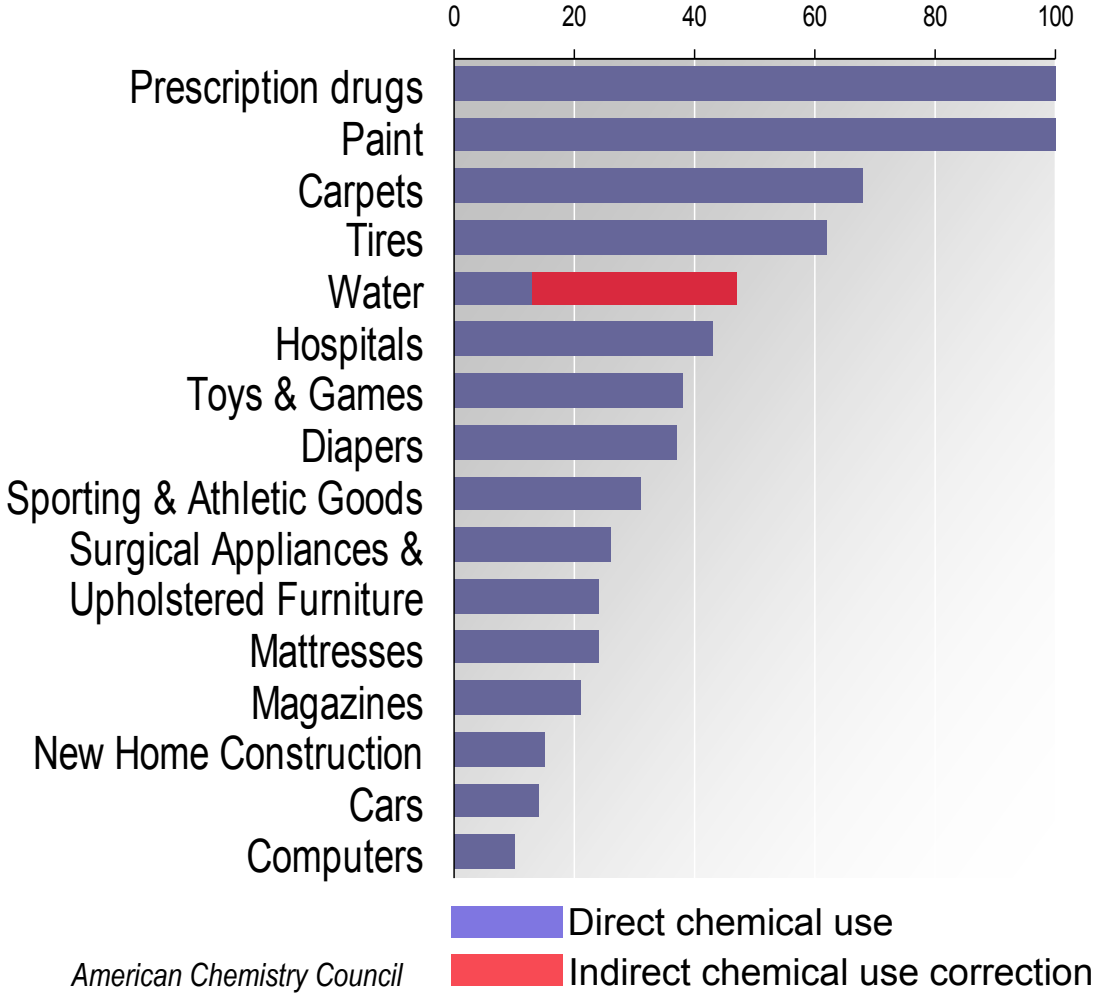
Challenges to Commercializing Technology in the Chemical Industry

