DFMA 2014

29th International Forum on Design for Manufacture and Assembly

Product Development & Innovation Practices Are Advancing

June 4, 2014

GGI PO Box 350 Dedham, MA 02027 Phone 781-444-5400
GGI 1346 South Street Needham, MA 02492 Fax 781-444-5475
www.goldensegroupinc.com

Product Development & Innovation Practices Are Advancing

by
Bradford L. Goldense
President
Goldense Group, Inc.

It has now been ten years since Business Week and Boston Consulting Group first ranked the most innovative global companies in 2004. After two decades of augmenting ways of doing business to include the practices of six sigma, lean, agile and flexible, corporations are now augmenting for innovation. There are clear changes in corporate focus on pre-product development activities. There is now a lasting increased emphasis on good old-fashioned organic internal innovation that appears to be settling in to become business-as-usual; even as industry product portfolios have become more conservative. In addition, a significant number of companies are adding focused infrastructure to acquire or otherwise transact innovation and/or IP through open external relationships. These activities have been going on for decades. The difference is the number of companies now doing them and the rate of growth. Supporting organization infrastructure is being built. Nascent service industries are emerging to meet growing industry demand, putting buyers and sellers together. Both infrastructure and nascent industries are strong indicators of strategies and practices that are likely here to stay.

This paper highlights the findings of recently published research. The findings result from the responses of a statistically valid sample of two-hundred cross-industry companies in North America; and are representative of overall industry practices. Thirty questions were posed.

The reader is encouraged to focus on large differences between responses that exceed the plus/minus of statistical ranges; and to focus on the absolute values shown by these data versus what experienced practitioners would consider or know to be traditional historical practices.

The focus of the research is on the R&D-Product Development Operating Environment, Organic Innovation, Open Innovation, and Intellectual Property; and CXO Corporate Metrics for these business activities. The research is aimed at culling-out the trends that might be fads and fade out, versus those activities that are destined to become general industry practices. For some subjects, there are five and ten year comparisons. For all, the research indicates a state of practice.

• • • • • • • • • • • • • • •

Note: The numbering of "Figures" and "Exhibits" in this paper is not sequential. The numbering scheme corresponds to the nomenclature used in the research questionnaire and the resultant summary of research findings. The original research questionnaire and research description may be found by going to "Research" and then the "2014" section on GGI's web site www.goldensegroupinc.com.

T100 **Product Development & Innovation Practices Are Advancing – Research Findings**
ISBN13 978-1-937115-10-4
BOOTHROYD-DEWHURST, INC. 29th International Forum on DFMA
Providence, Rhode Island
June 4, 2014

RESPONDENT PROFILE

All companies in this research identify define, and design products in North America. Development of the physical product is not necessarily in North America, but the decision making and direction for the product design and development emanates from the North American operations of the global group of companies participating.

To capture "North America," we assumed that R&D Spending was a better indicator for our research than GDP. The latest National Science Foundation 2014 figures are based on 2011 R&D Spending. To exactly hit the ideal mix of company participants to match the country ratios of R&D Spending would have risked our random sample approach. The result is that Canadian companies are slightly statistically overrepresented. That does not likely affect any findings.

Exhibit 1
North American Respondent Composition - Ideal vs. Actual

International comparisons of gross domestic expenditures on R&D and R&D share of gross domestic product, by region/country/economy: 2011 or most recent year

Region/country/economy	GERD (PPP $millions)	% GERD OF TOTAL	EXACT MIX BASED ON 200 RESPONSE	ACTUAL MIX OF 200 RESPONSE	DEVIATION FROM IDEAL
North America					
United States (2011)[a]	429,143.0	92.96%	185.92	181	- 4
Canada (2011)	24,289.3	5.26%	10.52	15	+ 4
Mexico (2011)	8,209.4	1.78%	3.56	4	----
	TOTAL = 461,641.7				

Source [Black Text On Light Green Inset]: National Science Board, 2014, Science and Engineering Indicators 2014, Arlington VA: National Science Foundation (NSB 14-01).
Source [Blue Text Within Light Green Inset]: Goldense Group, Inc. Response Comparison Versus North American NSF GERD.

Numerous industries are represented [Figure A4], and participant companies pretty evenly span all sizes of companies as measured by revenues [Figure A5].

The products developed by these companies cross the range of manufacturing environments: Continuous Process, Batch Process, Repetitive, Discrete, and Job Shop. The companies generally have global operations. Almost all do some R&D and some manufacturing in North America, Europe, and Asia. About half have operations in Rest Of The World geographies. Almost all sell their products across the industrialized geographies.

Respondents in this sample are overwhelmingly top managers from Headquarters, Strategic Business Units, and Business Units, and Plants who are involved with generating their company revenues and profits or losses. There are a handful of responses from a cost center only perspective. Because of the focus of this research, the findings are not likely affected.

ISBN13 978-1-937115-10-4

Figure A4
Industries Represented

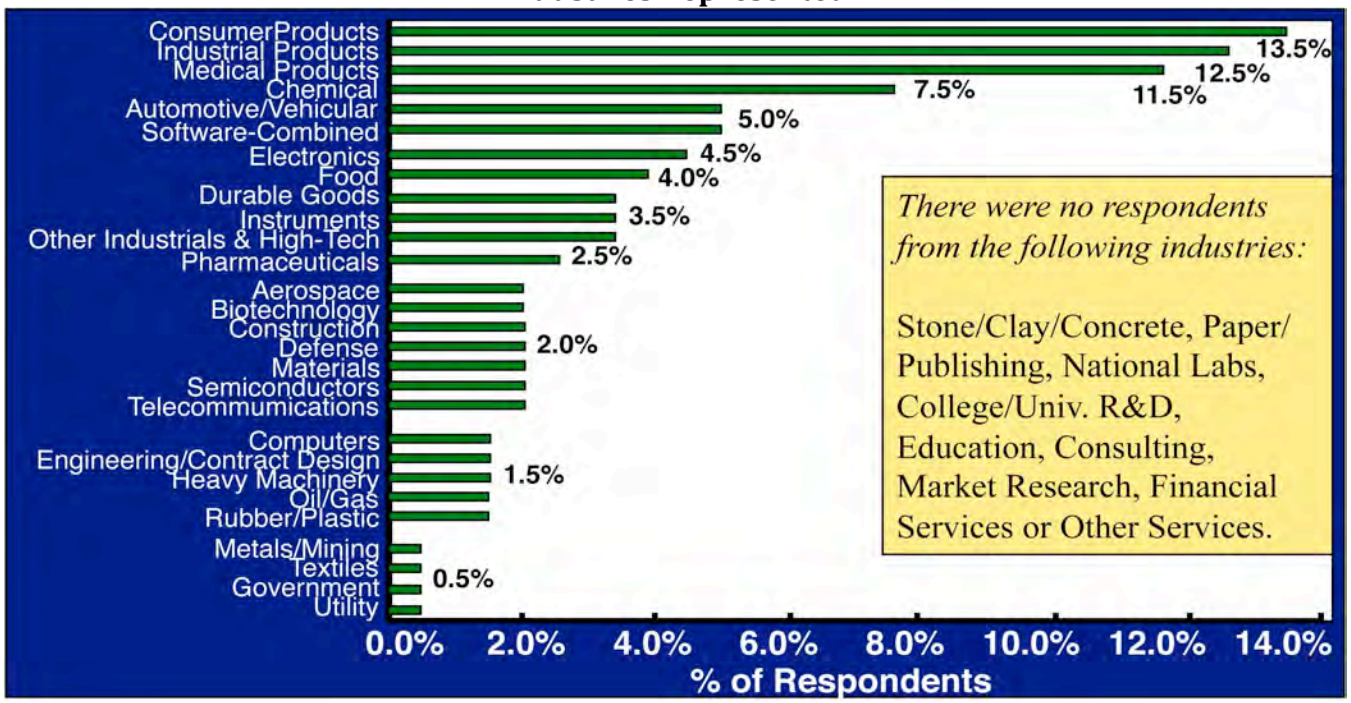
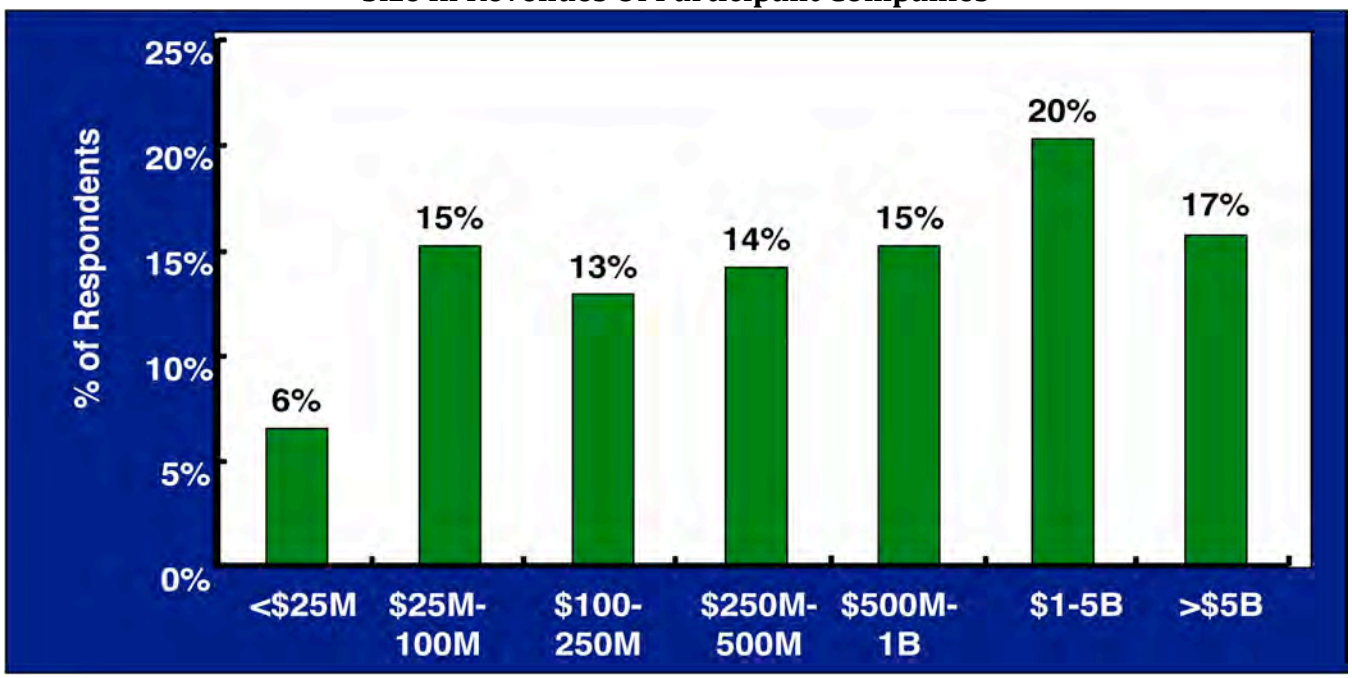


Figure A5
Size In Revenues Of Participant Companies



T100
ISBN13 978-1-937115-10-4

Almost all respondents are part of the management team, R&D, or engineering organizations at their companies [Figure A9a and A9b].

