

# Third Way Innovators to the Rescue!

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## Introduction

A keyword search of innovation delivers more than 200 articles in the archives of a research technology journal. Then, more detailed scrutiny reveals that innovation is now the subject of more than 800 scholarly articles a year (Hegedus<sup>1</sup>).

We know that innovation, in today's vernacular, may have already passed the buzz-word level, and is precipitously close to becoming cliché. It has become the darling of the latest crop of CEOs who realize they have no other place to go to achieve profitable growth after globalization and industry consolidation. Words that sound alike, but have different meanings are homophones. Innovation is not a homophone, but its many diluted uses give it homophonic tendencies. That's a shame because if the power of innovation is not supercharged in the chemical industry the state of our profession is in for tough times.

Innovation is the business process that leads to new products, processes and ideally, whole new businesses. It is all about growing sales and profitability. To those of us in the matter business, it matters because the material industry is in a virtual status quo as shown by the solid line in Figure 1 (Trainham<sup>2</sup>), which represents industry profit margin. This figure describes our industry's big picture and business drivers beginning in 1950s in relative terms. However, we must go back to the 1930s, to the beginning of our "field of dreams" age which lasted until the mid-1960s, when markets were created simply by producing new products from petroleum based-feedstocks (dashed curve in Figure 1). We know it now as the time of technology-push. From the 1950s into the 1980s, chemical engineers made breakthroughs in process technology, and then optimized the petroleum-based supply chains (dotted curve in Figure 1). As the 20<sup>th</sup> century began to close, the low cost of petroleum drove incremental improvement as globalization of conventional technology ensued.

Today, we are nearing the end of cheap petroleum and find ourselves mostly commoditized, and in dire need of real and many innovations to grow and prosper. Business and science types need to rewire themselves creating an interactive circuitry that inspires visions of new markets, new products and new businesses if we are to thrive. Lester Thurow<sup>3</sup> sums it up pretty well in the seventh of his 13 rules for building wealth: "Any society that values order above all else will not be creative, but without the right degree of order, creativity disappears as if into a black hole." As we chemical engineers know—the world can be described in terms of balancing mass, momentum, heat and charge. To truly innovate, corporate cultures must become adept at balancing order and creative chaos.

## After Commoditization

Of the three kinds of commercial research and development, two lead directly to commoditization. The first way is research conducted to lower the cost of products. It may be the introduction of lower-cost raw materials, or the discovery of new low-cost processes for manufacturing existing products. The second way is research that enables companies to reduce capital intensity—technologies that allow manufacturers to make more product in less time from existing assets. These R&D strategies are well defined and very attainable, which is why business leaders like them so much. They are tangible and usually provide quick payback.

Corporate leaders feel great pressures from the investment communities toward deliver-in-the-moment profitability which makes cost and process innovation a favorite. Cost cutting is a journey of diminishing returns. After a while, you begin to cut muscle. Then, the resource base becomes so diminished that the ability to innovate is lost. When the performance of two or more competing products has improved beyond what the market demands, customers can no longer base their choice on which is the higher performing product. The basis of product choice often evolves from functionality to reliability, then to convenience, and, ultimately, to price.

Someone, somewhere will always be willing to make a product or perform a process for less cost. Today, it is China.

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Tomorrow, it might be Vietnam. The day after tomorrow, it might be somewhere on the African continent. There are virtually no barriers to entry when competition is based on price. The cost and price reduction spiral has a ceiling—or rather a cellar that takes the mandate to grow in another direction.

## Globalization

The genius of process technology innovation will always be with us, and it should, although it cannot dominate as it has. As it takes products to the price cellars or commoditization, only geographic cures remain to assuage persistent profit pressures. Geographic cures? Yes. Moving closer to emerging markets, cheaper labor, raw materials, tax relief, or even talent pools are bottom line reasons why our world has shrunk. When the electronic circuit board industry migrated to Asia, PPG Industries formed a joint venture with Taiwan's Nan Ya PCB Corporation, creating PFG to make fiberglass in a plant they built in China, allowing better access to the market and less expensive labor. It directly feeds an adjacent printed circuit board facility. Similarly, DuPont followed the textile industry's movement to Asia by building new Licra® spandex plants in China for exactly the same reasons, remaining competitive by being near the market and affordable labor.

