MBA
Competitiveness

PHARMX Innovation Audit

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1. UNDERSTANDING THE ENVIRONMENT

1.1 INDUSTRY OVERVIEW

- The biotech industry is a highly regulated industry. The regulating bodies are the U.S. Food and Drug Administration (FDA), the Environmental Protection Agency (EPA) and the Department of Agriculture (USDA)

- There are 1,473 biotechnology companies in the United States, of which 314 are publicly held with a total market capitalization of $311 billion.

- Biotechnology is one of the most research-intensive industries in the world. The U.S. biotech industry spent $17.9 billion on research and development in 2003

- There are more than 370 biotech drug products and vaccines currently in clinical trials targeting more than 200 diseases.

- International markets accounted for at only 16% of firms' biotechnology-related net sales

- There are only 250 drug approvals from 1994 to 2003 for 1354 companies, which gives an average approval rate of 0.0 177 per company-year.

- The total development time for new drugs has decreased from more than 14 years in the 80's to less than 8 years currently (including the Approval Phase that is approximately 2 years).

- Almost three-quarters of firms (72%) indicated that human health (HH) applications are their primary area of biotechnology-related activity. Therapeutic drugs constitute their area of greatest concentration.

- Some examples of the new biotechnologies that have been developed over the last 15 years are:

    - Bioprocessing
    - Monoclonal antibodies
    - Cell culture
    - Recombinant DNA Technology
    - Cloning
    - Protein engineering
    - Biosensors
    - Nanobiotechnology
    - Microarrays

- The health care applications are primarily the following:

    - Diagnostics
    - Therapeutics
    - Regenerative medicine
    - Vaccines
    - Genomics and proteomics

1.2 INDUSTRY ANALYSIS

The environment in which the industry operates is highly regulated. Firms must constantly be aware of the changing regulatory and legal climate. There are three principle regulatory agencies in the US that regulate the market for pharmaceuticals: the FDA, the USDA, and the EPA. The FDA is the principle agency involved, since it regulates the market for drugs destined for the human health market. Firms wishing to market a drug for the human health market pass through a three-phase approval process that takes on the order of 10 years. The EPA also contributes to the regulatory environment, albeit in a less significant manner, through regulations that affect the use of hazardous materials.

The legal environment is extremely complex. As much of the value in the industry is due to intellectual property, the legal issues related to patent law are of paramount importance. Patents granted do not guarantee protection, since they may be challenged and potentially invalidated, as was demonstrated, for example, by Lilly-PHARMX (the joint venture between PHARMX and Eli Lilly to market Cyalis) who successfully challenged several Pfizer patents covering Viagra in the UK. In turn, Pfizer is suing PHARMX for patent infringement in the US, and the outcome is still uncertain. To complicate matters further, legal considerations concerning the validity of patents are changing, so that firms cannot be sure that current patent defenses will remain sufficient to protect them in the future. Many firms, including PHARMX, conduct research on candidate drugs that are covered by patents with the intent of challenging the patents if the candidates successfully negotiate the FDA approval process. All these complications are amplified when firms export, since the ability to obtain and defend patents depends on the legal system of each country.

In addition to the complexities associated with intellectual property rights, the industry is faced with legal issues pertaining to the protection of confidentiality agreements as well as health-care fraud-and-abuse laws. Confidentiality agreements are ubiquitous, and are formed between employers and employees, consultants, and partners. Health-care fraud-and-abuse laws include anti-kickback and false claims laws, and constitute an uncertain legal landscape, as precedences have not been set.

The industry must also deal with a changing demographic situation. Higher life expectancies and lifestyle changes are altering the market and making therapeutic drugs more attractive. Eastern medicines are also becoming more popular among western consumers.

1.2.1 Porter's Five Forces Analysis

FIGURE 1: PORTER'S MODEL FOR THE BIOTECHNOLOGY INDUSTRY.

Porter's 5-Forces analysis shows an industry that is intensely competitive, as shown by the large number of firms competing and the low rate of profitability in the industry. Rivalry may be eased if a firm specializes in a particular target disease that receives little attention from other firms. However, it is exceedingly difficult to identify a disease that promises a large market (many people suffer from it) and that is not already targeted by a significant number of biotechnology and pharmaceutical firms.

Entry into the industry is difficult due to the large capital requirements necessary to sustain a company over the long periods required to develop drugs.

The threat of substitutes is high for the industry (unless a firm specializes in a niche market drug). It is relatively easy to get around patents, and many biotech products have cheaper chemical alternatives. In addition, when patents expire (which may be only a matter of a few years after drug approval) generic drugs enter the picture and offer cheaper substitutes.