Figure A9a
Respondent Job Function

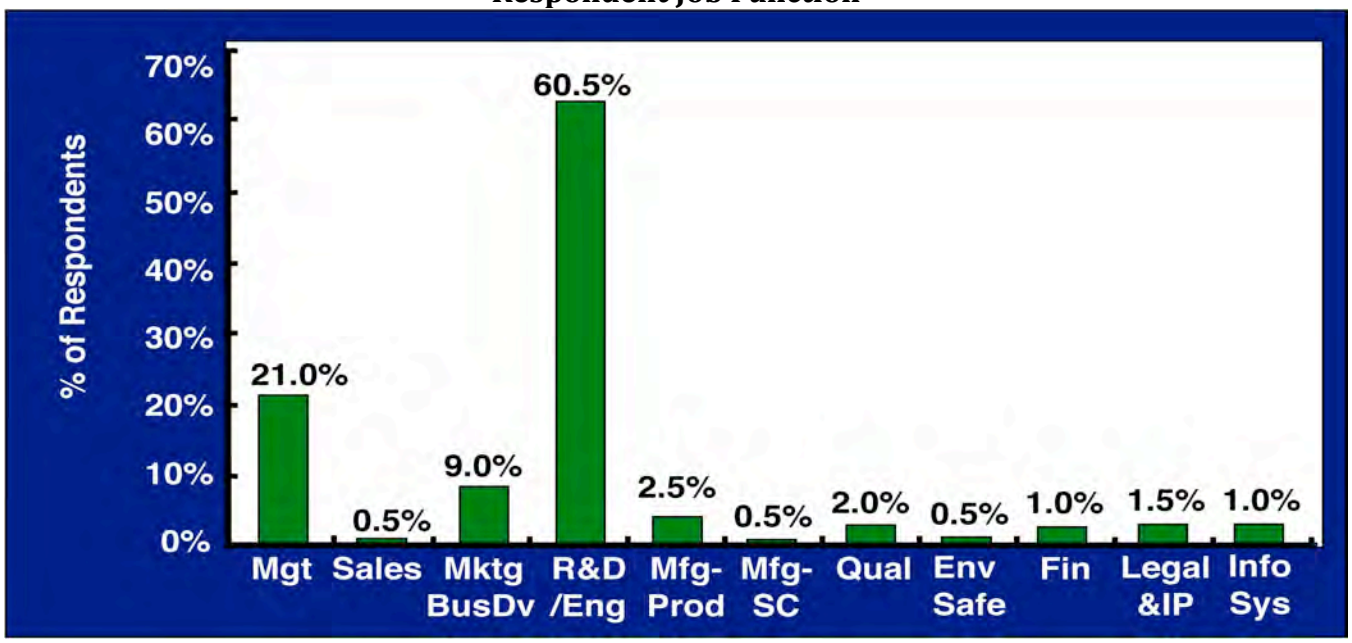
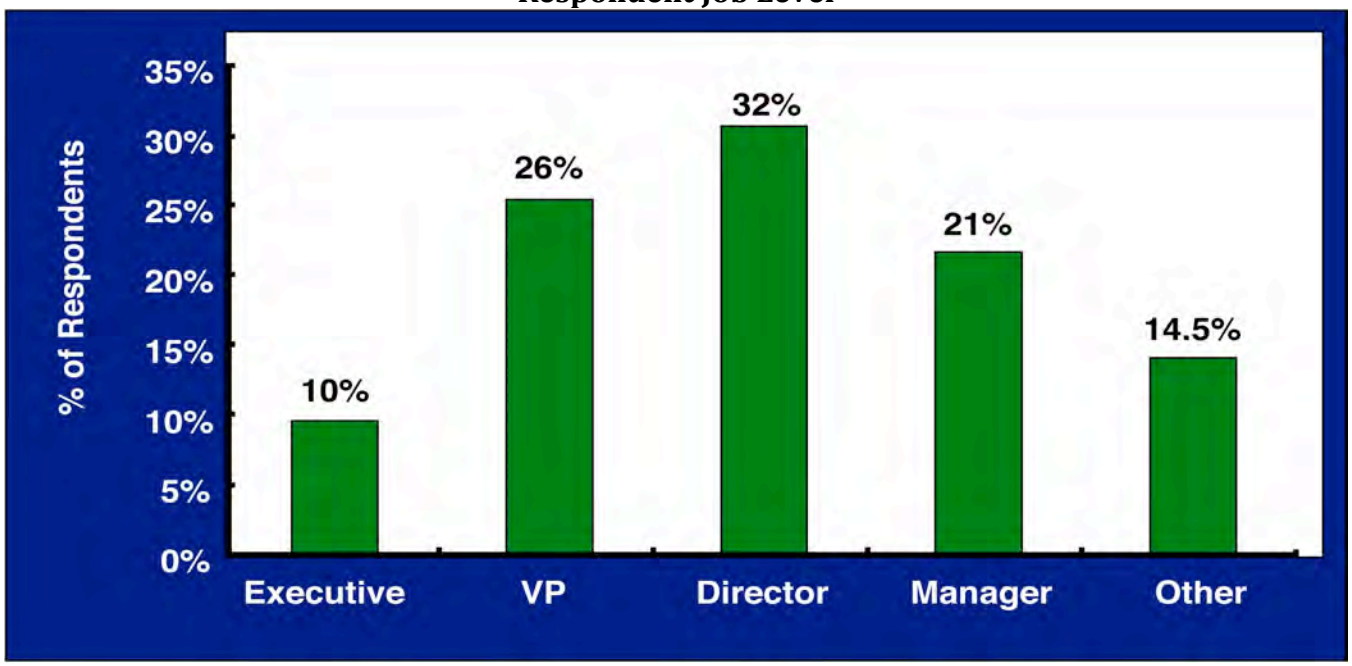


Figure A9b
Respondent Job Level



ISBN13 978-1-937115-10-4

R&D OPERATING ENVIRONMENT

R&D Operating Environment - Strategy

It is often challenging to ascertain exactly what the R&D strategy actually is. R&D executives always do their best to align an overall R&D plan to their company's strategic plan, and to nurture the nascent technologies that will be important to a long term product line. But, in the near and intermediate term, there are zillions of requests to do this and that project and many get approved. There is typically a lot of noise when one takes a snapshot of the working portfolio of products in the pipeline. Sales organizations are notorious for muxing-up a longer term development plan with very short term needs.

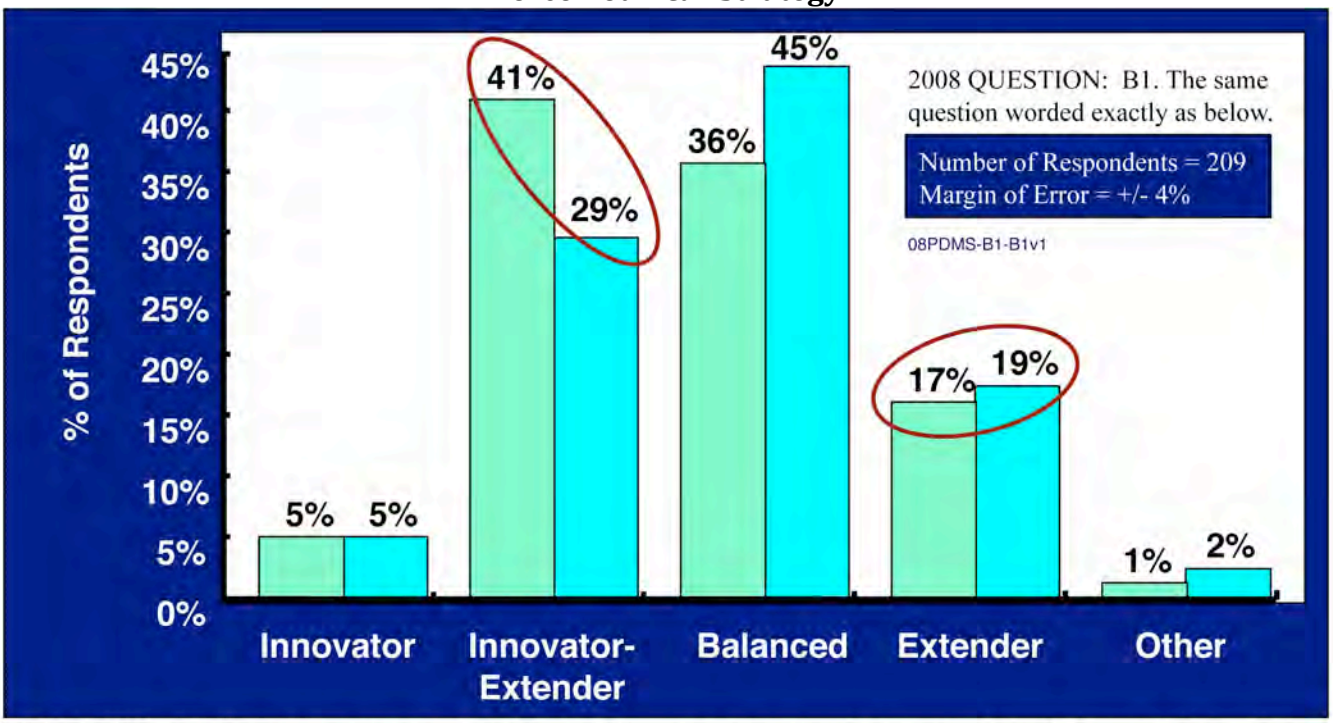
That said, rising above the noise level, there are about four major strategies that a company pursues. First is an "Innovator" strategy. It is the most risky of strategies because the majority of development money is spent on things that will be "new to." Failure rates are high, but the rewards can be great if you hit it just right. Just about every company wishes to innovate, but few companies actually pursue an innovator strategy. We researched the subject of R&D strategy in 2008 and now again five years later. In 2008, only 5% of companies classified themselves as following an innovator strategy. Our current research shows that number has stayed level these past five years, consistent with historical figures. With all the talk of innovation for the past decades, coupled with stronger global competitors and more total competition, it seems that few companies in North America have moved to a more risky Innovator strategy [Figure B1]. Pure Innovators are staying constant at five percent.

The second riskiest strategy, that has the attribute of having a longer time to realize an often much larger return, is "Innovator-Extender" aka "Platform-Derivative." In 2008, 41% of companies deemed themselves to be following a "Platform-Derivative" strategy. These companies create some type of "new to" product and then continue to "build it out over time." Our findings indicate that there has been more than a 29% decrease in the companies that pursue this strategy with the decrease going to either a "Balanced Portfolio" or an "Extender" strategy. Five years ago, 36% of companies were Balanced and they are now 45%. Extender was 17% and it is now 19%. The challenges of the great recession apparently caused the decline of Innovator-Extender just as it had risen since 1981 [IBM PC] to finally become the predominant R&D strategy in 2008. We corroborated our research with the research findings of colleagues. It is pretty clear that industry product portfolios are becoming more conservative for perhaps the past fifteen years, and certainly the past five.

The "Balanced Portfolio" has been the predominant R&D strategy for decades, except for a brief overtaking by Innovator-Extender at the end of its run in 2008 or thereabouts. Balanced is once again the predominant strategy, 45% of companies use it.

ISBN13 978-1-937115-10-4

Figure B1
Perceived R&D Strategy



QUESTION: B1. What is your company's fundamental approach to new product creation today? Please reply for what you currently do. Please do not reply as to what your company might do in the future or has done in the past, today's environment is the focus of this research. [Check One Box Only]

Number of Respondents = 198, Margin of Error = +/- 4%

13PDMS-B1-A2E

These data show also that the "Extender" strategy is growing. It seems that Innovator-Extenders may be looking to build-out or build-on or build-against first-to-market platforms with their own competing products. Don't invent the wheel, make the wheel better. Corroborating this finding, through separate business channels, we are seeing an increased level of discussion about how to "wait and see and then fast follow." There seems to be a growing industry pride in being a capable Extender. This strategy may be on a slow growth path.

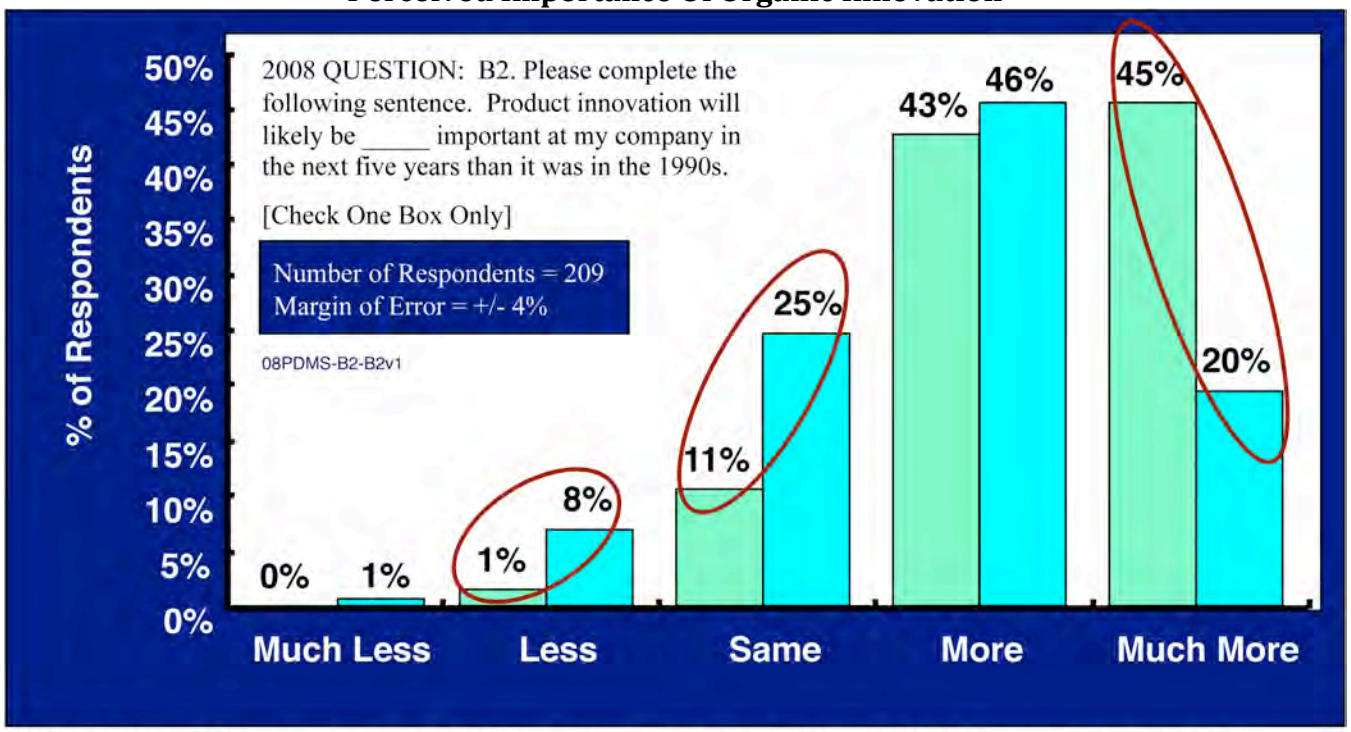
R&D Operating Environment - Organic Innovation

Organic Innovation is "the ability of a company to invent from within." Open Innovation is "the ability of a company to identify capabilities that exist outside the company that can create value within or for the company." It is perhaps the equivalent of make vs. buy for R&D, without quite the exactness of knowing exactly what will result. There has been a good deal of buzz about being open since the first books were penned in the early 2000s. While Proctor & Gamble has had success with being open, many that have tried it have not fared so well. To boot, and it is really hard to put facts and data to this statement, Wall Street analysts seem to appreciate the ability to invent from within greater than they appreciate the ability to acquire innovation externally. It

ISBN13 978-1-937115-10-4

makes sense. On the other hand, perhaps this view is just a matter of time. If corporations learn how to systematically acquire innovation, Wall Street may assign greater value to that. Buy is often much faster than make and results in quicker economic returns.

