Arrowhead Research Park

Business Analysis

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Executive Summary

Introduction

In the early 1980s, New Mexico State University (NMSU), like many major research institutions, recognized the potential benefits of developing a research park. At other institutions of higher education, such parks play a critical role in expanding research activity, transforming university-related research and development into commercially viable enterprises, and promoting state and local economic development. With the experience of other research parks in mind, Arrowhead Research Park (ARP) was created in 1989 to enhance NMSU's status as a major research university and to promote economic development within the state. Although there is great potential for success in this effort, ARP has not yet lived up to it. NMSU has not made the research park a priority, has invested little to foster its success, and, as a result, has received few benefits.

Arrowhead Research Park is a key component of a larger process of taking research ideas from the university community and transforming them into economic opportunities. ARP should be viewed as the physical and visible presence of NMSU's commitment to the wealth creation process. Without an active and successful research park, NMSU's creation of commercially viable intellectual property will continue to benefit firms and regions located mostly outside southern New Mexico and the state as a whole. A research park cannot guarantee the commercial or economic success of NMSU's intellectual property, but without such a park, the probability of transforming this intellectual property into technology-based economic development in NM is greatly diminished.

This business plan proposes a strategy for a successful and viable ARP.

ARP should not be evaluated only on the basis of its ability to generate positive net cash flow, as it is unlikely that this will occur in the near future. The research park should be viewed as a relatively small investment that can produce large positive effects for the university and the region. From the University's point of view, ARP can: expand opportunities for faculty development; expand real-world educational opportunities for students; transfer new expertise and knowledge to and from the university; facilitate the recruitment and retention of faculty, particularly in fields with high private sector demand; enhance the relationship among the university and the local and regional communities; and increase the number of funding sources available to the University. From the local economy perspective, ARP can expand employment through the provision of goods and services to the park and through the increase in businesses that will be created and fostered by the existence of the park.

The proposed vision of NMSU Research Park Corporation is:

> "By 2010, the NMSU Research Park Corporation will be managing ARP as an active research park with: new buildings housing both start-up and pre-existing companies; an increased employment level, including faculty and students; new research contracts with tenant companies; graduation of companies from the research park to the local economy; established outreach programs; and an attractive place to do business."

The Plan

Five major actions are critical to the success of ARP and the attainment of the vision. The five actions outlined below should be considered as a set of necessary conditions for the success of ARP, but not a set of sufficient conditions. In other words, implementing the action plan's steps does not guarantee success (although non-implementation virtually assures failure). In any event, ARP's success depends on the cooperation, participation, and support of all NMSU sectors.

Action Step1: Hiring a Management Team for ARP

Two full-time managers are needed to focus their attention on managing and growing ARP. One person will act externally to promote ARP and NMSU, and the second will manage ARP internally. These managers need to be familiar with research parks and technology incubators and be capable of assisting tenants along the path toward technology commercialization. The duties of the park managers include, among others, marketing ARP, planning the park's development, acting as a liaison between tenants and other parts of the university, and acting as liaisons between tenants and providers of business services.

Action Step 2: Investing in ARP Infrastructure

ARP presently has just one tenant (General Dynamics), and Genesis Center has 12 tenants. The park currently appears as nothing more than a short road in the middle of the desert and is marked only by a small wooden sign. Possible tenants may reasonably assume that this is not a successful research park and question a move to the ARP.

Additional buildings must be erected as quickly as possible to make the area worthy of being considered a research park. The new director should intensify efforts to find those companies that are large enough to occupy stand-alone buildings. Construction of a 40,000-45,000-square-foot multi-tenant incubator building should be considered. Grant monies and matching funds are possible funding sources, and lease payments can offset any loan payments. This structure could serve as a flagship building that indicates NMSU's dedication to the success of ARP. The Genesis Center buildings will complement the new stand-alone, multi-tenant incubator. Operational funds will be needed to maintain and grow the park.

The property requires considerable improve-ments in landscaping, signage, and amenities to make the park attractive to possible tenants.

Action Step 3: Ensuring that ARP Controls ARP Property

To accomplish its goals and develop the property to its potential, NMSU Research Park Corporation (RPC) and ARP should have control of the entire 257-acre property. This accomplishes three things. First, it ensures that the corporation can make plans for the entire research park property in a timely and efficient manner. The development plans should be under the direction of the Board of Directors of the NMSU Research Park Corporation. Second, ARP's control of the research park property allows revenue generated on any of the 257 acres to accrue to the ARP. This enables the ARP to have a revenue stream to fund growth that meets goals. Third, control of the research park property allows the ARP to coordinate the use of the Genesis Center with the proposed new incubator building and future development. Although the existing Genesis Center is not a prototypical incubator building, it is ideal for certain clients.

Action Step 4: Optimizing ARP's Location in the NMSU Organizational Structure

Currently, ARP is under the direction of the NMSU Research Park Corporation that reports directly to the Board of Regents of NMSU. The Genesis Center is under the control of the Vice Provost for Research. The role of developing intellectual property generated at the university has been assigned to the Arrowhead Center, which operates under a board of directors reporting directly to the Board of Regents. Meanwhile, the role of technical incubation has been given to the Physical Science Institute (PSI), a part of the Physical Science Laboratory that has its own line of control to the Regents of NMSU.

Although there may be reasons for this administrative structure, it certainly does not leverage or catalyze the synergy between the organizations that would allow ARP to succeed. Because the incubation services and the research park have the most in common, it is suggested that the NMSU RPC, the Genesis Center, and ARP have one board of directors. Moreover, because it is primarily an engine for economic development, we recommend a restructuring such that the NMSU RPC and ARP fall under the Vice-Provost for Economic Development's purview and, more specifically, the Arrowhead Center (AHC), which has its own board of directors.

Action Step 5: Review of All Policies and Procedures With Regard to Working Relationships with ARP

The literature on technology commercialization stresses nurturing an innovation culture on campus. All relevant NMSU policies and procedures should be reviewed and rewritten as appropriate to encourage faculty and staff to participate in these activities. Those already involved in research should be encouraged to consider how research could be commercialized, and incentives should be in place to reward them for doing so.

Financial Projections

The expected cash flows associated with the foregoing action plan are presented for the period June 30, 2005 to June 30, 2010. The base analysis includes hiring two full-time personnel and a full-time administrative assistant, constructing a new business technology incubator building, and improving the appearance of the existing park with landscaping and signage.

The base-case scenario generates a positive net cash flow of $26,337 in 2010. From 2006 to 2009, yearly operating net cash flows are negative and accumulate to -$457,394. In 2010, it is projected that 24 companies will be operating in Arrowhead Research Park and the total employees will number 110.

Arrowhead Research Park faces numerous risks, some of which can be incorporated into the pro formas and some that cannot. These risks can be divided into three broad categories: business risks, financial risks, and political risks.

Business risks can arise from an insufficient number of tenants or from the commercialization process within the university. Financial risks arise from the inability to repay debt principal and interest. Political risks arise from the fact that ARP requires the cooperation of many individuals from across the university, from business, and from government sectors.

A cash flow sensitivity analysis indicates that under a set of the most pessimistic assumptions, the net cash flow is still not positive for the year 2010 and equals -$287,629. The accumulated cash flows for 2005-2010 equal -$1,617,782 under this scenario. Under the set of assumptions that are considered the most optimistic, the net cash flow for 2010 is a positive $144,687,

and the accumulated cash flows are -$73,730.

The success of ARP is not measured solely by the cash flows generated by the park. In 2010, under the base-case scenario, a total of 24 companies are operating in ARP employing 110 individuals, some students of NMSU. Under the most pessimistic scenario only 12 companies are operating with a total employment of 50. The most optimistic scenario results in 16 companies and an employment level of 118.

Companies locate in the park to take advantage of the proximity to the expertise of the faculty and staff of NMSU. Therefore, research contracts will exist between the companies and faculty and staff of the university. As new ideas and products are developed, licensing agreements and/or equity positions in new companies will generate funds for the university.

It also is anticipated that firms from outside the university will want to locate in ARP to take advantage of the proximity to the faculty and staff of NMSU. Although no firms have

located in ARP recently, ongoing negotiations increase the probability of this occurring in the near future.

Conclusion

An investment in a research park is not without risks. However, if NMSU embarks on a concerted effort to foster the economic development potential arising from its research programs, it must invest in the physical infrastructure and ancillary services of a research park. ARP is an important component of the extended process of taking research ideas from the university and community and transforming them into economic opportunities. A research park cannot guarantee the commercial or economic success of the development of NMSU's intellectual property, but without such a park, the probability of success is greatly diminished. A research park is a necessary element in the transformation of ideas into jobs, income, and wealth.