Since the main source of value for biotech firms is intellectual property (patents), the main supplier for biotech firms are universities that produce scientific talent. The market for this talent currently is a buyer's market, which weakens the supplier's position. Another input into the process is scientific equipment, which cannot be counted on to produce a competitive advantage since all biotechnology companies may purchase state-of-the-art instruments. Again, the advantage falls in the camp of the biotechnology companies. However, going against the biotechnology companies is the fact that they are, for the most part, reliant on large blue-chip pharmaceutical companies for production, marketing, and distribution of their products. They therefore often will license their discoveries to these large companies. The power here is, for the moment, in the hands of the large pharmaceutical companies who can supply not only the route to the market, but much needed cash for the biotechnology companies.

Regarding the buyers, the power is split between the biotechnology companies and their customers. The large customers (government and hospitals) have considerable buying power and are able to squeeze the margins of the drug producers. Doctors and pharmacists are not price sensitive since they do not pay the bill for the drugs. Hence they exert less pressure on the margins, but require greater differentiation to win them over as customers. At the end is the final consumer, who has no power over the price of the drug and typically is not in a position to bargain. As a whole, the power appears to lie more with the biotechnology companies in this relationship.

1.3 INNOVATION IN THE INDUSTRY

With the advance of science, in particular in the field of genomics, developing novel medicines that are safer and more effective is becoming easier. The path from gene discovery to therapeutic candidate is becoming ever shorter (in some cases a few months).[1] This trend, it is claimed, will cause the disappearance of the one-drug, one-technology companies. Instead, companies that can create, interpret, and apply data will dominate. Hence companies that possess technologies that improve the drug discovery process will be well positioned to meet the demands of the market of the future.

These dynamics are driving the formation of new business models with characteristics that are different from the current models. Existing pharmaceutical and biotech companies are expected to fragment and be replaced by completely different organizations, as depicted below in Figure 2.

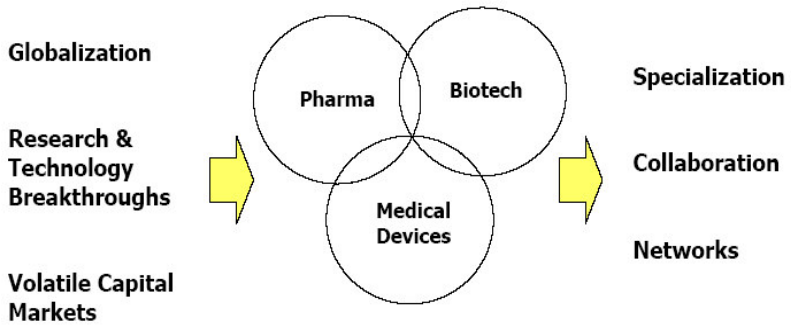

FIGURE 2: PHARMACEUTICAL INDUSTRY DYNAMICS AND CONSEQUENT EVOLUTION.

The new organizations will arise from the fusion of existing pharmaceutical, biotechnology, and medical device companies. These new companies will find themselves in an environment where specialization, collaboration, and networks are the ingredients of success. This decoupling of the value chain, depicted in Figure 3, will give rise to new business models. It will no longer be possible to be a completely vertically integrated company, as is exemplified in today's big pharmaceutical companies.

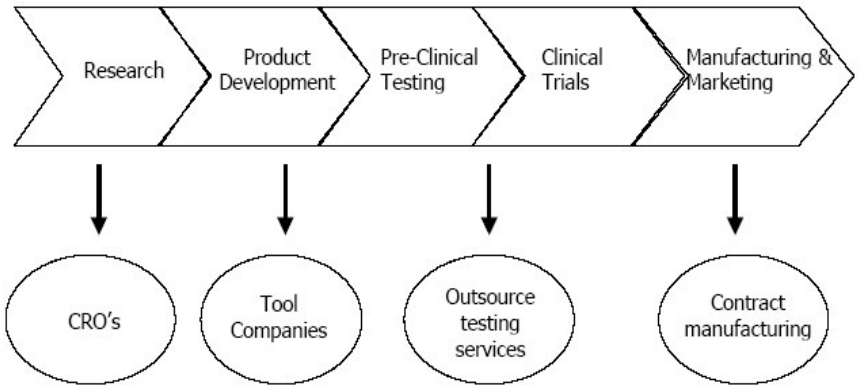

FIGURE 3: NEW VALUE CHAIN FOR PHARMACEUTICAL INDUSTRY. NOTE: CRO = CONTRACT RESEARCH ORGANIZATION.

The product development cycle will also be altered by the new dynamics of the market, as depicted in Figure 4 below. Whereas the cycle historically resided within one company, it is being split between different organizations.