Figure B2
Perceived Importance Of Organic Innovation



QUESTION: B2. Please complete the following sentence. Since 2008, "Organic R&D" [innovation/invention from within the company] has become _____ important at my company. [Check One Box Only]

Number of Respondents = 199, Margin of Error = +/- 4%

13PDMS-B2-A2E

In comparison to 2008, these data show a moderation in the level of zest for Organic Innovation. In 2008, almost every respondent classified organic innovation as being either more or much more important than it had been in the previous five years, 90%. In 2013, this figure dropped to 66% which should not be dismissed as it is still two-thirds of industry saying more or much more. We believe this is an indicator dampened by the great recession while also being true as the decade-long run on innovation is becoming business-as-usual. One would expect a decline in zest. Research in the next section shows infrastructure being built, corroborating permanency [Figure B2].

R&D Operating Environment - Organization Philosophy

Folks with grey hair often scoff at the various management structure changes companies attempt and/or undergo over time, only to return to their former ways years later. A favorite subject in

ISBN13 978-1-937115-10-4

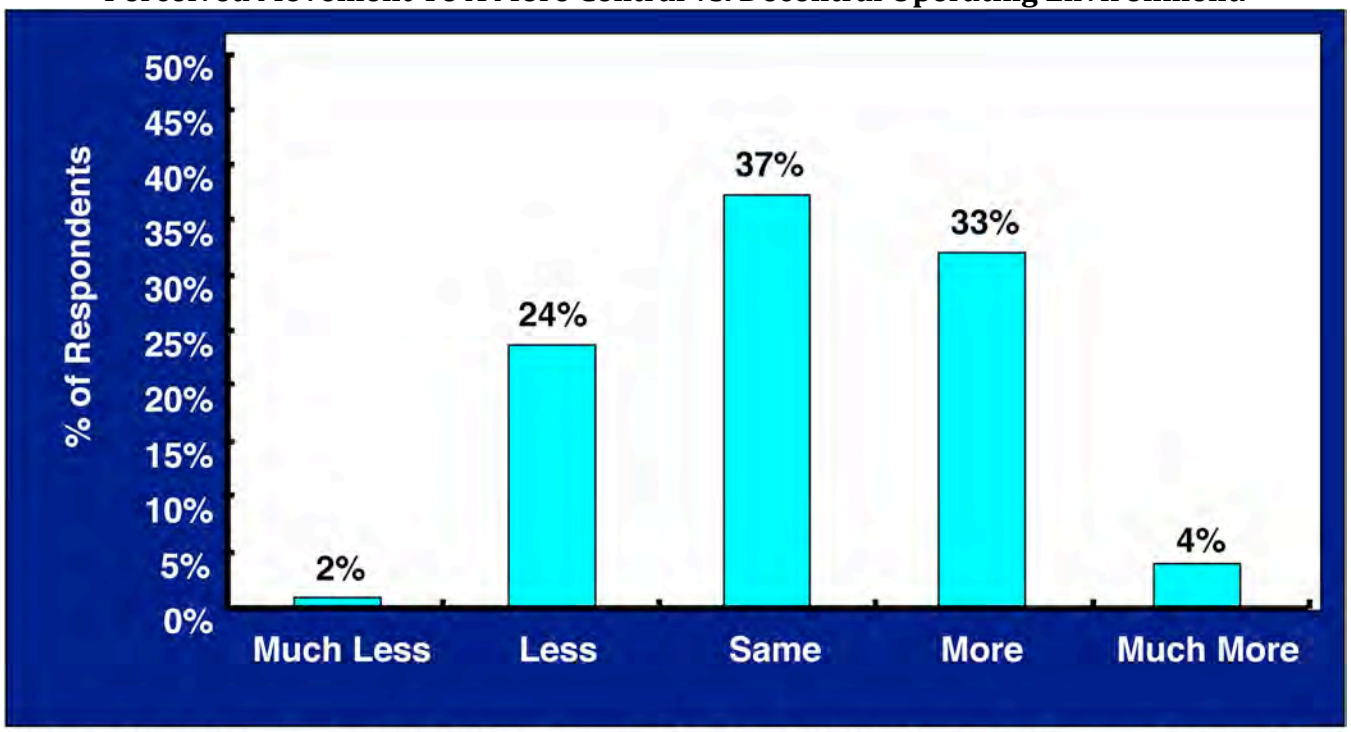
this domain is centralization vs. decentralization. This can manifest itself in the way a company makes decisions, the structure of its information systems, the number of physical locations it maintains, the geographic dispersion of a company, and a host of other operating parameters.

We examined the degree to which centralization might be occurring in R&D, product development, and engineering. We chose to research this because numerous studies have indicated that companies with tighter controls from the top mostly outperform companies that are more loosely organized. With the advent of more and stronger global competitors in the past ten years, we sought to learn if companies tightened their reigns to mitigate competitive forces.

These current data indicate that there is a slight change towards centralization. Given the infrequency of these events, we believe it to be a subtle but pronounced finding. [Figure B3].

What is clear is that the subject is in motion. Some 63% of respondents are moving one way or the other way.

Figure B3
Perceived Movement To A More Central vs. Decentral Operating Environment.



QUESTION: B3. Please complete the following sentence. Since 2008, "R&D and Product Development activities" have become _____ centralized. [Check One Box Only]

Number of Respondents = 199, Margin of Error = +/- 4%

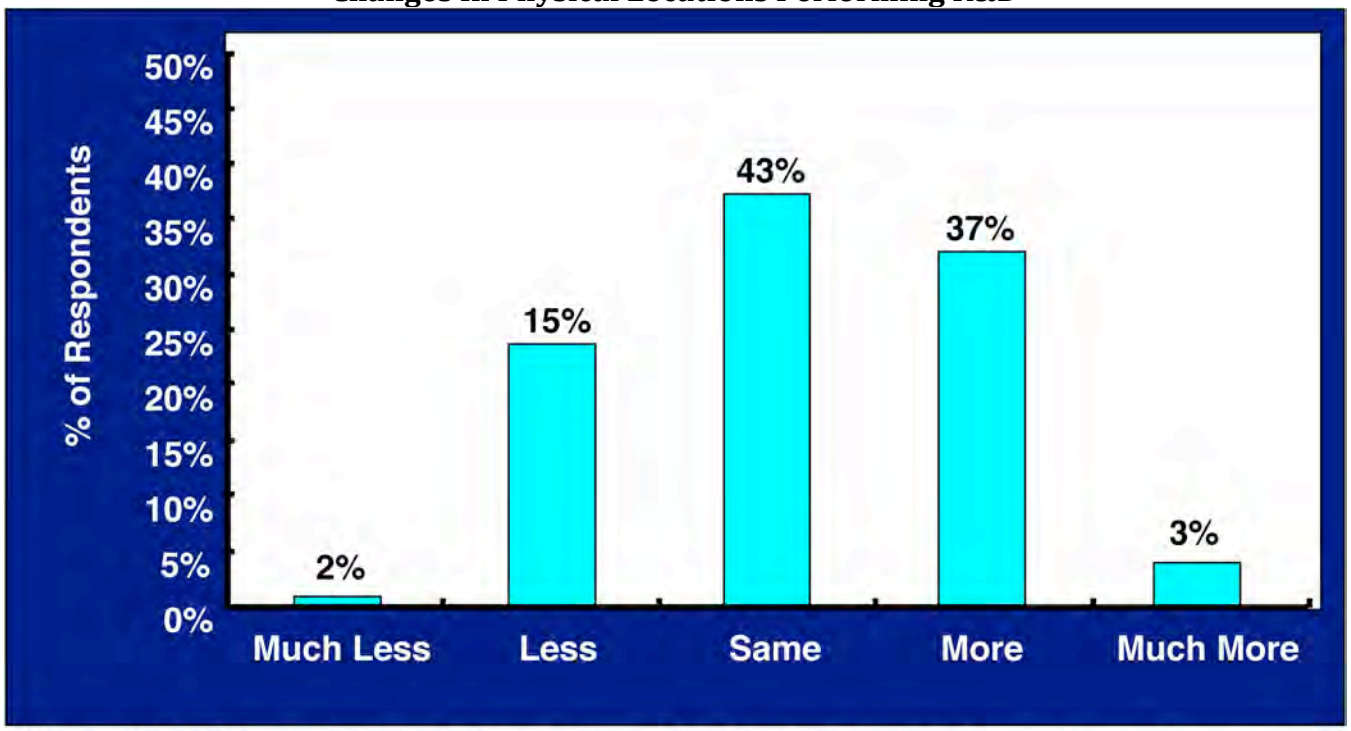
13PDMS-B3-A2E

ISBN13 978-1-937115-10-4

R&D Operating Environment - Number Of R&D Facilities

With more and more countries becoming significantly industrialized, we wanted to take a look at the dispersion of the R&D organization [Figure B4]. In the 1990s, companies looked to sell products around the globe. In the early 2000s, companies looked to manufacture products around the globe. Some companies were aggressive in their policies to also bring their R&D and Product Creation/Development capabilities to be global. On the other hand, many were hesitant to risk their IP to less than secure geographies and countries. But, most low-cost countries found ways to create disincentives for companies that only wanted to sell into their country and/or take advantage of low manufacturing rates. Companies that brought their R&D capabilities as well had a leg up on the companies that were more protective of their intellectual property, even if they had to give up some secrets in the process.

Figure B4
Changes In Physical Locations Performing R&D



QUESTION: B4. Please complete the following sentence. Since 2008, the "number of physical locations performing R&D and Product Development" are _____? [Check One Box Only]

Number of Respondents = 198, Margin of Error = +/- 4%

13PDMS-B4-A2E

At the same time, as one by one the conservative companies began to appease country officials by increasing their level of local R&D, the number of facilities performing R&D increased. This dispersion stressed the ability of many companies to innovate cohesive product lines and families.

ISBN13 978-1-937115-10-4

Several large consultancies observed this stress and researched how companies were mitigating its effects.

In 2009, Booz & Company published a report examining the various advantages and disadvantages of the global footprints of today's corporations.[1] This report caught the attention of many corporate leaders and gave them some reasons to reign in the number of R&D locations operated by their company.

What is clear is that every corporation is being asked by every country to bring their R&D into that country, to not just sell and manufacture. If you lead a corporation, the pressure to disperse R&D is immense. "No" is the hardest word in the English language to say, especially if you are without good data.

These current data indicate that dispersion is still occurring at a significant rate and pace. But, some 17% of companies are reducing the number of R&D locations they maintain. One company in the sample is significantly reducing their locations. They must have read the third party research on the effects of saying yes to every country that wants R&D to be local.

ORGANIC INNOVATION

Types Of Research & Development

For most of the 20th century, only the largest companies invested in research and pre-product development activities. Then, came the quest for innovation in the western world as it was searching to change the basis upon which it competed with low cost countries. Many firms have documented that corporations are moving some small part of their "D" budget to now be "R" and are increasing the number of R-related activities - even as product portfolios become less risky on average.

These current data show a number of companies across industries are now engaged in a significant amount of pre-product development activities that have remained statistically constant, with perhaps a slight decline, in the past five years. [Figure C1].