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List of Abbreviations

AHC	Arrowhead Center
ARP	Arrowhead Research Park
ATDC	Advanced Technology Development Center
AURP	Association of University Research Parks
BTI	Business Technology Incubator
C2T2	Collaborative Center for Technology Translation
CEO	Chief Executive Officer
CHECS-NET	Council for Higher Education Computer/Communications Service Network
DoD	Department of Defense
EBID	Elephant Butte Irrigation District
EDA	Economic Development Administration
Gbps	gigabits per second
ID	invention disclosures
IP	intellectual property
ISIS	Iowa State Innovation System
ISU	Iowa State University
LANL	Los Alamos National Laboratory
MEMS	Micro Electro Mechanical Systems
NASA	National Aeronautics and Space Administration
NBIA	National Business Incubation Association
NBIA	National Business Incubation Association
NCTDI	North Carolina Technology Development Initiative
NCW	Network-Centric Warfare
NM	New Mexico
NM Tech	New Mexico Institute of Mining and Technology
NMSU	New Mexico State University
POP	points of presence
PSI	Physical Science Institute
PSL	Physical Science Laboratory
RPC	Research Park Corporation
RTI	Research Triangle Institute
SBDC	Small Business Development Center
SCRI	South Carolina Research Institute
SNL	Sandia National Laboratories
STC	Science and Technology Corporation
SWOT	Strengths, Weaknesses, Opportunities, and Threats
TLO	technology licensing office
UNM	University of New Mexico
VT	Virginia Tech
VTCRC	Virginia Tech Corporate Research Center
WARF	Wisconsin Alumni Research Foundation
WFU	Wake Forest University
WSMR	White Sands Missile Range

1.0 Introduction

Arrowhead Research Park (ARP) was created in 1989 to enhance New Mexico State University's (NMSU's) status as a major research university and to promote economic development within the state. Although ARP has great potential for success in this, it has not yet lived up expectations. Ongoing research and development efforts, primarily, but not exclusively, funded by federal sponsors, are the genesis of technology-based economic development. In fiscal year 2002, NMSU received research funding totaling more than $120 million. It is estimated that more than $600 million per year is spent on research and development in southern New Mexico. Yet in terms of commercialization, New Mexico has little to show for it. NMSU has not made the research park a priority, has invested little to foster its success and, as a result, NMSU and southern New Mexico have received few benefits from ARP. This business plan proposes a strategy for a successful and viable ARP.

Arrowhead Research Park is a component of an extended process of taking research ideas from the university community and transforming them into economic opportunities. ARP should be viewed as the physical and visible presence of NMSU's commitment to the wealth creation process. Without an active and successful research park, NMSU's creation of commercially viable intellectual property will continue to benefit firms and regions located mostly outside of southern New Mexico and the state as a whole. A research park cannot guarantee the commercial or economic success of the development of NMSU's intellectual property, but without such a park, the probability of success is greatly diminished. A research park is a necessary element in the transformation of ideas into jobs, income, and wealth.

As NMSU embarks upon a concerted effort to foster and retain the economic development potential arising from funded research and development, it should consider additional investments in the physical infrastructure and ancillary services of the ARP. Space and services need to be provided to incubate knowledge generated in the laboratories and to create businesses in New Mexico. Otherwise, as has often been the case in the past, our knowledge will be licensed to firms creating wealth outside of New Mexico. Therefore, the ARP must be developed, marketed, and managed to capitalize upon its most significant asset, which is its proximity to the intellectual capital of NMSU.

ARP is only one, although an important, component in the ideas-to-commercialization process. Basic research generates ideas that could have commercial applications. Further development of those ideas is necessary to develop a product or service and to determine commercial viability. Finally, a business must be formed around the product or service. At best, ARP will break even in providing the physical space and services that can facilitate this process. Benefits will accrue to NMSU in other areas of the process, in the licensing agreements and equity positions in companies, in the employment of faculty and students, and in research contracts. Firms from outside the university, locating in ARP to take advantage of the proximity to NMSU's expertise, also will add to the

employment of faculty and students and the number and amount of research contracts.

Five major actions are critical to the success of ARP. First, a full time management team should be created. Second, additional buildings, services, and facilities should be provided to existing and potential tenants. Third, ARP needs to be transformed into an attractive place to locate. Fourth, the organizational structure should be changed in order for the director to provide efficient and consistent management of the facilities. And fifth, an entrepreneurial spirit should be developed at NMSU, requiring a change in policies and procedures that would encourage faculty and staff to participate in this undertaking.

Research park management duties are not limited to the mundane requirements of ensuring that the facilities are clean, that the air conditioning works, that the tenants pay the rent, or that the grass is cut. Rather, the director must market the park and search for tenants who not only would benefit from a connection with the university, but also would provide a benefit to the university. The director must develop relationships with researchers within the university and agencies and organizations outside the university to find tenants that have the best chance of success. The director also must coordinate services to the tenants once they are in the park. Who at the university can help develop the idea or product? Who can help develop a business plan? Who can provide funding for the business? The director must think about further development of the park. What new facilities need to be constructed? How are those facilities to be paid for?

Failure to accomplish any of these tasks lessens the probability of the park's success.

For a research park to be successful, it must have facilities for tenants to use. Therefore, a flagship incubator/multi-tenant building should be constructed. This would provide space to tenants for incubation of ideas and fledgling businesses. It would have space for the support services needed by the clients. It would send a message that NMSU is serious in its commitment to the idea-to-commercialization process. Other building options are available. Tenants that need a stand-alone building should be recruited. It is possible that existing tenants in the Genesis Center would be willing and able to move to more suitable facilities but not require an entire building. A builder could be encouraged to construct a building knowing that reliable tenants are waiting to move in. As more buildings are constructed, the site will look like a research park and encourage other tenants to locate at ARP.

Regardless of the number of new buildings that are constructed, the park must look attractive to clients. At best, the site presently looks like undeveloped desert with a wooden sign. A site that looks first class will attract first-class tenants. At a minimum, the site needs to be attractively landscaped with a sign that is noticeable and appropriate. The Master Plan for the park includes amenities that would make the park a good place to work, and plans for the provision of these amenities should be implemented.

To facilitate the movement of tenants from incubator services to research park tenants, the director needs to have the authority to provide the services necessary for the success of the park and the tenants. In order to make long-term plans, the director needs to be in a position to make decisions efficiently. Just as in any business, the director must be under the control of a Board of Directors. For the director to efficiently integrate the park into the idea-to-commercialization process, for the director to be able to move the client from

the incubation stage to a resident in the park, to be able to coordinate the services required by the client, the director should be placed in a position to have control of all of these aspects of running the park. This implies that the director will be answerable to one board of directors.

The administration, faculty, and staff of NMSU do not have a culture of entrepreneurship. One of the reasons for this is that some NMSU policies and procedures do not encourage, and may actually hinder, what faculty and staff do in terms of research and the commercialization of research. The primary reason for companies to locate in the park is to take advantage of the intellectual capacity of the faculty and staff at NMSU. If faculty and staff are not encouraged to participate in this undertaking, ARP will surely fail. Relevant NMSU policies and procedures should be reviewed and rewritten to encourage faculty and staff to participate in ARP research and commercialization activities.

The balance of this report will identify the current physical assets of ARP, provide details and rationales to the action steps specified above, and outline the costs and risks associated with the plan.

2.0 Mission Statement, Objectives, and Vision Statement

The New Mexico State University Research Park Corporation (RPC) was created in 1989 in accordance with the provisions of the New Mexico 'University Research Park Act' (NM Stat.Ann. § 21-28-1) for the benefit of New Mexico State University and engages only in activities authorized by the Act that support or benefit New Mexico State University within the meaning and intent of the Section 509(a)(3) of the Internal Revenue Code.

The success of any organization is dependent on how well it articulates its vision and mission and how well it follows through with trying to achieve its objectives.

The proposed vision of the NMSU Research Park Corporation is as follows.

> "By 2010, the NMSU Research Park Corporation will be managing ARP as an active research park with: new buildings housing both start-up and pre-existing companies; an increased employment level, including faculty and students; new research contracts with tenant companies; graduation of companies from the research park to the local economy; established outreach programs; and an attractive place to do business."

The proposed mission of the NMSU Research Park Corporation is as follows.

> "The mission of NMSU Research Park Corporation is to develop and manage the 257 acres designated as research park lands, in accordance with the provisions of the New Mexico 'University Research Park Act;' to enhance the teaching, research, and outreach missions of New Mexico State University; and to provide wealth creation opportunities within the Las Cruces community and southern New Mexico."

The goals and objectives of the RPC are shown in Figure 1.

