

F. Peter Boer
President and CEO
Tiger Scientific Inc.

Biography

Peter Boer has extensive practical experience in the valuation of R&D projects and portfolios, from the differing perspectives of an R&D practitioner, a senior R&D executive, a senior business executive and a board director. In recent years he has focused on issues in R&D finance, including the development of business models for early stage projects, decision and risk analysis, and real options.

He has taught courses in technology finance at the Yale School of Management and environmental engineering in the department of Chemical Engineering. He is the author of *The Valuation of Technology*, a book published by Wiley in 1999, and the *Real Options Solution*, published in 2002. His latest book, *Technology Valuation Solutions* (Wiley) appeared in August 2004.

He has had extensive operating and technical experience with three Fortune 100 companies, The Dow Chemical Company, The American Can Company, and W.R. Grace & Company, where he was Executive Vice President and Chief Technical Officer.

He is serving, or has served, on the board of directors of seven corporations, including NOVA Chemical. Dr. Boer is a former President of the Industrial Research Institute, and has been twice appointed as Chairman of the National Medal of Technology Evaluation Committee. Dr. Boer was elected in 1993 to the National Academy of Engineering.

He holds an A.B. degree in Physics from Princeton University and a Ph.D. in Chemical Physics from Harvard University.

**Knowing The Value of Opportunity
or How to Get Ahead in the
Innovation Economy**

F. Peter Boer

AIChE Management Conference

Cincinnati

November 3, 2005

1. The Situation

Common Complaints

- Foreign Competition in Manufactured Goods
- Dependence on Foreign Oil
- Job Loss from Outsourced Services
- Federal Budget Deficit
- Global Warming/Natural Disasters
- Low Domestic Savings Rate

Global Balance

- Trade Deficit and Investment Surplus are part of the same equation
 - US trade deficit financed by foreign investment
 - Foreign investment in US financed by positive trade balance
- (not easy to disaggregate the value drivers)

Global Balance

- Low domestic savings may indicate lack of opportunity (to earn a good return)
- But to a foreign investor, investment in US assets may already offer superior risk-weighted return to local investment
 - Evidence
 - Chrysler (Germany)
 - Toyota and Honda (Japan)
 - Lenovo (China)
 - Reliance (India)

Other Symptoms

- Global Overcapacity in Manufacturing
- Generally Low Returns on Invested Capital
 - Distress for investors and companies
- Capital flight to apparently Higher Return Vehicles
 - Private equity/distressed firms
 - Hedge funds/exploit financial inefficiencies
 - Venture capital/high-risk with high return
 - Real Estate/exploit low interest rates

U.S. Chemical Industry

- Reluctant to reinvest in core businesses
 - Limited opportunity
- Focus on industry consolidation
 - Mergers, synergies, plant closings
- Use cash to:
 - Retire debt
 - Buy back stock

What Really Hurts

- Global Lack of Investment Opportunity

Conclusion

- We are cash rich and opportunity poor

2. The Innovation Solution



Innovation

- U.S. Position
 - Disadvantaged in many raw materials
 - Disadvantaged in labor costs (on balance)
 - Advantaged in Innovative Capacity
 - University system (17 of global top 20)
 - Entrepreneurial activity (can easily generate \$100B/yr for ventures)
 - Sophisticated financial markets
 - Culture, reinforced by experience

The Innovation Economy

- Business Week 75th Anniversary Issue
 - *October 11, 2004*
- “Explosive Change”
 - IT
 - Health Care
 - Business and Finance
- “Slower”
 - Transportation
 - Energy
 - **Materials** and Manufactured Products

The Innovation Economy

- Business Week 75th Anniversary Issue
 - *October 11, 2004*
- “Explosive Change”
 - IT ← Chemistry is
 - Health Care ← Often Enabling
 - Business and Finance
- “Slower”
 - Transportation
 - Energy
 - **Materials** and Manufactured Products

Innovation and Value

- Business Models
 - Google, Walmart, Ebay
 - Creative destruction: Detroit business model, legacy airlines, traditional telephone companies
- Creative
 - Screenplays, Music, Literature, Games
- Technology
 - R&D

Technology is the Chief Source of Value

- **Technology accounts for half of the economic growth of developed countries.**
 - Lawrence J. Lau, "Sources of Long-Term Economic Growth," in *The Mosaic of Economic Growth*, R. Landau, ed.

