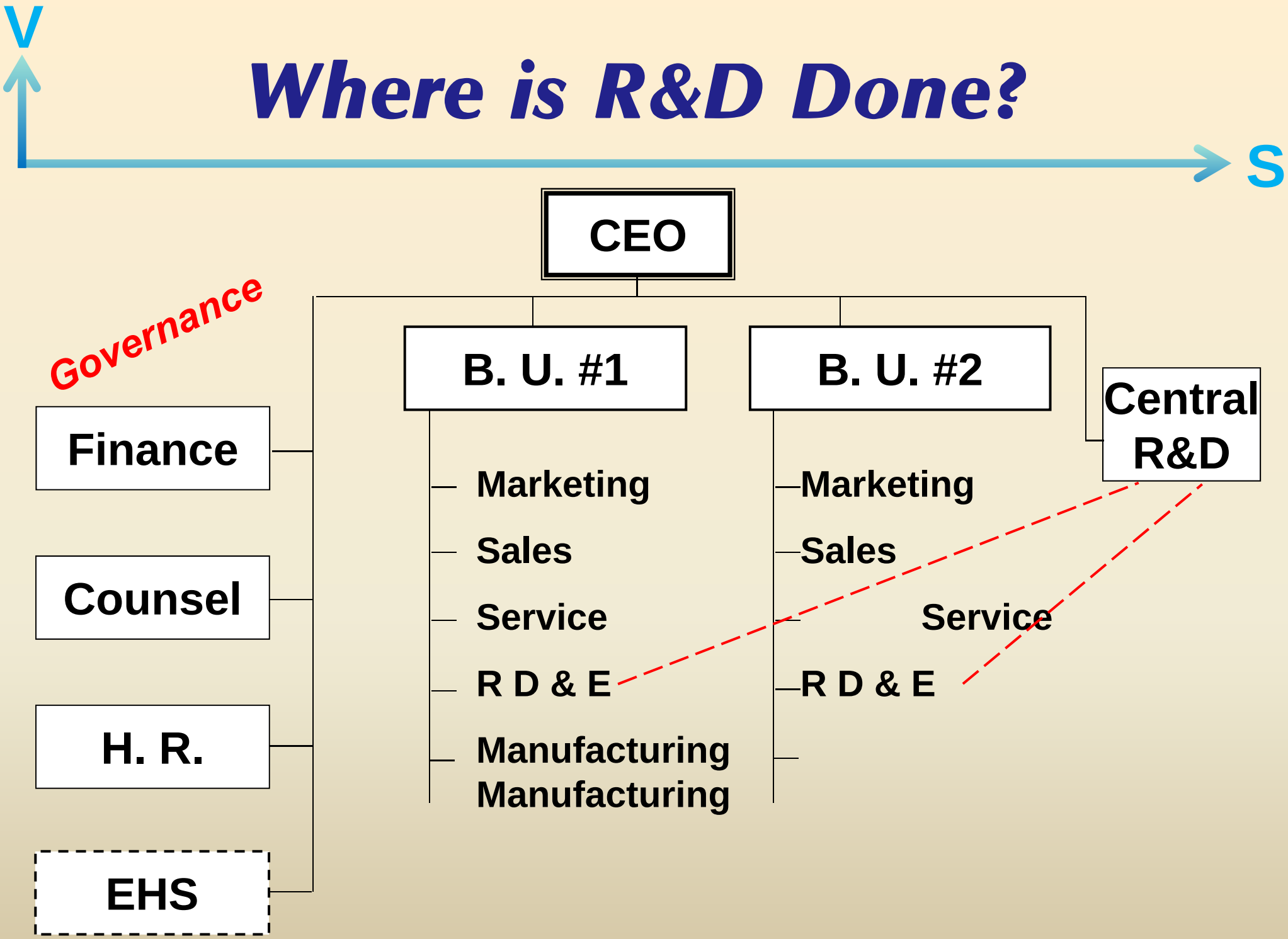
Impact and Influence

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

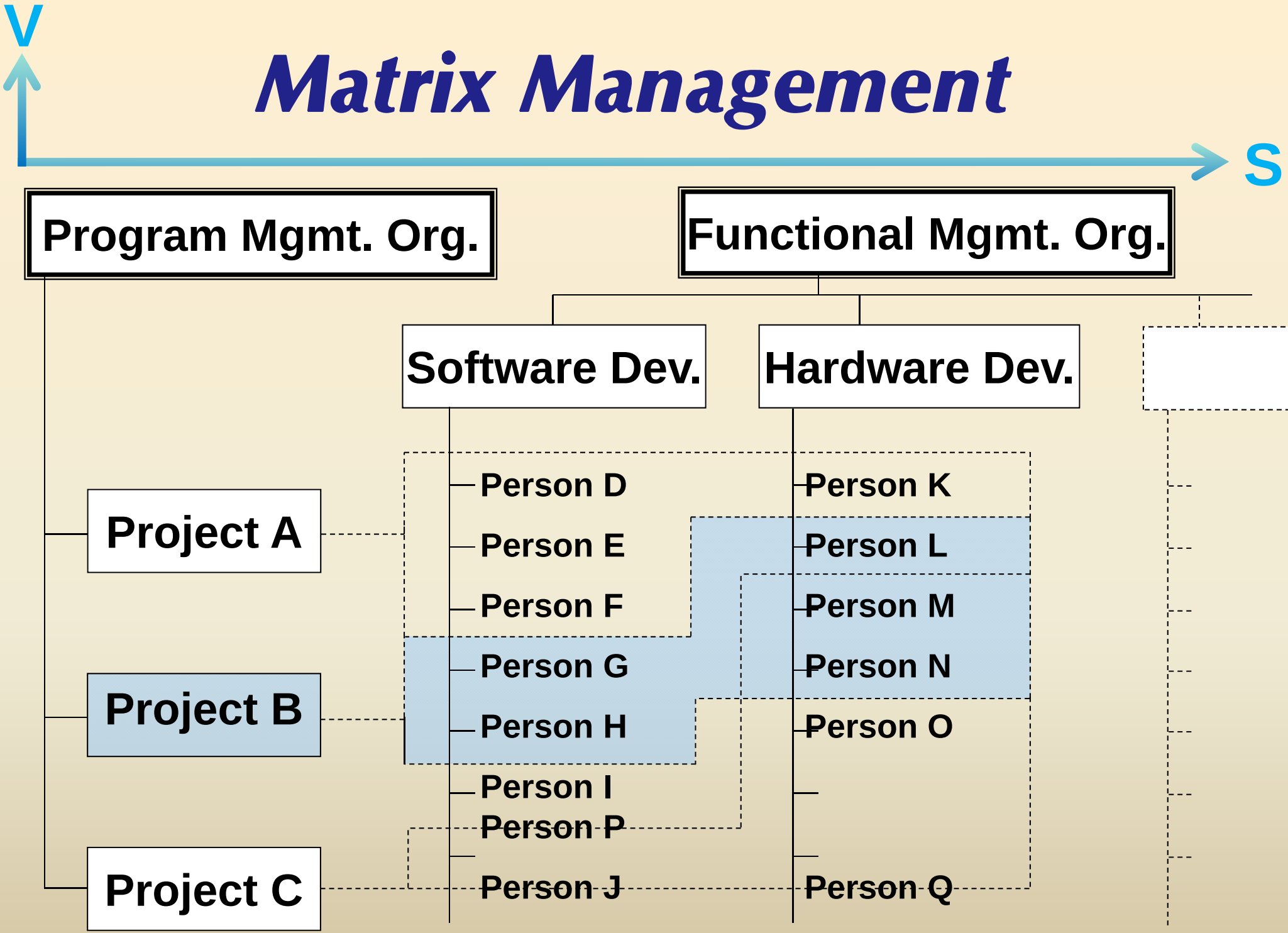
Team Leadership

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

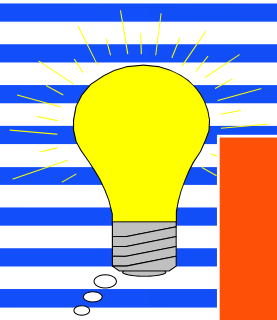
Where is R&D Done?