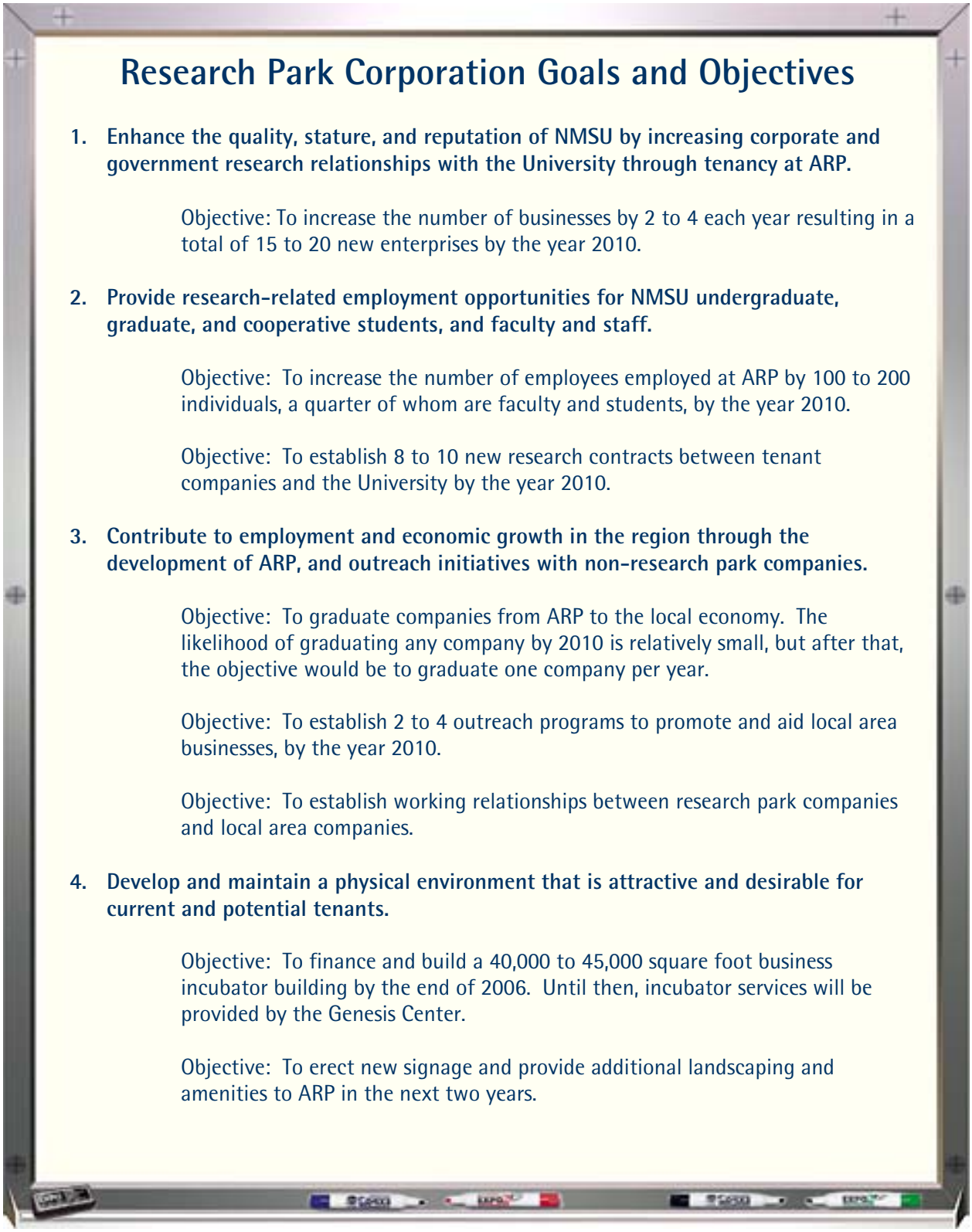

Figure 1. Goals and Objectives for RPC

3.0 Expected Benefits

The development of Arrowhead Research Park is expected to result in significant benefits to NMSU and its tenants. From the university's point of view, ARP will expand opportunities for faculty development; expand real-world educational opportunities for students; transfer new expertise and knowledge to and from the university; facilitate the recruitment and retention of faculty, particularly in fields with high private sector demand; enhance the relationship between the university and the local and regional community; and increase the number of funding sources available to the University.

The benefits that research park tenants can expect are: opportunities to collaborate with faculty; the availability of students and faculty as part-time and temporary workers; availability of students as interns and future workers; access to specialized infrastructure, equipment, and facilities; reciprocal purchase/ exchange of services and knowledge; opportunities to partner with the University in pursuit of grants and contracts; access to business assistance programs (small business development centers, angel funding networks, technology councils, etc.); availability of customized training courses; opportunities to teach; and access to campus and park amenities.

To indicate the possible benefits from a research park, provides information on ARP (the ARP column includes companies that reside in the Genesis Center) and 34 other research parks as reported in the Association of University Research Parks' (AURP) *2003 University Research Park Profile*. The report includes information on 79 parks categorized by the dominant technologies included in the parks. The statistics included in Table 1 are for the research parks that have dominant technologies, including computer/electronics, aerospace/defense, software development, information technology, agriculture, and mixed/other. All those with Medical or Biotech as a major interest in the park were not included because NMSU has neither a medical nor a veterinary school. On average, these parks are almost fifteen years old, have an average size of 746 acres, have 47 businesses located in the park, and have almost 4,800 employees.

Table 1. Research Park Statistics, N=35

	ARP	Averages	Median Values
Age of park (Years)	17	14.8	14.0
Size of park (Acres)	257	746.3	170.0
Number of companies in park	11	47.4	33.0
Number of employees in park	59	4,780.5	1,500.0
Employees per company	5.36	108.1	40.5
Companies per year	.65	3.9	2.6
Capital investment	$2,300,000	$245,621,364	$70,500,000
Number of staff	<1	5.0	3.0
Operating Budget	<$50,000	NA	$200,000-$499,000
Source: AURP 2003 University Research Park Profile			

These averages include a few very large parks. Median numbers may give a better picture of what ARP can become. In this survey, the median park size is 170 acres, has thirty-three companies, and a total of 1,500 employees.

ARP has been in existence longer, on average, than most of the other research parks. Because it has fewer companies and fewer employees, the implications are that there are fewer faculty and students employed, fewer research contracts generated, fewer companies graduating from the park, and, overall, less wealth-enhancing activity taking place. The opportunity exists for ARP to be at least as successful as the median-sized park, if not the average or largest parks.

One of the main services offered in the ARP will be business/technology incubation. The National Business Incubation Association (NBIA) reports that business incubation reduces risk. Eighty-seven percent of all companies that have graduated from incubators are still in business. (Of course, incubators tend to be selective about which ventures they let in, so there is bound to be some selection bias in this statistic.) There are approximately 1,000 business incubators in North America, up from 587 in 1980. The NBIA estimates that 60% of business incubators are self-supporting or could be self-supporting if subsidies stopped. The NBIA also estimates that for every dollar of annual public investment provided to an incubator, clients and graduates of the incubator generate approximately $30 in local tax revenue alone. Its member incubators report that 84 percent of incubator graduates remain in their communities and continue to generate returns on investment. Publicly supported business incubators create jobs at a cost of about $1,100 each; whereas, other publicly supported job creation efforts typically cost more than $10,000 per job created. On average, for every two jobs created by an incubator company, one additional job is created in the community.

4.0 Description of Physical Plant

The RPC maintains and operates Arrowhead Research Park. The Master Plan of ARP includes approximately 257 acres of land located at the southern end of NMSU bounded by interstate highways I-25 and I-10. Presently, the RPC leases approximately 18 acres from the NMSU Regents, and on that 18 acres is one tenant.

4.1 General Description of Arrowhead Research Park

ARP consists of a 257-acre parcel of land located south of, and contiguous to, the main campus of NMSU. It is bounded on the east by Interstate Highway 25, on the west by Interstate highway 10, and on the north by Research Drive and Standley Drive. The acreage is divided into seven planning areas, to be developed sequentially, and an Elephant Butte Irrigation District (EBID) easement. The EBID easement consists of a right of way, a dam, and a retention pond area. All the land is owned by NMSU. Presently Area 1, consisting of approximately 15 acres, and a small portion of Area 2b, are leased to the NMSU RPC.

The EBID easement area and Tortugas Arroyo, which runs through the northwest section of the park, cannot be used for physical structures. Both areas can be developed for recreational use.

The approximate distribution of the land in the park is indicated in

Table 2 and the map in Figure 2. Arrowhead Research Park

Table 2. Distribution of Land in ARP

Area	Approximate Acres
1	15
2a	23
2b	20
3	28
4	15
5	46
6	56
South Corner	8
EBID Easement	32
Roads	9
Tortugas Arroyo	5
Total	**257**

Figure 2. Arrowhead Research Park

4.2 Description of Individual Areas, Planned Land Use, and Physical Structures

According to the Master Plan (July 20, 1991) each area has an intended land use and will be developed sequentially as numbered.

4.2.1 Area 1

This area was the first to be developed in terms of infrastructure. It consists of approximately 15 acres with a direct visual exposure to I-10. It is accessed from the university on the frontage road, Sam Steel Way.

Lots – The area has been subdivided into ten lots ranging in size from 1.0069 to 1.2453 acres. A road has been built through the center of the area to provide access to the individual lots. This road is tied in to the main entrance road of ARP that lies on the south boundary of the parcel of land. The entrance road is accessed from the frontage road, Sam Steel Way, on the west side of the parcel of land.

Utilities – All utilities are provided to lot line for all ten lots. Utility corridors and easements have been plotted and can be seen on the accompanying map.

High Technology Communication Network – The high technology communications network at NMSU consists of a gigabit backbone powered by Cisco routers and three layers of switches. The system has been constructed as a double ring topology to provide redundancy and disaster recovery. In total, 87 buildings university-wide are connected to the system.

A client in the research park can contract directly with a telecommunications company to receive services. NMSU dark fiber can be leased to tenants. All services offered at NMSU are available to tenants.

NMSU has two points of presence (POP). A POP is a facility that ties the university to the public communication infrastructure. The main POP is an Optical Carrier Level 192 (ten gigabit per second [Gbps]). The secondary POP is an OC-3 with 155.52 megabit per second (soon to be upgraded to an OC-12 with 622.08 Mbps). Both POPs have a single and multi-mode fiber that ties them to any other portion of campus. The bandwidth can be used for voice, video, or data and can be partitioned in any manner desired.

Also available is the Council for Higher Education Computer/Communications Services Network (CHECS-NET). The network was formed by the University of New Mexico, New Mexico Institute of Mining and Technology, and NMSU to provide affordable and effective internet service. The branch campuses of the three universities also are connected to the system. The services provided by CHECS-NET include video and audio service, live internet streaming broadcast, media-on-demand streaming, media encoding (converting from analog or digital source to AVI, MPEG1-4, QuickTime, Windows Media or Real Media), and media bridging (includes Speed and IP to ISDN conversion).

For the future, access to LambdaRail, the national networking research infrastructure, is planned.

Landscaping – Minimal landscaping has been done on the property. The median strip of the entrance road has been landscaped and includes a small wooden sign indicating the location of the research park.

Lot 7 – This is the only lot that has been developed in the research park. General Dynamics Corporation currently leases lot 7 (1.2453 acres) through a sublease with ARP-ONE, LLC. In addition General Dynamics leases 1.353 acres for an antenna array

(located in area 2a) and solar view easements totaling 4.344 acres.