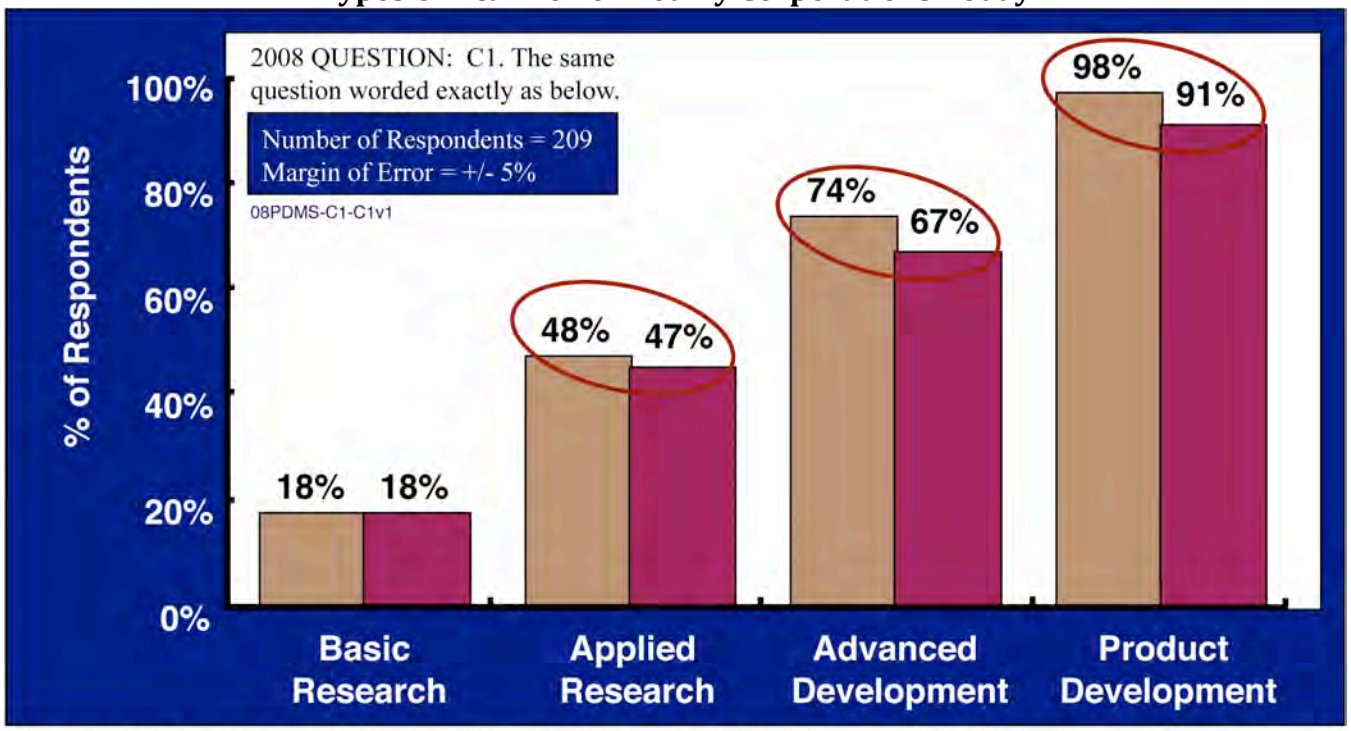
Please note that this is a cross-industry sample of 200 companies. Industry participants are summarized in the first section. Simple visual inspection of the findings indicates that today's corporate practices in Applied Research and Advanced Development are greater than historical cross-industry practices. One would expect 20% of a cross-industry sample to have Basic Research.

---

[1] Barry Jaruzelski and Kevin Dehoff, "Booz & Company 2008 Report: Beyond Borders -The Global Innovation 1000 Study Reveals A Global Shift In R&D Spending," Visions Magazine, PDMA – Product Development & Management Association, October 2009, Page 30, Exhibit 2: The Performance Payoff Of Global R&D.

ISBN13 978-1-937115-10-4

Figure C1
Types Of R&D Performed By Corporations Today



QUESTION: C1. Without disclosing any indications of emphasis or percentages of R&D investment and without regard as to whether the company accomplishes the type of R&D internally/organically or externally/open or both, please indicate the type(s) of R&D in which your company engages. [Check All That Apply]

Number of Respondents = 194, Margin of Error = +/- 6% 13PDMS-C1-A2E

Formalization Of Pre-Product Development Processes

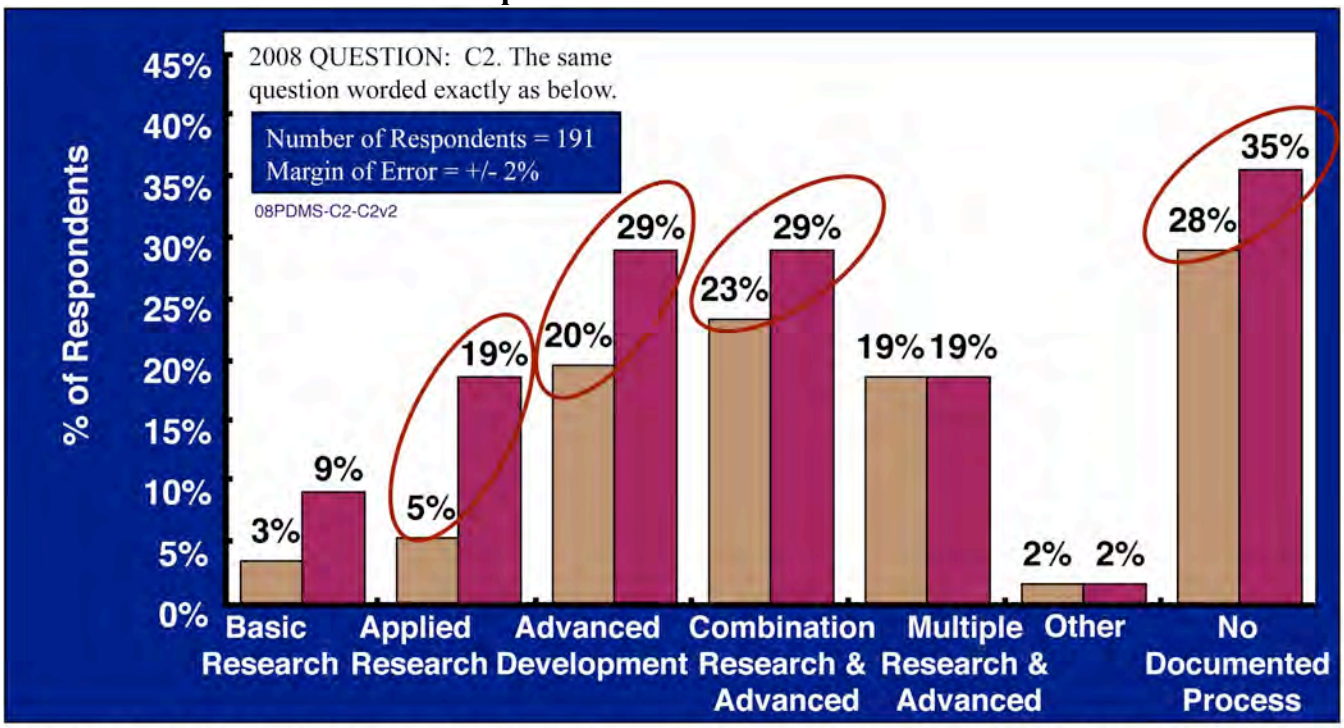
With more funding and increased activity in pre-product development activities, it should be expected that oversight and formalization will increase as companies shift to placing bigger bets on innovation - regardless of their stated R&D strategy or the dumbing of portfolios during the great recession. Even companies with Extender strategies need to innovate to out-compete their first-to-market competitors. Innovation can be a strategy unto itself, the Innovator company. It is also a component of all R&D strategies and risky bets have a place in every portfolio.

We examined this building of infrastructure in our 2008 research and have now looked again five years later. In 2008, about 28% of companies responded they had no documented process for pre-product development activities. In 2013, this figure increased to 35% [Figure C2]. For this particular finding, we believe it is due to our respondent mix. As well, many companies have put a "pre-product concept phase" on the front of their stage-gate for technology exploration and feasibility. Further research is needed to understand why this figure increased given the consistent findings of the remainder of this research question.

ISBN13 978-1-937115-10-4

For all four specifically-named process categories there was a significant increase. It is clear that industry is building infrastructure for pre-product development activities.

Figure C2
Pre-Product Development Documented Guidelines & Processes



QUESTION: C2. Excluding "Product Development Processes," please indicate the type(s) of R&D for which your company maintains a "documented process" or "documented guidelines." [Check All That Apply]

Number of Respondents = 196, Margin of Error = +/- 2% 13PDMS-C2-A2E

Between 2002 and 2008, the big change from the prior century was the growth in Advanced Development and the emergence of cross-industry Applied Research [Figure C1]. Infrastructure lags growth, so in 2008 Advanced Development and Applied Research remained largely informal. In 2013, many more are reporting that their research-related activities have now become more formal. We expect this trend to continue for some time, more so if a strong economy can be seen for a multiple-year stretch.

Formalization Of Product Development Processes

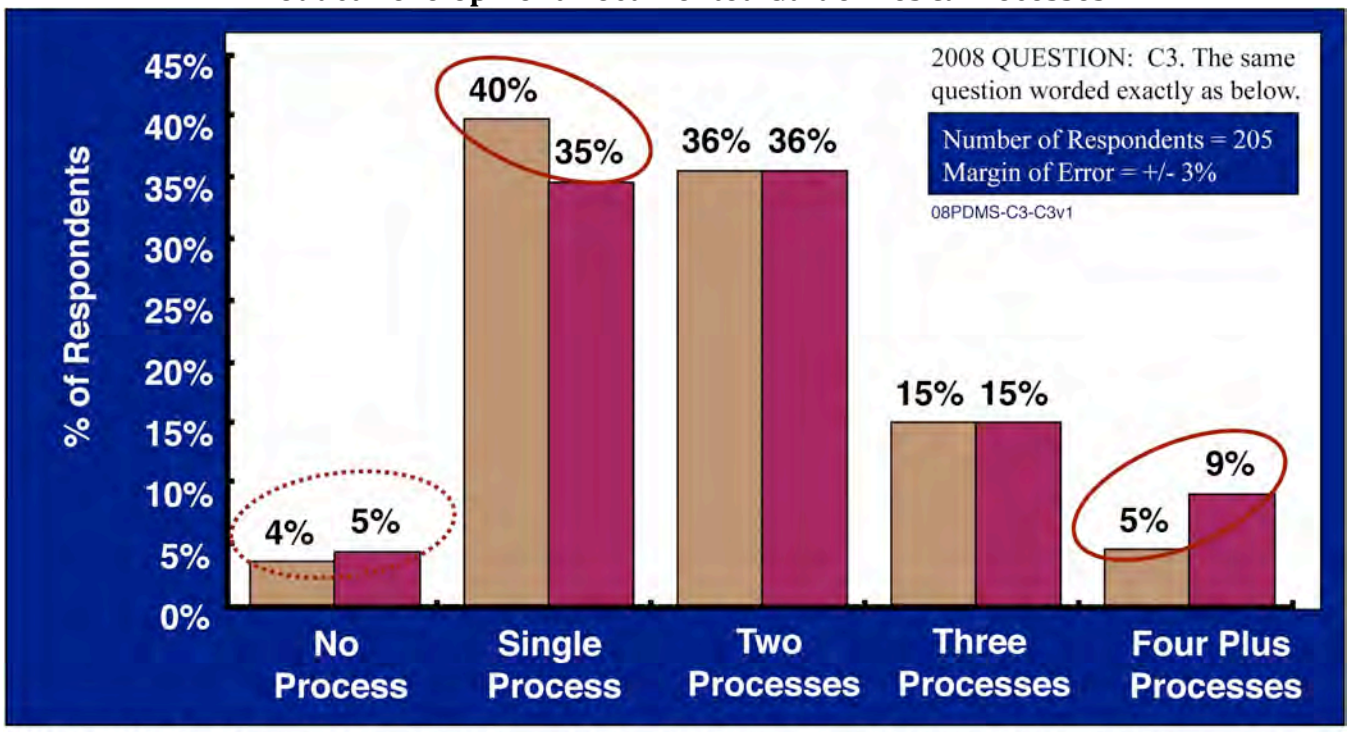
Since Robert Cooper wrote the first edition of his now infamous "Winning At New Products[2]" book in 1986, corporations all over the globe have been adding and building out processes for product

[2] Cooper, Robert G., *Winning At New Products: Accelerating The Process From Idea To Launch*, Addison-Wesley Publishing Co., Reading, MA, USA, First Edition, Copyright © 1986, 358 pages.

ISBN13 978-1-937115-10-4

development. We have researched this subject several times since the late 1990s and the refinement of processware continues. In 2013, there appears to have been a cadence. For the 95% of companies that have product development processes, some 5% of companies appear to have added another process in the past five years. Almost ten percent of industry now reports having four or more product development processes [Figure C3].