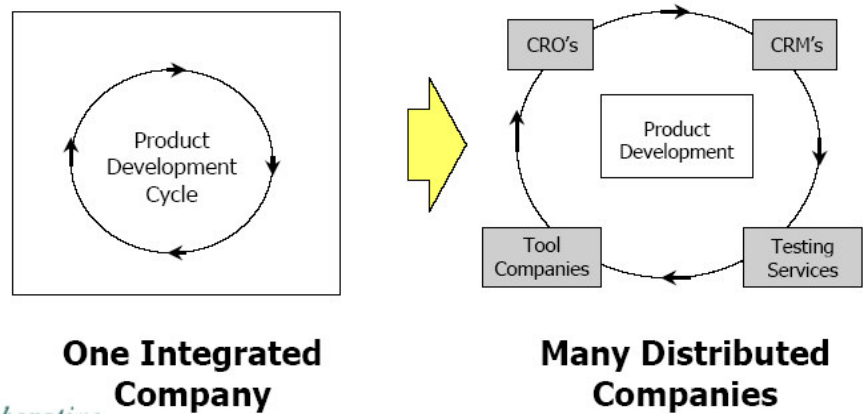

FIGURE 4: EVOLUTION OF PRODUCT DEVELOPMENT LIFECYCLE. NOTE: CRO = CONTRACT RESEARCH ORGANIZATION; CRM = CUSTOMER RELATIONSHIP MANAGEMENT.

1.4 TRENDS FOR THE FUTURE

1.4.1 Changing Demographics

Countries such as United States, Japan and Europe are facing ageing population; 450 million people are over 65 (7% of global population) and this number will double by 2020. In addition, immigration has increased significantly in the US for example which means more opportunities for Hispanic people

1.4.2 Individual Medical Treatment

One major problem is that drugs often do not have the expected effect; about USD 100 million are wasted every year in the United States alone because patients take drugs that are ineffective or have serious side effects. It is therefore perfectly plausible that doctors could treat you and I more effectively if the difference between us could first be determined with the aid of a lab test, enabling them to prescribe the most effective — personalized — medicine for each of us

1.4.3 The rising importance of Diagnostics

A third trend is the huge progress made by modern diagnostics, especially in combination with pharmaceuticals. Diagnostic procedures will continue to gain importance, allowing the earliest possible identification of predispositions for certain diseases and, as we have just seen, more effective treatment. Increasingly, this will include disease prevention.

1.4.4 Networks Pharma - Biotech

As pharmaceutical firms increasingly depend on biotechnology companies to improve their pipeline of products, biotech firms in the U.S. and Europe will gain leverage in negotiating strategic partnerships and licensing terms.

1.4.5 Global Competitiveness

European markets are reaching a level of balance, however there are still some global unease about genetics, consumer products and untested science. Besides, mergers and acquisitions are driving the global perspective of the market.

1.4.6 Consumer Empowerment

Internet portals empowered customers as well as general awareness of benefits and outcomes of the companies' products, so greater communication and education to avoid misunderstandings is imperative.

1.4.7 Convergence

The most obvious convergence is the bioinformatics where biotech and information technology are becoming blended. Convergences strategies suggest embedded approaches to form spin-offs and will require different skills sets and competencies.

1.4.8 New Economy Characteristics

Expectations for immediacy of resolution, access to experts and on-going ability to tap knowledge puts increased demands on networked business. Speed and flexibility foster a different pace of discovery, innovation and linkages to research patient-production. Networks are the new form of building relationships, coalitions and industry-entrepreneurial efforts connecting assets, people, institutions and resources.

1.4.9 E-Technologies

Firms will expand their use of e-technologies to reduce the length and cost of clinical development by improving the investigator site selection process, reducing delays in recruiting patients for clinical trials, lowering trial monitoring costs, and permitting quicker, cheaper collection of clinical trial data.

1.4.10 Biotechnology Products Trends

- Biotech firms will intensify their focus on the development of treatments for serious and life threatening diseases, especially in oncology, due in part to the availability of fast track designation.
- Use of gene-silencing technology (RNA interference) for identification of therapeutically important targets for biopharmaceutical and small molecule drugs will increase.
- Prophylactic vaccine product development will increase as concerns about bioterrorism prompts increased demand by the federal government for these products.
- Therapeutic cancer vaccines may become a reality.
- Success rates for humanized monoclonal antibodies suggest that 10 of the products currently in development will be approved for marketing within a few years.

2. UNDERSTANDING PHARMX

PHARMX Corporation is an early stage U.S. biotechnology firm specializing in the discovery and development of innovative therapeutic products, primarily for chronic inflammatory diseases. PHARMX was established in 1989 and is publicly traded on the NASDAQ exchange. It currently has one product on the market, Cyalis, which is a therapeutic drug for erectile dysfunction. It competes directly with Viagra from Pfizer.

The company's objective is to become a "leading biopharmaceutical company focused on the discovery, development, and the commercialization of innovative drugs".[2] They concentrate on drugs for which a large potential market exists.

The Strategic Position and Action Evaluation (SPACE) diagram for PHARMX is shown below in Figure 5. The outcome of the analysis puts PHARMX squarely in the competitive quadrant, which suggests that the strategic imperatives for PHARMX would be to improve their financial position and reduce exposure to environmental threats.