Matrix Management



Understanding What it Takes



3000 raw ideas
.03%

→

300 submitted ideas
.3%

→

125 beginning projects
.8%

↓

9 large developments
11%

←

4 major developments
25%

←

1.7 launches
60%

↓

1 commercial success

Miracles of Science

DUPONT®

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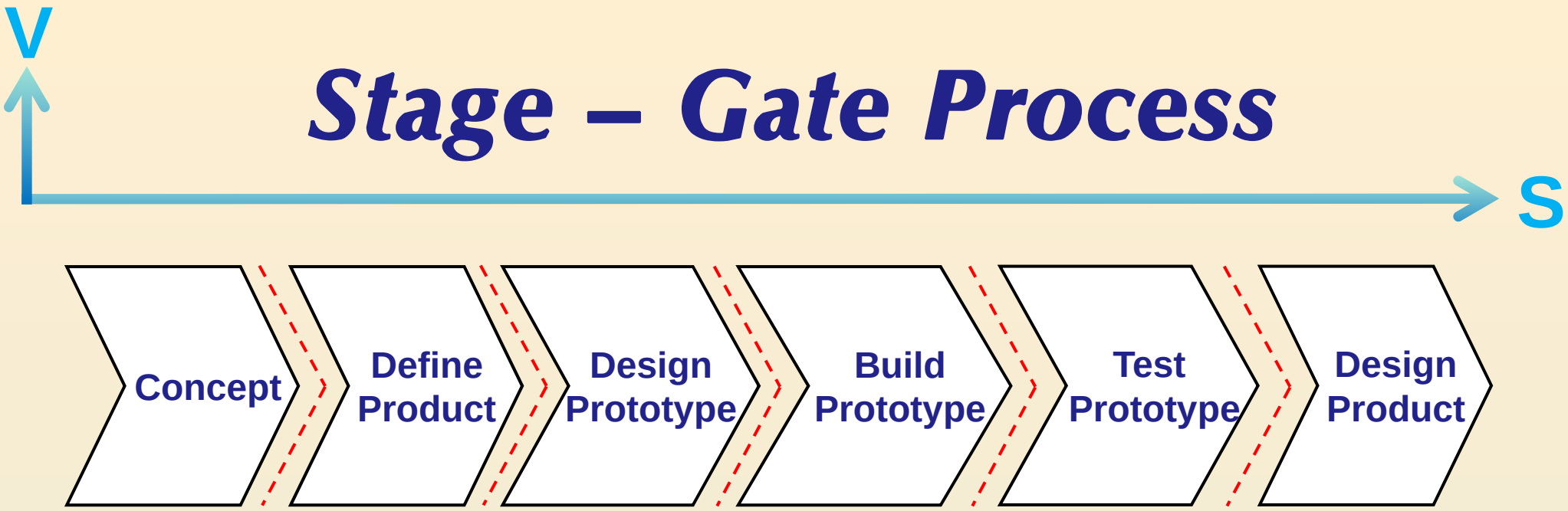
Stage – Gate Process

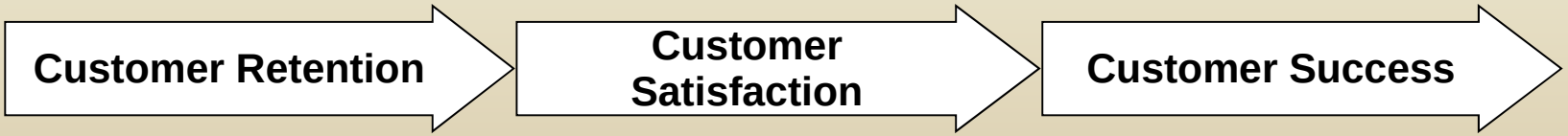


A gate review meeting after every stage:

- **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

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



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

From Henry W. Chesbrough, Open Innovation: The New Imperative for Creating and Profiting from Technology, Harvard Bus. School Press, 2003

People in Industry Often Fail to:

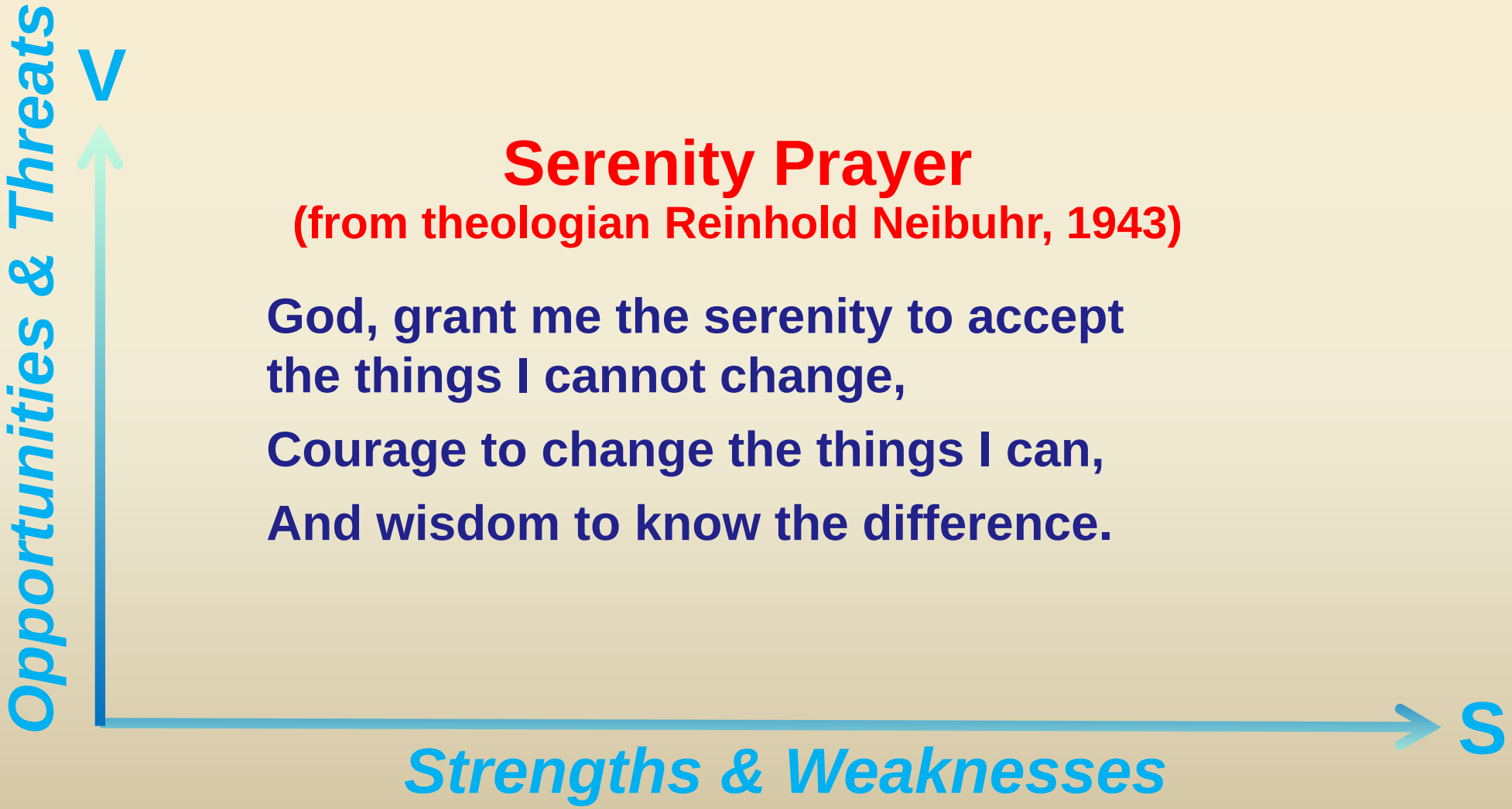
- Communicate and persuade (have impact)
- Be proactive rather than passive-aggressive
- Work in teams – in a virtual environment
- Learn and share across disciplines
- Integrate knowledge of others
- Take calculated risks and show self-confidence
- Be flexible and mobile (take advantage of opportunities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