4.2.2 Area 2a

This area consists of 23 acres and has a number of developed facilities on site. The facilities consist of the Photovoltaic Research Center, the Academic Research Building, the Genesis Center, and an antenna array operated by General Dynamics Corporation. The Photovoltaic Research Center is situated on 3.04 acres of the area and is operated by NMSU's College of Engineering. The Academic Research Building and the Genesis Center occupy 8.98 acres of the area and are operated under the general direction of NMSU and the Board of Regents. The antenna array occupies 1.353 acres and is leased with additional solar view easements (totaling 4.344 acres) by General Dynamics Corporation.

Photovoltaic Research Center – The Photovoltaic Research Center sits on 3.04 acres located in the southwest corner of Area 2b. The Center is operated and maintained by the NMSU's College of Engineering. It is financed through NMSU instructional and general funds.

Academic Research Building – The Academic Research Building houses a number of departments and offices that assist in the research mission of NMSU. The 10,038-square-foot building is split into three parts. The tenants of the building are various Table 3 lists the total rentable space in each of the buildings and the occupied square footage and occupancy rate as of July 2004. A list of tenants for each of the buildings is provided in Appendix A.

Building D houses the resident manager, the conference center, reception area, postal boxes, and various office machines.

administrative units of NMSU. A listing of the tenants is provided in Appendix A.

Genesis Center – The Genesis Center is housed in two buildings with a total net rentable space of 24,389 square feet. The Genesis Center was built originally as a technology transfer incubator. The first building has a triple-pod construction design, and the pods are designated Buildings A, B, and C. The second building is a stand-alone building and is designated as Building D.

The Genesis Center is operated and maintained through the office of the Vice-Provost for Research at NMSU. All operational, maintenance, and debt payments are paid from rents obtained from the tenants.

Building D houses the resident manager, the conference center, reception area, postal boxes, and various office machines.

4.2.3 Area 2b

4.2.4 Area 3

This area consists of approximately 28 acres and is the middle development area at the north end of the park. With its easy access to the university via Payne Street and its location just north of the EBID easement, it is to be developed for smaller, professional type users.

4.2.3 Area 2b

4.2.4 Area 3

This area consists of approximately 28 acres and is the middle development area at the north end of the park. With its easy access to the university via Payne Street and its location just north of the EBID easement, it is to be developed for smaller, professional type users.

Table 3. Genesis Center

Building	Rentable Space (Sq. Ft.)	Occupied Space (Sq. Ft.)	Occupancy Rate (%)
A	7,709	4,492	58
B	7,398	5,246	71
C	7,405	7,405	100
D	1,877	1,877	100

4.2.5 Area 4

This area consists of approximately 15 acres and is located in the northeast corner of the park. It is similar to Area 3 in terms of access and is intended for smaller, professional type users.

4.2.6 Area 5

This area consists of approximately 46 acres and is located at the southern end of the research park. Its large size and level surface makes it ideal for a large user.

4.2.7 Area 6

This area consists of approximately 56 acres and is the middle planning area on the east side of the park. A portion of this area is leased currently to Aldershot of New Mexico, Inc., a greenhouse facility, and is under the direct control of NMSU and the Board of Regents.

Central/Common Area: A central/common area has been designated as a central support area. It is located just south of the EBID easement.

5.0 Market Analysis and Position Statement

The main purpose of Arrowhead Research Park is to enhance the teaching, research, and outreach missions of NMSU; to foster the creation of intellectual property; and to enhance wealth creation opportunities in the Las Cruces community and southern New Mexico. The research park's operations will, therefore, be research and technology oriented. The park will house companies and entrepreneurs involved in research and development, prototyping, and early-stage manufacturing activities. It will involve those companies and entrepreneurs that have synergy with NMSU in the sense that they will involve faculty, staff, and students in their operations as direct employees, through research opportunities, or the contracting of services.

5.1 ARP SWOT Analysis

The economic viability of a research park depends upon building on the strengths of the park, eliminating or minimizing the weaknesses of the park, taking advantage of the opportunities provided by the park, and positioning the park to shield itself from the threats imposed by other entities.

Following is a summary of the strengths, weaknesses, opportunities, and threats facing ARP in its efforts to fulfill its mission. The strengths and weaknesses are items internal to the workings of the park; whereas, the opportunities and threats are external influences that could impact the success of the park. A complete list of all items appears in Appendix B.

5.1.1 Major Strengths

The major reason for a company to locate in ARP would be to access NMSU's intellectual capital. NMSU has considerable scientific, engineering, agricultural, and business expertise. In 2001, NMSU's University Research Council identified six major research themes at the university. The six areas most identified by the faculty were

border issues, biotechnologies, information services, security, aerospace, and sustainable development.

Not all of these research areas translate into advantages for the success of ARP. The management of ARP should concentrate on those areas that would most likely attract businesses to the park.

A second strength is that NMSU has an extensive list of partners with which to work. This allows the faculty of NMSU to leverage their areas of expertise to a higher level. NMSU is a member, has research contracts, or memoranda of understanding with Los Alamos National Laboratory (LANL), Sandia National Laboratories (SNL), New Mexico Institute of Mining and Technology (NM Tech), National Aeronautics and Space Administration (NASA), White Sands Missile Range (WSMR), High Tech Consortium of Southern New Mexico, Mesilla Valley Economic Development Association, the Economic Development Department of the State of New Mexico, and the Small Business Development Centers.

A third strength is the availability of high-speed connectivity to communication resources. The high technology communications network at NMSU consists of a gigabit backbone powered by Cisco routers and three layers of switches. A more detailed description is included in Chapter IV.

5.1.2 Major Weaknesses

The ARP is not presently in a position to succeed. There is no full-time manager to market and run the organization. The organizational structure is not conducive to making decisions on the future of the park. No one person is in a position to make a major decision. The land itself is unattractive to potential tenants. Services that would attract businesses are not being provided, and investment funds to properly develop the park are not forthcoming.

The administrative duties of the park are assigned to one person. This person, theoretically, dedicates only one-tenth of her time to both the ARP and the Genesis Center. In essence, this person acts as a rental agent. If tenants come to her, she deals with them. There are no marketing funds available to seek new tenants and no significant amount of funds to develop the park.

The lines of control for ARP and the Genesis Center are through two different organizations. The Genesis Center is under the direct control of the Vice Provost for Research, and the ARP is under the control of the NMSU Research Park Corporation. At this time, the CEO of the Research Park Corporation is the Vice Provost for Research, so the two organizations report to the same person. But any decisions that need to be made affecting both ARP and the Genesis Center need to follow two different lines of control.

The ARP looks undeveloped. There is a sign designating where the park is and an entrance with a minimal amount of landscaping. The Master Plan calls for extensive landscaping over the whole 257 acres, including a jogging trail and exercise equipment. Some of that landscaping would be included with the construction of the individual buildings. Because only one building has been constructed, no landscaping has been done. If this area is to attract businesses, landscaping will need to be done.

Although the single tenant of ARP is making a concerted effort to be involved with NMSU (staff teaching classes in aerospace program, employing 10-12 students, and research and development contracts), this does not seem to be the case with the other tenants of the Genesis Center. To take advantage of all the

synergy that could occur between NMSU and client companies, a number of services need to be made available, such as small business development and access to investors. Tenants also should have constant attention, and ARP's management should build relationships between NMSU and the tenants. These services will make the client happier and more successful and provide greater benefits to the university in terms of employment, research dollars, or return on investment. None of this is being done presently.

There is no plan for the continuing development of ARP property in terms of additional buildings, additional landscaping, or development of services. The main reason for this is the lack of investment funds. No funds are available, and there is no plan to make those funds available.

In addition, NMSU does not have a culture of entrepreneurship. Many researchers do not think about how their research can be converted into a commercialized product. This is not uncommon in an academic setting. Part of the reason is that the compensation system and the rules and procedures are not designed to encourage this type of work. At best, the system hinders the ability of a researcher to commercialize research and, at worst, provides disincentives for them to do so.

5.1.3 Major Opportunities

The fact that NMSU already does research in particular areas means that the University is prepared to take advantage of the opportunities presented in the external environment.

The New Mexico Department of Economic Development has identified clusters of companies that make up the high technology industries in New Mexico. These clusters form the nucleus of what is envisioned as the growth areas in New Mexico. The clusters identified are: optics and photonics, bio-technology and biomedicine, electronics, microsystems, aerospace, spaceport, hydrogen and fuel cell development, information technology, and digital media. The State is making a concerted effort to entice businesses in these areas into New Mexico. NMSU already does work in many of these areas, and partnering with the state leverages NMSU's strengths.

For the last 20 years, there has been a continued effort at the federal level to transform intellectual property from the government labs to commercialized property (Bayh-Dole Act). In addition, much of the government research is being contracted out. This means that there are opportunities for private companies to partner with an institution such as NMSU to provide contracted research.

Recent concerns about fossil fuels have renewed interest in making the existing energy system more reliable and in developing alternative energy sources. NMSU's expertise in the energy field, including nanotechnology, photovoltaics, fuel cell development, hydrogen storage and distribution, and the many centers already in existence that deal with different aspects of energy, places the university in a particularly good position to take advantage of both federal and state initiatives in this area.

NMSU has had a long-standing relationship with NASA and WSMR. This has led to a strong research program in the aerospace field. Two particular opportunities are available to NMSU. The first is a strong interest in unmanned aerial vehicles by the federal government. The second is the annual X-Prize Cup competition that will be held in southern New Mexico in the coming years. The companies involved in this competition are good candidates for ARP.

Information technology is another area of strength for NMSU. University researchers are known for their ability to capture, analyze, and visualize data. This capability places NMSU in a very good position to take advantage of a number of opportunities.