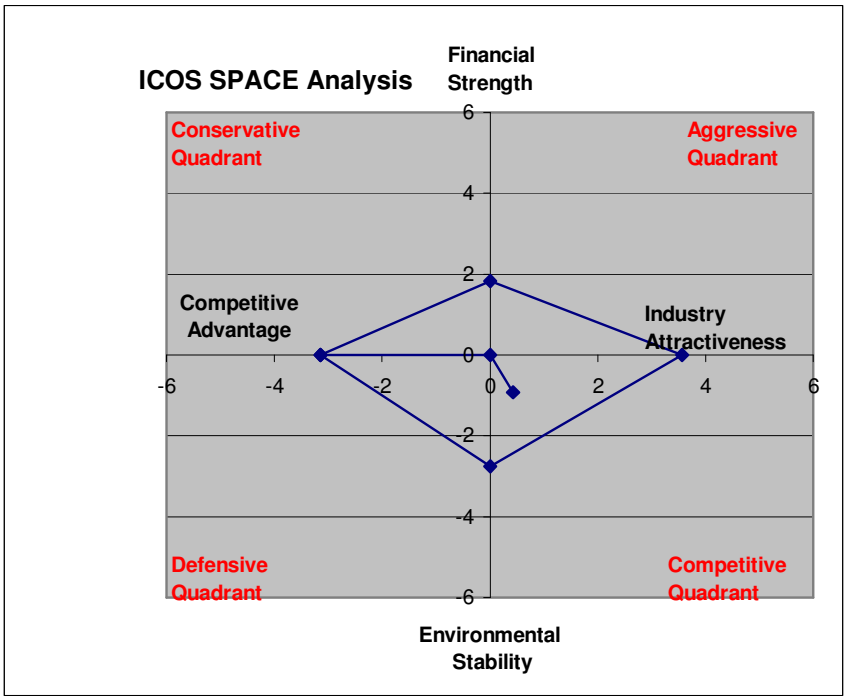

FIGURE 5: SPACE DIAGRAM FOR PHARMX. THE POINT AT (0.4, -0.9) DENOTES THE FINAL SPACE VECTOR.

PHARMX has been publicly recognized as an innovative company. For example, they came in third on Inc. Magazine's list of innovative companies in US for 2002, and their drug for treating erectile dysfunction, Cyalis, made Time Magazine's list of "coolest inventions" for 2003. In what follows we will analyze PHARMX's innovative capacity to see if these accolades were warranted.

2.1 RESOURCES

2.1.1 Capital

In 2003, the R&D budget for PHARMX stood at $85.8 million, much higher than the industry average of $17.9 million.[3] As shown in Table 1, a high level of R&D expenditures has been the norm at PHARMX over the most recent years.

TABLE 1: THE ANNUAL R&D BUDGETS FOR PHARMX AND THE INDUSTRY AVERAGE FOR THE YEARS 1999 THROUGH 2003 ($ MILLIONS).

	2003	2002	2001	2000	1999
PHARMX	$ 85.8	$ 129.4	$ 99.0	$ 83.0	$ 96.7
Industry Average	$ 17.9	$ 20.5	$ 15.7	$ 14.2	$ 10.7

Normalized to revenue, the 2003 PHARMX R&D budget stands at 114%, which is comparable to the five-year average of 115%. This figure is much higher than the industry average that stands at just 54% over the same period. Also significant is the fact the PHARMX's R&D budget withstood the effects of the weak economy after the burst of the internet bubble and the terrorist attacks of 2001, a trend that is apparent throughout the industry.

Per employee, however, PHARMX's R&D expenditure is more in line with the industry average. With 675 employees in 2003, the R&D expenditure per employee at PHARMX was just over $127 k in 2003, which is only some 20% greater than the industry average of $105 k. However, if we consider that PHARMX maintains a marketing department with approximately 200 employees[a], we arrive at an expenditure level of $181 k per (non-marketing) employee.

The figures cited above indicate that PHARMX capital resource allocation is largely sufficient to support an innovative R&D department.

2.2 CAPABILITIES

2.2.1 Targets

PHARMX's core competencies lie in research and development of drugs for the following target families:

- Chronic obstructive pulmonary diseases;
- Cancer;
- Inflammatory diseases;
- Infectious diseases.

When searching for a new target for which to develop a drug, PHARMX scientists essentially are constrained to search within these four target families. This approach appears wise from a business perspective, because the core competencies of PHARMX lie in these domains. However, the strategy has the potential drawback of putting institutional blinders on its scientists, preventing them from exploring further afield where they may perhaps make valuable discoveries.

