

Original Article

Pharmaceutical R&D productivity: the role of alliances

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ABSTRACT

In recent years, the major research-intensive biopharmaceutical companies (big pharma) have come face to face with a perfect storm of eroding profit margins from blockbuster expiration and generic competition coupled with growing R&D expenses and declining advances in truly novel therapeutics. With long-term research divisions shed in favor of short-term outsourcing options and with public good will at historic lows, industry innovators have sought to reinvent the model of big pharma, its relationship in public-private partnerships, and the role of technology and technology policy in reform. In this paper, we highlight a number of the major alliances reshaping the industry and the role of government, research institutions, and other players in the public-private interface in these endeavors. In particular, this paper looks beyond traditional biotechnology partnerships and focuses instead on the developing consortia between biopharmaceutical companies and with clinical research organizations and academic institutions. We examined each alternative model of alliance, identified specific hurdles and potentials for increased productivity.

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INTRODUCTION

THE GLOBAL BIOPHARMACEUTICAL industry is facing unprecedented pressure to produce sufficient numbers of important new drugs that can offer substantial return on rising research and development investment. The costs of research and development are rising and the number of approvals per year is dropping.¹ In the face of this productivity downturn, an understanding of where the industry is, where it is trying to go, and how to survive and thrive is necessary. We begin our analysis by reviewing macro industry trends that fall into the categories of challenges and opportunities to better understand the research and development environment.

CHALLENGES

The increases in cost for research and development have been attributed to the shift in focus to chronic diseases that require larger scope, longer clinical trials as well as the advances in technology raising specificity and complexity in the compound identification process.² Though the estimates of the cost of development vary greatly across disease states and projects, costs across all therapeutic areas are increasing at an alarming rate. Another ominous trend is the amount of time required for research and development. On average, it takes 17 years for emerging medical knowledge to become a reality to patients and depending on when patents are filed, market exclusivity periods are shrinking.³ Compounding these issues is the high attrition rate throughout the drug pipeline. Only 11% of drugs that enter clinical testing are approved.⁴ The 11% that do make it to the market have to gross enough revenue to rationalize the investment made in their development as well as the investment made in the 89% of compounds that failed during clinical development. Rising expenses of drug development and increasing time to market leaves very few products that are able to break even on their research and development spending. A blockbuster model, that had served the industry well for generations as a reliable profit-center are becoming more difficult to come by, with the disproportionate expiry of a number of these drugs creating added pressure. Whereas the rise of orphan indications and the mini-blockbuster has been suggested to fill this

gap, criticism has grown over the extraordinary prices these drugs command and the growing percentage of approvals (roughly a third) these “orphans” make up.

Utilizing executive interviews and forums of the Blanche and Irwin Lerner Center for the Study of Pharmaceutical Management Issues and the Rutgers Business School Pharmaceutical Industry Alumni Association (Appendix A), we sought to better elucidate the key management strategies being employed to reform pharmaceutical R&D practice and productivity in the face of these challenges. The initial list drawn from executive interview and supported by literature review found these to include acquisitions, strategic partnerships, budget cuts, layoffs, focusing on internal discovery, partnerships with academia, movement of research and development facilities, closing of research and development facilities, and narrowing therapeutic focus.

With access to executives from throughout the biopharmaceutical industry, we next sought to pinpoint current trends in management strategies from this list. Our survey was conducted via an e-mail linked, anonymous, multiple choice and open answer electronic survey. A cluster of three questions pertaining to R&D Practices were included in the survey (Appendix B). Executives that held a variety of positions and had varying levels of experience, from mid-level to senior level, were provided the optional survey. A total of 30 executives completed the survey. Whenever possible, additional input from executives was garnered through open answer on the survey or direct dialogue.