Figure C3
Product Development Documented Guidelines & Processes



QUESTION: C3. Not considering "Basic Research," "Applied Research," or "Advanced Development" in your reply, please indicate the number of documented processes or variants of an overall documented process that your company utilizes for "Product Development." [Check One Box Only]

Number of Respondents = 197, Margin of Error = +/- 4%

13PDMS-C3-A2E

OPEN INNOVATION

The Importance Of OI

Henry Chesbrough[3] is often credited with coining the term and beginning the body of knowledge on the subject of Open Innovation [OI]. Open Innovation is "the process a company undergoes to

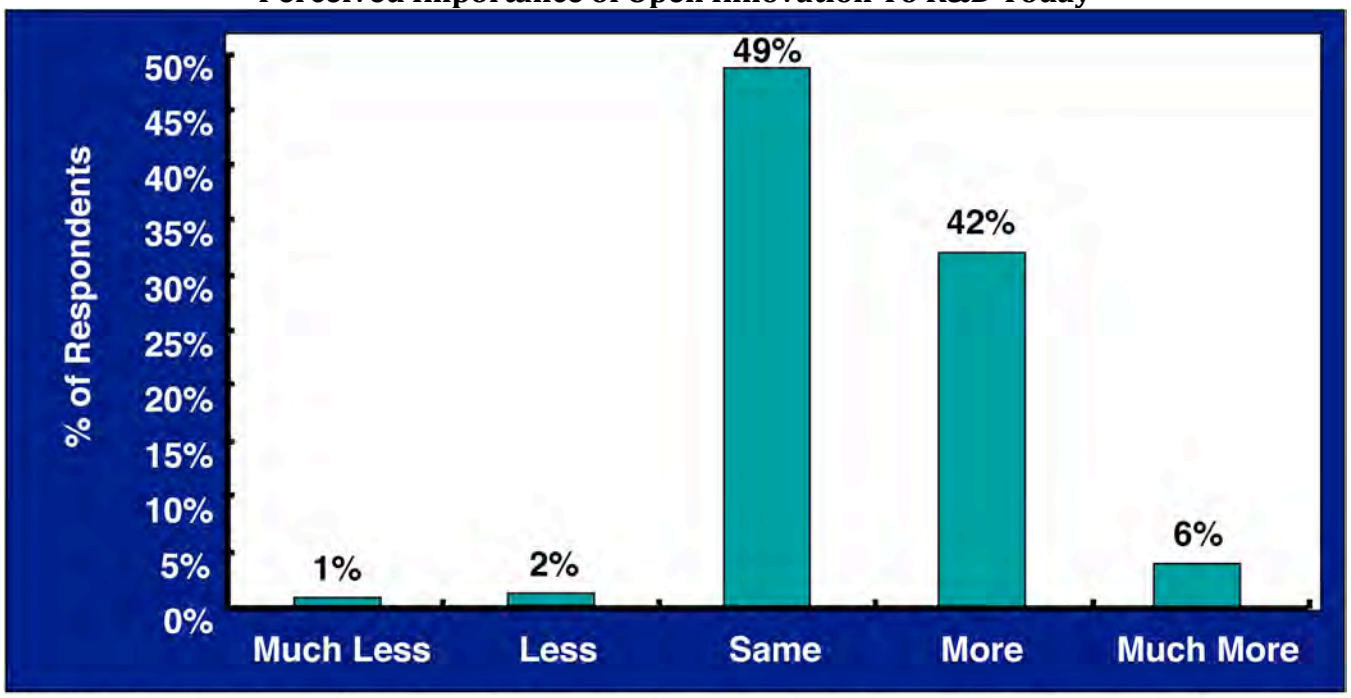
[3] Chesbrough, Henry, *Open Business Models: How To Thrive In The New Innovation Landscape,* Harvard Business School Press, Boston, MA, USA, Copyright © 2006, 256 pages.

ISBN13 978-1-937115-10-4

buy, barter, joint venture, ally, or otherwise acquire innovation and/or enabling capabilities from third parties and bring it to bear on the product offerings of their company."

Proctor & Gamble[4] seems to have had the most success at OI techniques over the years. Perhaps they have chosen to publish their good news more than others. Word on the street is quite mixed about OI[5], but in this global world OI is here to stay [Figure D1].

Figure D1
Perceived Importance of Open Innovation To R&D Today



QUESTION: D1. The term "Open Innovation," acquiring or collaborating on innovations and inventions with external organizations, has now been in the nomenclature of corporations for a number of years. Please indicate the degree to which your company utilizes Open Innovation techniques compared to what it did in 2008. [Check One Box Only]

Number of Respondents = 197, Margin of Error = +/- 4%

13PDMS-D1-A2E

Our current research is our initial foray into the subjects of Open Innovation. We find that about half of respondent companies say there has been no change in their emphasis over the past five years. We cannot determine from these data if there was a big push by these companies on OI in the early 2000s and therefore is a constant today, or if these firms never really got on the bandwagon. We believe that the 3% of companies, that indicated the importance of OI today is

[4] Bruce Brown and Scott D. Anthony, "How P&G Tripled Its Innovation Success Rate: Inside the company's new growth factory," Harvard Business Review, Harvard Business School Publishing, 60 Harvard Way, Boston, MA, 02163, USA, June 2011.

[5] David Matheson Ph.D., "Assessing The State Of Innovation: The Top Four "Must-Do" Areas of Innovation Practice," White Paper [Drawn From Frost & Sullivan Conference In Anaheim, CA In June 2010], SmartOrg Inc., 55 Oak Grove, Suite 202, Menlo Park, CA, 94025, USA, November 2011.

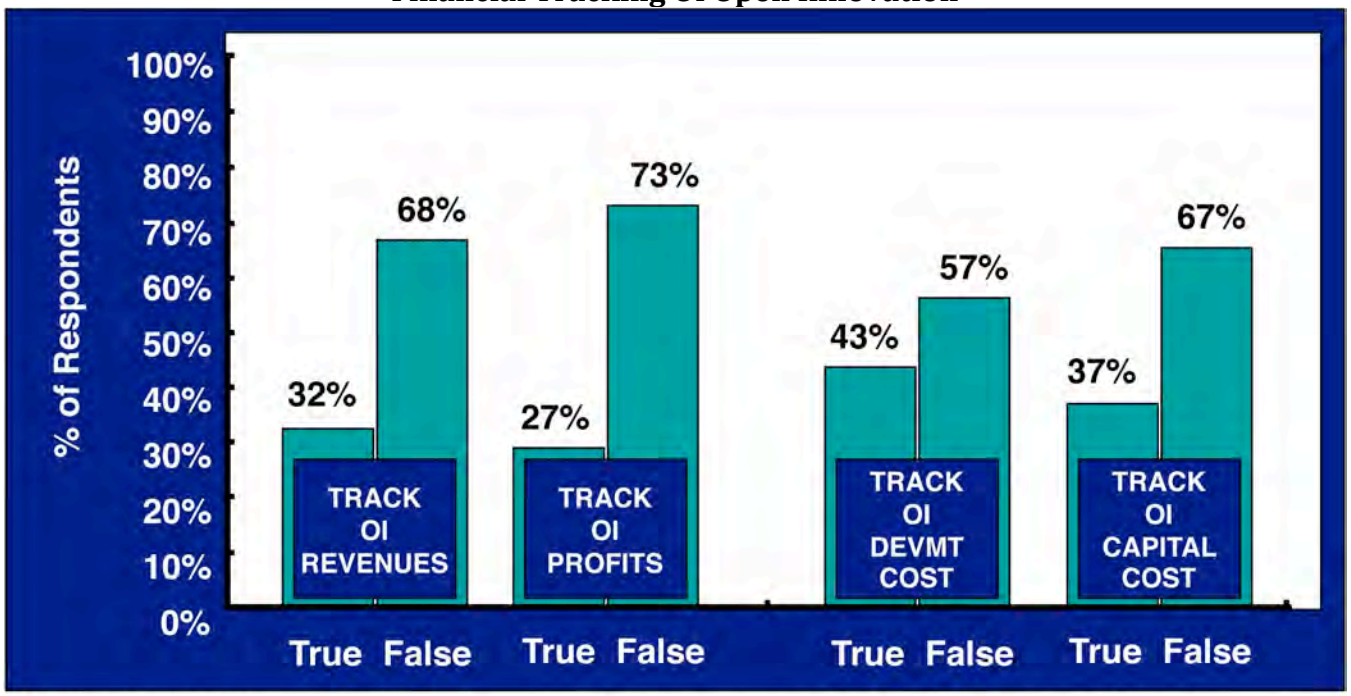
ISBN13 978-1-937115-10-4

less or much less for them, did try it and were not satisfied with the results. We believe that the 48% or so, that said it was more or much more important today than five years ago, are either late to the table or have had sufficient success and are moving forward with even more zest. What can be concluded is that about half of industry is pushing forward on OI.

Returns From OI Activities

Not surprisingly, as infrastructure and systems for new initiatives lag the initiative itself, only a quarter to a third of companies have the tools in place to track the financial investments and results from OI [Figure D2]. We had anticipated the lack of OI infrastructure when we developed our research approach. We did expect the tracking of costs to be more pervasive than the tracking of revenues and especially profits, and that was the case [Figure D2].

Figure D2
Financial Tracking Of Open Innovation



QUESTION: D2. My company separately tracks, or breaks out as an analysis, the financial results of Open Innovation initiatives. [True or False]

Number of Respondents = 193, Margin of Error = +/- 7%

13PDMS-D2-A2E

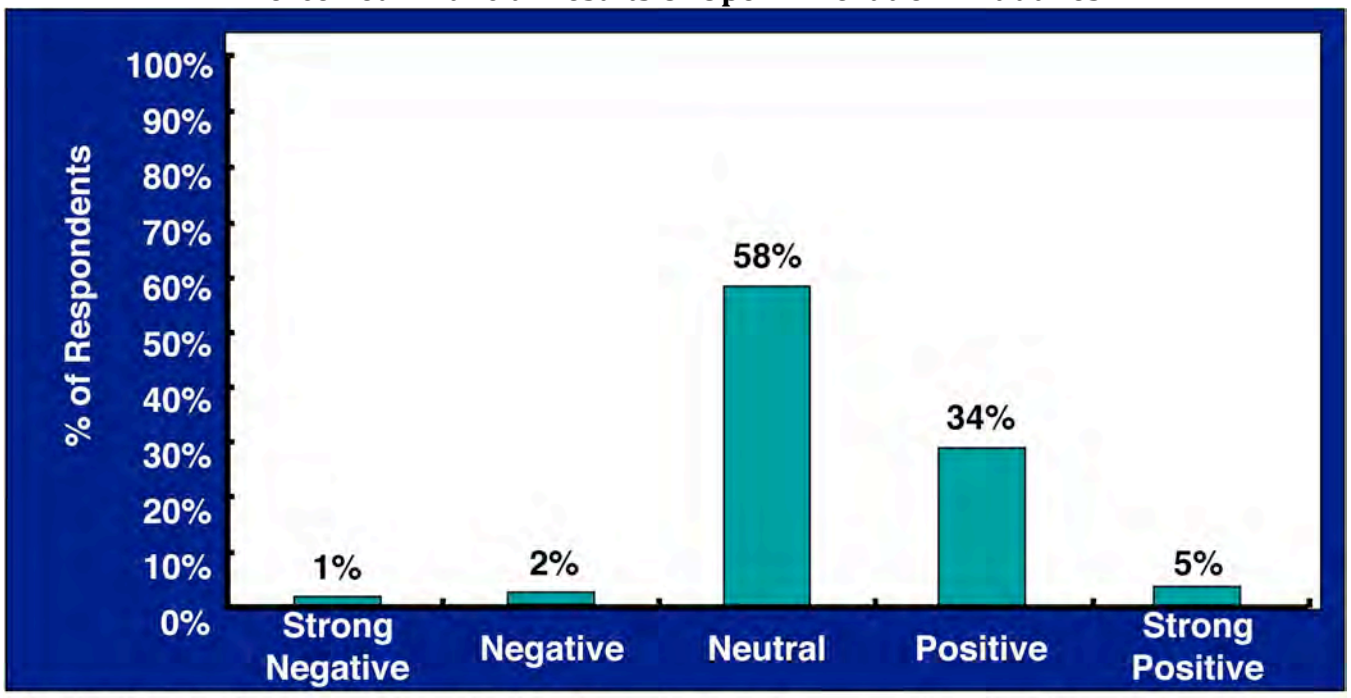
Cost tracking, even capital cost tracking, exceeded revenue and profit tracking by five to ten percent, fifteen-to thirty percent for those respondents that do tracking of any type. Financial controller capabilities are better suited to cost tracking. Revenue and profit tracking does not have a clear corporate home.