Information technology also is important in the area of genetics testing. Genetics testing is used in parentage testing, oncology (cancer) testing, prenatal testing, and forensic testing. NMSU, as the home of the Genetics Testing Laboratory, is positioned well to take advantage of this market.

NMSU has recently received a grant to establish a center of the study of bioinformatics. Bioinformatics, or computational biology, involves the application of information technology to the understanding of biological processes. It has implications for a variety of fields, including medicine, agriculture, and homeland security.

There is an increasing demand for the integration of information technologies in the areas of defense and security, space, and border activities. The Department of Defense (DoD) has initiated a transformation program to reconfigure itself to address the requirements of "Network-Centric Warfare" (NCW) with its emphasis on multi-modal sensors, autonomous vehicles, multi-source information fusion, and enhanced situational awareness and opportunities for remote action. NMSU has proposed, with various partners, to establish the Collaborative Center for Technology Translation (C2T2) to take advantage of this DoD initiative.

5.1.4 Major Threats

Two major threats exist for ARP. First, numerous research parks already exist that concentrate on the same dominant technologies in which NMSU has expertise. Research indicates that there are at least 35 other parks that have companies dealing in the areas of computers/electronics, aerospace/ defense, software development, information technology, and agriculture. Not all of these parks are direct competitors with ARP. But, in general, these parks have larger operating budgets, have more staff, and have an established track record.

Second, much of the funding for the initiatives mentioned above comes from the federal government. A change in spending priorities by the federal government could have a direct impact on the opportunities available to ARP.

5.2 Position Statement

ARP is operating in an environment that includes government organizations that have specialized needs. Organizations, such as LANL, SNL, NASA, and WSMR all are supported by federal or state funds, and have
high-tech needs associated with information technology, aerospace, defense, and homeland security. ARP should target those firms that have an interest in working with these organizations in these fields. Tenants in these fields will have the opportunity to be in close proximity to the intellectual capital already created by NMSU. A position focusing on these high-tech areas is consistent with the State of New Mexico's research clusters, NMSU's research themes, and the economic development of New Mexico, particularly, the southern part of the state.

6.0 Action Plan

The action plan explicitly outlines the steps necessary to implement the business plan. The steps recommended are straightforward and as follows:

1. Hire, or identify, a management team whose prime responsibilities are to manage ARP.
2. Make a significant investment in further development of the existing property.
3. Give ARP full control over ARP property (subject to existing agreements and organizational limits).
4. Optimize ARP's position in the organizational structure at NMSU.
5. Review and evaluate the policies and procedures that govern the actions of faculty and staff to provide incentives for them to participate in ARP.

The action plan should be considered as a set of necessary conditions for the success of ARP, but not a set of sufficient conditions. In other words, implementing the action plan's steps does not guarantee success. Rather, ARP's success depends on the cooperation and participation of all NMSU sectors and partners. The goal of the park is to aid in the development and, ultimately, the commercialization of intellectual property. Not only will ARP be providing a physical space for these companies, but also will be developing relationships among the companies and the university community.

All segments of the university can contribute to the success of the park. The Vice Provost for Research needs to encourage faculty to be mindful of the potential for their research to result in commercial products. This may mean writing research proposals in a different fashion or to different funding sources. The Office of Grants and Contracts should work closely with the companies to ensure the best possible working relationship between university and business so both can benefit from the collaborative effort.

6.1 Step 1: Hiring Management for ARP

Two managers are needed to focus their full-time attention on managing and growing ARP. One person will primarily act externally to promote the ARP and NMSU, and the second will manage the ARP internally. These managers need to be familiar with research parks and technology incubators, and be capable of assisting tenants along the path toward technology commercialization. Potential candidates should have experience either as research park managers or with marketing research parks. Hiring experienced people will require a significant investment, but this is a necessary and important step for ensuring the success of the ARP. Leaving this critical role to any individual distracted by other duties will result in a continuation of the ARP's poor past performance.

The duties of the park managers include, among others, the marketing of the ARP, the planning of the park's development, acting as liaisons between tenants and other parts of the university, and acting as liaisons between tenants and providers of business services. It is critical that these managers, and particularly the external person, be familiar with modern image management and integrated marketing programs to maximize their benefits to NMSU and the ARP.

6.2 Step 2: Investing in ARP Infrastructure

ARP presently has just one tenant (General Dynamics). Possible tenants reasonably may assume that this is not a successful research park and question a move to the ARP. Therefore, ARP must make a strong statement of commitment to the development of the park. Additional buildings must be erected as quickly as possible to make the area look worthy of being considered a research park.

The new management team should continue efforts to find those companies that are large enough to occupy stand-alone

buildings. This was the original intent of ARP, and the configuration of the park encourages these types of buildings. This may be a difficult task given past history. The park does not look much like a typical research park and may not be very appealing to possible clients.

It is recommended that ARP consider constructing a 40,000-45,000-square-foot multi-tenant incubator building on or near Area 1. Grant monies and matching funds are possible funding sources, and lease payments can offset any loan payments. This building would serve as a flagship building that indicates that NMSU is dedicated to the success of the ARP. The purpose of developing a multi-tenant incubator building first is that smaller start-up firms can locate in the research park without the significant costs associated with a stand-alone building. The ARP will need to provide support services and facilities, including labs, communications, computing and broadband, library connections, and business support (mailing, messaging, etc.). A multi-tenant incubator building also encourages the critical mass necessary so that there is an opportunity for tenants to socialize with one another. The purpose is to create a community, which has been identified in the literature as an important factor for research park success.

The Genesis Center was conceived as an incubator, but the Center's buildings are not ideal incubators, because their spartan characteristics do not foster a sense of comfort or community. Also, support services provided by typical incubators are not present. Larger tenants cannot locate in the Genesis Center, because there is not enough space. However, the Genesis buildings will complement a new stand-alone, multi-tenant incubator.

Another option is available. It is possible that existing tenants in the Genesis Center would be willing and able to move to more suitable facilities but not require an entire building. Either NMSU could finance and build this smaller building, or a builder could be encouraged to construct a building, knowing that reliable tenants are waiting to move in. As more buildings are constructed, the site will begin to look like a research park, encouraging other tenants to move in.

Further investments in the ARP are necessary. To further the sense of community and commitment by the university, the property requires considerable improvements to make the park attractive to possible tenants. At a minimum, the current 15-acre property needs some landscaping. A desert theme can be maintained, but an up-market character is necessary to compete with other research parks. The original Master Plan included many landscaping and amenity ideas that need to be implemented. Some of the ideas discussed included trees, a putting green, tennis court, lighting, jogging track, tables, chairs, and awnings.

The existing Arrowhead Research Park sign needs to be replaced with one similar in design to those found elsewhere on the NMSU campus, but much taller so that it is noticeable from the highway. The sign could be made of stone and in the shape of an arrowhead to promote the research park. It should be well lit at night for the same reason. Any new signs need to be attractive, noticeable, and contribute to the notion that the research park should be taken seriously.

Steps 1 and 2 require a serious investment in the ARP. Although it is unlikely that NMSU can do more than break even by leasing either land or building space in the park, benefits derive from a variety of other sources (as described in the Expected Benefits section of this document). These include such benefits as economic development for Las Cruces and New

Mexico, increased recognition of NMSU as a research university, increased monies flowing to NMSU from grants and other research activity funding, employment opportunities for NMSU faculty and students, and the potential for income from commercialization activities associated with the development of intellectual property (e.g., licensing agreements and equity positions in companies). Therefore, the ARP should be operated on a break-even basis (at best), because charging rents above a break-even level likely ensures that the ARP is uncompetitive both with other research parks around the country (particularly those in the southwest U.S.) and local commercial properties in Las Cruces, Dona Ana County, or the neighboring region. Pro forma financial statements, provided in the next section of the report, offer a forecast of the cash flows associated with operating ARP under the scenario recommended.

6.3 Step 3: ARP Controls ARP Property

The existing Master Plan describes ARP property, which includes the 257 acres of land bounded by NMSU on the north, I-10 on the west, and I-25 on the east. However, ARP currently controls only Area 1 and the antenna array in Area 2a. To date, there is just one tenant in the research park (General Dynamics).

To accomplish its goals and develop the property to its potential, NMSU Research Park Corporation and ARP should have control of the entire 257-acre property. This action accomplishes three things. First, it ensures that the corporation can make plans for the entire research park property in a timely and efficient manner. The development plans should be under the direction of the Board of Directors of the NMSU Research Park Corporation. Second, ARP's control of the research park property suggests that revenue generated on any of the 257 acres accrues to ARP. This enables ARP to have a revenue stream to fund growth that meets goals. Third, control of the research park property allows ARP to coordinate the use of the Genesis Center with the proposed new incubator building and future development. Although the Genesis Center is not a prototypical incubator building, it is ideal for certain clients.

6.4 Step 4: Optimizing ARP's Location in the NMSU Organizational Structure

Currently, ARP is under the direction of the NMSU Research Park Corporation (with the Vice Provost for Research as CEO) that reports directly to the Board of Regents of NMSU. The Genesis Center is under the control of the Vice Provost for Research. The role of developing the intellectual property generated at the University has been given to the Arrowhead Center, which operates under a Board of Directors reporting directly to the Board of Regents. Meanwhile, the role of technical incubation has been given to PSI, a part of the Physical Science Laboratory that has its own line of control to the Regents of NMSU.

Although there may be reasons for this administrative structure, it certainly does not leverage or catalyze the synergy between the organizations that would allow ARP to succeed. The development of a commercial idea that originates from research sponsored by outside sources, that would require incubation services, and eventually evolve into a business that could reside in the ARP, could be controlled by five entities (ARP, NMSU Research Park Corporation, Vice-Provost for Research, Arrowhead Center, and the Board of Regents). This complicated organizational structure makes it difficult for decisions to

be made efficiently and in the best interests of everyone involved.