A RENEWED FOCUS ON DIVERSIFYING PARTNERSHIPS

A notable initial commentary voiced by numerous industry executives, in confidence, and supported by a review of the literature, reveals that those strategies pertaining to short-term cost-cutting measures, including outsourcing and staff reductions, and market expansion attempted via merger/acquisitions, failed to address the core issue of productivity plaguing the industry. Often blamed on the past harvest of “low hanging fruit” and an overzealous FDA, it is becoming increasingly clear that a short-term focus on risk reduction and profit maximization coupled with devastating rounds of cuts and realignments, have served only to enhance short term profit at the expense of outside relationships. Our survey of the Rutgers Business School Pharmaceutical Industry

Alumni network and other willing industry professionals from the Lerner Center and beyond appear to have captured this trend. Seventy-three percent of respondents indicated their company was making process changes within the research and development department in the light of external cost pressures (Figure 1). However, the above-mentioned misgivings with short-term cost controls and adverse consequences of cost control on relationship management appear to have trickled into updates in R&D strategy. When polled among the nine strategies to reform R&D practices (acquisitions, strategic partnerships, budget cuts, layoffs, focusing on internal discovery, partnerships with academia, movement of research and development facilities, closing of research and development facilities, and narrowing therapeutic focus) (Figure 2), budget cuts and closing of

R&D facilities were noted by only ~15% of respondents and partnership strategies with academic institutions garnering less than 20%.

However, with research divisions gutted or severely curtailed and public goodwill at historic lows, industry innovators have sought to reinvent the model of big pharma, its relationship in public-private partnerships, and the role of technology and technology policy in reform. In our poll of the above-mentioned nine strategies to reform R&D practices (Figure 2), respondents overwhelmingly noted strategic partnerships (>60%) compared to the nearest alternatives, a veritable tie between acquisitions, budget cuts, and layoffs at roughly 40%. In reevaluating the value of this broader R&D ecosystem to externalizing expenses while growing innovation, a number of groundbreaking strategic partnership models have been implemented by the leading players in big pharma and enabled by policy makers over the past decade. In subsequent sections, we will review the literature discussing the implications and opportunities of strategic partnerships, beginning with classic alliances between biotech and pharma and extending to partners valuable in both early stage research as well as late stage development and clinical trial design and execution. Best practices documented within the literature will be described and the recent development of unique consortia highlighted.

Majority of Companies Making Changes to R&D Practices

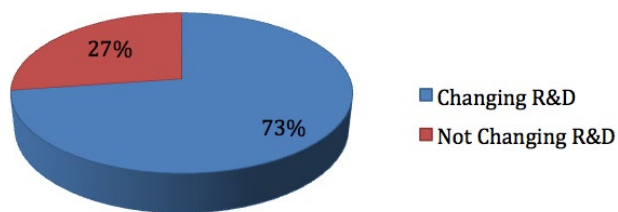


Figure 1: Responses to the prompt, “Has your company made any process changes within the R&D department in light of external cost pressure?”

Lack of Consensus R&D Change Across Industry Professionals

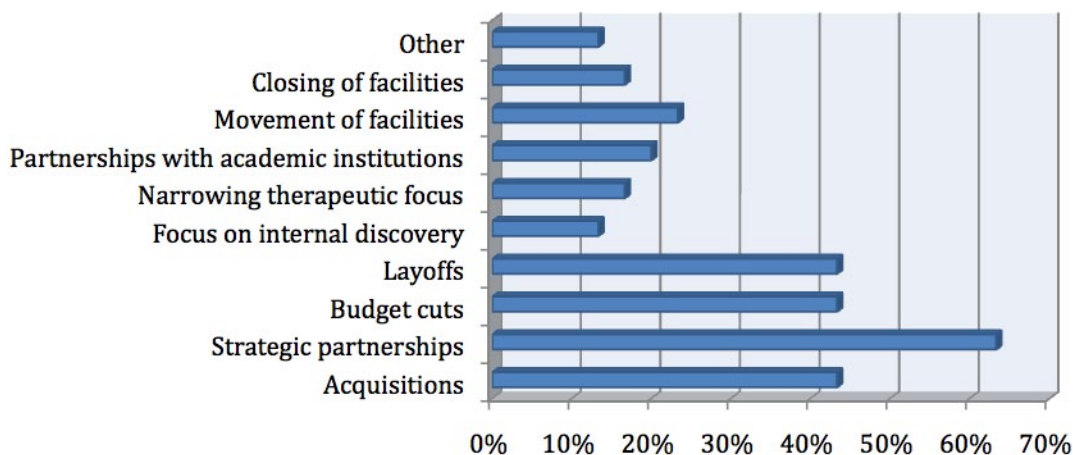


Figure 2: Responses to the prompt, “Has your company done any of the following in an attempt to update their R&D practices? (Select all that apply)”