3. Making it Happen



Innovation is Risky

- To be advantaged, innovators need to understand the nature of risk
 - Unique risk can be diversified
 - Systematic risk can be exploited
- Few corporations act as if they understand this

Avoid Denial

- A tendency to avoid reality, to minimize bad news, is embedded deep in corporate culture. But while most cultural change must start at the top, I believe this change can start anywhere. The penalty for not changing seems to be getting stiffer.

Geoffrey Colvin, *Fortune*, Aug. 3, 2005

- Abdication of quantitative methods of assessing risk and reward is very common

The History of the Bubble

- At the Top
 - Investment in opportunity creation richly rewarded
 - VC Fund returns 50%+
 - Indigestible cash flow from investors (10X previous levels)
 - Conventional companies
 - Opportunities quite highly valued

“Tangible assets amount to just a fraction of the value of the S&P 500 companies. In fact, less than 25% of their market capitalization is backed by cash flows to be derived over the next 5 years.”

J. Campbell and C. Knoess, *How to Build a FutureWealth Company*

After the Fall

- Loss of confidence in unrealistic plans
 - Broadband timing
- Flight of capital from Nasdaq stocks and venture capital
- Migration of capital toward cash generating assets
 - Fall in corporate bond rate
- Result: shift to current *opportunity poor/cash rich* position

Assets and Options

- Risk = volatility: reduces the value of Assets
 - Explicit in Capital Asset Pricing Model
- Risk = volatility: increases the value of Options
 - Explicit in Black-Scholes formula

Assets and Options

- Risk = volatility: reduces the value of Assets
 - Explicit in Capital Asset Pricing Model
- Risk = volatility: increases the value of Options
 - Explicit in Black-Scholes formula

After the fall; Loss of value was followed by loss of volatility

Total Value

Economic Value

Cash Flow Generated
by *in-place* Physical,
Intellectual and
Financial Capital
(measure as NPV)

Strategic Value

Value of Intellectual
Capital Incorporated in
Unrealized Business
Plans
(measure as Options)



Opportunity

Total Value

Plans are Options

- No need to invest in assets until favorable returns are assured
- Applies to
 - Business plans
 - R&D plans
 - Creative products
- Volatility is helpful

4. Getting Ahead through R&D

R&D is an Investment

- It is not properly an expense since the payoff is in the future
 - Treatment contradicts the accounting principle of matching expenses with revenues
- The investor usually owns an option, not an asset

R&D Acrobatics

- Level of unique risk very high compared to financial markets
- Probabilistic
 - Cannot be properly managed with discount rate, though it has been tried
 - Psychologists tell us the human brain is poorly wired for calculating unique risk
- Situational
- Non-liquid
- Non-linear
- Discontinuous
 - Often Bipolar Y/N

R&D Acrobatics (con't)

- Technical complexity impenetrable to many non-technical competitors
- Business situation has hidden variables

All of these “problems”
can become sources of
competitive advantage!

The Enemy: Diminishing Returns

- What is not helpful is technological maturity
- Result is incrementalism to the point of diminishing R&D returns
 - Lower R&D productivity
- Volatility helps: new combinations of technology and new market needs

Seek Volatility

- Failing Business Models
 - Airlines, Telephone
- New Business Models
 - Internet retailing
- Capacity Imbalance
 - Feedstock Supply
- Globalization
- Technology
 - Internet app's
 - Scientific medicine
 - GM agriculture
- Catastrophes
- Politics/ Nationalism
- Changes in leadership