ISBN13 978-1-937115-10-4

Knowing that limited financial tracking abilities were still a reality as we were composing the research, we asked about the gut feel that respondents had about the financial performance of the OI initiatives in which their companies were engaged. Sarbanes-Oxley regulations also now influence how questions of this nature are asked by researchers.

Three percent of respondents indicated their experience was negative financially, and 58% said it was at least neutral. Encouragingly, about 40% said their returns were positive or strongly positive. Both the lack of a downside and the presence of an upside are reinforcing to the general belief in industry that OI is on its way to becoming a "general industry practice" [Figure D3].

Figure D3
Perceived Financial Results Of Open Innovation Initiatives



QUESTION: D3. My company believes that Open Innovation has had a _____ impact on the overall financial performance of the company. [Check One Box Only]

Number of Respondents = 193, Margin of Error = +/- 5%

13PDMS-D3-A2E

One of the first rules of corporate strategy is to not hurt yourself too badly by trying something new. OI seems to pass that test.

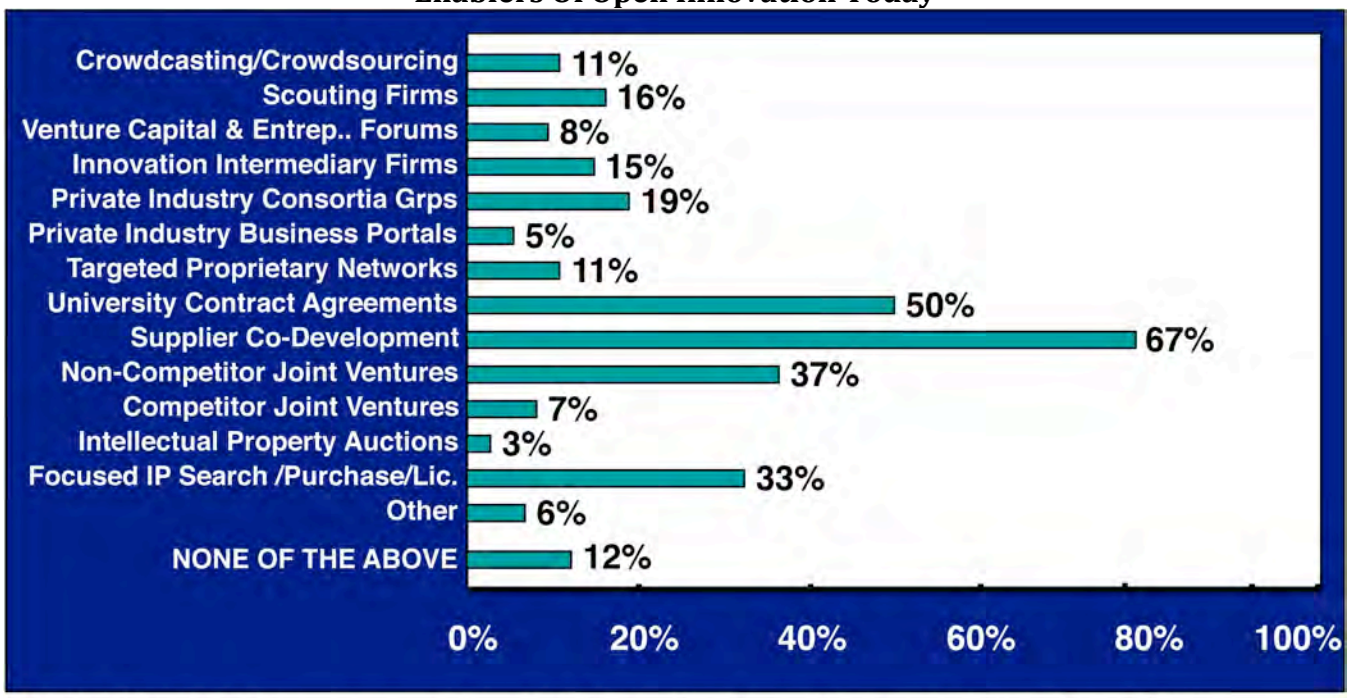
Enablers Of OI

As with any new business opportunity, the bleeding-edge and leading-edge companies experiment as to what works and begin the refinement of the practices that lead to the eventual codification of

ISBN13 978-1-937115-10-4

a/the body of knowledge. This number of years into OI, some second-quartile fast follower companies have also now engaged with OI. Providers of enabling technologies, services, and software are jumping in to make money now that the demand from industry has reached a point that the market is big enough for emergent service industries. Clearly, a number of tools, techniques, and services to enable OI now exist [Figure D4]. Not clear yet, are the approaches that will stand the test of time and become generally adopted.

Figure D4
Enablers Of Open Innovation Today



QUESTION: D4a. My company now utilizes the following Open Innovation approaches to acquire capabilities. [Check All That Apply]

Number of Respondents = 194, Margin of Error = +/- 3%

13PDMS-D4a-A2E

The most popular technique is Supplier Co-Development. We are a bit cynical about this finding. A strong argument could be made that that train has been on the tracks since the value-chain initiatives began in the 1980s. There has been a steady evolution however from sending prints to be reproduced, to black box outsourcing, to now an even higher level of collaboration in the invention and discovery phases. Our same cynicism possibly exists for liaisons with Universities, although that activity does seem to have increased significantly over what the experienced researchers at our firm would have considered to be an historical average. Fifty percent of companies now claim formal University relationships as part of their approach to OI, and relationships are more contractual in nature. For some time there was a duration difference in the needs of Universities and companies, longer vs. shorter term respectively, that limited growth.

ISBN13 978-1-937115-10-4

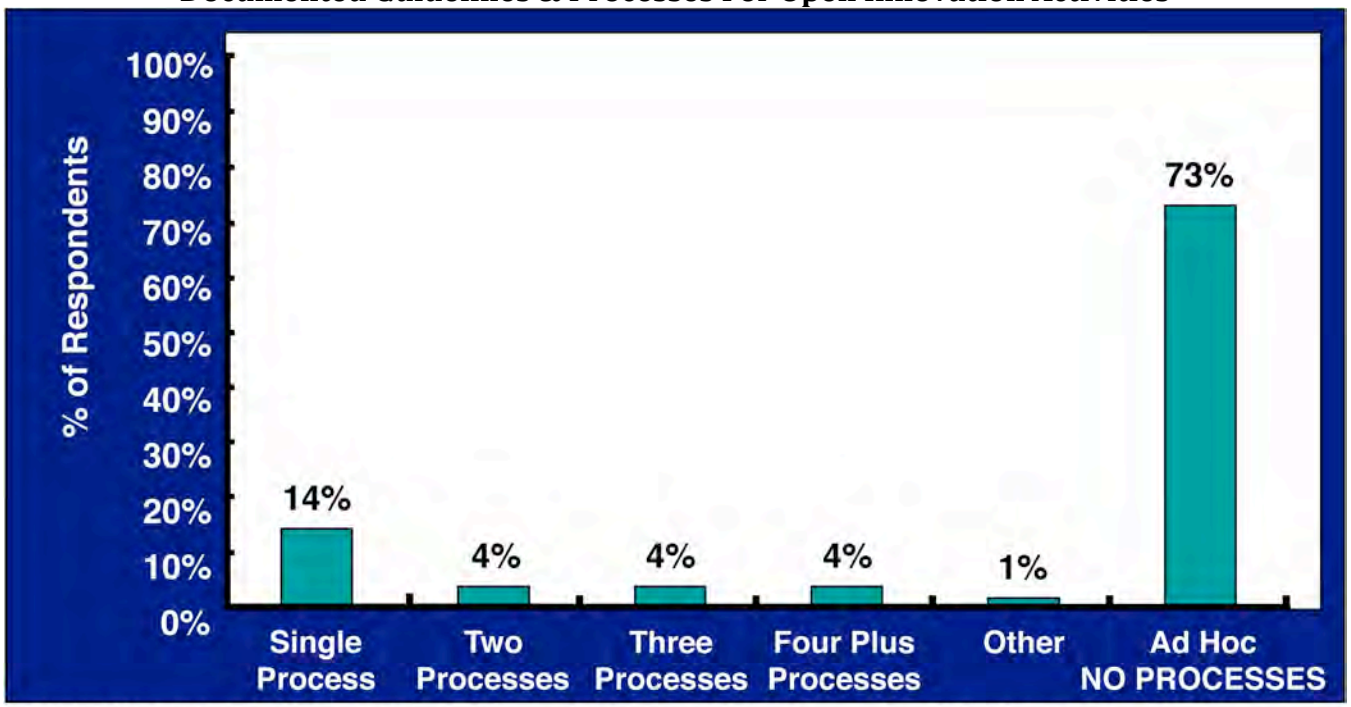
The other two findings that appear to be statistically significant are joint ventures with non-competitors and the acquisition or licensing of intellectual property from third parties. Around a third of industry is currently practicing either or both.

Our findings regarding the emergent professions and industries of scouting, consortia, networks, crowdsourcing, crowdcasting, and innovation intermediaries are not compelling enough to draw a conclusion. These separate emergent service industries may continue to grow individually. Some will likely fade-out, or get ingested by the winning segments as an expanded service offering. Some examples of all-in-one already exist.

Processes For OI

OI Processes are still in their nascent stages, very much lagging industry activity [Figure D5]. We believe the large gap is due to the lack of a corporate home for OI. At the present time it is the part time responsibility of a number of separate departments to seize opportunities as they arise. The wide range of activities under the OI umbrella also contributes.

Figure D5
Documented Guidelines & Processes For Open Innovation Activities



QUESTION: D5. Excluding all "Applied Research," "Advanced Development," and "Product Development" processes identified in the previous Section C of this survey, please indicate the nature of any separately documented "Open Innovation [OI]" processes for which your company maintains either a "documented process" or "documented guidelines." [Check One Box Only]

Number of Respondents = 191, Margin of Error = +/- 3%

13PDMS-D5-A2E

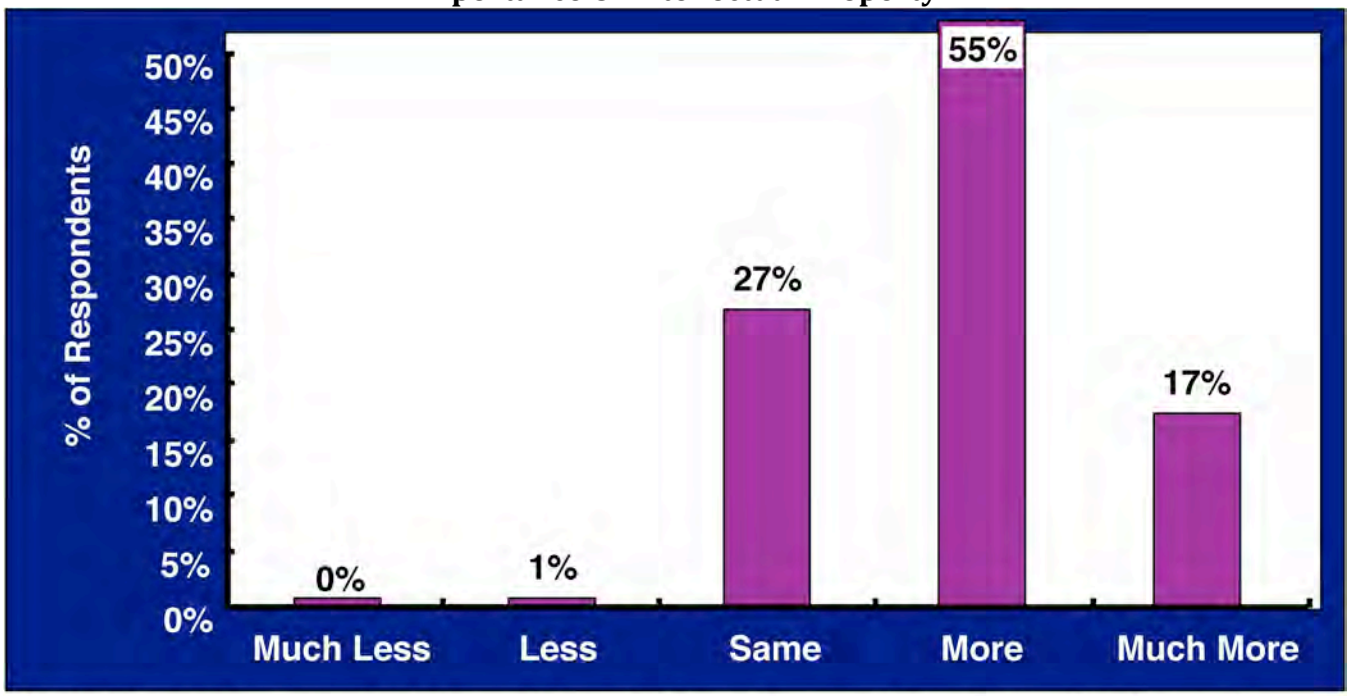
ISBN13 978-1-937115-10-4

INTELLECTUAL PROPERTY

The Importance Of IP

GGI has been forecasting the increase in importance of Intellectual Property [IP] for over a decade now. From every angle we know, this train is clearly on the tracks. While it may not move as fast as technologies change, or even at the slower pace at which processes change, it is clearly augmenting in its importance. An overwhelming 72% of respondents indicated that IP will be more or much more important in the next five years than in the past five years [Figure E1].