BIOTECH PARTNERS IN BUSINESS DEVELOPMENT

The pharmaceutical industry has long capitalized on the technology and expertise of biotech companies in early drug development. They have chosen to partner with, license technology, or acquire the companies altogether. Rigorous academic studies have found that collaborative R&D projects involving biotechnology companies in pharmaceutical development have higher probability of success in developing a marketable product.^{5,6} Size and experience of the involved companies for product developments are important determinants of success in a collaborative projects as well.^{5,7} Companies are choosing to do collaborative research and development twice as frequently as performing in-house development, across industries.⁸ This trend represents an opportunity for companies to accomplish more with fewer in-house employees.

STRATEGIC PARTNERING WITH VENTURE CAPITAL

The application of venture capital by the pharmaceutical industry can be labeled as either classic corporate venture capital (CVCs) or strategic limited partner relationships. CVCs tend to be separated from the parent company by somewhat porous “Chinese walls”, designed in principal to prevent issues of intellectual property cross-contamination and unintended disclosure of confidential information. Sharing much the same structure and management of independent venture funds, they differ only in their willingness to invest in early stage ventures. For example, a report by David and colleagues found that Novartis CVC demonstrates an enhanced focus on early-stage opportunities compared to a set of independent venture funds.⁹ Whereas this has often been cited as examples of improved visibility into emerging biotech and enhanced access to innovation, these arguments are more attuned to classic business development functions. Rather than such informational and networking services, the role of CVCs in big pharma are more attuned to contributing to the health of the early-stage innovation ecosystem, by promoting the growth of innovation ecosystems most aligned with larger development goals.

In addition to internal CVCs, a number of biopharmaceutical companies have chosen to outsource their venture capital efforts, supporting early stage innovation by making strategic alliances with venture capital firms (Appendix C). As a significant limited partner, a biopharmaceutical company or even its associated CVC, can hold sway on deal sourcing, execution, and risk profile. Although some control is lost, these

drawbacks are often outweighed by the established nature and risk-sharing advantages of an external firm.¹⁰ As with most outsourcing mechanisms that utilize balance sheet cash, strategic alliances with venture capital allow for greater strategic flexibility than internal infrastructure development. However, this comes at the expense business development participation, toward capability bartering (incubators, data, reagents, development assistance). In addition, a biopharmaceutical company, as one of many limited partners, may inadvertently find themselves in a venture fund alliance alongside an industry rival. Given the overlapping interests in drug class, disease, and sector, this was bound to occur, especially as major biopharmaceutical companies have invested the heaviest in partnerships with those venture funds holding the greatest hope of bringing new drugs of popular or orphan niche classes forward. An example of how this can be handled is given by the case of GlaxoSmithKline (GSK), Johnson & Johnson and Index Ventures (see Appendix C). Of the nine-member Science Advisory Board to be formed, Index will be given five seat, GSK given two seats, and J&J two seats. Under this structure, 50% of funding will come from Index, while 25% contributed by GSK and 25% J&J. Target companies of this fund will need to pursue licensing agreements with Index, as opposed to either GSK or J&J.

OVERSEAS PARTNERS

China and India have gained ground in drug development by serving as strategic outsourcing partners of certain research and development functions.¹¹ Outsourcing overseas, while inexpensive, can lead to frustrations with regulatory standards, quality, and respect of intellectual property. Merck, for instance, outsourced portions of their drug development to WuXi Pharmatech in China, which led to quicker compound discovery, although at the expense of frequent quality issues. The partnership also resulted in a lawsuit against a Chinese scientist who was eventually convicted of stealing and selling two Merck compounds.¹² Such instances further feed the hesitance by Western Biopharma companies that have limited the extent to which such partnerships have been pursued.