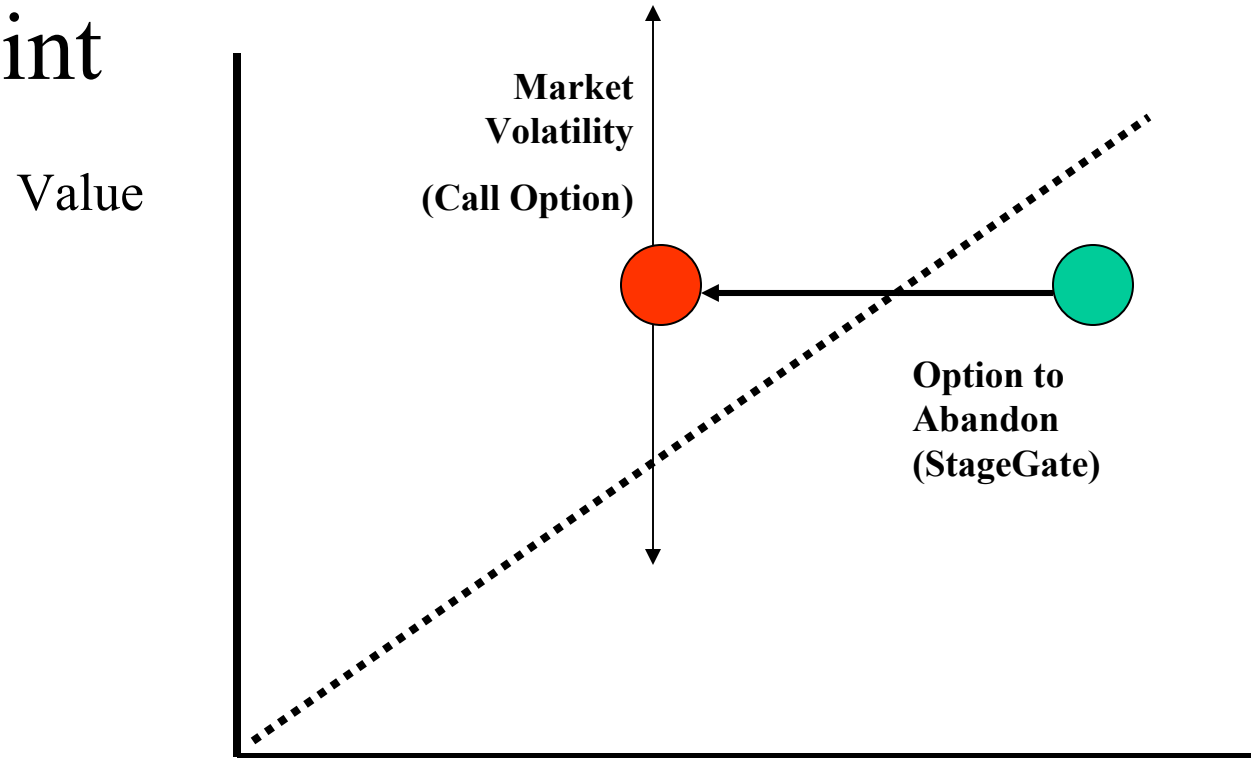
Challenge #1

- Determine Value/Risk position of key R&D investments
 - Exploit risk mitigation techniques used in financial markets
 - Stage-gate system (option to abandon) reduces unique risk
 - Call option exploits volatility

Calculate Technology Project Value

- NPV
 - The Time Value of Money
(Payoff is deferred)
 - R&D Costs
 - R&D Risks
 - Unique (Diversifiable) Risk
 - Market (Undiversifiable) Risk

