



DFMA 2016

**31st International Forum on Design for Manufacture
and Assembly**

**DFMA &
Breakthrough Innovation Techniques**

June 7, 2016

GGI PO Box 350
GGI 1346 South Street
www.goldensegroupinc.com

Dedham, MA 02027
Needham, MA 02492

Phone 781-444-5400
Fax 781-444-5475

DFMA & Breakthrough Innovation Techniques

by
Bradford L. Goldense
President
Goldense Group, Inc.

Clayton Christensen introduced "Disruptive Innovation" to the business world in 2005. 2015 was the twentieth anniversary. In the years after Geoffrey Boothroyd, Peter Dewhurst, and others pioneered DFMA, the body of knowledge expanded as the refined logic for the needed specialty areas of both DFM and DFA was developed. It continues today, decades later. So too is this occurring for Disruptive Innovation. GGI conducted a secondary research project in 2015 to examine what has developed. We identified ten differentiable refinements of approaches to achieve Disruptive Innovation. They have really great names like: Big Bang, Trickle Up, Digical, Ambidextrous, Design Thinking, Sustainable, and Bottom Of The Pyramid. Each of the ten breakthrough "methods" will be discussed, along with an examination of the opportunities where DFMA can play a role. Several are tailor-made for DFMA and analogous techniques.

According to W. Chan Kim, the author of Blue Ocean Strategyⁱ, just 14% of new products are aimed at blue oceans. These 14%, however, produce 38% of global revenues and 61% of global profits.

Robert G. Cooper's researchⁱⁱ indicates much the same. Cooper finds that an allocation of 4% of projects and associated resources yields 22% of new product sales in their first year after launch. Another holy smokes. Why then have companies reduced their funding for breakthrough products by almost fifty percent?

Let us not debate the funding decisions of executives in this article, but rather let's focus on the science of breakthrough innovation. Clayton Christiansen introduced "Disruptive Innovation" to the world in 1995. Last year, 2015, marked its twentieth anniversary.

Over the past two decades, many companies and makers have targeted the creation of new-to-the-world products. This has resulted in a number of approaches that are all disruptive in their own way, but not as Christiansen originally intended.

GGI has been keeping track of these emergent breakthrough techniques. At this time, there are ten differentiable techniques that have evolved [Figure 1].



T109
ISBN13 978-1-937115-20-3

Copyright © 2016 Goldense Group Inc. All Rights Reserved.

DFMA & Breakthrough Innovation Techniques
BOOTHROYD-DEWHURST, INC. 31th International Forum on DFMA
Providence, Rhode Island
June 7, 2016

TEN BREAKTHROUGH INNOVATION TECHNIQUES

01. Disruptive Innovation

Christiansen's original work focuses on identifying the next generation technology that will disrupt the existing base of products and cause abandonment to move to the next generation technology.ⁱⁱⁱ He expresses these jumps using S-Curves. The essence of Christensen's breakthrough innovation is to be the first to market with the next generation technology in existing markets.

Figure 1

Disrupting, Radical, Breakthrough, & Disproportionately Innovative Innovation Techniques



02. Big Bang Disruption

Larry Downes and Paul Nunes approach suggests that markets can be disrupted by moving away from traditional innovation models that "seek innovation in lower cost, feature-poor technologies that meet the needs of underserved customer segments." They suggest that a "big-bang"^{iv} can be achieved by "seeking innovation through rapid-fire, low-cost experimentation on already popular platforms." If achieved, market adoption is immediate and meteoric.

03. Emerging Technology Innovation

Robert Phaal, et. al., maps out a structured "S-T-A-M" approach for taking an emerging technology that is still in its "science-dominated" stage and managing it through three successive stages: "technology-dominated" to "application-dominated" to "market-dominated".^v Digital imaging provides a good case in point. In the 1960s, digital imaging was the purview of focused space and military applications. Over the next four decades, innovators shepherded the technology to the mass-market cameras we all use today.

04. Digital Innovation

Darrel Rigby's approach centers on "digital-physical mashups. To consumers, the real and virtual worlds are one. The same should go for your company"^{vi}. On-line vs. retail shopping provides a good example. Today, one cannot physically stand in a retail store and purchase an item off the retailer's web site and then take the item off the store shelves and head home. We must wait for it to be shipped from the on-line store. Why not, the real and virtual worlds are one to consumers.