PATIENT GROUPS

Patient groups have always been welcoming of partnerships with big pharma to help fund a variety of projects including disease awareness campaigns, patient information, patient advocacy, and meetings and conferences.¹³

Pharmaceutical giants have used these connections in the past to salvage their public reputation and achieve public outreach objectives. Recently, however, we have seen a shift from pure public outreach to true collaboration between patient groups and pharmaceutical companies in early stages of drug development.

The first example of early R&D collaboration between pharmaceutical companies and patient groups occurred during the development of AIDS treatments. AIDS activists and disease sufferers formed the Clinical Trial group and helped guide clinical trial design at the industry level to meet the needs of the patients.¹⁴ This resulted in products hitting the market that patients felt they were a part of increasing their overall market value. We are also starting to see more patient group involvement in the development of orphan disease treatments. Identifying patients in these small populations can prove difficult so companies like Vertex have chosen to leverage partnerships with Cystic Fibrosis patient groups to raise awareness of current clinical trials and new drugs on the market. In their partnership with Cystic Fibrosis Foundation Therapeutics, Vertex is also receiving funding (\$1.5 billion through 2016) for early stage development efforts for the orphan population.¹⁵ With goals aligned, both organizations are sharing the risks associated with clinical development to ultimately reach a small, underserved population.

CONTRACT RESEARCH ORGANIZATIONS

A Contract Research Organization (CRO) represents a unique outlet for innovation. CROs provide a variety of services along the clinical trial process including but not limited to study management, biostatistics, data management, pharmacovigilance, and laboratory processing. Because of organizational structure and specialization, CROs are in a better position to conduct clinical trials concurrently in multiple countries including China, India, Brazil, Russia, Eastern European countries and others where the cost of trials are at a fraction of those in the United States.¹⁶ Recent research highlighted the top five strategic Pharma/CRO partnerships in 2012.¹⁷ Four of these partnerships are between Pfizer and Parexel-ICON, between Sanofi and Covance, Eli Lilly and Parexel, between Takeda and Covance-Quintiles. It is important to identify why companies are turning to CROs at a high rate and what the key success factors are if this trend is to yield the desired results.

A *Pharmaceutical Technology* survey of industry professionals in 2012 found that 62% of respondents saw an increase in contract research spending from 2011 to 2012 within their organizations.¹⁸ There are a variety of strategic motivations for increasing reliance on CROs. The Pfizer-Parexel-ICON partnership is a five year deal

for Pfizer's clinical trials management, Sanofi-Covance partnership is a ten year deal for discovery, toxicology, chemistry, clinical trials, and market access services. Eli Lilly turned to Parexel for help in expanding Lilly's access to the Asia-Pacific drug market. In addition to those functional services, there is a tactical advantage to utilizing CROs. Research has shown that FDA submissions that had high CRO involvement were significantly more complex and they were submitted 30 days closer to the projected submission date.¹⁹ The same study showed improved submission timelines without a significant difference in quality. They were unable to quantify cost differences between internal and external clinical trial management due to the inability or unwillingness of the companies to expose their budgets. This study does, however, provide evidence of a tangible advantage to using CROs.

How can companies structure their partnerships with CROs to maximize their return on investment and reap the advantages cited above? Strategic partnerships and outsourcing innovation require a high level of mutual commitment between parties and enhanced information transfer. Research into successful strategic partnerships indicates that high levels of trust and measurability of results fosters closer relationships between the two parties. One Tufts Center for the Study of Drug Development survey identified the following specific relationship management tools as moderately to highly effective when working with a CRO; negotiation of a relationship management plan with the CRO, co-developing performance metrics, conducting lessons learned reviews with the CRO, and using the CRO's standard operating procedures after sponsor review.²⁰ Each of these tools requires both trust and information sharing between partners. Pharmaceutical companies will need to understand this and adjust if they want the new alliances being formed with CROs to be effective.