Because the incubation services and the research park have the most in common, it is suggested that the NMSU RPC, the Genesis Center, and ARP have one board of directors. Moreover, because it is primarily an engine for economic development, we recommend a restructuring such that the NMSU RPC and ARP fall under the Vice-Provost for Economic Development's purview and, more specifically, the Arrowhead Center (AHC), which has its own board of directors.

6.5 Step 5: Review of All Policies and Procedures with Regard to Working Relationships with ARP

The literature on technology commercialization stresses nurturing an innovation culture on campus. All relevant NMSU policies and procedures should be reviewed and rewritten, as appropriate, to encourage faculty and staff to participate in these activities. Those already involved in research should be encouraged to consider how research could be commercialized, and incentives should be in place to reward them for doing so.

7.0 Financial Projections

This section of the business plan discusses the financial results that could reasonably be expected as a result of implementing the action plan discussed earlier. The action plan includes hiring two additional full-time personnel and employing a full-time administrative assistant, constructing a new Business Technology Incubator building, and improving the appearance of the existing park lands with landscaping and a new sign. The financial plan shows the expected cash flows generated during the period ending June 30, 2005 through June 30, 2010. The discussion begins with key assumptions regarding building space and number of tenants, rent per net square foot, personnel costs, and space per employee. Following the assumptions are the resulting cash flows and then the key results and implications. In the final section, the risks associated with the base case pro formas are discussed together with different scenarios.

7.1 Assumptions

7.1.1 Genesis Center

The Genesis Center (except for space occupied by the Vice Provost for Research, the NMSU Safety Training Lab, and the Primate Research Lab Archives) will come under the control of the RPC. Thus, the Genesis Center's rental revenues and expenses (pro-rated for space occupied by tenants and management staff) will be controlled by the RPC. The Genesis Center contains 32,511 gross square feet that translates to an area of 24,389 net square feet after subtracting common areas.

Currently, a total of 5,371 net square feet is unoccupied. The pro formas assume that two additional companies are recruited to the Genesis Center and will occupy the empty space. It also is assumed that Genesis Center tenants will pay rent at the current lease rates. The average lease rate is presently $13.79 per net square foot per year.

The Genesis Center's actual operating costs for the 2003-2004 fiscal year were obtained from Facilities Operations at NMSU. These costs are pro-rated in the pro formas based on the space occupied by RPC units and non-rent-paying units. The Vice Provost for Research office occupies 3,014 net square feet, the NMSU Safety Training Lab occupies 1,684 net square feet, and the Primate Research Lab Archives occupies 132 net square feet. Because these three entities do not pay rent, their respective shares of the expenses are assumed to be paid from other NMSU funds. Thus, the RPC's share of

expenses is based on the Genesis Center's net rentable square footage of 24,389 – 4,830 = 19,559 net square feet.

7.1.2 Business Technology Incubator Building

In order to encourage economic development in the research park, it is important to have up-to-date, state-of-the-art facilities for start-up companies. About two-thirds of the research parks surveyed by the Association of University Research Parks include an incubator as part of the park. Presently, Virginia Tech (VT), one of NMSU's peer institutions, is building a 45,000-square-foot multi-tenant technology business incubator as part of its VT KnowledgeWorks program.

Incubators include attractive offices and amenities, plus laboratory space needed and desired by knowledge-based companies. Additionally, an incubator provides centralized and convenient business services to its client companies. For example, VT KnowledgeWorks offers clients a host of services, such as business planning, recruiting assistance, funding assistance, and administrative support. As the client matures, it receives additional mentorship and advice from seasoned executives and other legal and business professionals.

This plan uses the name "Business Technology Incubator" to indicate that business services will be offered and technology incubation may be performed by start-up and emerging companies. In spite of using the name "incubator," the RPC realizes that it may accept tenants that are more mature businesses, especially in the early years of the building's life in order to provide a more stable flow of rent revenue. However, the idea of "incubation" is to nurture a young company to the point at which it can survive on its own and presumably move to another building in the research park.

The following assumptions are used to model the expected cash flows for the first five years of the Business Technology Incubator (BTI) building.

Size – The size of the proposed BTI building is 45,000 gross square feet. For the sake of the pro formas, it is assumed that the building will be completed and begin to be occupied by June 30, 2006. As in the Genesis Center, it is assumed that 25 percent of the gross square footage is devoted to common areas, such as hallways, restrooms, etc. Thus, a total of 33,750 square feet is considered net square feet. It is assumed that 5 percent of the space will be occupied by the BTI management staff and incubation services. Thus, a total of 32,063 square feet is considered "net rentable square feet."

Tenants – Based on the AURP survey of existing university-related research parks, the median number of companies per year entering a research park that reports no medical or biotechnology presence is approximately three. The pro formas are consistent with this observation and assume that one of the companies is a start-up company that will occupy 1,000 net square feet. The other two companies are assumed to be already existing companies that are recruited to the park and therefore are assumed to be somewhat larger and occupy 3,000 net square feet each. This translates into occupancy rates ranging from 22 percent in the first year of the building's life to 87 percent by the fourth year.

In contrast, the Virginia Tech Corporate Research Center (VTCRC) reports that it attracts 20 companies per year to its park, and based on the VTCRC's published figures, the average tenant occupies approximately 5,000 gross square feet, or about 3,750 net square feet. Admittedly, the VTCRC is a

mature, well-run park, but it also shows what can be achieved by a rural, land-grant university.

The pro formas assume the lease rate is $17.00 per net square foot. The assumed lease rate includes the cost of providing utilities, custodial services, operation and maintenance expenses, mail services, and building insurance at the same rate per square foot as for the Genesis Center. To the extent the BTI building operates more efficiently than the Genesis Center because it is newer, the costs may be less. In addition, it is assumed that the expenses associated with the BTI are lower in the early years of its life and scale up as more tenants move in.

Cost and Financing the BTI – At this point in the analysis, the pro formas do not include any financing charges for the BTI. There are a variety of funding sources available for the BTI building, including grant monies from the Economic Development Administration (EDA) and other entities as well as issuing bonds. Alternative scenarios are provided later to illustrate the impact of grants vs. loans on the cash flows.

7.1.3 RPC Personnel, Marketing, and Amenities

The Cabral-Dahab Science Park Management Paradigm includes 10 points to provide guidance for success at research parks. One of the points relates to the management of the park:

- Include in its management an active person, with power of decision and with a highly visible profile, who is perceived by relevant actors in society as embodying the interface between academia and industry with long-term plans and good management—a "Mr./Ms. Science Park."

Dr. Joe Meredith, the president of the VTCRC and adjunct professor in Industrial and Systems Engineering at Virginia Tech, notes that having a technologist in the leadership position, rather than a real estate agent, has greatly benefited the health and growth of the VTCRC.

Based on the AURP profile of research parks, the median number of staff is three (although the average is five). Therefore, the pro formas are developed assuming three full-time staff members: a Research Park Chief Executive Officer at a salary of $130,000 per year, a Chief Operating Officer at an annual salary of $50,000 and an administrative assistant at a salary of $30,000 per year. Benefits are assumed to amount to 20% of salary. Thus, the total personnel cost will amount to $252,000 per year. The CEO salary is consistent with the 2004 salary survey conducted by the AURP. In that survey, 11 of 30 respondents indicated that their salary was between $100,001 and $125,000 per year. It should be noted that many of the respondents indicated that they also received annual bonuses or other incentive compensation. The pro formas presented below do not explicitly include any incentive-based pay.

In addition to salary and benefits, it will take funds to effectively market and promote the research park. The pro formas assume that $20,000 per year is allocated to promotion, marketing, and travel expenses.

One of the distinctive features of research parks and the knowledge-based companies and employees working there is amenities. Research parks around the country include common areas, such as jogging/walking paths, exercise rooms, golf courses or driving ranges, and other such facilities. In addition, appropriate signage and landscaping is important to make the park stand out, be noticeable, and be attractive from nearby roads and highways. Therefore, the pro

formas include $50,000 per year for two years to incorporate these kinds of amenities.

7.1.4 Additional Sources of Cash Inflows for the Research Park Corporation

Greenhouse Lease – Assuming that the entire land set aside for the Arrowhead Research Park is managed by the RPC, the entire amount of rental revenues from the existing greenhouses is assumed to flow to the RPC. According to the lease agreement with Aldershot, the estimated annual lease payments for the next five years are assumed to be $23,027. We assume these lease payments will be paid to the RPC and no expenses will accrue to the RPC. Even though the lease agreement calls for the annual rent payment to increase according to a rate of inflation, in keeping with earlier assumptions, the pro formas do not incorporate inflation forecasts.

General Dynamics Lease – Similarly, the pro formas assume the ground lease agreement with the Board of Regents is re-negotiated so that the entire lease payments made by ARP ONE, LLC flow to the RPC. According to the sub-lease agreement signed with ARP ONE, the builder of the General Dynamics SpacePlex, the lease payments for the next six years are $24,468, $24,468, $24,468, $26,914, $26,914, and $26,914. Because these payments are scheduled by contract, the pro formas include them as given.

7.1.5 Research Park Corporation Pro Forma Cash Flows

Base-Case Pro Forma Cash Flows, Key Results, and Implications

The pro forma cash flows are given in Table 4. Given the assumptions discussed above, the RPC's annual net operating cash flows become positive in 2010 at a level of $26,337. The maximum cumulative amount of **Table 4**operating cash flows needed by the Research Park Corporation is $457,394 and occurs in 2009. The 2010 cumulative net operating cash flows amount to -$431,056.