William Banholzer
ADHOC 2015

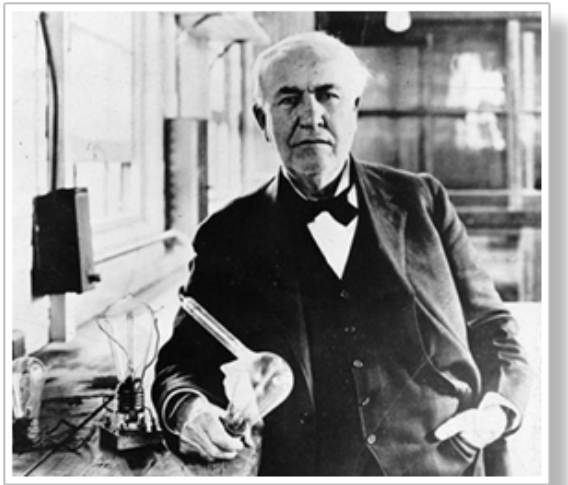
The World Needs Chemistry

Value of chemistry as % of all materials



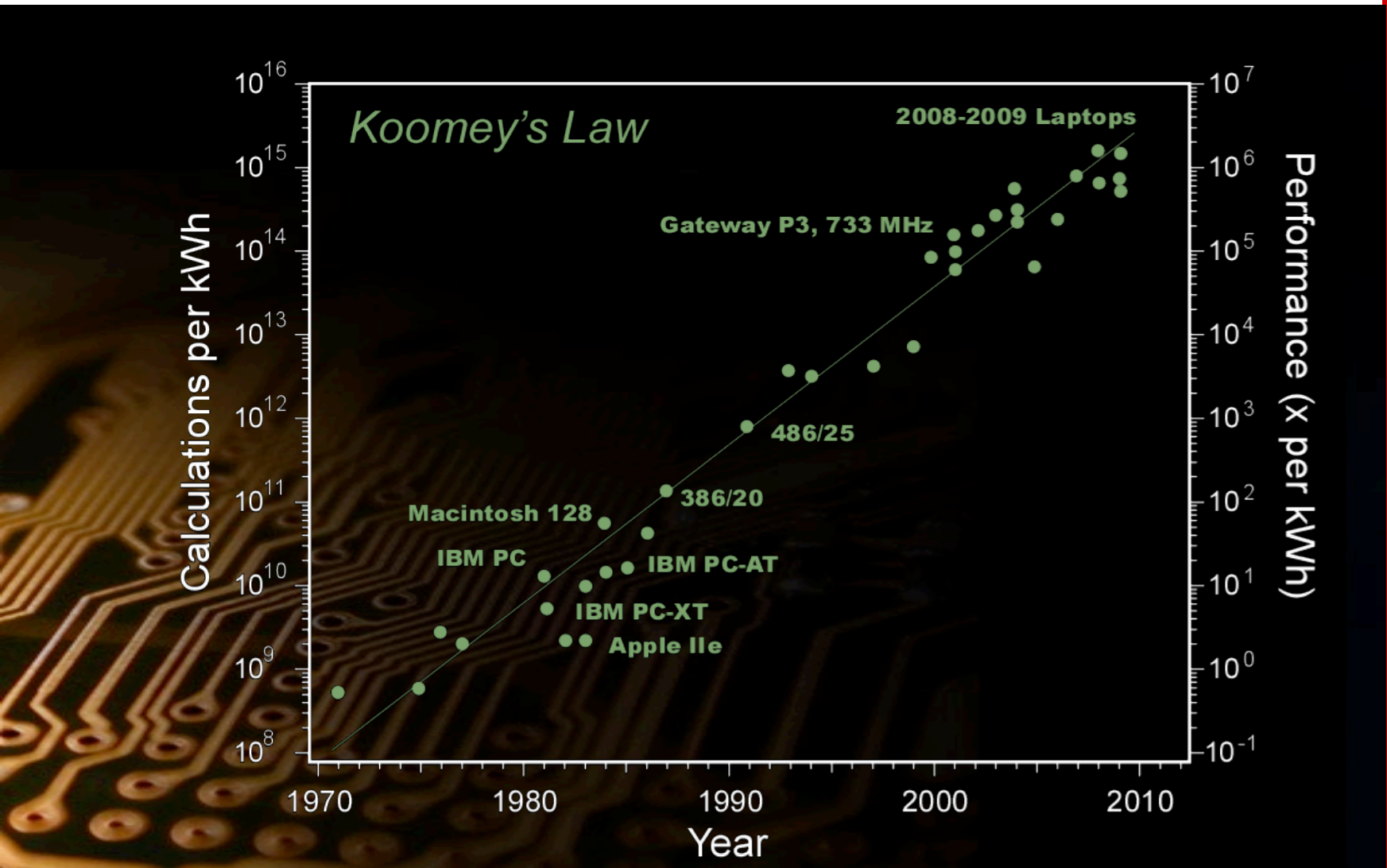
American Chemistry Council

Innovation

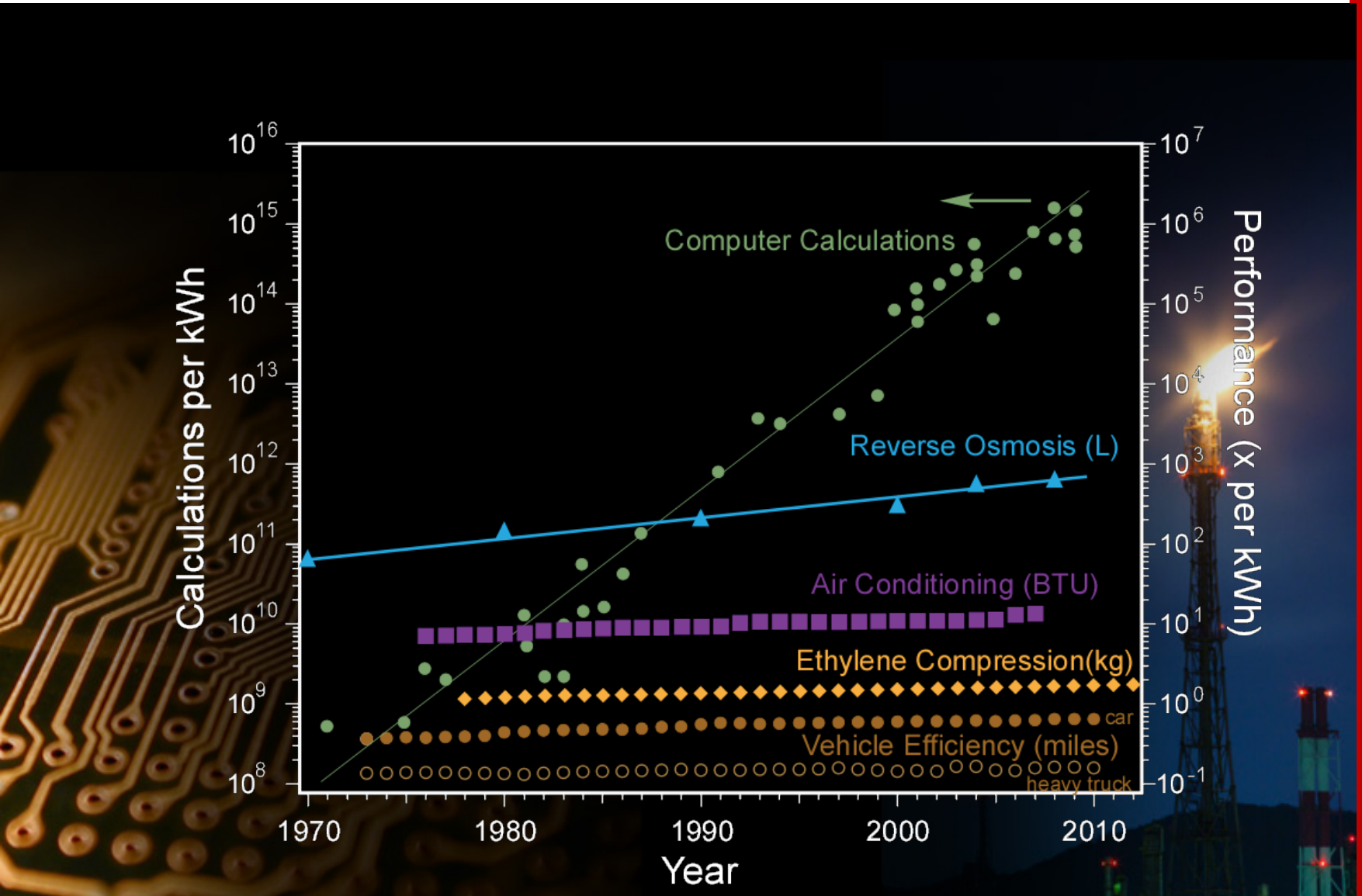


Rules for Business

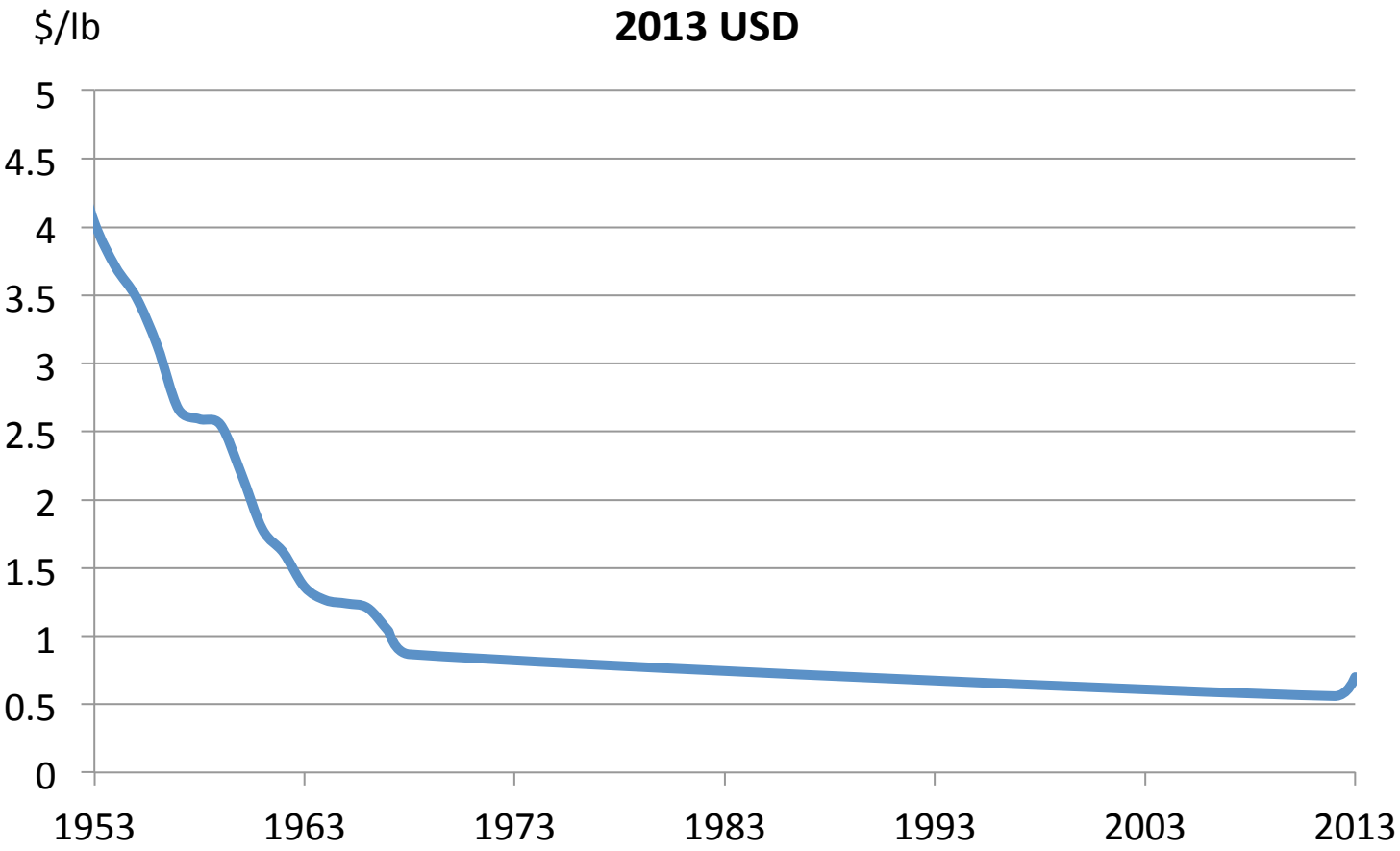
Engineering Triumph



Moore's Law Sets Unrealistic Expectations



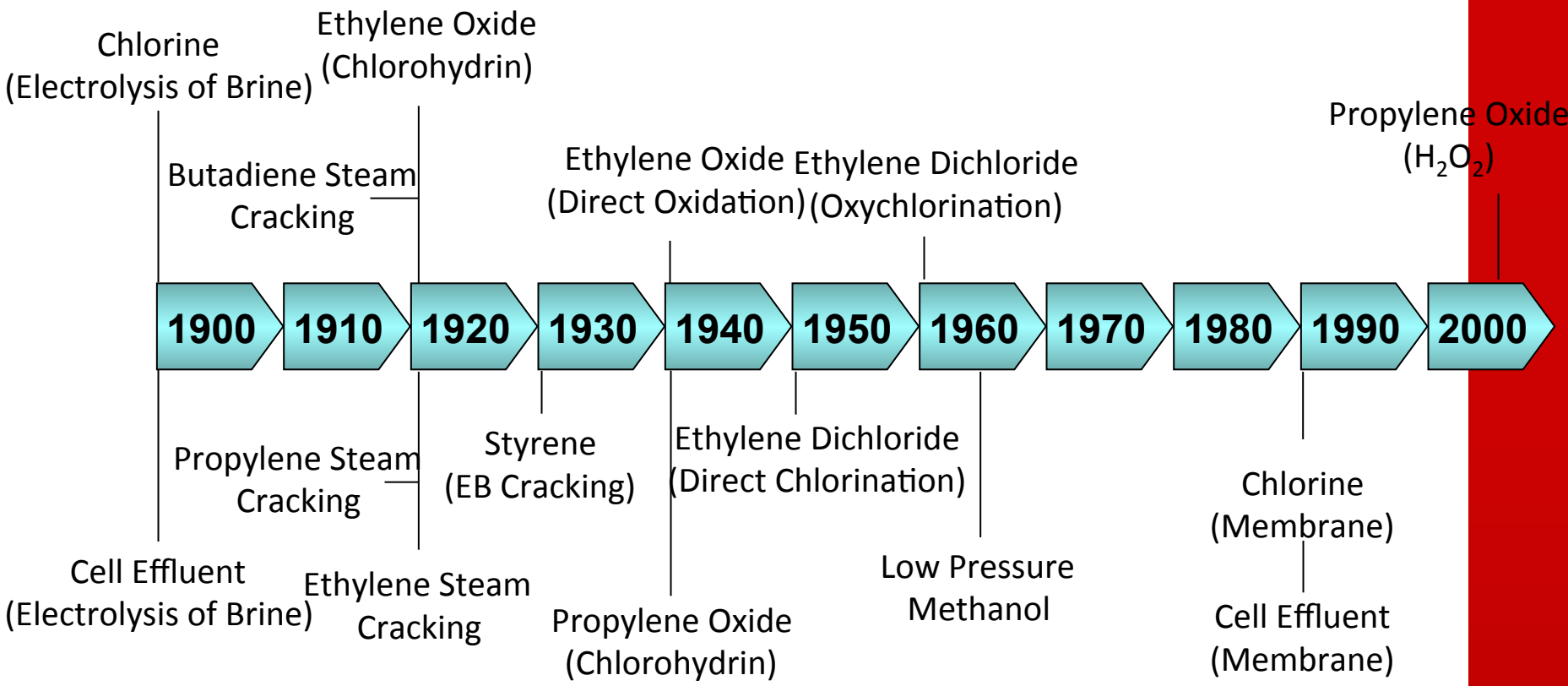
LDPE Cost Trend



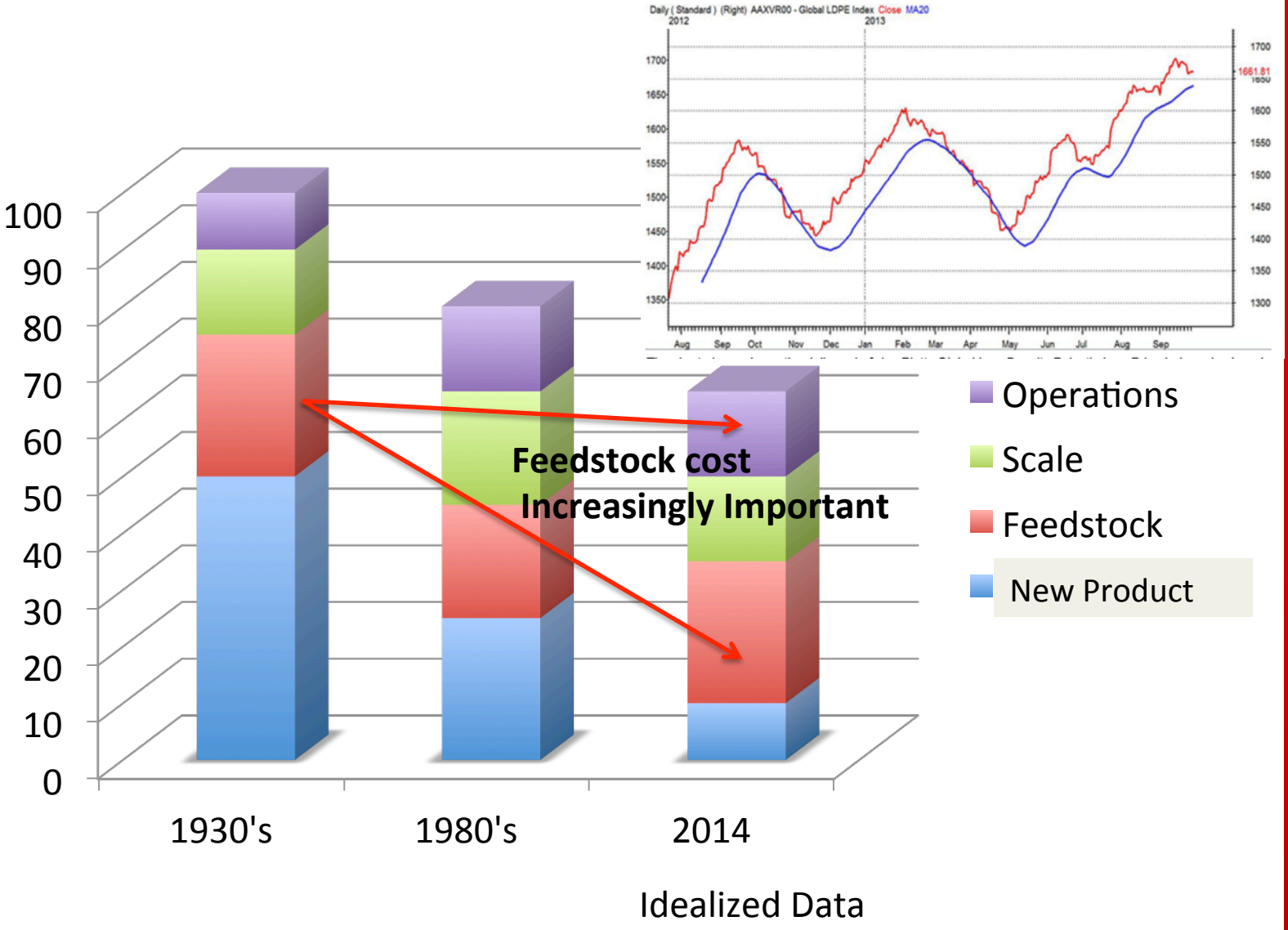
Source PCDB.Santefe.edu

Basic Raw Material Transformations

Technology is highly optimized



Relative Source of Profit



Top US Chemical Companies 1970

Rank '69	Rank '68	Company	Chemical sales (Millions)	Total revenues[a] (Millions of dollars)	Chemical sales as per cent of total revenues	Company SIC class.[b]	After-tax earnings[c] (Millions of dollars)	Profit margin[d]	Rank '69	Rank '68	Return on investment[e]	Rank '69	Rank '68
					TOTAL COMPANIES								
1	1	Du Pont[f]	$3220	$3,655	88%	281	$343.5	9.4%	4	3	5.6%	7	4
2	3	Union Carbide	1815	2,933	62	281	186.2	6.4	18	24	3.2	36	42
3	2	Monsanto	1735	1,939	89	281	109.4	5.6	26	22	3.3	34	33
4	4	Dow Chemical	1570	1,876	84	281	148.7	7.9	10	12	4.7	15	19
5	7	Celanese	1028	1,250	82	281	76.3	6.1	22	34	3.8	29	45