ACADEMIC INSTITUTIONS

Multiple companies are moving their research and development sites closer to the world's greatest academic institutions. This is not just a coincidence. With government funded research declining, and biopharmaceutical companies cutting back on in-house research staff, the ideas have to come from somewhere. Industry giants like Pfizer and Sanofi have chosen to focus on academic research institutions for their early stage research efforts to gain access to the investigators, their innovative projects, and the technology already in place.²¹ Partnerships with academia have been identified as key linkages in the translational medicine movement. In this section we

will analyze past mistakes and compile best practices for both sides of the agreement to explore.

Goal misalignment has plagued industry-academia partnerships of the past. Academia's desired rewards include publications and grants while industry is hoping for successful regulatory filings from their pipeline. One Stanford University Medical Center developmental biologist described partnerships with pharmaceutical companies as distractions from his work.²² Another participant in the system went so far as to say that academic scientists view the private sector as, "an ATM for basic research."²² This goal incongruence comes to light most often in three areas; timelines, confidentiality, and intellectual property. Agreements between industry and academia have gone awry and lead to lengthy and costly legal battles. The agreement Novartis had with Dana-Farber Cancer Institute has led to a continuing battle over intellectual property with a third entity, Gatekeeper Pharmaceuticals.²³ A case between Stanford University and Roche over rights to a diagnostic HIV test went all the way to the U.S Supreme Court in 2011.²³ Stories like this have not scared industry or academia away from such partnerships. Recent research has identified the top 20 public-private partnerships involving pharmaceutical companies and academic institutions in 2012.²⁴ The list includes partnership between Sanofi and the University of California at San Francisco for research in diabetes, between Johnson and Johnson and the University of Queensland for research in chronic pain, Novo Nordisk with Oxford University for Rheumatoid Arthritis, Novartis with the University of Pennsylvania for research in personalized T-Cell Therapy, and many others. If these groups hope to avoid disagreements and inefficiencies, both parties need to find ways to align their work and manage their partnerships to make them mutually beneficial and less of a drain on resources.²⁵

Both parties, in this case, need to understand each other better to harness the valuable technology that can come out of these partnerships. The first step for a biopharmaceutical company is to pick research institutions or scientists that are already doing research that is closely aligned with their commercial goals. If industry asks an academic researcher to stretch too far from their comfort zone they can find themselves a low priority on the list of tasks. The next step involves front-loading the contracting effort. Confidentiality and intellectual property disputes can be addressed on the front end with explicit contracting language. The issues with timeline adherence are a little more difficult to address as they are grounded in fundamental management differences. Devoted academia project liaisons that understand both sets of interests have been particularly helpful to academia. If these liaisons can keep academic researchers on schedule while respecting their personal motivation there is a

large upside. Other industry adjustments include altering academia incentives. The biggest dollar amount is not always the contract winner; sponsored research, publications, and indemnification are necessary to an academic institution's success.²⁶

Adjustments from the university side are also helpful in facilitating smooth technology development. Johns Hopkins has started a technology transfer group, which essentially acts as a business concierge.²⁶ This new, innovative group has led to five straight years of record breaking performance by their research staff. Pharmaceutical companies should seek out universities or private institutions with infrastructure catered to industry needs and relevant experience to increase the probability of success.

One noteworthy example of industry attempting to adjust to the specific needs of a partnership with academia is seen in Pfizer's Centers for Therapeutic Innovation (CTI). The model hinges on co-location of academic and industry researchers, sharing proprietary technology, and equitable intellectual property and ownership rights.²⁷ Proposals for research in this program receive a pre-approval from Pfizer before the larger final proposal is drafted by a team of both industry and academia. Safeguards are put in place to ensure that terminated research projects have safety-net salary built in for researchers to limit the risk the academic institution must take on. In addition, Pfizer guarantees one-month turnaround on manuscript reviews to ensure non-proprietary information can be published in a timely manner.²⁸ Pfizer's willingness to understand and adjust to the specific interests of academia has led to enhanced relationships and project output.