Project Viewpoint



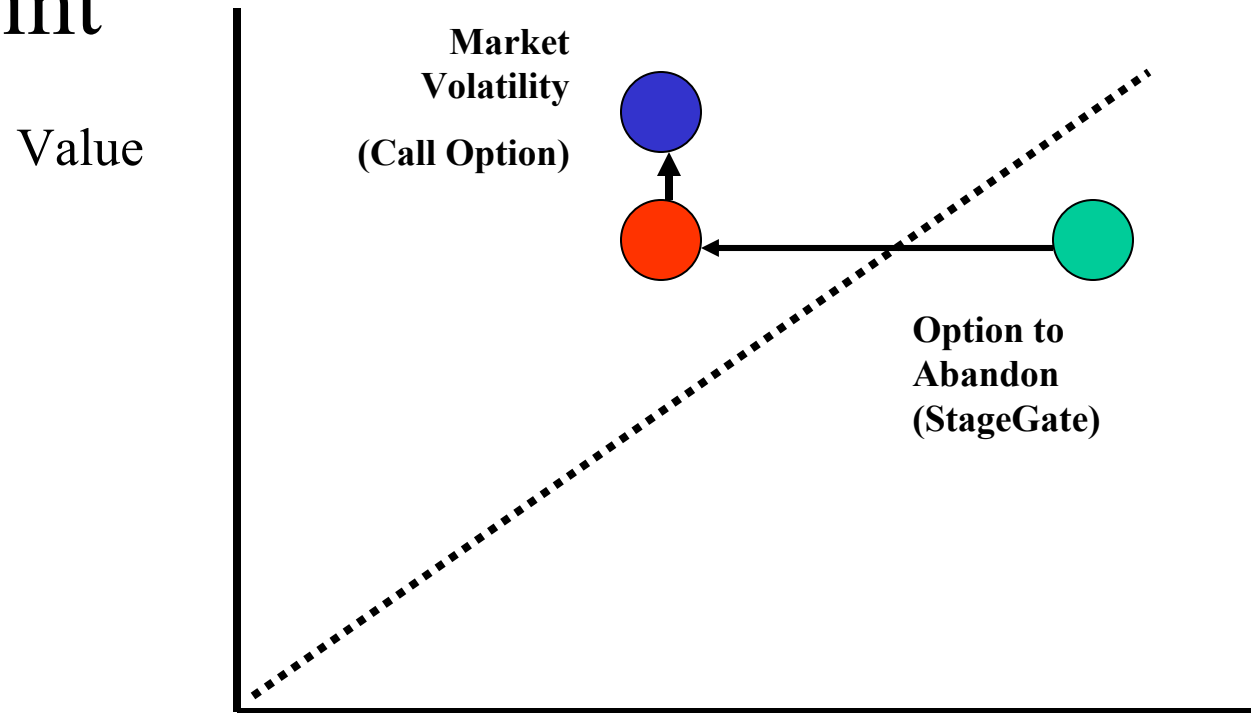
Value = Project NPV - R&D Cost

Unique Risk

Unique Risk = (R&D Cost - Option to Abandon) x Probability of Failure



Project Viewpoint



Value = Project NPV - R&D Cost

Unique Risk

Unique Risk = (R&D Cost - Option to Abandon) x Probability of Failure

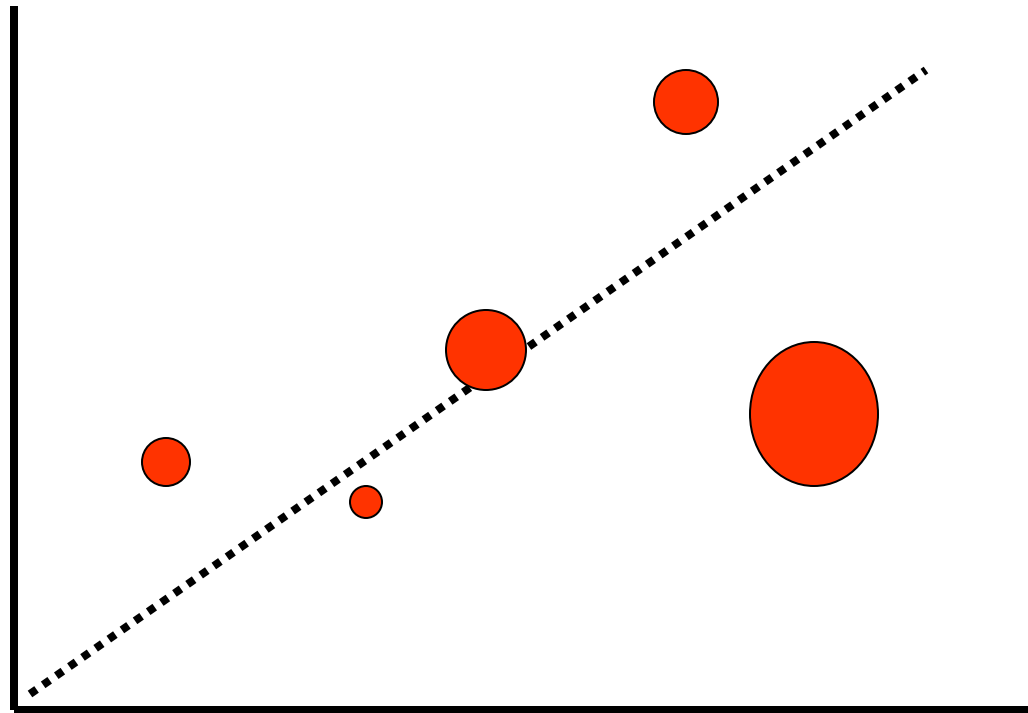
Challenge #2

- Select Best Projects for Portfolio based on Value/Risk proposition
- Is optimum result cash or opportunity constrained?

Project

Selection

Value



Constraint

Enough Cash?