6	5	W. R. Grace	1015	1,812	56	281	51.0	2.8	45	45	2.8	40	41
7	6	Standard Oil (N.J.)	1004	16,900	6	291	1243	7.4	12	9	5.1	11	9
8	8	Allied Chemical	895	1,316	68	281	68.0	5.2	30	46	2.7	41	48
9	9	Hercules	642	746	86	281	43.9	5.9	24	14	4.1	26	12
10	11	Occidental Petroleum	625	2,059	30	509	174.8	8.5	7	14	7.3	3	3
11	10	FMC	620	1,409	44	281	67.3	4.8	32	29	5.0	13	6
12	12	American Cyanamid	576	1,067	53	281	89.9	8.3	8	5	6.2	6	5
13	13	Shell Oil	544	4,276	13	291	291.2	6.8	15	10	4.2	21	18
14	14	Eastman Kodak	522	2,747	19	383	401.1	14.6	1	1	10.5	1	1
15	16	Uniroyal	513[g]	1,554	33	301	46.6	3.0	44	40	2.7	41	31
16	15	Stauffer Chemical	499	499	100	281	31.6	6.5	17	17	7.2	4	9
17	17	Phillips Petroleum	471	2,227	21	291	134.3	6.0	23	19	3.2	36	35
18	18	Rohm and Haas	448	453	99	281	33.5	7.4	12	8	4.8	14	9
19	19	Mobil Oil	444	7,573	6	291	434.5	5.7	25	22	4.4	17	22
20	21	Borden	394	1,756	23	202	47.9	2.7	46	47	4.2	21	24
21	26	Ethyl Corp.	382	517	74	281	33.0	6.4	18	20	4.3	20	19
22	20	Cities Service	361	1,595	23	291	127.2	8.0	9	5	4.0	27	26
23	23	Ashland Oil	342	1,151	30	291	52.3	4.5	34	32	4.4	17	15
24	28	Diamond Shamrock	327	555	59	281	30.7	5.5	28	17	3.2	36	30
25	24	Continental Oil	325	2,607	13	291	146.4	5.6	26	21	3.7	30	24