"BIG DATA" AND THE EMERGENCE OF INDUSTRY-LED DATA CONSORTIA

Even before the landmark passage of the Affordable Care Act, a new era in open information in integrated healthcare was well underway. The digitization and standardization of medical records by big pharma and other organizations has brought with it the demand for transparency and searchability by the healthcare sector as a whole. Described as "big data", for its sheer volume, complexity, diversity and timeliness, a variety of stakeholders have begun to analyze big data to obtain insights. Software and hardware improvements are overcoming many of the traditional obstacles to compiling, storing, and sharing information securely. These advances have extended to patient privacy, allowing for more convenient means to sanitize data.²⁹

Meanwhile, policy-makers have sought legislation that balance patient privacy with the social utility of big data as a collaborative mechanism. For example, the 2009 Open Government Directive and the Department of Health and Human Services (HHS) under the Health data Initiative (HDI) have begun to liberate data from various agencies including the Centers for Medicare and Medicaid Services (CMS), the Food and Drug Administration (FDA), and the Centers for Disease Control (CDC). In another example, as part of the 2009 American Recovery and Reinvestment Act, the Health Information Technology for Economic and Clinical Health (HITECH) Act, seeks to incentivize payment for providers to use EMRs. In yet a third example, the federal government is sponsoring big-data initiatives at the state level. HHS has allocated \$550 million in funding for the State Health Information Exchange Cooperative Agreement Program, for the creation of information exchanges.

More recently, a consortium of pharmaceutical companies, CROs, and various research institutions have come together under a project entitled “DataSphere”, to create a repository of data sets from cancer trials conducted by drug companies, academic labs, and other organizations. Started through the CEO Roundtable on Cancer, a non-profit convened in 2001 by then president, George H. W. Bush, the DataSphere initiative has been launched with two data sets contributed by Sanofi. Companies, research institutions, and universities are expected to contribute additional data. Whereas such strategies have been long-encouraged by all parties involved, efforts have previously been hampered by patient privacy, data security, international law, corporate policies, and system incompatibility. Utilizing advanced data-security and anonymity technologies, the platform promises to pool multiple studies associated with the same diagnosis. The network will be hosted by the Synapse technology platform sponsored by Sage Bionetworks. Notably, this platform already serves the Cancer Genomics Hub, a large-scale data repository and user portal for the National Cancer Institute. It is hoped that sponsors can design more cost-effective trials and thereby reduce drug development costs by as much as 10%.^{30,31}

A yet more comprehensive strategy has taken shape out of a regular meeting of the industry’s leading research chiefs. TransCelerate BioPharma Inc., a nonprofit established by 10 major pharmaceutical companies, aims at accelerating the development of new drugs, beginning with improving the efficiency of clinical trials. The founding companies include Abbott, AstraZeneca, Boehringer Ingelheim, Bristol-Myers Squibb, Eli Lilly and Co., Genentech (a part of Roche), GlaxoSmithKline, Johnson & Johnson, Pfizer, , and Sanofi. Each company’s R&D head sits on TransCelerate’s board of directors. In the

spring of 2013, six new companies joined TransCelerate, including Astellas Pharma Inc., notably the first member of TransCelerate headquartered in Japan, Biogen Idec, Braeburn Pharmaceuticals, EMD Serono, Inc. (a subsidiary of Merck KGaA), Forest Research Institute (a subsidiary of Forest Laboratories, Inc.) and Onyx Pharmaceuticals. With clinical study execution the most immediate area of focus and standardization, five major topics have been selected for further funding and advancement. These include development of risk-based site monitoring approach and standards, development of a shared user interface for investigator site portals, mutual recognition of study site qualification and training, development of clinical data standards, and establishment of a comparator drug supply model.^{31,32}

Although one of the most ambitious, TransCelerate is by no means the first of such consortia. In 2012, Merck and Eli Lilly and Co. joined with Janssen Research & Development LLC in the establishment of a global cross-pharmaceutical Investigator Databank designed to improve efficiencies of industry-sponsored clinical trials. Similar to above consortia, the new Investigator Databank will serve as a repository for key information about clinical trial sites, such as infrastructure and Good Clinical Practice (GCP) training records. It is hoped that such synergy will reduce duplication of time-consuming administrative work involved in the identification of appropriate clinical trial sites.