Singapore with its lack of resource scale, has developed a tax incentive and subsidy strategy to encourage foreign investment in R&D. Its intent is to add to its position as a trading center by also becoming an intellectual capital hub. Singapore's recruiting includes promises of first-class laboratories, equipment and project funding. The government has been successful in luring multinational pharmaceutical companies. For example, Novartis, the Swiss pharmaceutical with the Singapore government has created the Novartis Institute for Tropical Diseases, with a 10-year \$120 million budget.

Globalization is controversial, and proponents argue it allows poor countries and their citizens to develop economically and raise their standards of living, while opponents of globalization claim that the creation of an unfettered international free-market has benefited multinational corporations in the Western world at the expense of local enterprises, local cultures, and common people. Like it or not, there is a reality to globalization profit growth. However, it resembles its cousin commoditization. The reality is there are limits. Sooner or later growth via globalization runs out of economically secure places to go. Political instability in geographies such as Africa deter investment, additionally shrinking potential until secure resolutions evolve. Or, as the golfer nearing the 18th hole says: "We're running out of real estate."

So, if we are near pricing cellars and are in the process of creating territory famine, where do we go to feed the ravenous growth and profit appetite? With apologies to an earlier inspiration, the answer is written on the wind of pure innovation—the development of new products and processes and even whole new industries—the third way of conducting commercial R&D. Third-way innovation is the current favorite way of describing the hero strategy we chemical engineers need to employ. The development of entirely new products, processes and industries is where researchers should spend more of their time. Management should devote more resources and support to discovering technologies that will enable our companies to

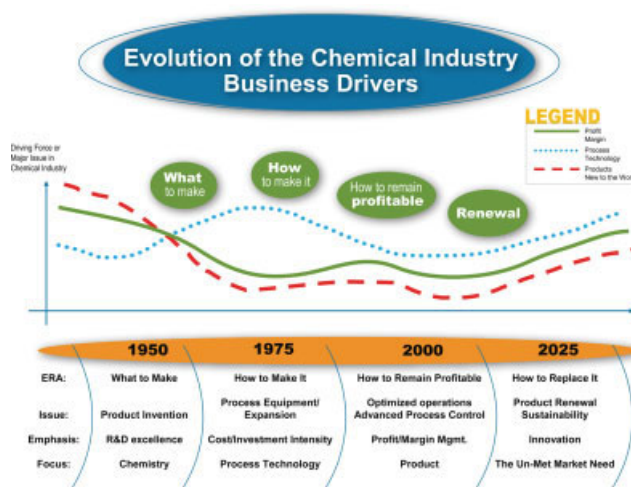


Figure 1. Evolution of the chemical industry.

enter new markets and deliver value in new ways. However, where might we find these opportunities for pure innovation? Not in the labs, at least not initially. They are in the marketplace where major global trends of significant duration are a result of many forces that cannot be manipulated in areas, such as demographics, environment, society and technology. The popular term is macrotrends, and we will use it henceforth. The opportunities are abundant, but we almost have to don a euphemistic set of translator lenses to see them.

## Opportunity Knocking

The best sources of growth opportunities are often right under our noses. Some are so big—macrotrends—we do not see them. The "you can't see the forest for the trees" cliché is apt here. Two redwoods in our euphemistic forest are nanoscience and replacing petroleum feedstocks. These macrotrends offer the biggest opportunities for the renewal of the chemical industry.

The science of the very small—nanoscience—whether it involves inorganic or organic molecules is driving change. Its implications to the chemical engineering community are very exciting. The frontiers of modern engineering are at the nanoscale. One challenge involves developing fundamental understanding, and quantitatively describing the phenomena at the nanoscale, and translating those effects to the macroscopic world. Chemical engineers today are turning to molecular and mesoscale modeling to understand the self-assembly processes at the nanoscale. In the future we can look forward to many new products including engineered catalysts, low-cost high-efficiency solar cells, photonic devices, biosensors, gene therapy, and low-cost routes to potable water, to name a few.

Our second redwood, replacing petroleum feedstocks, presents more opportunity. Causes notwithstanding, global climate change is aligning the general populace, and the corporate world behind efforts to create greenhouse gas-neutral solutions.

Two popular solutions are clean coal technologies and renewable feedstocks from biological sources. Clean coal

technologies provide a CO<sub>2</sub> stream that can either be sequestered (not our favorite), or reacted to methanol (Olah et al.<sup>4</sup>). A challenge will be to make this reaction system as efficient as possible, resulting in the lowest possible cost and investment intensity. Another is developing efficient air/CO<sub>2</sub> separation processes.