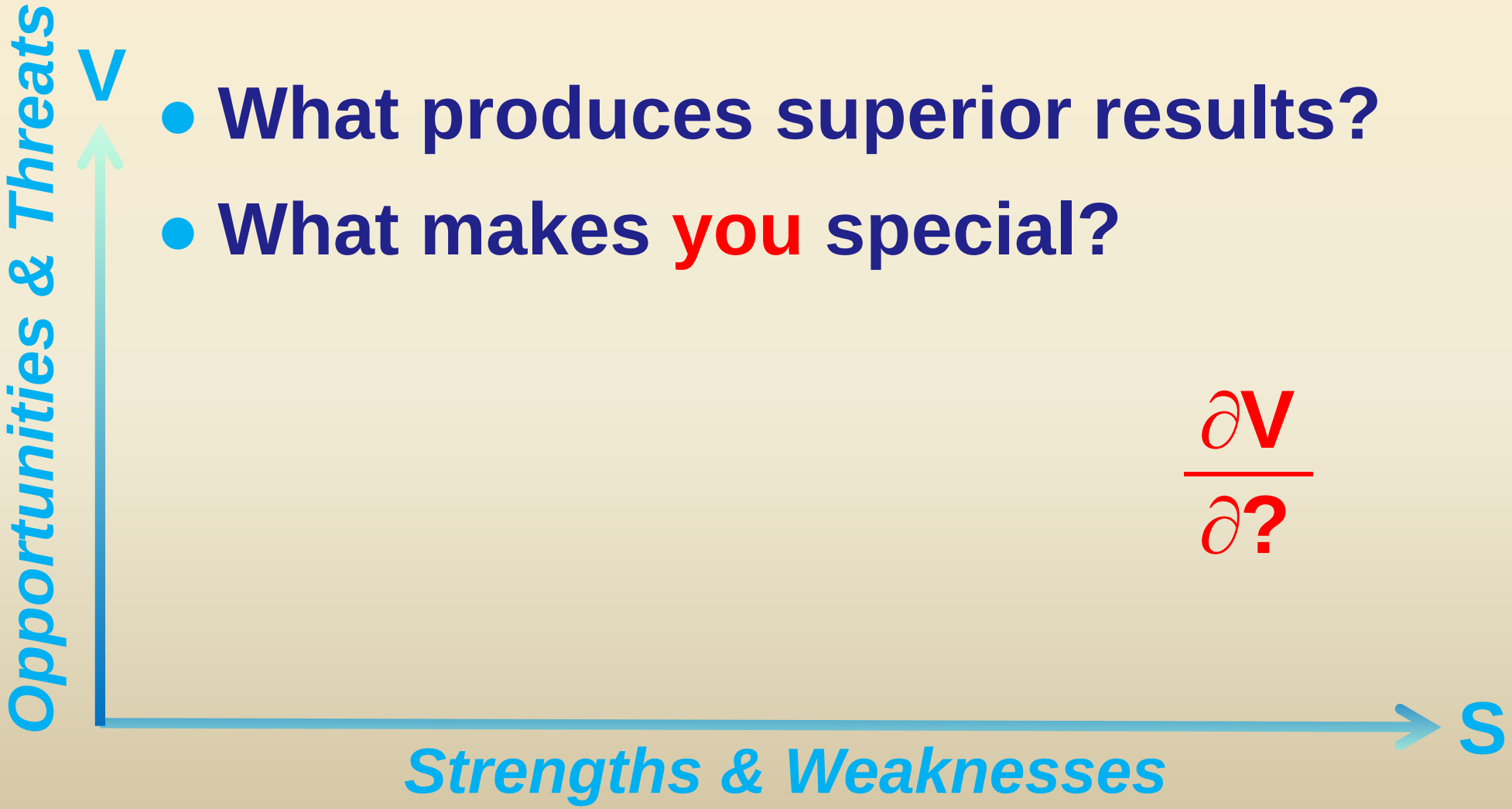
Serenity Prayer
(from theologian Reinhold Neibuhr, 1943)