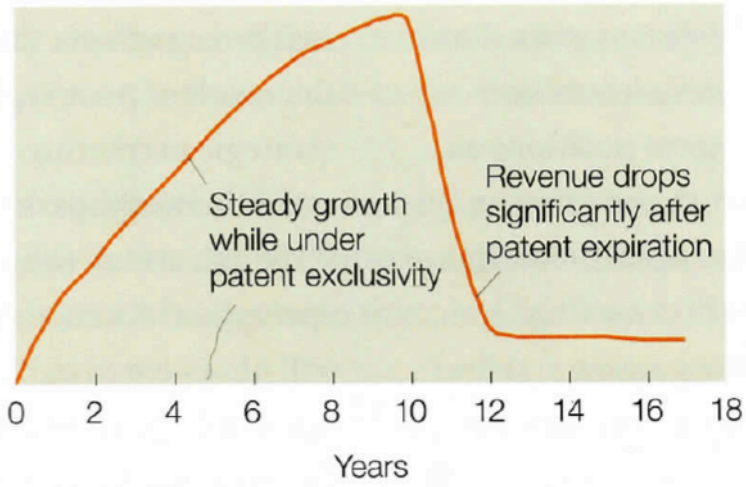
Bio

Bio/Rest.

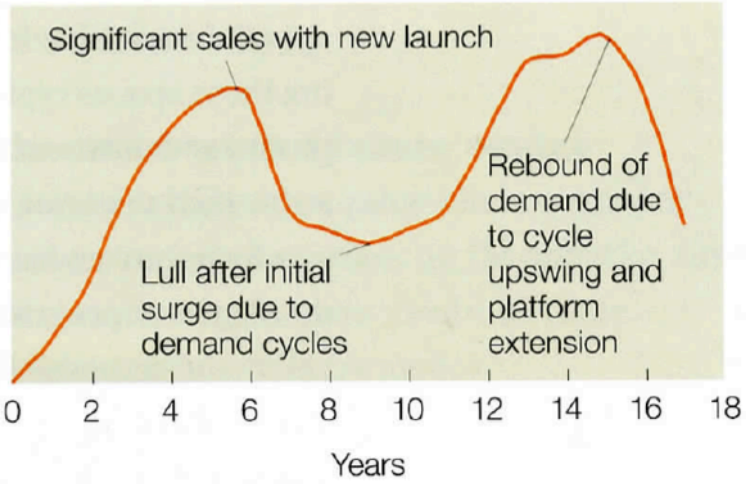
Time to Realize Materials Benefits

Revenue evolution to peak and beyond for various industries

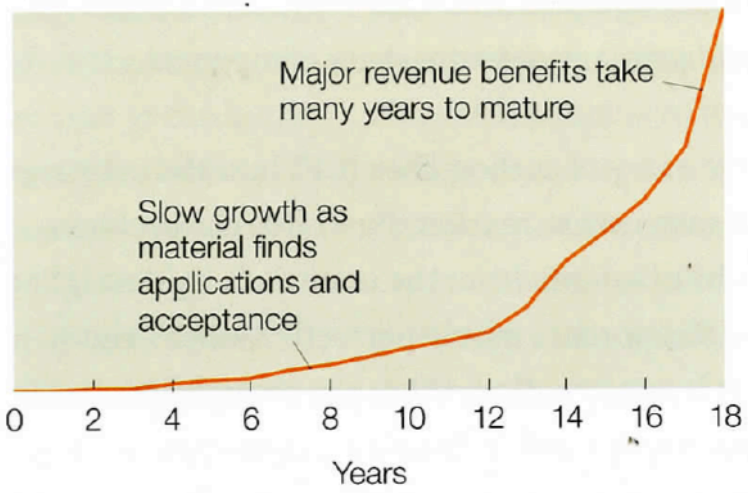
Pharma (new drug)



Aerospace (new aircraft platform)



Materials/chemicals (new product launch)



McKinsey on Chemicals: The path to improved returns in materials commercialization, Number 4 Spring 2012

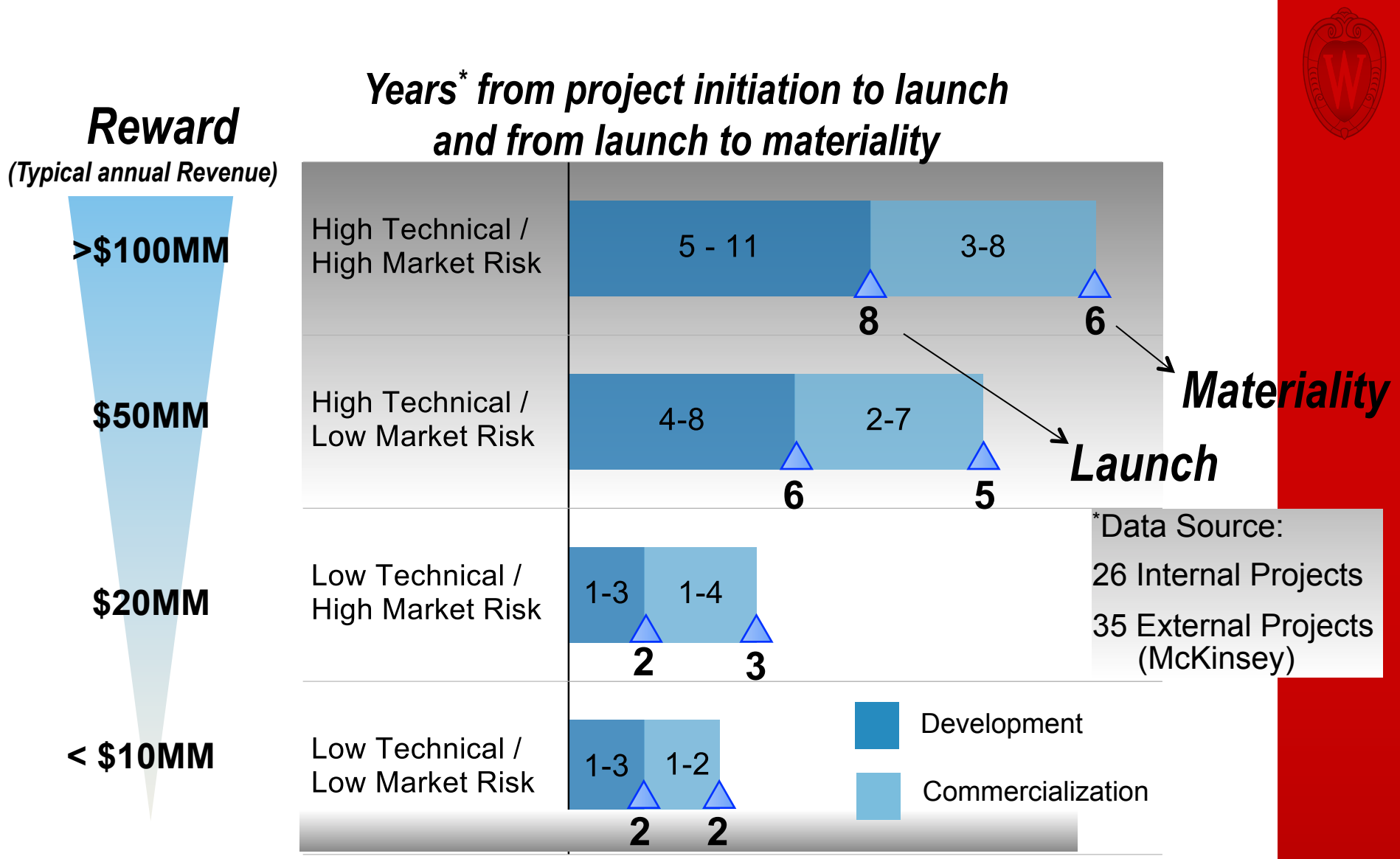
Time and Risk Matrix

Degree of Market Familiarity	High Degree of Technology Familiarity	Low Degree of Technology Familiarity
Low	**Product-line extensions into new markets** Success rate: 30–40% Time to commercialization: 2–7 years (average 5) Average IRR 20-25%	**New-product launches in new markets** Success rate: 15–20% Time to commercialization: 8–19 years (average 14) Average IRR 8-12%
High	**Product-line extensions into existing markets** Success rate: 40–50% Time to commercialization: 2–5 years (average 4) Average IRR 18-23%	**New-product launches in existing markets** Success rate: 30–40% Time to commercialization: 6–15 years (average 11) Average IRR 13-18%