Biology-based feedstocks can be derived from current agricultural crops (corn, soybeans and sugar cane), bioengineered plants that would produce a biofeedstock not necessarily derived from ethanol processes, and biofeedstocks produced from synthetic biology (Service,<sup>5</sup> Cho,<sup>6</sup> Stephanopolous<sup>7</sup>).

Parenthetically, in the petroleum economy, much innovation energy has been spent reducing our environmental footprint. We did not get a whole lot of growth value from R&D aimed at meeting regulatory requirements.

An alternative to petroleum renews a cycle that begins with discovery, and will then demand a continuous flow of innovation, ingenuity and investment. That cycle may very well have begun with breakthroughs in biocatalysis that led to replaceable, repeatable, renewable energy, and chemical feedstocks from corn, sugar beets, soy, sunflower, canola, cellulose/lignin, and bioengineered plants.

That is cycle renewing. Peaking oil production in the near future, ending cheap oil and global warming will accelerate renewable energy and feedstock cycle renewal. Renewable energy and feedstock cycle renewal will speed past its petroleum predecessor that long languished with whale oils and coal until the modern oil age began in the mid 1800s, fed by a strong market demand for lighting and lubricants. Then the combustion engines rocked our worlds.

The holy grail of innovation hides in plain sight in the previous paragraph. It is: “fed by a strong market demand.” Innovation’s third way, from the market backwards to the innovators, begins when we all realize that Gordon Brunner’s adage “making things that people want to buy,” is as correct as it is succinct (Brunner<sup>8</sup>). The Procter & Gamble company’s retired chief technology officer G. Brunner, says: “Innovation is not about the number of patents or new technical developments. It is the ultimate product user who dictates whether you’re successful. Integrating consumers’ needs is the main task of a highly effective, innovating organization.” His get-it-done shorthand: “Marry what’s needed with what’s possible.”

No matter where your company feeds the value chain, third-way innovation must ultimately involve a consumer want or need realized. Third-way innovation is a change for many in the current generation of researchers. Innovation has often resulted from technology-push by R&D centers and universities, or as a result of single customer requests. These forms of innovation will always be with us, but all forms need to be evaluated in a market-back context, before substantial resources are committed. That means we have to go to the marketplace to find out what is needed so that we, who should know what’s possible, can begin the innovation process.

Booze Allen Hamilton cites an aggressive technique by International Game Technology (IGT). They send their engineers into the casinos to watch game players (Clark<sup>9</sup>). Procter & Gamble, again, sent designers and engineers out to observe people cleaning bathrooms and kitchens. It did not take long for the team to recognize something most of us have known for some time: wet mops tend to move dirt around, while dry

rag, thanks to electrostatic attraction, tend to pick it up. And, voilà! The Swiffer and its many product extensions were born.

These “inspiration safaris” are valid ways to begin to develop a market-back influence in research and development. Like many explorations consider hiring a guide—one of your marketing people—they can interpret, offer contributory views and buy lunch. Where should your inspiration safari begin? Your company does not make floor cleaners or slot machines, so casinos and kitchens might be out. Thinking that way is looking at the trees. The forest is your market. The redwoods in your opportunity forest are the macro trends in our world. Take a hike. Go into the forest and look up. Look around, feel the trees, smell them, touch them, and hear the wind. They are macro trends, and you need to realign your senses to understand them. When you do, your Swiffer is not far behind.

As chemical engineers, our tallest redwoods are in trends: renewable energy, food, potable water, human health, security and global warming. The opportunities to innovate in those critical areas are abundant. The methanol economy (Olah et al.<sup>4</sup>), solar energy, fuel cells and nanotechnology, are but a few of the innovation areas that are high on the planet’s opportunity and priority list.

The challenge is to understand how you can leverage your company’s strengths to develop products and processes that capitalize on the unmet market needs within the macro trends. Understanding these undercurrents in our global society puts you and your company in a position to participate in third-way growth.

As cost and process innovation produces less value, albeit faster and with less risk, the clarion sounds loudly for third-way innovation. Like any rally horn, it needs to be blown from high-ground to be more effective. Leadership hornblowers, policy makers and management must recognize the need for a corporate culture change, or relegate them and you to compost in the forest.

## Culture Clash

The commoditizers have diluted value. The globe is shrinking. Is your sky falling? Not if third-way innovation becomes your new way of sparking to new concepts, and you have resources and support from your leadership. Is that too much to ask? In some cultures, sadly, it might be.