**Enough
Opportunity?**

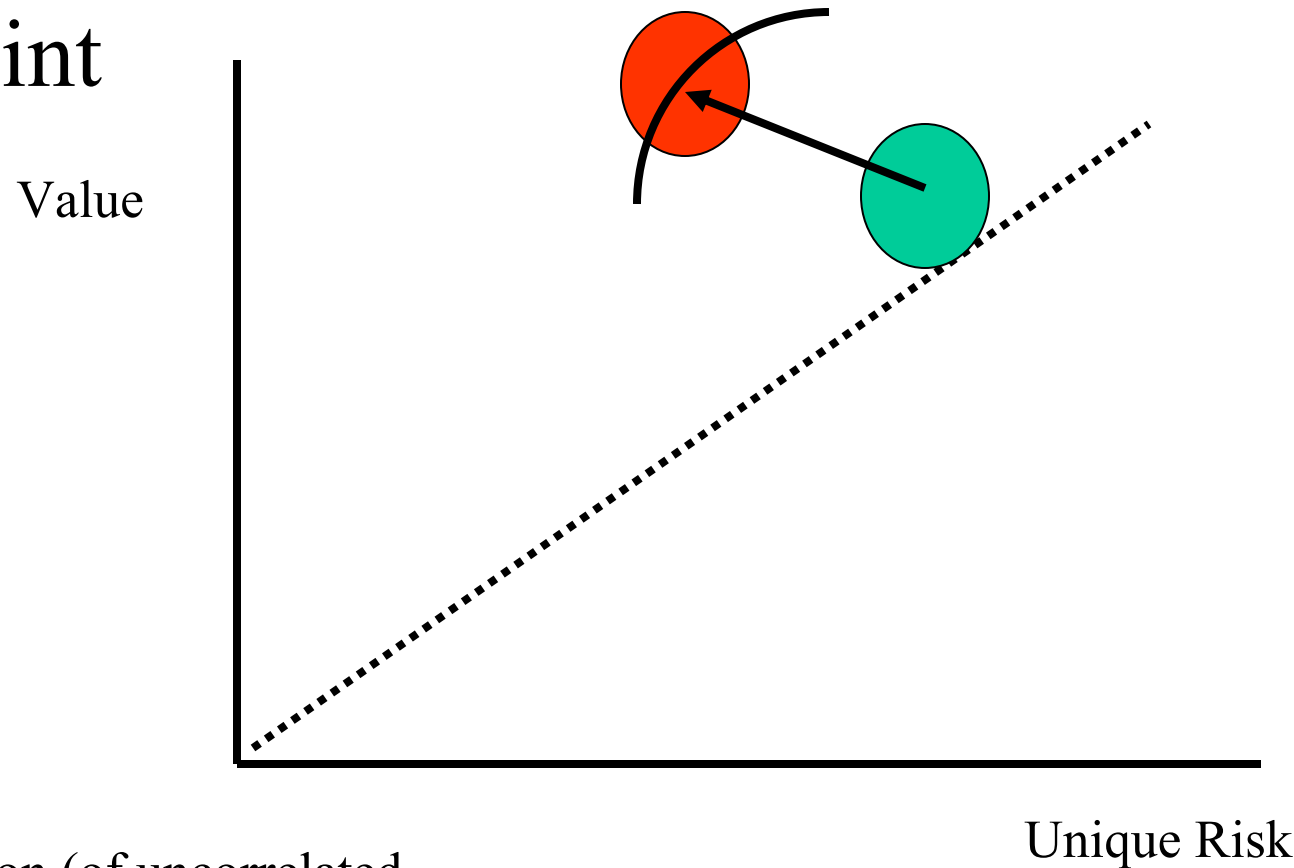
Unique Risk



Challenge #3

- Capture value of diversification to reduce overall unique risk
- Theoretically possible to select different risk/reward positions on efficient portfolio curve
 - Illiquidity may limit application