New Technology Risk > New Market Risk

McKinsey on Chemicals Chemical Innovation: An Investment for the Ages, Mehdi Miremadi, Christopher Musso, and Jonas Ozgaard, May 2013

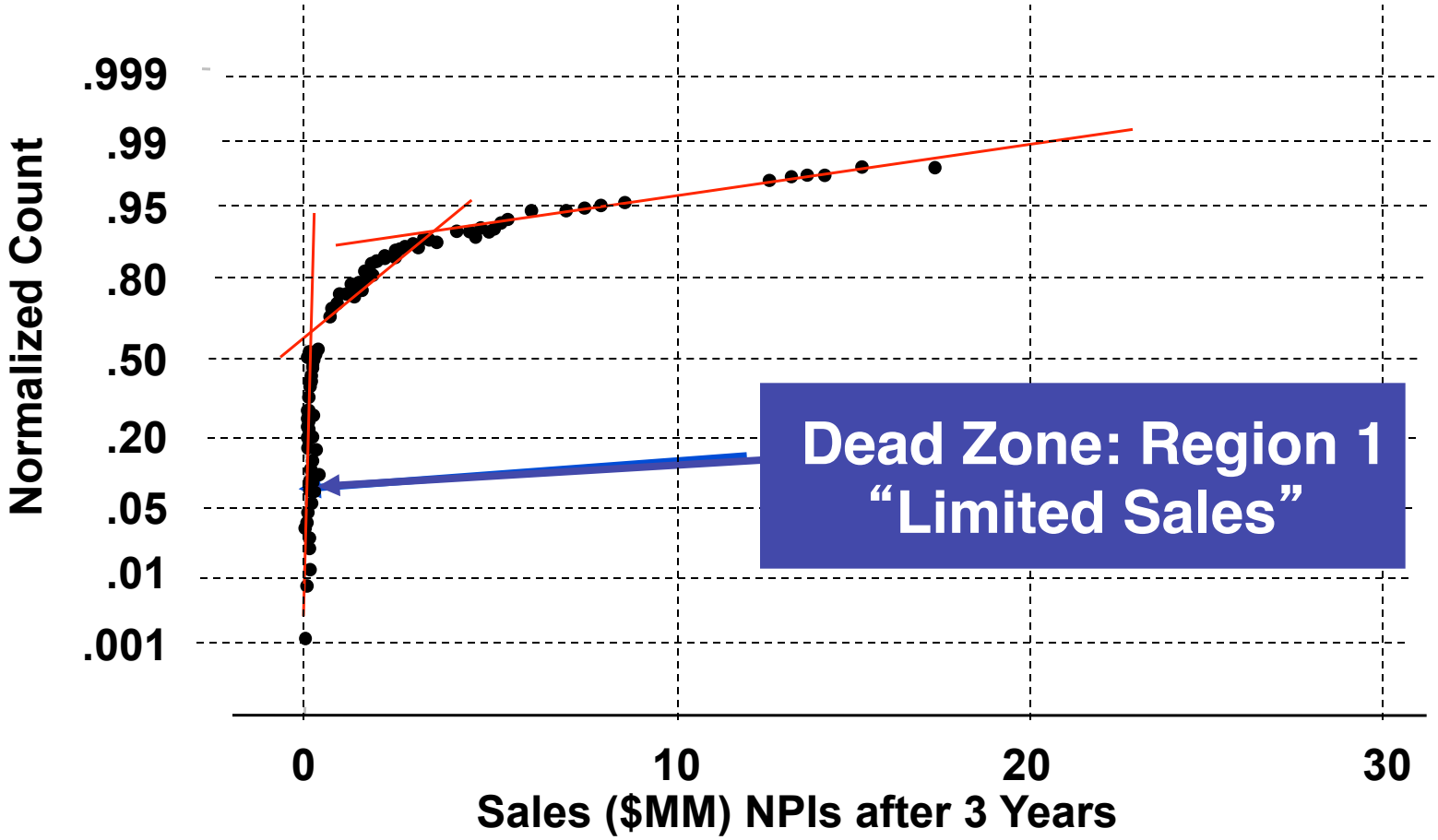
Timeline to Innovate



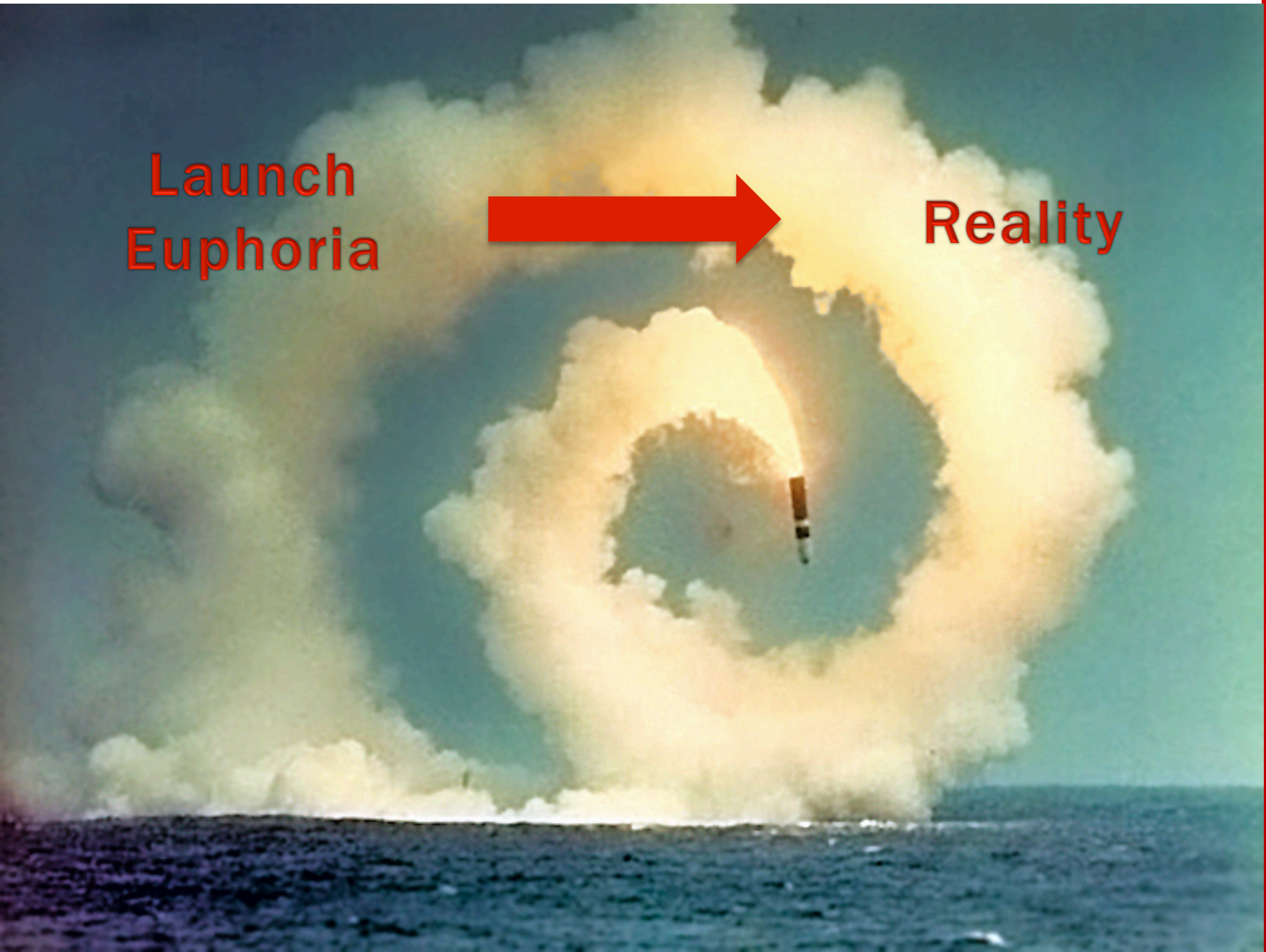
The Trouble With Averages …

Photo credit: www.outdoorchannel.com

NPI Analysis



Innovation Failure Modes



Failure Modes- Value Proposition

1-Fads

Non Sustainable Trends- often with poorly formulated value proposition, or incomplete analysis.