Our brains are prewired with homeostasis, the natural movement of any organism toward equilibrium and away from change. Hence, change is pain. Another reason organizational change is difficult is that in the brain “error” signals (i.e., change) are neighbors to fear circuitry, and can hijack intelligence and push people to become emotional and act impulsively (Rock et al.<sup>10</sup>). According to these authors, “The implications of this new research are particularly relevant for organizational leaders. It is now clear that human behavior in the workplace does not work the way many executives think it does. Managers who understand the recent breakthroughs in cognitive science can lead and influence mindful change.” So leaders need to change. What about R&D people? Lindquist<sup>11</sup> states: “We have a tactical culture of invention and a tactical culture of mar-

keting, but not a strategic culture of innovation. We manage discrete functions instead of leading integrated systems.” Lindquist<sup>11</sup> describes a typical big company project review where most management expect and most staff know no better than to focus on the project-technology, staffing, resources, processes, etc. “Where is the value to the customer?” he asks. “Missing,” he answers, “right down to the basic conceptual understanding of value.”

Value creation through innovation provides the highest quality of profitable growth. Almost every product-based company can point to a star business that was created through innovation. Lindquist<sup>11</sup> attributes the narrow-mindedness of his exhibit to our training: “Engineering schools teach engineering, not finance, distribution or marketing. They graduate narrowly focused experts. Business schools teach business, not science. Each is taught that theirs is the true core expertise needed by the world. Neither is taught to respect each other.”

We are in dire need of changing our ways, but afraid to do it. It is going to take some very old-fashioned values, integrated in a new-fashioned world. Our business leaders need to muster the courage many of their entrepreneurial predecessors had. Long-term support of R&D needs to be treated as an investment rather than a cost. Leaders have to regain the ability to engender enthusiasm in the research communities. Lip service and platitudes will not do anymore. Real, meaningful, trusted leadership will inspire third-way innovators to achieve again. Egos need to be parked, and a touch of the parenting passions corporate leaders exhibit at home needs to be brought to the boardroom. They may not be around to directly benefit from many of the innovations they inspired that the next generation of their company will commercialize. However, they will be revered in the new culture as the agents of change whose courage enabled them.

In reality many of today’s leaders have grown up running existing businesses built by their predecessors. Their experience base is not founded on using innovation as the means to build profitable growth. It needs to be.

We, in the technology and science world, need to reignite our passion for discovery and innovation. We must open ourselves to new ways to absorb information and ideas. Go on a marketing safari. Widen the focus. Buy a marketer lunch. Seriously, the cudgel we need to pick up is as important as top-down inspiration. Our responsibility to third-way innovation is to reinvent ourselves. We must picture ourselves as science and engineering pioneers again. Our world is depending on us.

## Adjustments

Reinvent ourselves? Yes, if we are to remain relevant and contribute. Chemical engineers are surely in the wedding party when need marries possibility, but the terms of the courtship are in flux. Flowers and chocolate might not go as far as a hip instant message, today.

We need to broaden our skill set, adjust our attitude, demonstrate a willingness to adapt and empathize with the business side. Suits have hearts and families and hobbies and ambitions, too. Third-way innovation takes initiative and initiators. “Initiators are energized by the organization’s needs,

as well as by his or her own ego. Innovation is an act of an individual who has triumphed over the status quo. The triumph requires personal initiative. There are four common behaviors associated with taking initiative:

- Asking questions in order to identify problems and opportunities.
- Teachings oneself new skills.
- Taking action.
- Aligning strong personal beliefs with the organization’s values and goals.

At the same time, there are actions that leaders can take to encourage such personal initiative, including focusing more on the initiative act rather than the outcome” (Frohman<sup>12</sup>).

Innovations die in a gap termed the valley of death. Innovations need champions to steer a product or idea across the valley that separates discovery from commercialization. The stages a champion must take an innovation through to reality include:

- Define its commercial value and manifest it as a product.
- Communicate potential with a compelling business case.
- Get and use resources to establish potential and reduce risk.

If we are not the innovator’s champion we need to understand and support their zeal. The process of nurturing an innovation within a structure may be as unique to that entity as your fingerprints are to you.