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?

$$\frac{\partial V}{\partial ?}$$


imagination at work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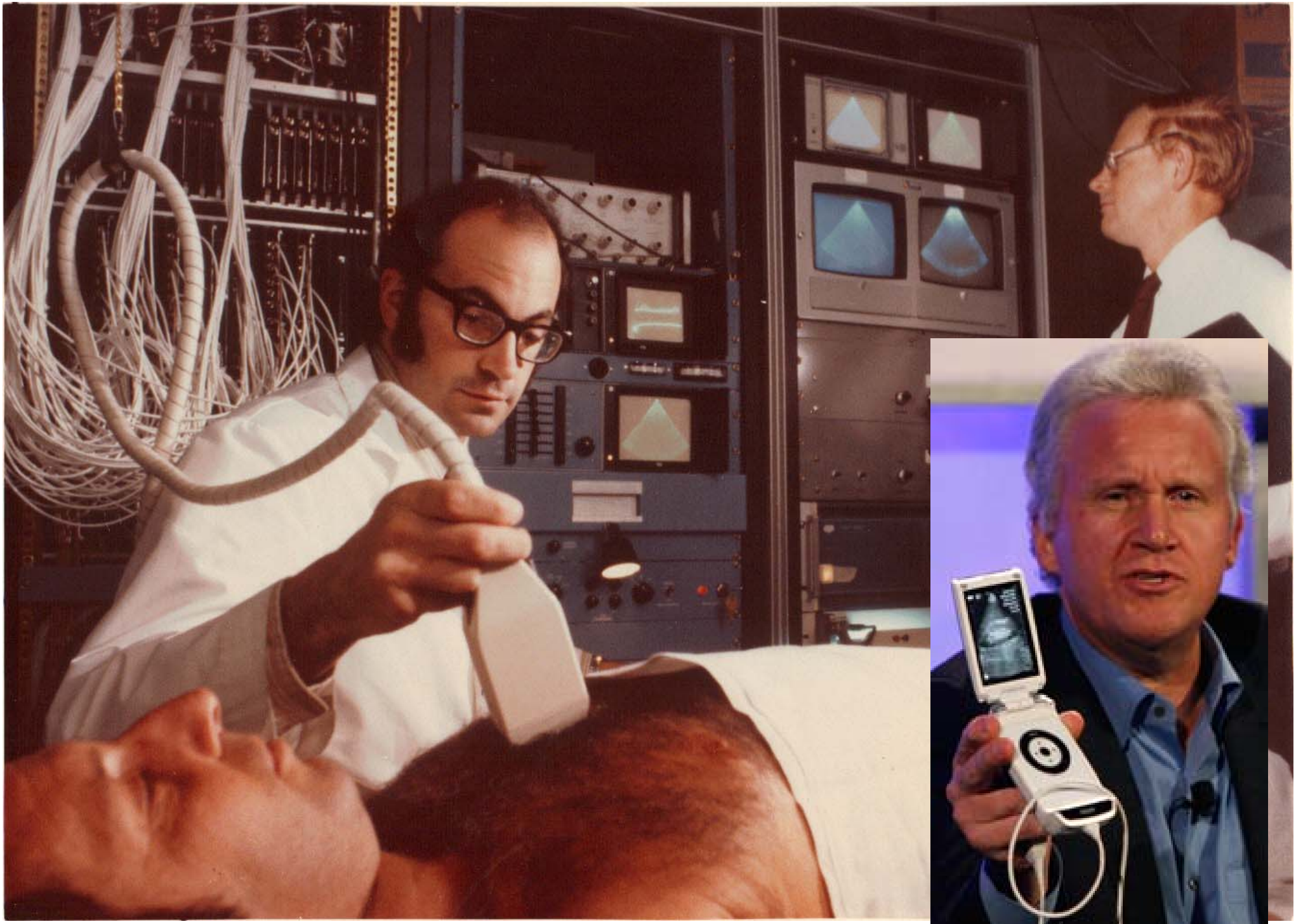