CONCLUSION

Biopharmaceutical research and development is in a state of flux due to internal and external pressures and is facing an unprecedented lapse in productivity. Both financial and social pressure to make the drug development process, including clinical research, more efficient has prompted a growing wave of consortia initiatives among pharmaceutical companies, government agencies, research institutions, and academic medical centers. At its core, technological improvements in standardization and protection of patient privacy, backed by support of policymakers, has brought big data to the forefront in collaborative initiatives. In this review of current trends and potential strategy updates we hope to have increased awareness of challenges and potential solutions. Each alternative has specific hurdles but also significant potential for increased productivity. We will be watching closely to see how the industry responds and what proves successful in the long term.

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APPENDIX A: SURVEY RESPONDENTS

BLANCHE AND IRWIN LERNER CENTER FOR THE STUDY OF PHARMACEUTICAL MANAGEMENT ISSUES

The Lerner Center is an endowed center established in 2004 at the Rutgers Business School with an objective to promote and facilitate research in economic and management issues in the Bio-Pharmaceutical industry. The Center is overseen by an 11 member external of Board of Advisors. Members of the board are senior leaders (CEOs, Senior VPs, former CEO, Group President etc)

in the bio-pharmaceutical industry. The Center provides Executive Education to the industry executives – both on campus at the Rutgers Business School and customized training on companies' sites. It also hosts a high profile healthcare conference each year with speakers from the government and academia. About 200 executives from the bio-pharmaceutical industry attend the conference. The Center maintains data base of bio-pharmaceutical executives those attended any of the events organized by the Center. Currently, it exceeds over 1,200 in number.

The Center also maintains several data bases acquired from the IMS Health. These data bases are available to the faculty, PhD students and other researchers at Rutgers and elsewhere for conducting their research.

RUTGERS BUSINESS SCHOOL ALUMNI ASSOCIATION

Rutgers Business School is recognized as one of the top MBA programs for Health Care, Pharmaceuticals, and Biotechnology in the world. Rutgers Business School has been able to capitalize on both the location of the school within the pharmaceutical hub of New Jersey and partnerships with leading pharmaceutical companies to build and establish a pioneering pharmaceutical management MBA concentration. The well established pharmaceutical management program has produced alumni, over 250, who have gone on to contribute to major pharmaceutical companies around the world. Many of them are now senior executives in the industry. The alumni networks of both the pharmaceutical management program and the larger school database were leveraged to complete the survey provided.

APPENDIX B: EXECUTIVE SURVEY

Central Questions: What are the changes pharmaceutical companies are making to reduce R&D spending and increase quality product approvals? What are the best practices within the industry? What can the pharmaceutical industry learn from other trailblazing process-oriented industries?

1. Has your company made any process changes within the R&D department in light of external cost pressure?
 - Yes
 - No
2. Has your company done any of the following in an attempt to update their R&D practices (check all that apply or rank)?
 - a. Investing in smaller Biotechs
 - b. Strategic partnerships with a competitor
 - c. Budget cuts

- d. Layoffs
 - e. Focus on internal molecule discovery
 - f. Partnership with academic institutions
 - g. Movement of facilities
 - h. Closing of facilities
 - i. Narrowing therapeutic focus
3. Do you have any specific examples of a particularly successful update to your R&D processes or practices.
(Free text entry)

APPENDIX C

Biopharmaceutical Industry Venture Fund Alliances, 2013		
Biopharma / Associated Venture Group	Venture Fund	Million (USD)
GlaxoSmithKline (GSK) and GSK's Venture arm, SR One	Canada Life Sciences Innovation Fund	\$50
Merck & Co.	Lumira Capital	\$101
Merck & Co.	Teralys Capital	\$50
Eli Lilly	TVM Capital, Teralys Capital, BDC Venture Capital, Fondation, Advantus Capital Management	\$150
Daiichi Sankyo	Kearney Venture Partners	\$180
GlaxoSmithKline (GSK), Johnson & Johnson	Index Ventures	\$200
GlaxoSmithKline (GSK)	Sanderling Ventures	\$250
Novartis, Amgen Ventures	Atlas Ventures	\$265
Merck Research Laboratories (MRL) + Merck Research Ventures Fund	Flagship Ventures	\$270
GlaxoSmithKline (GSK)	Avalon Ventures	\$495