Figure E1
Importance Of Intellectual Property



QUESTION: E1. Recognizing that Intellectual Property has been in the nomenclature of corporations for centuries, please indicate the degree to which IP will be more important in the next five years than it was in 2008? [Check One Box Only]

Number of Respondents = 191, Margin of Error = +/- 5%

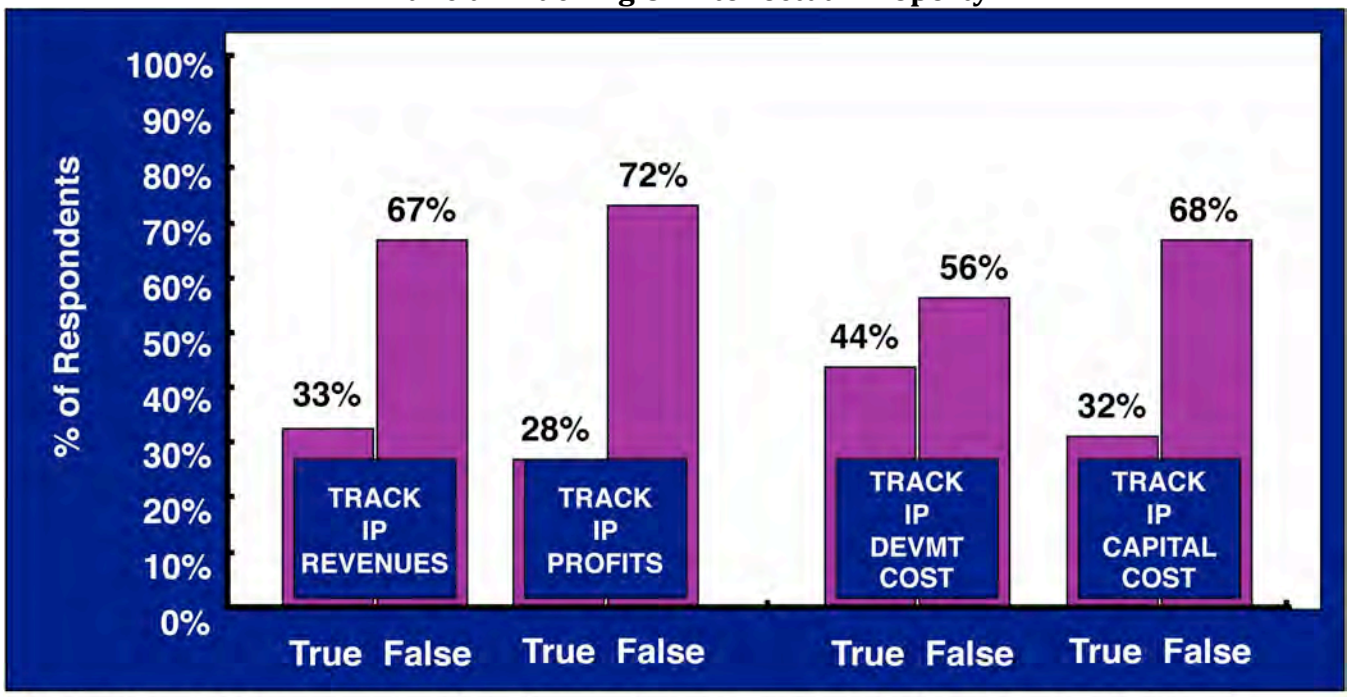
13PDMS-E1-A2E

Returns From IP Activities

Consistent with our previously discussed findings on systems and infrastructure for open innovation, are our findings for the same questions regarding intellectual property. Slightly more companies have the tools in place to track the financial investments and results from IP [Figure E2].

ISBN13 978-1-937115-10-4

Figure E2
Financial Tracking Of Intellectual Property



QUESTION: E2. My company separately tracks, or breaks out as an analysis, the financial results of Intellectual Property initiatives. [True or False]

Number of Respondents = 189, Margin of Error = +/- 7%

13PDMS-E2-A2E

As with OI, we anticipated the lack of IP infrastructure and the impact of Sarbanes-Oxley when we developed our research approach. We asked about the gut feel that managers had about the financial impact of the IP initiatives in which their companies were engaged [Figure E3]. No respondents indicated their experience was negative financially, and only 26% said it was neutral. Overwhelmingly, about 74% said their returns were positive or strongly positive. There is a much greater corporate history with IP than there is with OI. We consider this to be a strong finding based on corporate familiarity. Clearly, the prevalence IP is going to increase in the years to come.

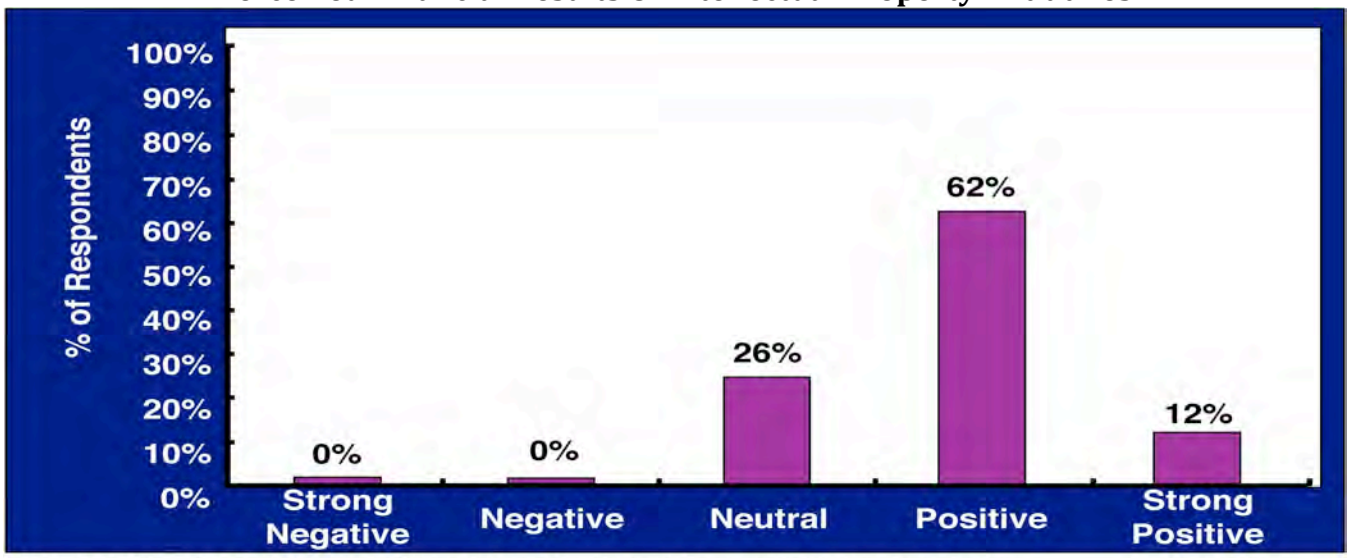
Again, one of the first rules of strategy is to not hurt yourself by trying something new or increasing its emphasis. IP seems to pass that test as well.

IP Guidelines & Processes

We sought to establish a baseline for future research on the presence/absence of formalized guidelines and processes for the various categories of IP [Figure E4]. These data are self explanatory. Our first snapshot in 2013 shows that the IP that is registerable across countries has the largest degree of formalization: Copyrights, Trademarks, Provisional Patents, and Patents.

ISBN13 978-1-937115-10-4

Figure E3
Perceived Financial Results Of Intellectual Property Initiatives

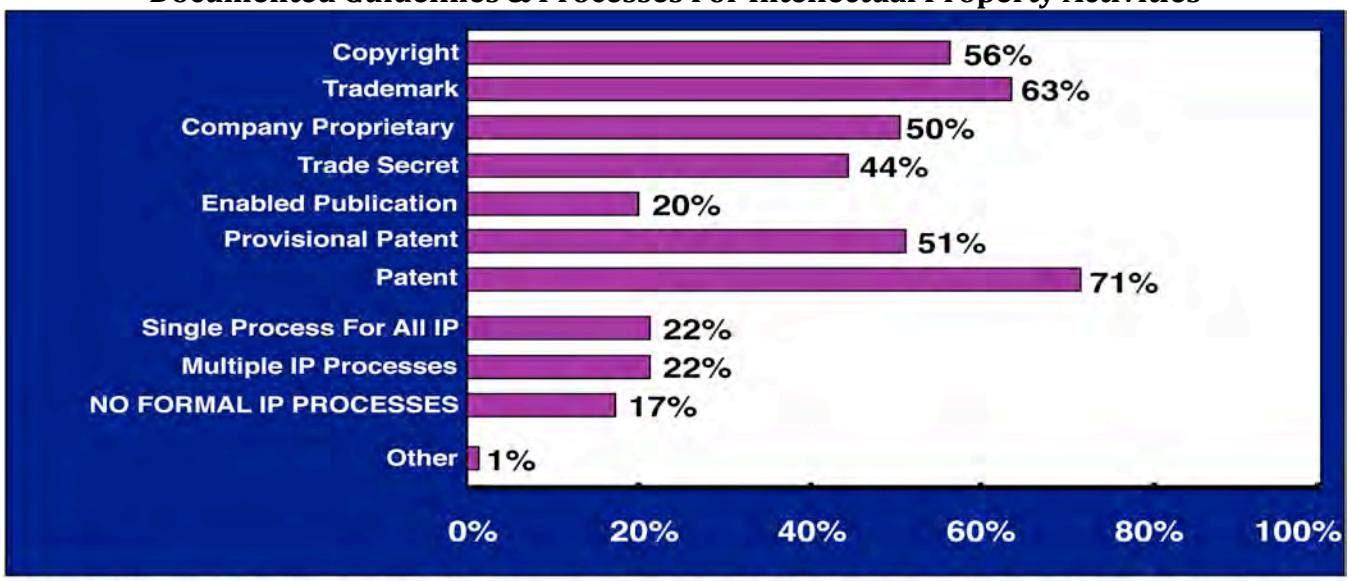


QUESTION: E3. My company believes that our Intellectual Property initiatives have had a _____ impact on the overall financial performance of the company. [Check One Box Only]

Number of Respondents = 192, Margin of Error = +/- 5%

13PDMS-E3-A2E

Figure E4
Documented Guidelines & Processes For Intellectual Property Activities



QUESTION: E4. Excluding "Product Development Processes" and "Open Innovation Processes," please indicate the type(s) of IP for which your company maintains a "documented process" or "documented guidelines" for protection and/or registration. [Check All That Apply]

Number of Respondents = 192, Margin of Error = +/- 2%

13PDMS-E4-A2E

ISBN13 978-1-937115-10-4

Interesting and a clear opportunity for the future, now that First-To-File Legislation is now law in the United States as of March 2013, are the widely less formalized processes for managing and protecting IP that is not registered. We believe practices to protect "non-registered IP" will augment in the years ahead. Fewer people will have access to these internal capabilities and secrets; and the corporate rules that govern them and access to them will increase.

CXO CORPORATE METRICS PRACTICES

GGI has surveyed "R&D Metrics Used In Industry" six times since 1998. What gets measured gets done. Metrics indicate the pulse of recent and current business priorities. Their changes over time foretell the future, both increasing and decreasing change. Each time, the list of metrics we survey grows - necessarily. Computing capabilities continue to increase the information available, and R&D metrics are no exception The cost per metric is dropping, incenting even more metrics.

Our core list of 33 metrics in 1998 has grown to 88 in 2008 and 101 in 2013 [Exhibit 2]. There are another 25-30 corporate metrics we should have listed in the emerging priority areas of Advanced Development, IP as relates to Advanced and Product Development, and Functional/Technical Competencies; not to mention OI. We omitted several bleeding-edge metrics as well, refinements of several of industry's main stream metrics. And, capital metrics as a general category are gaining steam.