Symptom:

"Every one of our competitors is starting ….."

"This was used before but times have changed"

Example:

Biofuels

Biomaterials

Hype Around Cleantech

Ivy League Brains Figure Out How to Make Biodegradable Plastic from Greenhouse Gases

September 28, 2012 cleantechnica.com

Two graduates from Princeton University and Northwestern University have developed a process for converting greenhouse gases from sewage treatment plants, landfills, and power plants into a biodegradable plastic called Airflex™

As described by Newlight, the process for making Airflex ™ breaks down into a few simple steps. First, a mix of gases, including methane and carbon dioxide, is funneled into a reactor. Next, carbon and oxygen are separated out, and then they are reassembled into a long-chain thermopolymer.

September 25, 2012 presswire.com

"We are pleased to receive this seventh patent," stated Newlight CEO, Mark Herrema . "While the size of our patent portfolio is a testament to Newlight's pioneering inventions and nearly decade-long leadership in this field, we expect our patent portfolio to continue to grow at a rapid pace, particularly in the areas of new product applications and commercial-scale manufacturing systems."

Permanent Exhalation Conveyance

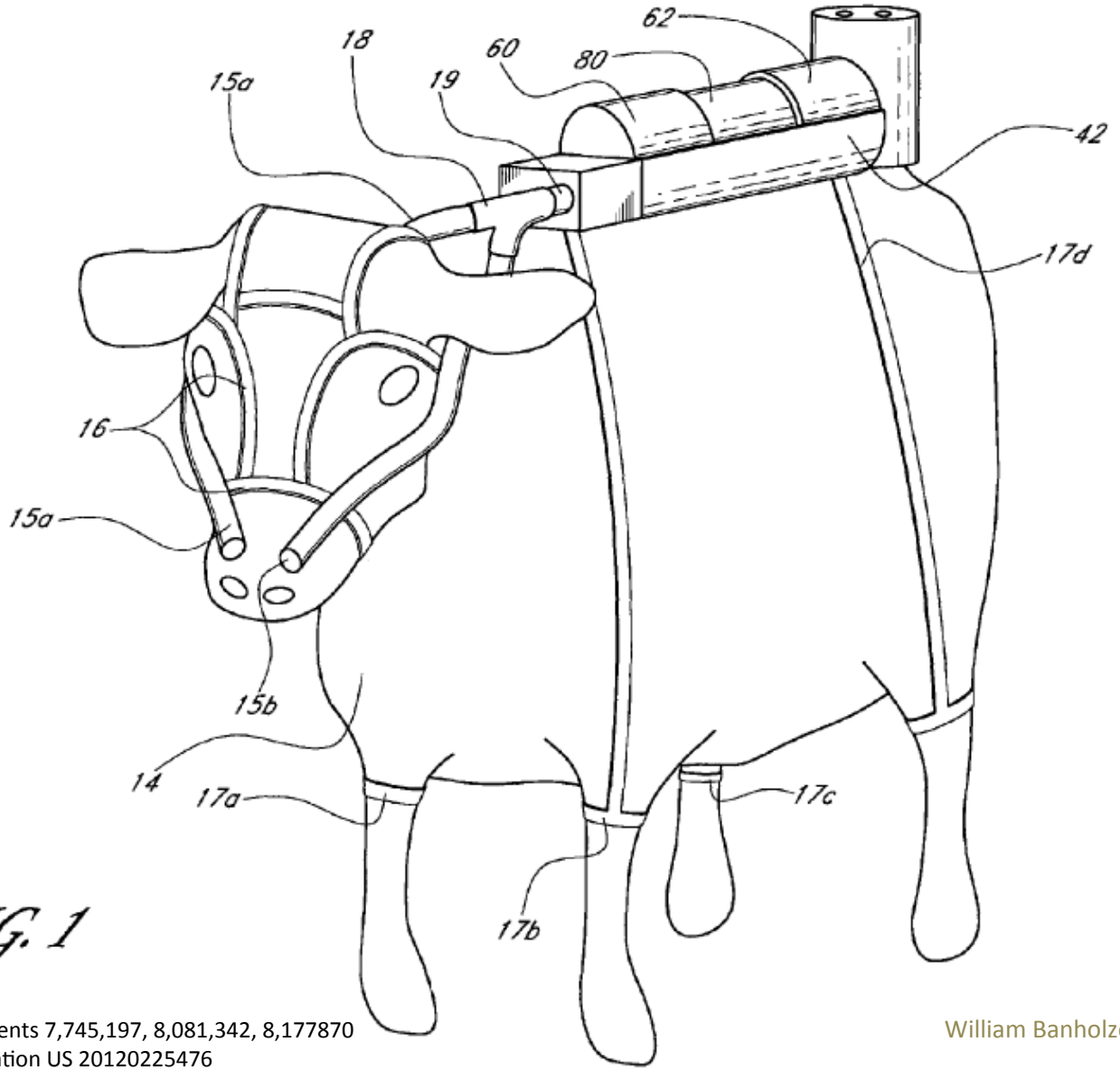


FIG. 1

US patents 7,745,197, 8,081,342, 8,177870
application US 20120225476

William Banholzer

Failure Modes – Value Proposition

2-Risk Disequilibrium

Benefits of new material < Risk of end product

Corollary Benefit of new process < Risk of process failure

Symptom:

"The customer doesn't understand the benefits we can generate."

"Their Testing in Ridiculous"

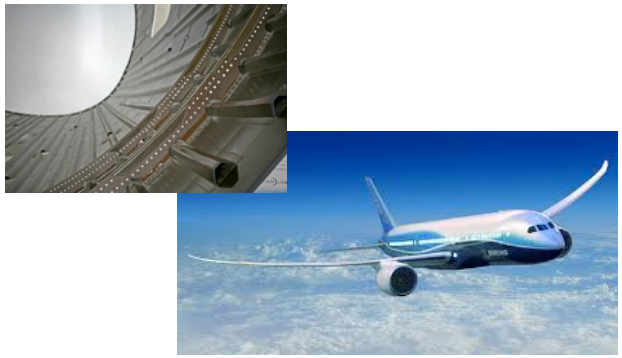
Example:

Carbon Fiber in Plane Fuselage:

1960 CF Developed

1980's Initial components

1990's Primary Structures:



Challenging Entry Segments: automotive, safety equipment, in body devices, primary aerospace components:

Failure Modes –Value Proposition

3-Inadequate Segmentation:

Belief New Product Widely Applicable

Corollary: Neglect tangential process considerations

Symptom:

"This will completely replace all ……"

Examples:

BioPlastics

CLF/LED Light bulbs

Failure Modes- Value Proposition

4-Panacea Illusion- Failure to appreciate alternatives

Belief New Material's Properties Totally Disruptive

Symptom:

"Our Material has such superior XXX ….."

Examples:

HDPE

Nano materials

Failure Modes- Value Chain Issue

5-Value Chain Resistance Complexity - Losers

Existing Value Chains are entrenched and the losers don't just capitulate.

Symptom:

"The existing value chain can't compete."