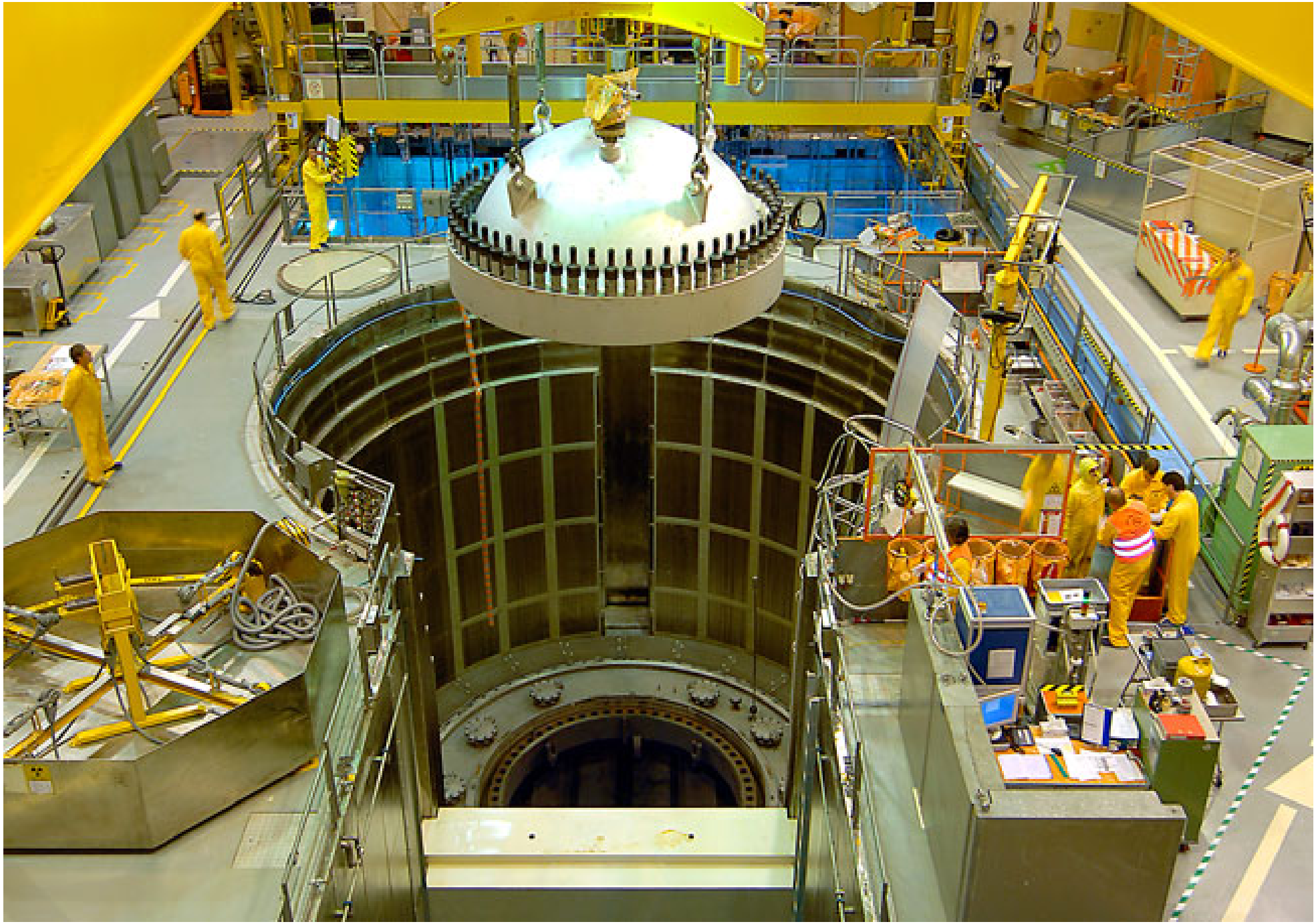


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CANADA'S WEEKLY BUSINESS AND FINANCIAL NEWSPAPER

FINANCIAL TIMES

FINANCIAL TIMES OF CANADA ■ SEPTEMBER 21-27, 1992

ild ride: y in chaos

he foreign exchange and savvy investors

vous 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 smidgen 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 Cunning-

CONTINUED ON PAGE 6

g new values dper 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 shows mettle — 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

CRAY

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BLUE WATERS

SUSTAINED PETASCALE COMPUTING

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

For More Information

Browse the *APS News* "Profiles in Versatility"

http://www.aps.org/publications/apsnews/features/profiles.cfm

Profiles in Versatility

A Leading Lederman in Industry

By Alaina 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 of Alcoa, doesn't question his decision to choose industry over academia. "After all," he chortles, "another Lederman won the Nobel Prize in my field." He and famed Fermilab physicist Leon Lederman are not related and have never met. But the non-collision of Leon and Frank never deterred the latter Lederman from pursuing his great love of physics.

Yet, when he graduated with his PhD in both theoretical and experimental solid state physics (he had two thesis advisors) from the University of Illinois at Urbana-Cham-

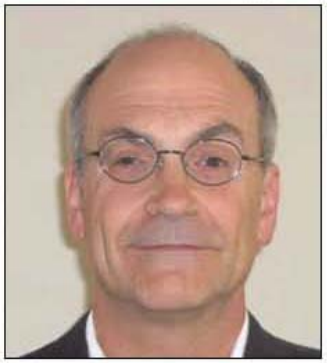
an interview and again told him at the start of the visit that there was no job for him. "But they must have liked what they saw," says Frank, "because they called a week later with an offer. My new boss, also a physicist, said that he found room for me, thanks to his losing a government contract."

Frank started at GE as a physicist where he conducted research in different subjects, including ultrasonic imaging. In fact, he was one of the designers of GE's first medical ultrasonic systems. He found his work fascinating, with great physics content to it, and within a year, Frank was given the opportunity to coordinate a large study for the group vice president, who at the time was Jack Welch. The chance to play such a role so fresh out of school was "very unusual," recalls Frank. Management must have seen something in him.