Michael Porter and James Heppelmann are espousing essentially the same approach, which they refer to as "The Smart Connected Company"^{vii}. Their approach expands beyond a single company and its own digital-physical mashups and looks at groups of companies in different industries and segments and how they will add digital capabilities to integrate into "The Internet of Things" as a "new technology stack"^{viii} evolves in the decades ahead.

For the purposes of this paper, noting that Porter and Heppelmann use the "The Smart Connected Company" to describe their work, GGI has included both approaches under the heading of "Digital" as they both involve the addition of digital capabilities to augment the feature sets of physical B2B or B2C product environments.

05. Reverse Trickle-Up Innovation

Vijay Govindarajan and Ravi Ramamurti espouse looking for solutions in poor and developing countries that work extremely economically, then adding selective capabilities to these solutions and moving them up market into more established economies. In the more established economies, these products would appeal to the poorer people living in the rich economy^{ix}.

06. Lead User Analysis

Eric von Hippel began exploring a technique in the 1970s that involved looking for users of products whose needs were five or more years ahead of the needs of the general mass market. He recognized that soliciting information from focus groups, which all competitors in a given market were equally proficient in assembling, resulted in competing products that were not generally dissimilar. von Hippel described "lead users"^x as those who "face needs that will be general in a market place - but face them



months or years before the bulk of that marketplace encounters them." As well, "lead users are positioned to benefit significantly by obtaining a solution to those needs."

07. Bottom-Of-Pyramid Innovation

C. K. Prahalad, recently deceased, espoused a radical approach to generate corporate wealth in the early 2000s. Rather than target affluent consumers in up market economies that everyone else targets, why not target the millions of people at the bottom of the economic pyramid whose needs are largely unserved. While price points and feature sets would be much reduced, total wealth generated would be comparable due to the large size of the unserved market. Prahalad and Erik Simanis had worked together this past decade. Simanis recently published more detailed information that discussed nine different ways to address bottom of the pyramid^{xi} markets.

08. Design Thinking

Tim Brown and many others since, espouse a thinking process that starts with a clean sheet of paper, before the direction has been set for a product. "Along with business and technology considerations, innovation should factor in human behavior, needs, and preferences. Human-centered design thinking—especially when it includes research based on direct observation—will capture unexpected insights and produce innovation that more precisely reflects what consumers want^{xii}."

09. Ambidextrous Innovation

Michael Tushman, et. al., writes that "firms thrive when senior teams embrace the tension between old and new and foster a state of constant creative conflict at the top." And, that "balancing the needs of core businesses and innovation efforts is a central leadership task^{xiii}." "When conflicts about funding old and new businesses are resolved at lower levels, innovation usually loses out."

10. Sustainable Innovation

Green design has been espoused by many folks over the past many years. Companies across industries encounter many different types of challenges ranging from the raw materials they incorporate at the beginning to how the customer ultimately disposes of the product at the end of its life. Many small breakthroughs are typically required to design from a clean sheet of paper, or redesign a product that is not green. The economic performance of sustainable products often gets into the revenue and profit zone of breakthrough products. In a sample of 12 S&P Global 100 companies, revenues from green products grew 91% while overall sales climbed just 15%^{xiv}.

BREAKTHROUGH INNOVATION TECHNIQUES IMPACT ON DFMA PRACTICES

Noting that companies currently allocate a relatively small portion of their R&D spending to high risk disruptive and breakthrough products^{xv}, that could change again as it did in the late 1990s.