Exhibit 2
Number Of Metrics Used By Industry

% COMPANIES USING	NUMBER OF METRICS USED					
	1998	2000	2002	2004	2008	2013
> 70 %	1	0	0	1	1	1
> 60 %	3	1	1	3	3	4
> 50 %	5	3	2	5	5	6
> 40 %	8	3	7	7	7	7
> 30 %	11	4	10	15	14	14
> 20 %	16	9	15	28	23	24
> 10 %	24	19	28	47	54	56
NUMBER OF METRICS TO CHOOSE FROM	33	48	60	75	88	101

ISBN13 978-1-937115-10-4

After eliminating all the possible corporate metrics just described, it is safe to say that the 101 metrics researched are all generally utilized and/or are general industry practices. The 101 metrics represent a quite comprehensive set of the CXO-level R&D-Product Development metrics used by industry and high-tech companies today, regardless of global geography. The "most used" metrics show up in high percentages of industry penetration. Note that no more than 8 metrics have ever penetrated more than 40% of industry any time in the past fifteen years. The "possible emergent" metrics can be found in low percentages. Some will break through to become general industry practice, such as "new product sales" did starting in the 80s and "return-on-innovation" has since 2000.

It is essential to understand that all metrics in this research are all "corporate-level" metrics. They measure the output of R&D as a whole and are not inclusive of the additional hundreds of metrics utilized for the lower-level activities of projects, functional disciplines, improvement efforts, or other lower-in-the-organization activities. That said, almost half the corporate-level metrics surveyed do derive from these lower-level metrics. If a company systematically measures lower level activities such as projects uniformly across all projects and invests the effort to calculate metrics across the project population, then the result measure is an overall measure and represents corporate-level performance. Average Time-To-Market, Average Schedule Slip %, and Average Target Product Cost Slip % are examples of corporate-level metrics that are derived from lower-level metrics. When you see an "arithmetic term" at the front of the listed metric in the survey, its data sources are likely lower in the organization.

In summary, there are two types of corporate-level metrics. The first are "pure," those that can only be measured at the overall/top of the organization. The second are "derived," those that are rolled to the top by uniform and systematic aggregation of lower-level organization metrics. Their name is typically prefaced by the name of the aggregating math approach to create them.

Having summarized the large number of metrics that were legitimate candidates for inclusion in the research, and noted that all 101 metrics were legitimately being used by industry on a regular basis, the focus of analysis now shifts to the most used industry metrics - the Top 28.

The Top 28 Metrics: State-Of-Industry Practices

R&D and Product Development professionals have historically enjoyed certain freedoms in their "inventive function" that professionals in transaction processing functions have not. Since R&D is harder to measure, and most executives truly do not understand how it functions, many of the R&D measures historically focused on things that could be classified and counted with certainty - to the exclusion of true performance measures.

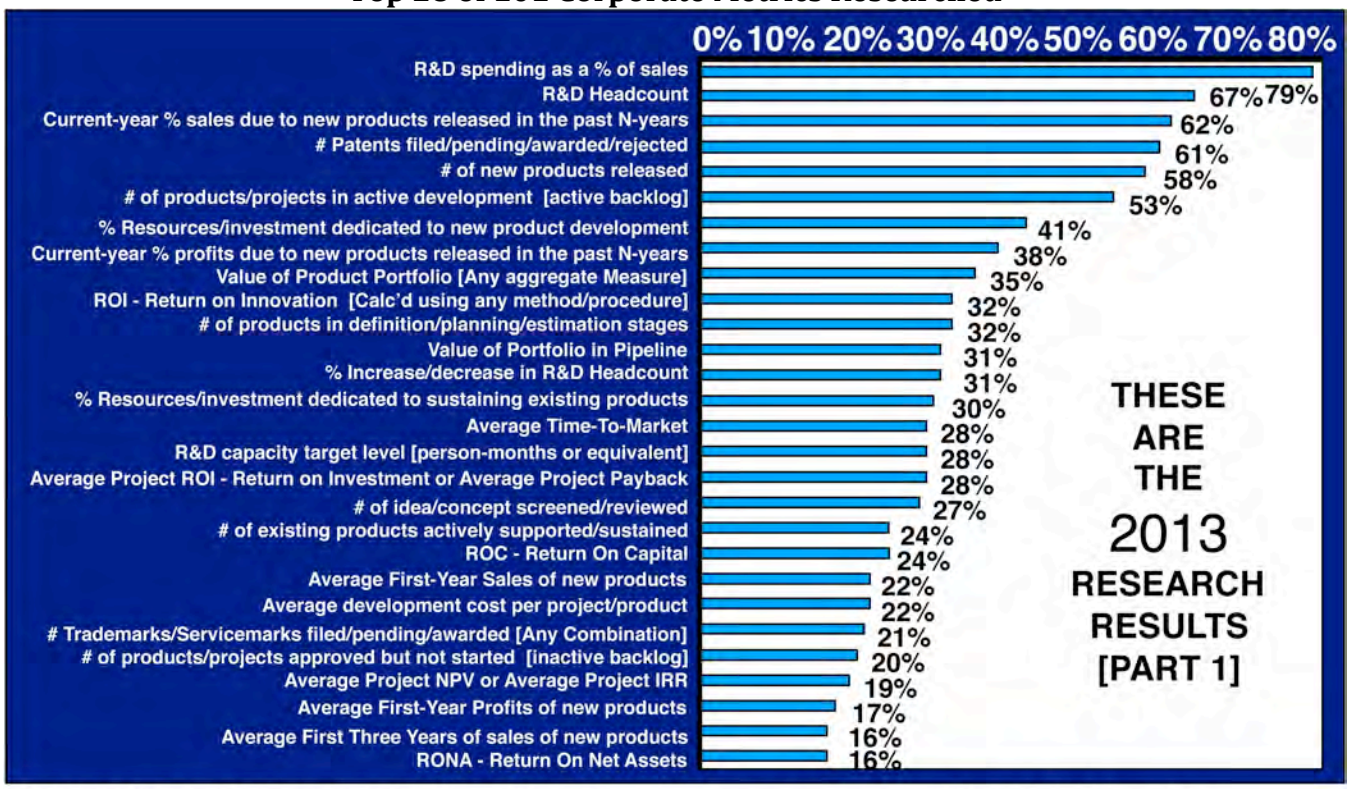
The top metrics in this research effort, for the first time since we began researching them in 1998, are now focused on performance and business results! We first observed that the tide seemed to be changing in our 2008 research. That trend has continued.

True performance measures often take the form of "output," or "output/input" which is the industrial engineering definition of efficiency or productivity. True performance measures now dominate the top

ISBN13 978-1-937115-10-4

metrics used for measuring R&D and Product Development. Key capacity regulating metrics like R&D Spending, Headcount, and Products In Backlog remain in the top group which is appropriate. Managing the input is essential for achieving the output goals promised for the business.

Figure F1
Top 28 of 101 Corporate Metrics Researched



QUESTION: F1. Which of the following R&D metrics are "in use" at your company: (Check all that apply).

Number of Respondents = 189, Margin of Error = +/- 6%

13PDMS-F1-MDB

The Top 10 Metrics: Highlights

Six of the Top 10 metrics are true measures of performance, meaning R&D is the primary or co-driver of the metric: Current-Year Sales Due To New Products, Total Patents, # of New Products Released, Current-Year Profits Due To New Products, Value of Product Portfolio, and ROInnovation. In 2008, only 4 of the Top 10 measured performance.

Current-Year Sales Due To New Products, a new-to-the-world metric invented by 3M in 1988, often called the "Vitality Index," has been enjoying a steady rise in industry penetration since its inception. In 1998, 10% used it. In 2004, 44% used it. In 2008, 56% used it. In 2013, 62% used it. It is safe to say at this time that this metric is now the standard for measuring R&D output in North America. Companies that use this metric typically define a new product as being less than

ISBN13 978-1-937115-10-4

either 3 or 5 years old, 59% and 21% respectively. Other companies in this research used N = 1, 2, 4, and 7. No companies reported using N = 6.

Current-Year Profits Due To New Products, a natural derivation of the Sales metric, has also been rising steadily the past 15 years. In 2013, 38% are now using it. More importantly, a profit metric has now broken into the Top 10. R&D has been too focused on the revenues it generates for too long. Especially in a world where economic growth about keeps pace with inflation, profit is perhaps the more important figure.

Value of the Product Portfolio also broke into the Top10 for the first time. Like profits, this is another indication that R&D is truly beginning to focus its metrics on output and contribution to the business. Many other portfolio-related measures also rose in their penetration since 2008, i.e. Value in the Pipeline and Value in Backlog [Pre-Pipeline.]

ROI, a dual-meaning acronym that in this case means Return On Innovation and is not to be confused with Return On Investment which is a project-level metric, was first defined as a measure in the early 2000s. It, like the Vitality Index, has been on a meteoric rise since its inception. To avoid confusion, many now write it as "ROInnovation." For a given "N," it is defined as the profits from new products divided by the R&D spending to create new products. This definition is not exact and leaves companies many calculation options, making it almost impossible to compare this metric across companies at this time. ROInnovation is now used by 32% of companies and appears to be on its way to becoming a standard alongside the Vitality Indices for Revenue and Profit.

The Top 28 Metrics: Pre vs. Post Great Recession

With few exceptions, the rank order of metrics that had penetrated industry had been relatively constant since the early 1990s, and certainly since the early 2000s. Our current findings indicate that there was a significant changing of positions across the Top 28 metrics during the past five years [Figure F2]. Business and performance metrics rose in their relative positioning, significantly so. A handful of the Top 28 metrics in 2008 fell off the list in 2013 and were replaced by business and performance metrics.

The significant rise in ranking of the Value of Product Portfolio and Value of Portfolio in Pipeline metrics are reinforcing to the rise in the absolute measures of revenue and profit generation from new products. The rise in Return On Innovation is as well. Increased "pursuit" of one of the most difficult measures to calculate and keep control of, R&D Capacity Target Level, is also a great indicator of elevated business focus in R&D. R&D capacity is extremely difficult to calculate.

All in all, this is a historical and significant step forward for the measurement of R&D and innovation capabilities. Management awareness appears to be growing on the application of appropriate measures to ensure and assure the revenues and profits it needs from R&D for overall corporate financial success.

Figure F2
Top 28 Metrics Five-Year Comparison - Pre vs. Post Great Recession

T100
ISBN13 978-1-937115-10-4

SUMMARY

Apart from significant changes in R&D strategy that are taking place, generally away from risky innovation strategies, the blocking and tackling in traditional product development processes and practices appears to be maturing after three decades of rapid evolution. As well, the zest of the corporate quest for improved Organic Innovation during the past decade appears to be subsiding as an elevated state of innovation comes of age and begins to become business-as-usual. Companies seem to be attaining their desired level of entitlement for Organic Innovation capabilities in product development. The areas of applied research and advanced development are still quite dynamic however. The chips have been put down, but the hands are still playing themselves out. While the absolute level of practice stabilized during the Great Recession, processes and infrastructure grew significantly. Industry initiatives to raise total innovation capabilities will continue to influence these pre-product development activities for some time to come; more so if a healthy economy returns for a multiple-year period.

Even more dynamic is the recent industry initiative towards increased levels of Open Innovation. Open Innovation has all the attributes of a new market and industry that is still sorting itself out. A significant driver is that few believe they have a financial downside from pursuing OI. The first rule of good strategy and good management is not to hurt oneself. OI is perceived to be producing neutral to positive results. Remembering that almost half of new product launches have negative results, neutral is just fine for OI as it increases the number of alternatives available to a company in its quest for success. And, buy vs. make is faster.

Both combined with OI, and independently of OI, the growth in the importance of Intellectual Property is second to none in the R&D-Product Development space. It also has a bearing on Organic Innovation. With the growing ability to monetize patents and other forms of IP, this subject will remain dynamic for decades to come. Governments, legislators, and financial regulators change slowly. Industry is sure to be waiting on them. As well, IP cannot reach "commodity status" until more countries treat it equally. But, it will be increasingly monetized and transacted.

Infrastructure, processes, systems, and the ability to measure financial performance are lagging for both OI and IP. Best practices for both areas are still in the process of being culled out. Over time, we can expect to see a maturation process and path that will be quite similar to what has taken place for product development during the past thirty years. OI will not take as long as IP, as corporations have direct control over the outcomes.

Management's focus on attaining tangible business results from R&D and product development has significantly risen to a level of a new historical precedent these past five years during the Great Recession. Never before have corporations so closely scrutinized the inputs and outputs of R&D and product development in business and financial terms. The total number of measures is skyrocketing as computer processing power and data warehousing capacity has greatly decreased

ISBN13 978-1-937115-10-4

the cost per metric; while the complexity of R&D increases due to Open Innovation, IP, Competency Management and other emergent business drivers.

For professionals involved with R&D and product development, the next twenty years will be as exciting as the past twenty years. The challenges will be more complex and more intangible. These dynamics increase the degree of learning, while changing the type of learning, necessary to stay professionally current. In the not too distant future, product development professionals will become proficient in acquiring innovation from outside their companies and in the legalese of IP that heretofore has been the realm of counsel. The number of measures for these areas will continue to grow.

* *

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.

ISBN13 978-1-937115-10-4