An example of this effect is well illustrated by the history of the development of Viagra (and Cyalis).[4] Both drugs reached their final development stages in the mid-1990's, and neither was

[a] Personal communication with R. Vazeux, PHARMX Senior Scientist and Product Leader.

targeting erectile dysfunction at that time (the market was not considered sufficiently large to be interesting). Pfizer was testing their drug for hypertension, and was disappointed when it failed the final clinical trials. However, they were surprised to discover that the patients who were involved in these trials repeatedly requested further samples of the drug. It was in inquiring why the patients were interested in their drug that Pfizer discovered its value for treating erectile dysfunction.[b] PHARMX and GlaxoSmithKline proved no less clairvoyant. As it happened, six months prior to the discovery of Viagra's potential in treating erectile dysfunction, GlaxoSmithKline severed their relationship with PHARMX and abandoned all claim to the relevant intellectual property. Thus PHARMX found itself in the fortuitous position of owning all intellectual property rights to Cyalis, and discovered through the experience of Pfizer that this drug had a significant market potential as a treatment for erectile dysfunction.

Hence both Pfizer and PHARMX appeared to suffer from a tunnel vision that prevented them from identifying and exploring other potential uses for their drug candidate. This is an excellent illustration of the danger of imposing institutional blinders that discourage operational personnel from taking initiative and exploring alternative solutions, and is a lesson PHARMX should heed in the future.

2.2.2 Patents

For an objective measure of innovative capacity, we analyze the patent record of PHARMX. Since its founding, PHARMX has obtained 142 patents with the U.S. Patent and Trademark Office, for an average of 11.8 patents per year. This compares quite favorably with the industry average of 4.4 patents per year over the same period, which would suggest that the innovative capacity of PHARMX is significantly above the norm for the industry.

While this is an encouraging sign for PHARMX, one must look at the price paid to obtain this patent portfolio. With 675 employees, PHARMX required 67 employees per patent in 2003. The industry average (in 2002) was 25 employees per patent. This ratio of 67:25 (or 2.68) agrees remarkably well with the advantage that PHARMX enjoys in the generation rate of patents, which is 11.8:4.4 (also 2.68!). Furthermore, the cost per patent in 2003 for PHARMX was 3.25 times the average for the industry ($8.58 million compared to $2.64 million). Hence it would appear that PHARMX is not significantly more innovative in R&D than the industry average, but rather that they devote more resources (financial and human) to the problem.

Of course, one may view this approach of dedicating greater than average resources to the drug discovery process as an innovative management strategy. In this light, PHARMX may be considered remarkably innovative since their patent generation rate is triple the industry average.

Another point worth discussing is the value of the PHARMX patent portfolio. To measure the worth of a patent, we use the number of external forward citations (external means citations from non-PHARMX organizations), and the number of scientific references made by the patent. There is ample evidence in the literature that patent forward citations can be used as a proxy for the economic value of a patent,[5] and that scientific intensity[c] is positively associated with a firm's subsequent financial performance.[6]

PHARMX patents average 1.2 external citations per patent.

[b] A similar story is behind the discovery of the Propecia, Pfizer's drug for hair-loss.

[c] The term scientific intensity refers to the number of references a patent make to original scientific work.

Of the 142 patents in PHARMX's portfolio, 90 are not referenced by any other patent. Of the remaining 52, the distribution in the number of external references is shown in the figure below, which shows, for example, that some 22 PHARMX patents have received on external citations and 10 have received 2 external citations. Only about 15, or 10% of the entire patent portfolio, have received 5 or more external citations.

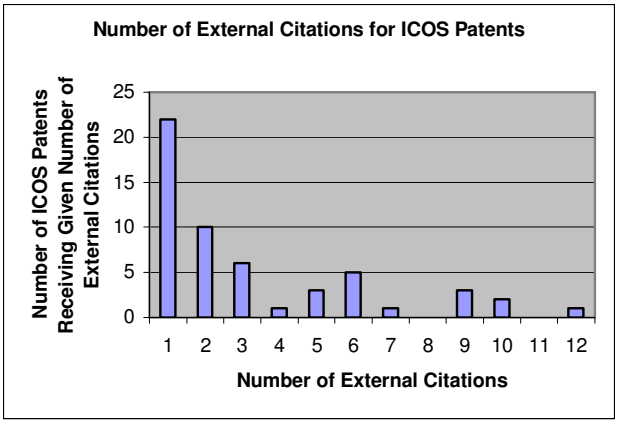

FIGURE 6: THE DISTRIBUTION OF EXTERNAL CITATIONS FOR PHARMX PATENTS.

However, it must be noted that recent patents are less likely to be cited than older patents, since their existence in the public domain is more brief. In Figure 7, we show all PHARMX patents, and the number of external citations for each. The Figure shows a sharp drop in citation numbers around September of 2002. This drop is not likely to be due to a sudden decrease in the quality of research done at PHARMX, but is more likely to be due to the shorter time that these patents have been in the public domain.