Even though the RPC does not produce positive net operating cash flows until 2010, the results should be interpreted in a broader context. The wider benefits of the research park and the commercialization process are discussed elsewhere in this document, but are also addressed at this point as well. The key results for the base case as well as the scenario analyses given below are shown in Table 4.

Key Result 1: Companies in Arrowhead Research Park – Given the assumptions about attracting tenants to the park, by 2010, a total of 24 companies are operating in the Arrowhead Research Park, 12 in the Genesis Center and 12 in the Business Technology Incubator.

Key Result 2 Occupancy Rates in ARP Buildings – Assuming the companies are attracted to the park and they occupy space according to the stated assumptions, the Genesis Center is expected to be 100 percent occupied in 2006, and the Business Technology Incubator is expected to be 87 percent occupied in 2010.

Key Result 3: Employment – Based on the AURP survey of research parks, it is assumed that about 300 net square feet is required for each employee. Therefore, based on the assumed number of companies attracted to the park, a total of 110 new employees will be working in the Arrowhead Research Park as of 2010. Some of these employees may be part-time NSMU students.

7.1.6 Risks and Sensitivity Analysis

There are numerous risks faced by the Arrowhead Research Park, some of which can be incorporated into the pro formas and some that cannot. These risks can be

thought of as being categorized into three broad categories: Business Risks, Financial Risks, and Political Risks.

Business Risks – The main business risk faced by the ARP is that the Business Technology Incubator is built but an insufficient number of tenants will locate there. The effects of the macroeconomy and the business cycle may mean that overall economic conditions hinder the development of new companies or the expansion of existing companies.

Alternatively, business risk may arise due to the operation of the commercialization process within the university. If the research park is somehow seen as separate and distinct from the entire commercialization efforts of the university, then it may deter companies from locating in the park. In a recently completed study, the University of Arizona has noted that technology transfer must be seen as a continuum from invention and discovery based on research to technology development to incubation to commercialization with production and sales. Arizona calls this the "Interventionist Approach" in which these different, sequential processes overlap each other.

This is in contrast to the "Traditional Model" in which these activities are seen as separate and distinct from one another.

Table 4. NMSU Research Park Corporation Pro Forma Cash Flows – 2005-2010

KEY ASSUMPTIONS:	Year Ended June 30,					
	2005	2006	2007	2008	2009	2010
Gross square feet:						
Genesis Center	32,511	32,511	32,511	32,511	32,511	32,511
Business Technology Incubator			45,000	45,000	45,000	45,000
Genesis Center:						
Number of new tenants		2				
Additional net square feet occupied		5,371				
Business Technology Incubator:						
New startups			1	1	1	1
Additional net square feet occupied by startups			1,000	1,000	1,000	1,000
Companies recruited to research park			2	2	2	2
Additional net square feet occupied			6,000	6,000	6,000	6,000
Rent per net square foot:						
Genesis Center		$13.79	$13.79	$13.79	$13.79	$13.79
Business Technology Incubator			$17.00	$17.00	$17.00	$17.00
Personnel:						
Chief Executive Officer annual salary		$130,000	$130,000	$130,000	$130,000	$130,000
Chief Operating Officer annual salary		$50,000	$50,000	$50,000	$50,000	$50,000
Administrative assistant annual salary		$30,000	$30,000	$30,000	$30,000	$30,000
Benefits (as % of salary)		20%	20%	20%	20%	20%
Total annual personnel costs for RPC		$252,000	$252,000	$252,000	$252,000	$252,000
Employment:						
Estimated net square feet per employee		300	300	300	300	300

CASH FLOWS:	Year Ended June 30, 2005	2006	2007	2008	2009	2010

KEY ASSUMPTIONS:	Year Ended June 30,					
	2005	2006	2007	2008	2009	2010
Operating cash inflows:						
General Dynamics (per Ground Lease)	$24,468	$24,468	$24,468	$26,914	$26,914	$26,914
Genesis Center rental revenue	178,325	250,732	250,732	250,732	250,732	250,732
Greenhouse revenues	23,027	23,027	23,027	23,027	23,027	23,027
Business Technology Incubator			$119,000	$238,000	$357,000	$476,000
Total operating cash inflows	**$225,820**	**$298,227**	**$417,227**	**$538,673**	**$657,673**	**$776,673**
Operating cash outflows:						
Salary and benefits		$252,000	$252,000	$252,000	$252,000	$252,000
Utilities: Electricity	32,059	32,059	46,298	57,772	69,245	80,719
Utilities: Gas	1,396	1,396	2,016	2,515	3,015	3,514
Utilities: Water and sewage	8,387	8,387	12,112	15,114	18,116	21,117
Custodial	26,073	26,073	37,653	46,984	56,315	65,647
Operation and Maintenance	120,108	120,108	173,457	216,443	259,428	302,414
Mail service	978	978	1,412	1,762	2,112	2,462
Insurance	978	978	1,412	1,762	2,112	2,462
Promotion, marketing, and travel		20,000	20,000	20,000	20,000	20,000
Landscaping and signage		50,000	50,000			
Total Operating Cash Outflows	**$189,978**	**$511,978**	**$596,361**	**$614,353**	**$682,344**	**$750,336**
Net Operating Cash Flows	**$35,842**	**($213,751)**	**($179,134)**	**($75,679)**	**($24,671)**	**$26,337**
Cumulative Net Operating Cash Flows	**$35,842**	**($177,909)**	**($357,043)**	**($432,722)**	**($457,394)**	**($431,056)**

KEY RESULTS and IMPLICATIONS:	2005	2006	2007	2008	2009	2010
Number of tenants:						
Genesis Center	10	12	12	12	12	12
Business Technology Incubator			3	6	9	12
Net square feet occupied:						
Genesis Center	18,315	18,315	18,315	18,315	18,315	18,315
Business Technology Incubator			7,000	14,000	21,000	28,000
Occupancy rates (% of total net rentable SF)						
Genesis Center	71%	100%	100%	100%	100%	100%
Business Technology Incubator			22%	44%	65%	87%
Employment:						
Estimated additional employees in Genesis Center		18				
Estimated additional employees in BTI per year			23	23	23	23
Cumulative estimated additional employees		18	41	64	87	110

Therefore, the links between the tenants and the university may not be very strong. In fact, a 1997 performance audit of Arizona universities' research parks by the State of Arizona Office of the Auditor General noted that one of the important deficiencies (at that time) was the lack of strong ties between research park tenants and the university. One of the important purposes of a university-related research park is to fulfill the university's academic mission related to student, faculty, and staff

development. Furthermore, one of the main attractions of tenants to a research park is the park's proximity to university resources, in particular its human resources. If the research park's tenants are viewed as separate and distinct from the faculty, staff, and students, then it will not have completely fulfilled its mission and will possibly interfere with the ability to recruit additional companies to the park. It is incumbent on the research park management team to ensure that strong ties are forged between the research park tenants and the

University. In this regard, one advantage the ARP has over the University of Arizona Science and Technology Park is that the latter is 15 miles from the U of A campus.

Another business risk faced by the research park is the competition from other universities for NMSU faculty. If faculty can be lured away from NMSU to other universities that are better positioned to commercialize their research, then Arrowhead Research Park will be less able to compete and it will be more difficult to fill unoccupied space in the park.

Financial Risks – Typically, financial risk concerns the ability of an entity to repay debt principal and interest payments when due. The pro forma operating cash flows presented above do not include any debt payments. There are different ways of financing the buildings in a research park. According to the 2003 AURP Research Park Profile, of the 35 research parks that did not include medical or biotechnology research (the "non-med/biotech parks") as one of their research park's dominant technologies, 13 parks noted that a non-university entity owned the buildings, 3 indicated that the university owned the buildings, 17 parks reported that some of the buildings were owned by the university and some were owned by a non-university entity. Two parks did not respond to the question. Furthermore, and as expected, the survey reports that when the research park buildings were owned by a non-university entity, most of the financing came from private sources. When research park buildings are owned by the university, most financing comes from the university.

Clearly, there is no dominant pattern in university-related research parks as to the ownership of buildings. But there is a link between ownership and financing. Therefore, if the university owns the buildings and provides the financing, there is a risk that the research park may not be able to repay associated financing charges.

So, the question remains about the source of financing for the new multi-tenant Business Technology Incubator building shown in the cash flows. In a report prepared for the New Mexico Economic Development Department, Chuck Wellborn details business incubation facilities across the state. The incubators he reports on were financed mostly from government grants or from collaboration from the cities in which they are located, although one incubator was established with a bank loan.

Political Risks – Political risk arises from the fact that a research park, like any other endeavor, requires the cooperation and collaboration of many individuals from across the university, business, and government sectors. One way that political risk may hinder development of the park is from the lack of leadership at the highest levels of the university. Unless the top leaders view commercialization and economic development as high priorities for the university, the effort may fail, and tenants will not desire to locate in the Arrowhead Research Park. Recent actions, such as the establishment of the Arrowhead Center, the naming of a Vice Provost for Economic Development, and the establishment of the Garrey E. and Katherine T. Carruthers Chair in Economic Development, point toward the university's

recognition of its importance as a driver of commercialization and economic development.

Another potential risk is that expectations for the park will be too high, may be misdirected, or may not focus on the right metrics. As a result, the leaders may make decisions that are detrimental to further research park development. University and political leaders must be made aware that commercialization of university-generated research and development takes time and that many of the invention disclosures from faculty do not translate into large cash flows to the university. For example, Michael Allan, vice-president of technology assessment at First Principals, Inc., reports that at Yale University, of the 850 invention disclosures from 1982 – 1996:

- One percent (10 of 850) of total disclosures led to 70 percent of the $20.4 million in licensing fees;
- Four percent (33 of 850) of disclosures accounted for 90 percent of total licensing income; and
- 88 percent (748 of 850) of disclosures generated less than $10,000 each, the approximate cost for processing one invention disclosure.