Figure 2 describes a third-way innovation process. The focus is on the front-end of innovation to identify large business opportunities before feeding the output to a standard stage-gate process, which speeds development and commercialization. In describing this process, third-way innovation provides enough order and enough freedom to effectively encourage engineering ideation bounded by identifiable market needs. The concept definition and valuation steps require that enough resources are invested to test the viability of the new inventions from an engineering, market, and economic perspective. This process does not preclude technology push ideation. In Figure 2 a technology push-idea can be inserted

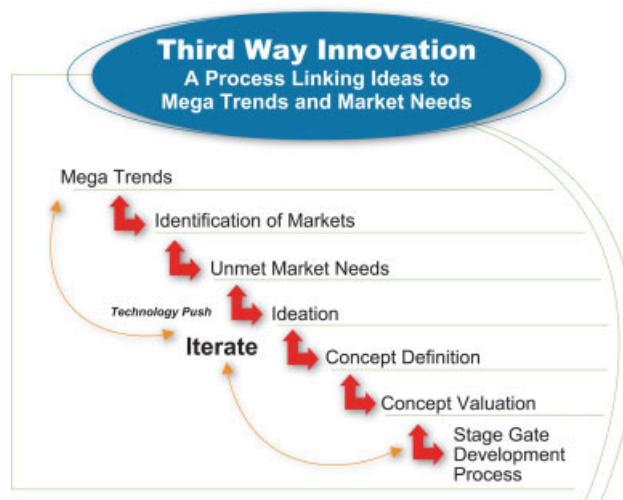


Figure 2. Third-way innovation.

into the process at the ideation stage, and recycled to market and unmet needs identify stages which will identify large business opportunities before major resources are assigned. So with an innovation process we honor Thurow, and provide just enough order for creativity to thrive. R & D innovators cannot work in isolation. Coalitions of support must be built. The innovation process itself brings functional capabilities together in an organized way. It commands cooperation and collaboration. Third-way innovators need balance and clarity. It is essential.

## Happy Endings

As location, location, location is to real estate, timing, timing, timing is to innovation. The time for emphasis on third-way innovation is now. However, we must balance the first and second ways of innovation. They are ever important to our sustenance. Joyce Wycoff,<sup>13</sup> co-founder of The Innovation Network invokes Yin/Yang as innovation element opposing and in balance. "Innovation is never 'either/or'; it's always 'both/and'. That's what makes it such a complex, wonderful and frustrating mix. It is never one thing. It is always an intermingling of black and white, in a way that yields not a dull grey, but rather an endless kaleidoscope of dramatic patterns." "Innovation," she says, "is both:

- Science and art
- Systems and tools and people and passions.
- Deliberate exploration and happy accidents.
- Crazy ideas and return on investment.
- Bold leadership and personal initiative.
- Collaboration and competition."

The collective brains and brawn of scientists, engineers and marketers have an imperative to adjust and innovate not only for profitable growth but self betterment, and the preservation of the planet.

Chemical engineers, if third-way innovation is the hero strategy, what size is your white hat?

## Literature Cited

1. Hegedus L. *AICHE/ACS Management Conference, Innovation: The Engine for Growth*. Cincinnati, OH; November 2–4, 2005.
2. Trainham JA. *The Matter of Matter, Matters*. Plenary Lecture Aspenworld. Orlando, FL; 2004.
3. Thurow LC. *Building Wealth the New Rules for Individuals, Companies, and Nations in a Knowledge-Based Economy*. 1st ed. New York, NY: HarperCollins; 1999.
4. Olah GA, Goeppert A, Surya Prakash GK. *Beyond Oil and Gas: The Methanol Economy*. Wiley-VCH; Mar. 2006.
5. Service RF. Jay Keasling profile: Re-Thinking mother nature's choices. *Science*. 2007;315:793.
6. Cho A. James dumesic profile: catalyzing the emergence of a practical biorefinery. *Science*. 2007;315:795.
7. Stephanopolous G. Challenges in engineering microbes for biofuel production. *Science*. 2007;315:801–804.
8. Brunner GF. The TAO of Innovation. *Res. Technol. Management*. Jan.-Feb., 2001:45–51.
9. Clark MA. *Mastering the Innovation Challenge: Unleashing Growth and Creating Competitive Advantage*. 2006. 11 Jan. 2006 <www.boozallen.com>.
10. Rock D, Schwartz J. The neuroscience of leadership. *Strategy and Business*. 2006:71–79.
11. Lundquist G. The missing ingredients in corporate innovation. *Res. Technol. Management*. Sept.-Oct., 2004:11–12.
12. Frohman AL. Personal Initiative Sparks Innovation. *Res. Technol. Management*. May-June, 1999:32–38.
13. Wycoff J. *The Innovation Network*. 11 Jan, 2007. <www.thinksmart.com>.