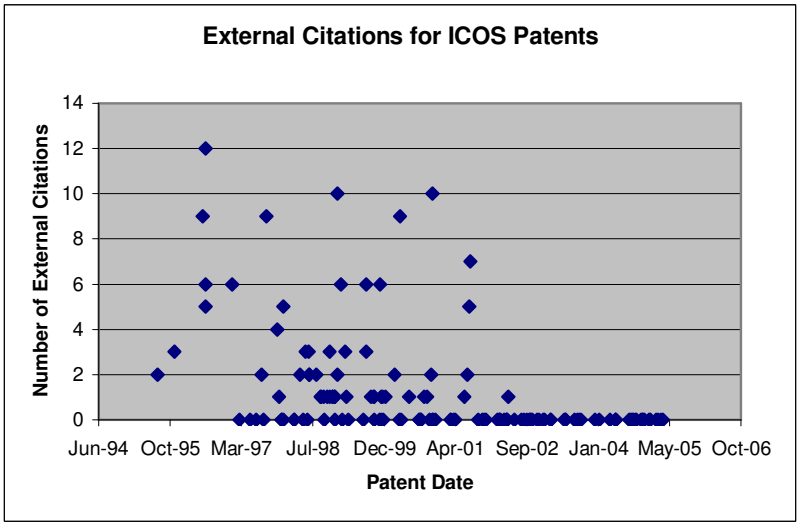

FIGURE 7: EXTERNAL CITATIONS FOR PHARMX PATENTS.

If we consider only patents awarded prior to September of 2002, we find that PHARMX patents are cited an average of 1.7 times by external sources. This seems extremely low. In survey of 116 U.S. biotechnology firms from 1988 to 1995, Gittelman et al. found a mean number of patent forward citations of 12.3. This comparison suggests that the PHARMX patent portfolio is not of high economic value and does not represent important innovative work. A more careful analysis is warranted, but is unfortunately not possible since your authors were unable to obtain access to a patent statistical package (e.g. Derwent Biotechnology Abstracts).

Finally, we note that PHARMX patents make references to scientific publications an average of 51 ± 41 times. This compares favorably with the mean scientific intensity found in survey by Gittelman et al. of approximately 40. This suggests that PHARMX is poised for strong financial performance. However, the caveat mentioned in the previous paragraph applies here as well.

2.3 ORGANIZATION

To develop drugs, PHARMX uses a matrix organization that allows researchers to apply an integrated scientific approach to target areas of research. Each product candidate falls under the responsibility of a product leader. This person is a scientist and, typically, is the one that discovered the candidate and the one that will lead the effort to get the candidate to the market. Hence this person is intimately involved with essentially one product for an extended period (can be as much as 10 years, if the product candidate is successful). Working with the product leader are other scientists who are specialists in given areas, such as biochemistry, synthetic chemistry, robotics, pharmacology, etc. These specialists work with several product candidates and are thus not as intimately tied to any particular candidate. This organization has the advantage of providing cross-functional interaction, which increases the adaptive capacity of the participants and hence serves to fertilize the mental landscape, thus increasing the probability that innovation will flourish.

2.4 PEOPLE

2.4.1 Leadership

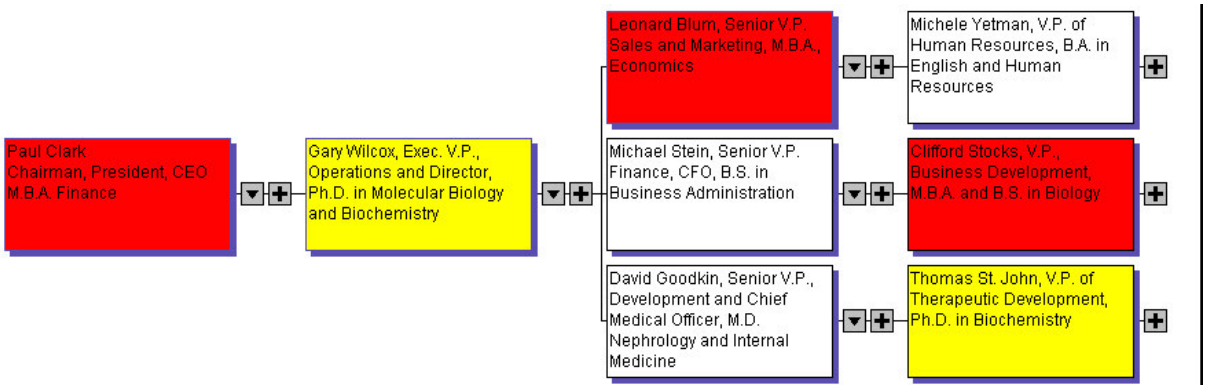

FIGURE 8: PHARMX EXECUTIVE HIERARCHY

The executive hierarchy for PHARMX is shown above in Figure 2. The executive team of PHARMX is composed of 2 Ph.D. scientists (in yellow), 3 people with M.B.A. degrees (in red), 2 more with undergraduate degrees in business, and one physician. The Chairman, President, and CEO, Paul Clark, is a specialist in finance and has extensive experience in the pharmaceutical industry, but no scientific credentials. The second man in the hierarchy is Gary Wilcox, a Ph.D. scientist specializing in molecular biology and biochemistry. Of the entire executive team, he is the only person to have experience as a founder of a company.[d]

The next level of the hierarchy boasts not a single person with a research background, but people whose experience lies in business and health-care. There is an M.B.A. economist who directs the

[d] In 1982 Dr. Wilcox co-founded International Genetic Engineering, Inc., which was acquired by XOMA Corporation in 1989.