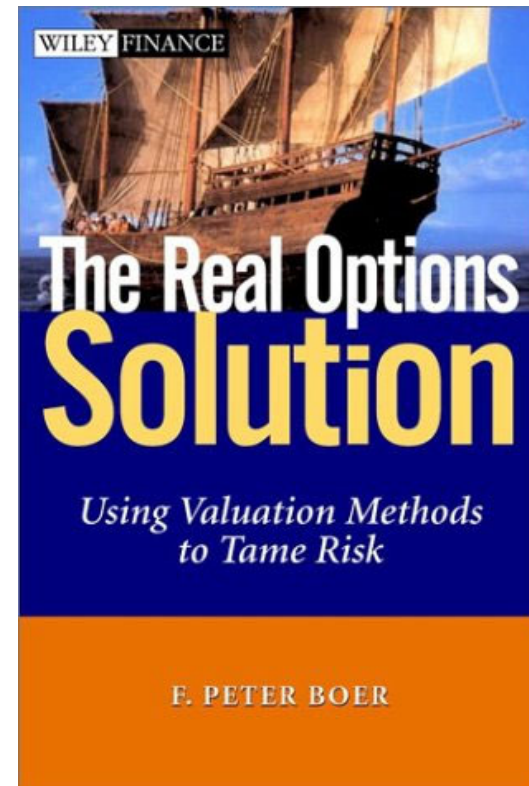
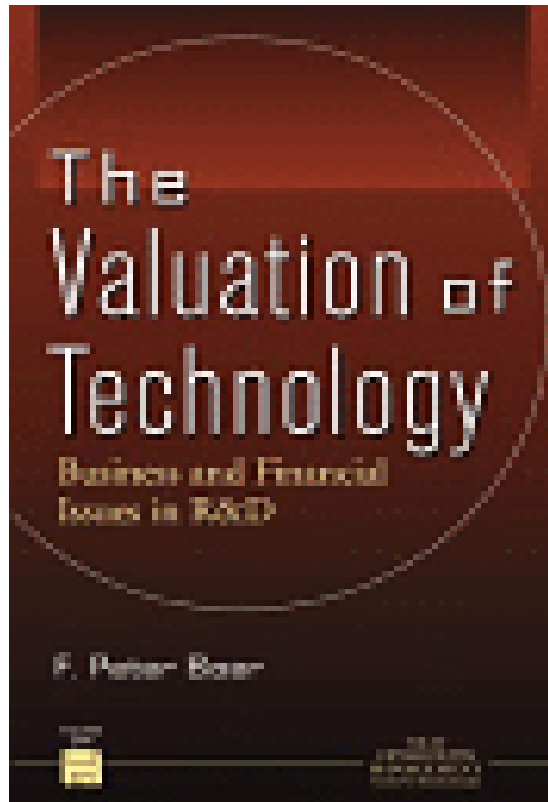
Portfolio Viewpoint



Diversification (of uncorrelated
investments)/ efficient portfolios
Markowitz's "Last Free Lunch"

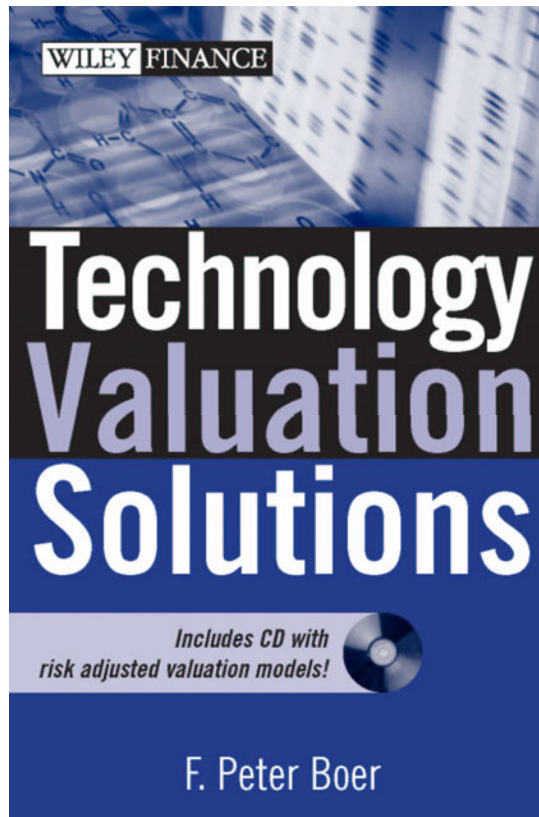


Books



<http://www.tigerscientific.com>

New !



Business Characteristics of R&D

- Huge Level of Risk
 - Outsize Rewards
 - Often non-linear
- Abdication of Quantitative Methods is Common
- Very Complex Business Environment
- Impenetrable Culture