As an outcome of the study, a multi-million dollar project was formed, and Frank took a leader-

managerial career was right for him. "I went into management, partly because I didn't want this guy to control my destiny, I wanted to do that myself," 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. "It means change, of-



ten when others are most resistant to it," he says. "But that's what leaders

away from ultrasound, which is now a billion dollar business for GE.

In 1988, Frank left GE for Canada-based Noranda, where he was Senior Vice President of Technology, and then for Alcoa, the world's leading producer of aluminum and its products, where he served as the Vice President and Chief Technical Officer for six years.

Frank asserts his physics PhD was always an asset and never a liability. When you head a research group, he says, "a PhD 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 taking big complex problems and breaking them down into bite-size pieces. And you have to recognize what you have done already," Frank says. "You need to look at the toughest parts of a project

As a member of Alcoa's executive team, Frank participated in the business decisions 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 as CTO came when he convinced the CEO and key business managers that they had to play a bigger role in deciding which technologies get pursued and how they are managed. The technologies ranged from the design of alloys for an airplane wing to "enabling technologies" such as the physical chemistry behind production processes.

"We formed a 'virtual technology organization'" Frank recalls, "I gave up a lot of direct control over people, and I think I was respected for putting the company first, with a structure that is more global for a global company."

Although he is retired, Frank Lederman still stays involved in technology management as a mem-