Sales & Marketing Division, a physician who is the Chief Medical Officer and the V.P. of Development, and a finance specialist who is CFO. The physician, Dr. Goodkin, is an internist and a Fellow of the American College of Physicians, a distinction awarded to doctors that are committed to continuing their education in medical practice, research, or teaching.

The least senior level of the executive team contains one Ph.D. scientist, one person with a scientific undergraduate degree and a M.B.A., and a last person with business background.

We thus find that top leadership positions at PHARMX are filled primarily with businessmen with no scientific training or research experience. These appointments suggest a slight emphasis on the business side of PHARMX (finance, marketing) rather than on the scientific side, to the detriment of the product innovative capacity of PHARMX. It is hard to imagine the high caliber scientists working at PHARMX taking seriously when a proclamation from the CEO that PHARMX is dedicated to "brining innovative therapeutic products to patients".[7]

In addition, the fact that only one member of the executive team can boast of an entrepreneurial background suggests that the leadership's attitude towards risk is likely to be conservative. More about this will be said in the following section.

2.4.2 Values

The mission statement of PHARMX is

> *"To target serious unmet medical needs – and to address those needs with novel, effective products that can improve the quality of life for millions of people".*

In the PHARMX Annual Review for 2003, the first sentence claims that PHARMX is "dedicated to bringing innovative therapeutics to patients." In the 2003 Form 10-K the word "innovative" appears twice on the first page, and the objective given for PHARMX is

> *"To become a leading biopharmaceutical company focused on the discovery, development, and commercialization of innovative drugs."*

These statements suggest that senior management is aware of the value of nurturing the innovative capacity of PHARMX. However, the evidence is not clear as to whether these statements accurately reflect the true values of PHARMX.

Certain aspects of PHARMX suggest a dedication to supporting an innovative climate. For example, as discussed above, the use of a matrix structure to organize the product development teams enhances the innovative capacity of PHARMX. Employees are also encouraged to maintain their adaptive capacity through a continuing education opportunities and an educational assistance program. As part of the continuing education program, scientific guest speakers are invited 4 times per month to present their work to PHARMX scientists. In addition, PHARMX scientists are encouraged to give internal seminars on their research. The educational assistance program allows employees to be reimbursed for tuition should they wish to pursue further education. By maintaining the adaptive capacity of the scientists, these programs enhance their innovative capacity. Equally important, they send a signal throughout the company that innovation is valued and supported.

Other efforts to improve the innovative capacity of PHARMX include measures to facilitate the transfer of tacit knowledge between employees. These include a casual dress environment for all employees, even senior management, a tactic that reduces the power-distance thereby facilitating knowledge transfer. There are also numerous company-sponsored social activities, such as sports teams, company parties, and celebrations in honor of company milestones. Employees are also encouraged to partake in the planning of social events, which is touted as an excellent way to meet

colleagues and to develop friendships and collaborations. All of these efforts are geared towards facilitating socialization in order to maximize the circulation of tacit knowledge within the company.

However, while PHARMX celebrates company milestones, there is no celebration for failure, which is an inevitable part of research. PHARMX and its scientists set out on the drug development trail knowing full well that the majority of development efforts will fail (statistically, only 15% of biopharmaceutical products make it through the pipeline[8]). Product Leaders are likely to spend years working to develop a particular drug, only to have the program canceled for economic or medical reasons, obliging them to abruptly change focus and return to the starting point of searching for a new drug candidate. This failure is not seen in a positive light at PHARMX.[e]

This reluctance to accept failure as a necessary part of research sends the wrong signals to the people who conduct the research. Knowing they are likely to be penalized for failure, they become less bold, less confident, and will refrain from embracing ideas that do not emanate from well-trod intellectual fields. This stifles innovation.

In this aspect of the PHARMX culture one feels the hand of management team overly focused on financial issues. While a negative reaction to failure may make sense from a financial standpoint, where one is of course reluctant to waste resources, from a standpoint of innovation and research this reaction is counter-productive. To encourage innovation, PHARMX management should take a page from Bayer and celebrate failure as they do success.