"Current Suppliers and Customers will have no choice"

Examples:

PCV pipe

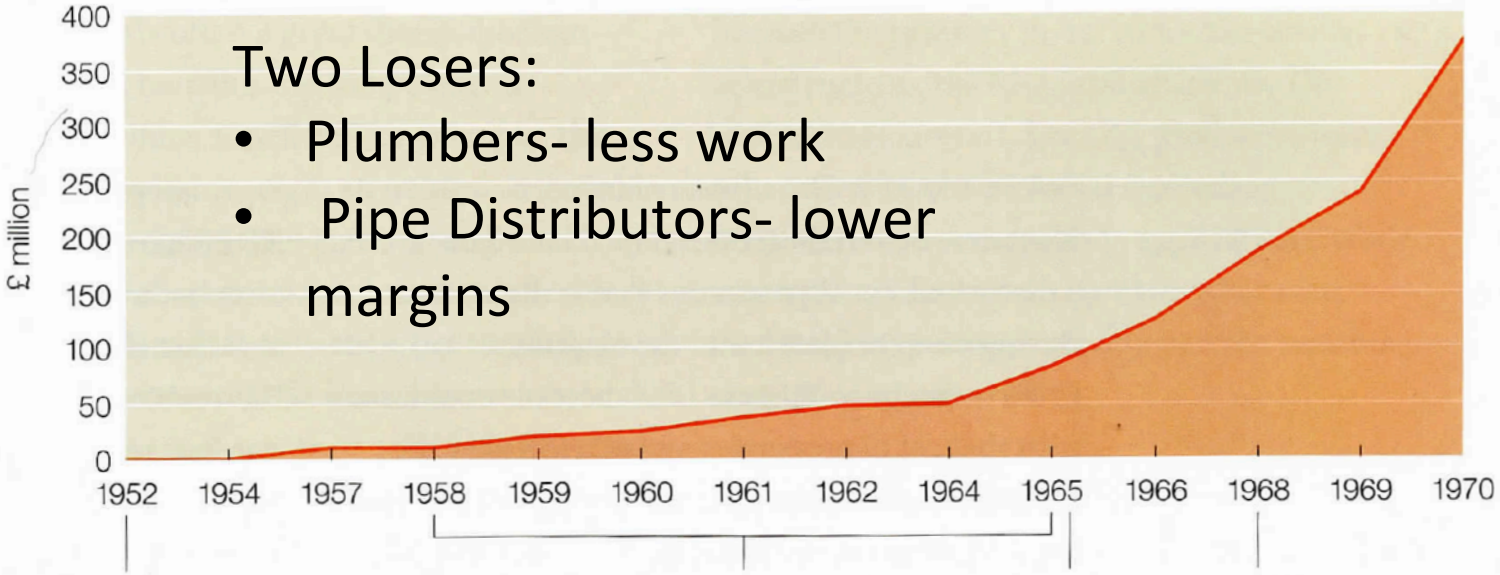
BPA can coatings

PC window Glazing

Value Chain Resistance- e.g. PVC

PVC pipe sales took nearly 15 years to reach reasonable volume.

PVC[1] pipe sales



Two Losers:

- Plumbers- less work
- Pipe Distributors- lower margins

[1]Polyvinyl chloride.
[2]Federal Housing Administration.

Source: Modern Plastics; McKinsey analysis

Value Chain Resistance e.g. BPA Can Coating

Base Material

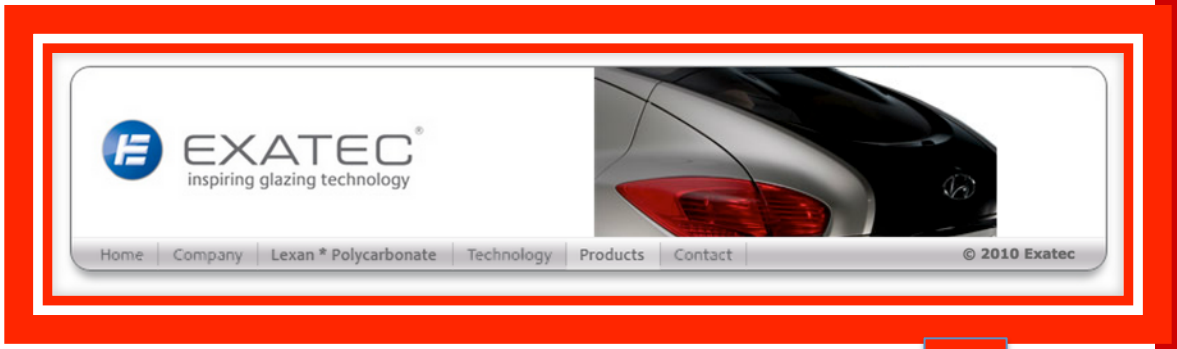
Formulated Coating

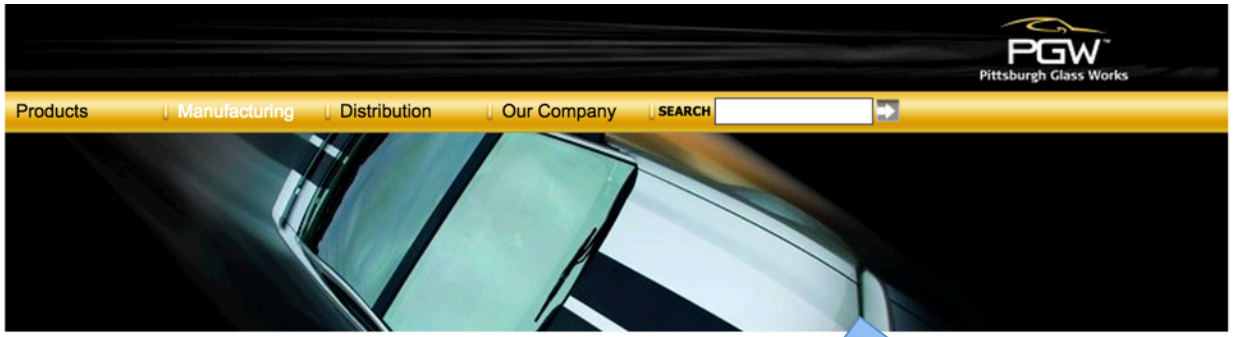
Can Manf.

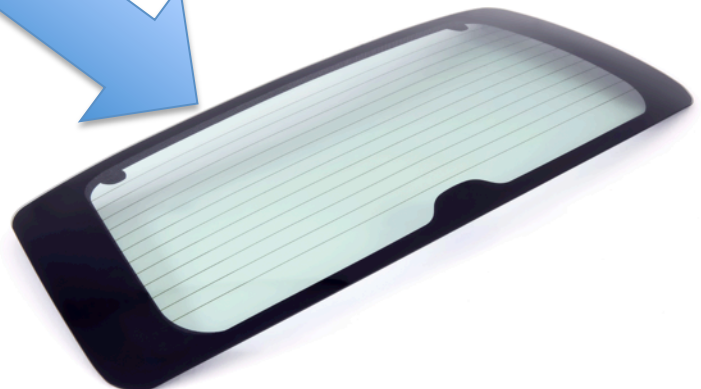
Customer

Can Coating Formulators discourage disruption in existing products/value chain

Value Chain Resistance e.g. PC Glazing







Hurdles:

- TCE
- Design
- System Cost
- Scratch

Failure Modes Value Chain Issue

6-Drop In Solutions

Material will "drop in" to existing process/market

Symptom:

"Nothing will have to change."

Examples:

Plastics Body panels

Composite Auto Parts.

Failure Modes

7-Single Customer NPI

New Product Effort Based on Single Customer Input

Symptom:

"XXX is the market leaders and will drive market adoption."

Examples:

Rubbermaid Food Storage

Market-Back Example

What Not To Do…

Rubbermaid®

New

Rubbermaid initial CTQs:

- Clarity – quality image
- Stain resistance
- Food contact approved
- Dampened / "rugged" sound
- High flow for thin-walled lids & bowls

This project was:

- #1 Rubbermaid program
- Large Add Spend
- Proprietary product
- But it failed!!!