T109
ISBN13 978-1-937115-20-3

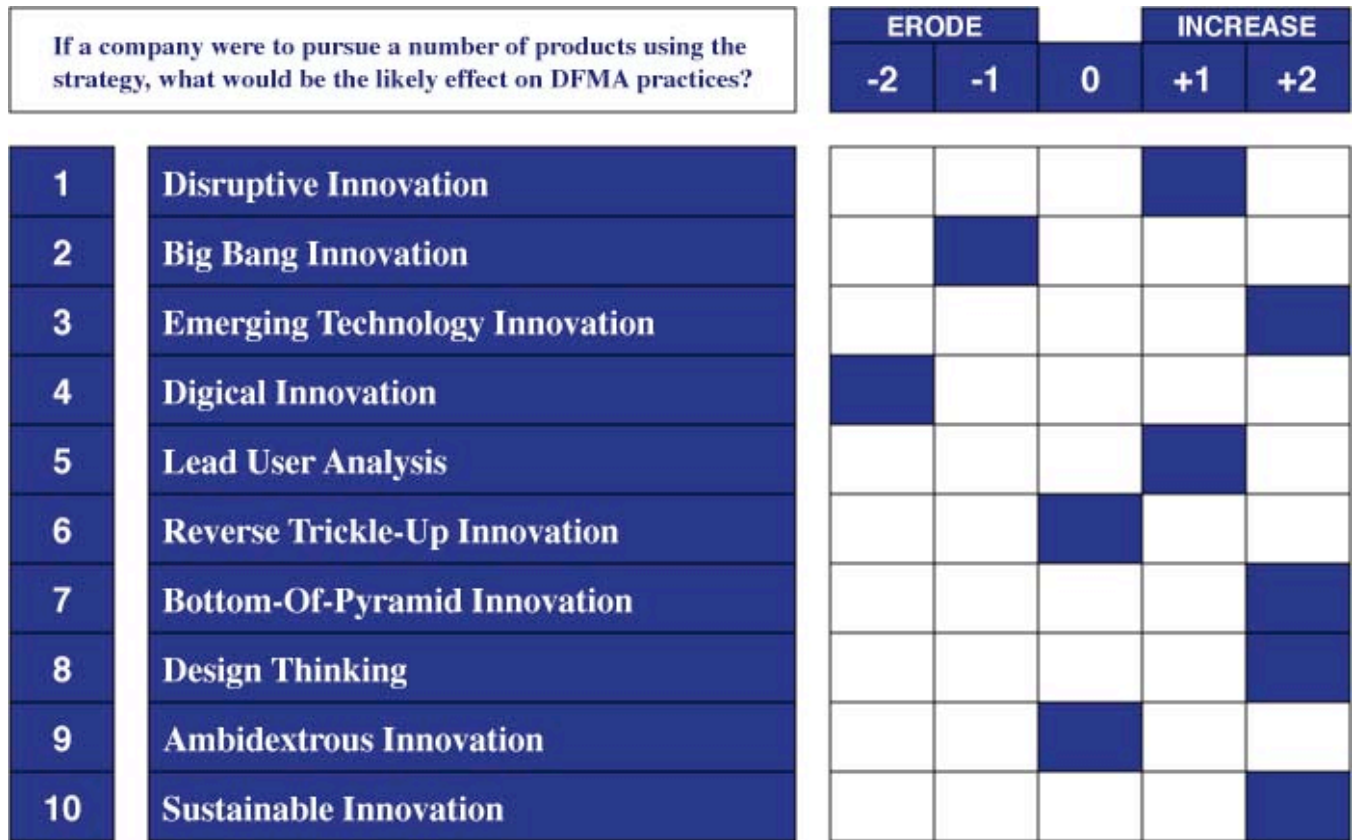
Copyright © 2016 Goldense Group Inc. All Rights Reserved.

DFMA & Breakthrough Innovation Techniques
BOOTHROYD-DEWHURST, INC. 31th International Forum on DFMA
Providence, Rhode Island
June 7, 2016

Should executives choose once again to increase the amount of high risk spending, the actual effects on DFMA practices would depend on the actual types of disruptive breakthrough products that companies chose to pursue [Figure 2].

Figure 2

Strength Of Probable Synergies Between DFMA & Breakthrough Innovation Techniques



In some cases, the importance of DFMA to product success would increase significantly. In other cases, especially if those breakthrough strategies that are software intensive, the importance of DFMA would decrease. Based on the analysis shown in Figure 2, an increase in the pursuit of breakthrough innovation is likely to have a neutral to positive effect on the need for strong DFMA practices.

SUMMARY

Yes, attempting breakthrough products definitely increases the risk in any company's product portfolio. Cooper's findings represent the state of practice after many years of decreasing the funds allocated to breakthrough "new-to" innovation. Companies currently allocate 4% of resources to breakthrough, a

relatively small risk, to gain an overall 22% increase in revenues^{xvi}. As long as companies don't take on more than they can manage, breakthrough innovation pays disproportionate returns. Except for "software-intensive" strategies, the importance of DFMA practices is likely to increase as the percentage of spending on breakthrough products increases.

A Note About The Author: Bradford L. Goldense NPDP, CMfgE, CPIM, CCP is president of GGI. Founded in 1986, the consulting-market research-education company is recognized across the major industrial continents for expertise in R&D, advanced and product development, innovation, and the metrics that drive corporate performance. Mr. Goldense has worked with 200 of the Fortune 1000 and over 500 global manufacturing locations. GGI is based in Needham, Massachusetts.