2.4.3 Recruitment

Since "scientific research and development is at the heart of [their] business",[9] the recruitment of scientific talent is vital to the success of PHARMX. For this reason the recruitment practices of PHARMX constitute a revealing indicator of the company culture.

In recruitment, PHARMX obviously looks first for scientific alignment of the candidate with the position. With this criteria satisfied, the recruitment decision is based largely on the candidates potential to fit into the team with which they will work. No professional personality profiling is done to aid in this judgment, but the ability to "get along" is valued.

This recruitment strategy likely results in building a team of like-minded individuals, which can lead to groupthink and a reduction in innovative capacity. The creative abrasion that is useful for innovation is not likely to occur in such a group.

In addition, scientific candidates are recruited on the basis of their "academic" credentials (publications, conference presentations, peer review…). While this is certainly important, it is not everything. There is no objective measure of innovative capacity of the candidates.

2.5 PIPELINE

PHARMX has one product candidate in phase 3 of development, one in phase 2, eight in the preclinical phase, and one in the research phase. Without a budget for obtaining quality pipeline statistics we are obliged to satisfy ourselves with the limited information shown in the table below, which is taken from the Revere Consultancy[10] web site. The table compares the PHARMX pipeline with that of 16 biotech companies.

[e] Personal communication from R. Vazeaux, Product Leader and Senior Scientist at PHARMX.

TABLE 2: A COMPARISON OF THE PHARMX DEVELOPMENT PIPELINE WITH THE AVERAGE TAKEN OVER A SAMPLE OF 16 BIOTECH COMPANIES.

	Phase I&II Preclinical	**Phase III FDA Filed**
PHARMX	10	1
Sample Average	6.2	2.8

The data in the table indicate that the PHARMX pipeline is strong in the early phases, but weak in the late phases.

3. RECOMMENDATIONS FOR INNOVATION

While PHARMX has proven itself an innovative organization in many respects, there are areas where improvement is possible, specifically in its attitude towards risk, its recognition of patents, and its recruitment policy.

3.1 RISK ACCEPTANCE

When product candidates fail, the weight of the failure is borne almost entirely by the product leader. This person must not only accept the failure of years of work, but must muster the courage to return to the starting point and search for a new product candidate with which to begin the research and approval process anew. The failure is not a positive mark on the record of the product leader.

This attitude towards failure is counter-productive, especially considering that, on average, only 15% of the product candidates successfully negotiate the approval process. The leadership of PHARMX must recognize the inevitability of failure in research, and the valuable lessons that failure often brings to the organization. The leadership should publicly acknowledge and stress the positive aspects of failure, and instead of chastising their best scientists when failure occurs, they should be congratulated on the value they have brought to the company through the learning that comes from failure. Such an attitude would lift the unwarranted stress from the shoulders of the product leaders – a stress that inhibits innovation. In its place a culture of risk acceptance would grow, encouraging researchers to challenge themselves and explore beyond their traditional boundaries. This would increase the innovative capacity and the long-term value of PHARMX.

The implementation of such a policy need not be overly complicated. As mentioned above, some companies throw parties to "celebrate" the cancellation of a product candidate. Another approach, not necessarily orthogonal to the party approach, would be to require the product leader to give an internal seminar detailing what he/she sees as the reasons for failure, and the reasons why the failure was not detected earlier. Other approaches are not excluded, as long as they fulfill the requirement of recognizing that failure is an inevitable, and in many cases beneficial, part of research.

3.2 PATENT RECOGNITION

In an industry where value resides primarily in a company's intellectual property, the fact that PHARMX does not provide official recognition of the primary contributors to its IP portfolio is curious. While obtaining patents will enhance a researcher's prospects for promotion, there is no further incentive for them to obtain patents for PHARMX.

To address this situation, PHARMX should institute a policy to reward researchers who obtain patents. An incentive system that encourages researchers to patent may include monetary rewards, although these are typically not the most effective for inciting the desired behavior in technical professionals. Public recognition of the value that the researchers bring to the company through their patents would likely prove an effective way to promote the obtaining of patents. Such a system should be sensitive to the value of the patents, using, for example, such measures as were discussed above to evaluate a patent's value.

3.3 RECRUITMENT POLICY

The current recruitment policy at PHARMX stresses conformity and teamwork. No effort is made to blend different personalities into teams with an eye to increasing the creative potential of the team. Instead, by searching for people who will not rub the current team members in the wrong way, PHARMX is promoting an environment where group think may flourish, leading to a decrease in innovative capacity.

To counter this effect, the recruitment policy of PHARMX needs to be modified. New recruits should of course possess the necessary scientific talents, but in addition be vetted to ensure that they will fit into a team that is creative. To build creative teams, the personality types of the current team members should be established, for example by using the Meyers-Brigg Test. New recruits could then be sought to fill in the missing personality types, leading to more balanced teams with a healthy amount of creative abrasion. Such teams would be more likely to produce innovative work than a team of like-minded individuals.

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