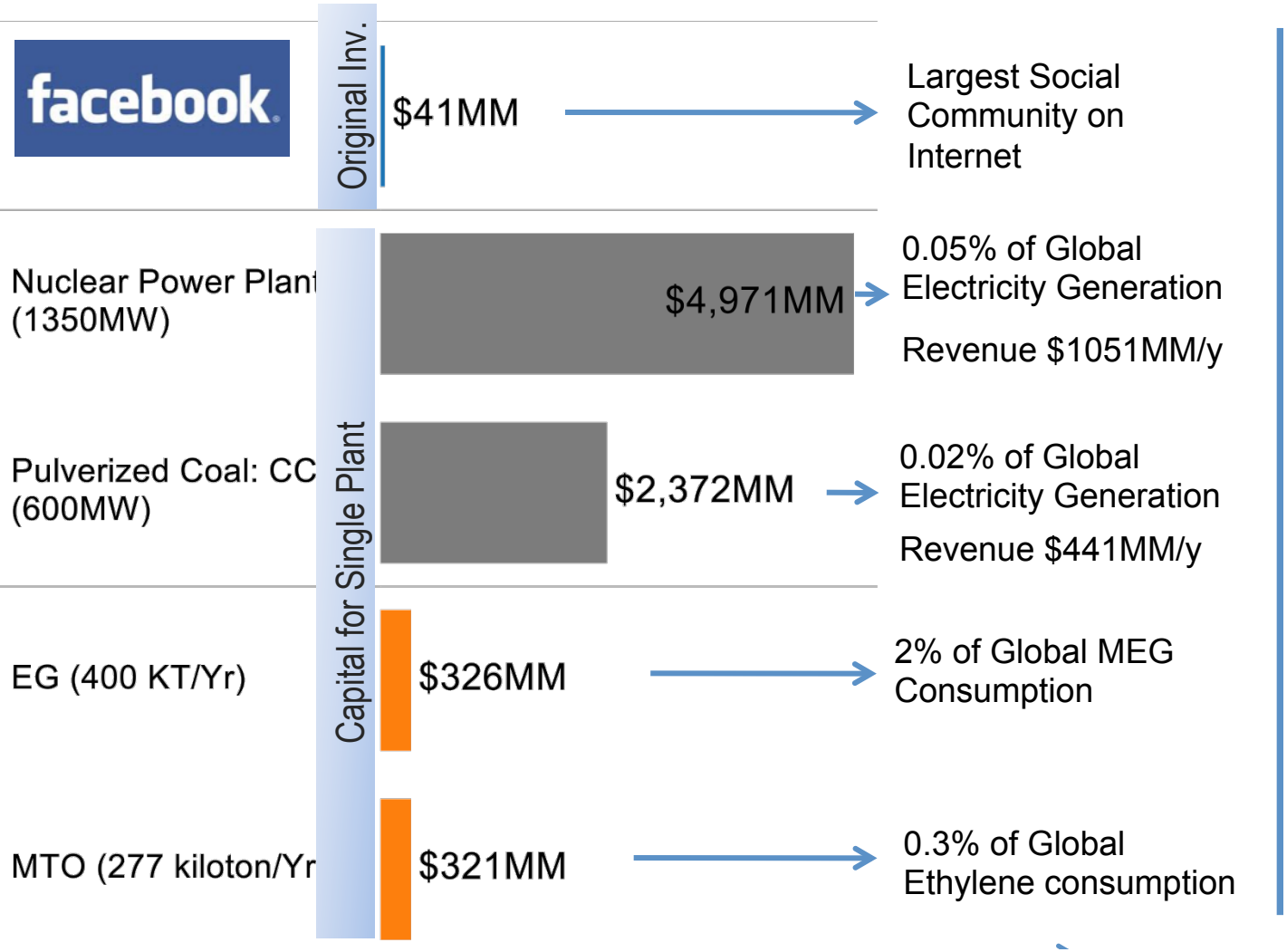
Single Customer CTQs – Use Extreme Caution

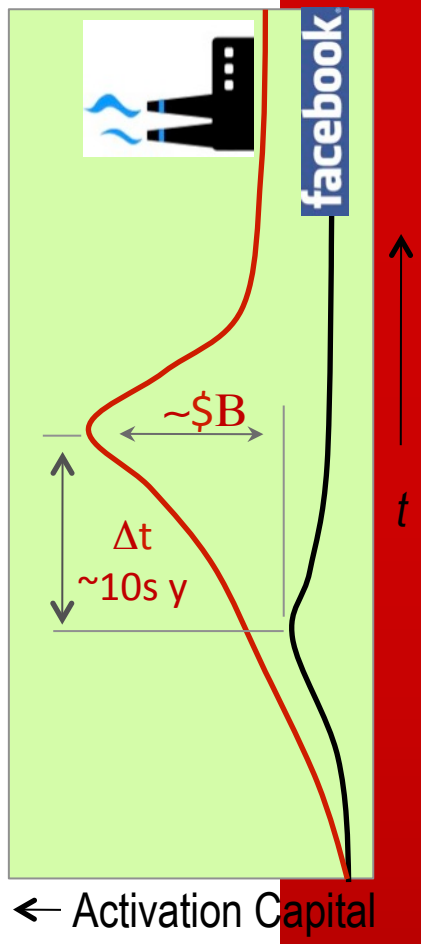
Venture Model in Chemicals?

Google

Where are the Facebook and Google of the Chemical Industry?

Scale of Fuels/Chemicals Makes it Harder

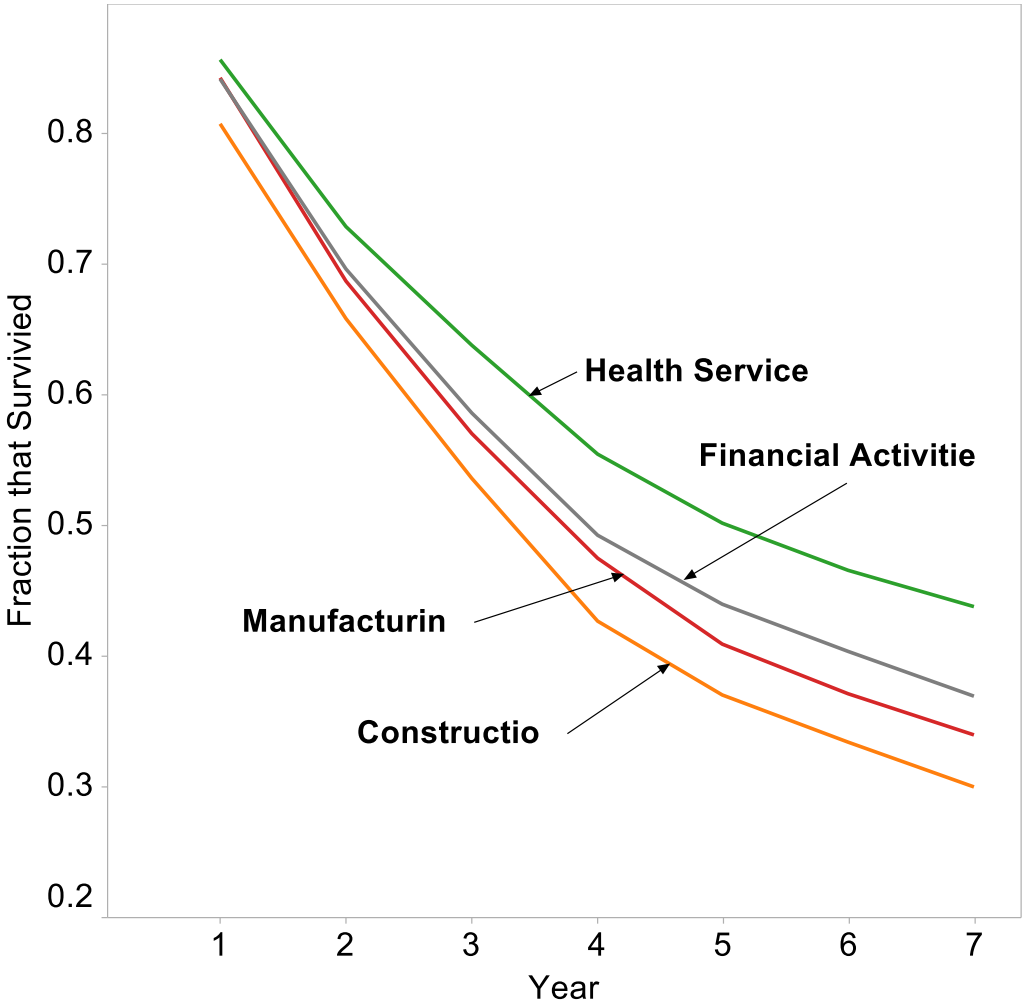




Sources: facebook original investment showing combined amounts from Peter Thiel (PayPal cofounder), Accel Partners and Greylock Partners as described in the History of facebook on wikipedia; Power Plants: RL34746 report - Stan Kaplan - Congressional Research Service; MTO: PEP Report 261 – SRI and EG: PEP Repor 2I – SRI; **Revenues** for Power Plants calculated using 2010 electricity average retail prices (all sectors) 9.88 cents/kWh (data from DOE)

The Challenge of a New Company

Fraction of companies that survived after launch



Energy & chemical industries require very high reliability

Energy & chemical industries are extremely capital intensive

Failure has massive financial and social consequences

Source: Knaup, Amy E., May 2005, "Survival and longevity in the Business Employment Dynamics data," *Monthly Labor Review*, pp. 50–56; Knaup, Amy E. and MC. Piazza, September 2007, Business Employment Dynamics Data: Survival and Longevity, Monthly Labor Review, pp 3-10.

Single Customer vs. Market Driven Programs

Single Customer	Market Driven
➢ Speed to market ➢ CTQs easily defined ➢ Easier to predict returns ➢ Customer credibility	➢ Broader reach ➢ **Potential stronger IP** ➢ Independent of customer disengagement ➢ Industry credibility
➢ Risk of customer disengagement ➢ **Potential weaker IP** ➢ Customer IP limits growth potential	➢ Potential slow adoption ➢ Complex CTQs

Thank You