References

- ⁱ W. Chan Kim and Renee Mauborgne, "Blue Ocean Strategy," Harvard Business School Press, 2005, Copyright 2005 Harvard Business School Publishing Corporation. Page 7. Figure 1-1.
- ⁱⁱ Robert G. Cooper, "Where Are All the Breakthrough New Products?," *Research & Technology Management*, Industrial Research Institute, 1550 M Street NW, Washington, DC, September-October 2013, Pages 25-33; Figure 2 – Page 27. A sample current-state assessment showing an overabundance of tactical projects.
- ⁱⁱⁱ Clayton M. Christensen, "The Innovator's Dilemma: When New Technologies Cause Great Firms To Fail.," Harvard Business School Press, Copyright 1997 by the President and Fellows of Harvard College, Page 40.
- ^{iv} Downes, Larry and Nunes, Paul F., "Big Bang Disruption," Harvard Business Review, Harvard Business School Publishing, 60 Harvard Way, Boston, MA, 02163, USA, March 2013, Pages 44-56; Inset: Upending The Conventional Wisdom, Page 52.
- ^v Robert Phaal, Michele Routley, Nikoletta Athanassopoulou, and David Probert, "Charting Exploitation Strategies for Emerging Technology," *Research & Technology Management*, Industrial Research Institute, 1550 M Street NW, Washington, DC, March-April 2012, Pages 34-42; Figure 1 - Phases and transitions of industrial emergence (adapted from Phaal et al. 2011, 221)
- ^{vi} Darrell K. Rigby, "Digital-Physical Mashups: To consumers, the real and virtual worlds are one. The same should go for your company.," *Harvard Business Review*, Harvard Business School Publishing, 60 Harvard Way, Boston, MA, 02163, USA, September 2014, Page 91, Inset: Digital's Growing



Momentum.

vii Michael E. Porter and James E. Heppelmann, "How Smart, Connected Products Are Transforming Competition," *Harvard Business Review*, Harvard Business School Publishing, 60 Harvard Way, Boston, MA, 02163, USA, November 2014.

viii Michael E. Porter and James E. Heppelmann, "How Smart, Connected Products Are Transforming Companies," *Harvard Business Review*, Harvard Business School Publishing, 60 Harvard Way, Boston, MA, 02163, USA, October 2015.

ix Vijay Govindarajan and Ravi Ramamurti, "Reverse Innovation, Emerging Markets, and Global Strategy," *IEEE Engineering Management Review*, Vol. 42, No. 2, Second Quarter, June 2014, Page 84, Table 2 - Why Innovations May Trickle up From Poor to Rich Countries.

x Glen L. Urban and Eric von Hippel, "Lead User Analyses For The Development of New Industrial Products," White Paper, June 1986.

xi Erik Simanis and Duncan Duke, "The Profits At The Bottom Of The Pyramid: A Tool For Assessing Your Opportunities. The same should go for your company.," *Harvard Business Review*, Harvard Business School Publishing, 60 Harvard Way, Boston, MA, 02163, USA, October 2014, Page 92, Inset: Nine Kinds of Opportunities.

xii Tim Brown, "Design Thinking," Harvard Business School Publishing, 60 Harvard Way, Boston, MA, 02163, USA, June 2008, Page 84-95; Inset - Page 86.

xiii Michael L. Tushman, et al., "The Ambidextrous CEO," Harvard Business School Publishing, 60 Harvard Way, Boston, MA, 02163, USA, June 2011, Page 74-80; Insets - Page 76 Firms Thrive, Page 77 Idea In Brief, Page 78 When Conflicts.

xiv David McCann, "Sustainable Products Fatten Corporate Coffers," CFO Magazine, The Economist Group, 25 St. Jame's Street, London, SW1A 1HG, United Kingdom, Volume 31, Number 7, September 2015, Page 16.

xv Robert G. Cooper, "Where Are All the Breakthrough New Products?," *Research & Technology Management*, Industrial Research Institute, 1550 M Street NW, Washington, DC, September-October 2013, Pages 25-33.

xvi Robert G. Cooper, "Where Are All the Breakthrough New Products?," *Research & Technology Management*, Industrial Research Institute, 1550 M Street NW, Washington, DC, September-October 2013, Pages 25-33.



T109
ISBN13 978-1-937115-20-3

Copyright © 2016 Goldense Group Inc. All Rights Reserved.

DFMA & Breakthrough Innovation Techniques
BOOTHROYD-DEWHURST, INC. 31th International Forum on DFMA
Providence, Rhode Island
June 7, 2016