Gregory, Heiman, and Zilberman review the progress made by offices of technology transfer and conclude that licensing income has grown tremendously over the years but is still very small relative to research budgets. They point out that one important reason the situation may not change in the future is that university faculty, in general, highly value the freedom to pursue research projects that they are interested in even if those projects do not result in any commercially viable inventions. To the extent that faculty do not have incentives to induce them to pursue commercialization activities or that internal barriers make the commercialization process too cumbersome, faculty may not pursue these activities as vigorously as they otherwise would. This in turn may negatively affect the research park and its ability to locate tenants.

7.1.7 Cash Flow Sensitivity Analysis

To test the pro forma cash flow statements for possible negative outcomes, various scenarios were developed. Each scenario is independent of the other scenarios. The cumulative effect of all scenarios is described in Scenario 6. Scenario 7 is a more optimistic scenario. The 2010 net operating cash flows for the base case and the different scenarios are shown in .. Scenario 1: Fewer tenants than planned locate in Arrowhead Research Park. This scenario is implemented by assuming that, on average, only 1 startup every two years (rather than every year as in the base case) locates in the park's facilities and only 1 outside company (rather than 2) re-locates in the park every year. The net outcome of this scenario is that by 2010, the park experiences a negative projected net operating cash flow of $75,679. The cumulative net operating cash flow through 2010 is -$686,098. By 2010, the Business Technology Incubator building is only 44 percent occupied and a total of 66 new jobs are created.

1. Scenario 2: The tenants are smaller than forecast. This scenario is implemented by assuming that startup companies occupy only 750 (rather than 1,000) net square feet on average; whereas, existing companies re-locating to the park occupy only 2,000 (rather than 3,000) net square feet on average. The net outcome of this scenario is that in 2010, the park experiences a negative projected net operating cash flow of approximately $39,245, and the cumulative net operating cash flow in the fifth year is about -$595,012. By 2010, the Business Technology Incubator building is only 59 percent occupied and a total of 82 new jobs are created.

2. Scenario 3: The cost of operating the research park buildings is 10% higher than forecast. This scenario results in net operating cash flow in 2010 of -$21,469. The maximum cumulative net operating cash flow is -$619,591. By 2010, as in the base case, the Business Technology Incubator building is 87 percent occupied with a total of 110 new jobs created.

3. Scenario 4: Rent per net square foot for the BTI building is 10% less than forecast. This scenario results in net operating cash flow in 2010 of -$21,263. The cumulative net operating cash flow in 2010 is -$550,056. By 2010, as in the base case, the Business Technology Incubator building is 87 percent occupied with a total of 110 new jobs created.

4. Scenario 5: $1,500,000 must be borrowed to finance the construction of the Business Technology Incubator building. This scenario assumes the RPC would borrow $1,500,000 at 4.00% interest rate for 15 years. The remainder of the cost of the building is assumed to be secured from grants, such as from the U.S. Economic Development Administration. The annual principal and interest payments for the assumed loan are $133,843. This scenario results in a serious deterioration of cash flows. It results in net operating cash flow of -$106,087 in 2010. The cumulative net operating cash flow in 2010 is -$1,096,775. By 2010, as in the base case, the Business Technology Incubator building is 87 percent occupied with a total of 110 new jobs created.

5. Scenario 6: All of the above (Scenarios 1 – 5) occur. This scenario is called the "Pessimistic" scenario because it has the most drastic negative effect on the pro forma cash flows. The 2010 net operating cash flows are -$287,629, and the 2010 cumulative net operating cash flows amount to -$1,617,782. The Business Technology Incubator building is only 30 percent occupied with a total of just 50 new jobs created.

6. Scenario 7: Recruiting efforts are more successful than the base case; costs are 10% lower than forecast; rent is 10% higher than forecast; no borrowing is used to finance the Business Technology Incubator. This scenario is called the "Optimistic" scenario, because it essentially reverses all the negative assumptions in Scenarios 1-4 and assumes that grant monies are used in the construction of the Business Technology Incubator building. It assumes that, on average, 4 companies locate in the park every year but the companies are each slightly smaller than the base case assumptions. Building operating costs are assumed to be 10 percent less than the base case; whereas, rent per net square foot is assumed to be 10 percent greater than the base case. Under these assumptions, the result is that the annual net operating cash flows in 2010 are $144,687. The cumulative net operating cash flow in 2010 is -$73,730. By 2010, the Business Technology Incubator achieves 94 percent capacity, and a total of 118 new jobs are created.

7. Scenario 8: Recruiting efforts are more successful than the base case; costs are 10% lower than forecast; rent is 10% higher than forecast; $1,500,000 must be borrowed to finance the Business Technology Incubator. This scenario is called the "Optimistic and Borrow" scenario because it repeats Scenario 7 but also makes the financing assumption of Scenario 5. It assumes that, on average, 4 companies locate in the park every year, but the companies are each slightly smaller than the base case assumptions. Building operating costs are assumed to be 10 percent less than

the base case; whereas, rent per net square foot is assumed to be 10 percent greater than the base case. Under these assumptions, the result is that the annual net operating cash flows break even in 2010, achieving a positive cash flow of $8,543. The cumulative net operating cash flow in 2010 is -$739,449. The Business Technology Incubator achieves 94 percent capacity in 2010, and a total of 118 new jobs are created. Please note that personnel costs are not changed in any of the seven scenarios discussed above.

Figure 3 indicates the amount of cash flow that will occur in 2010 under each of the scenarios described above. It should be remembered that the success of ARP is not measured solely by the cash flows generated by the park. In 2010, under the base-case scenario, a total of 24 companies are operating in ARP employing 110 individuals, some students of NMSU. Under the most pessimistic scenario only 12 companies are operating with a total employment of 50. The most optimistic scenario results in 16 companies and an employment level of 118.

ARP is only one part of extensive organization. In the best case ARP will break even. The benefits of the park accrue to other parts of the university. Companies are located in the park to take advantage of the proximity to the expertise of the faculty and staff of NMSU. Therefore research contracts will exist between the companies and faculty and staff of the university. As new ideas and products are developed, licensing agreements and/or equity positions in new companies will generate funds for the university.

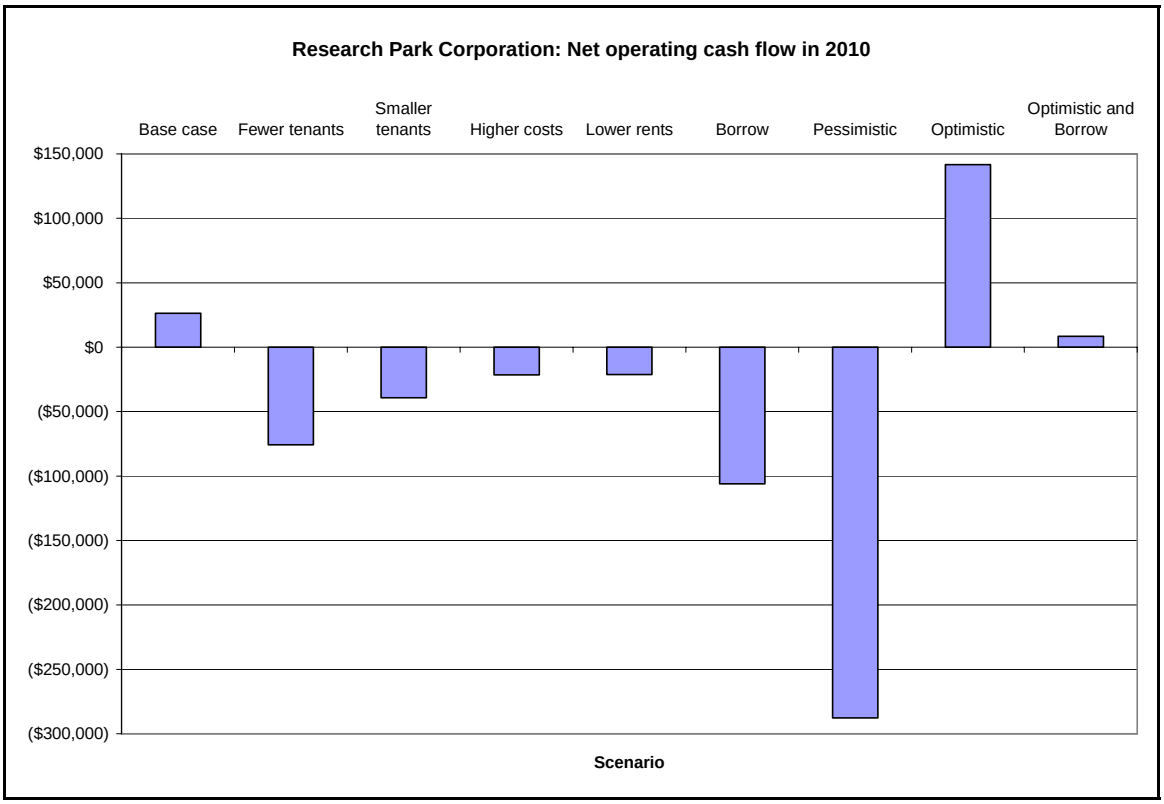

Figure 3. RPC: Net Operating Cash Flow in 2010

8.0 Summary and Conclusions

With the experience of other research parks in mind, ARP was created in 1989 to enhance NMSU's status as a major research university and to promote economic development in the state. While there is great potential for success, ARP has not lived up to this potential.

Arrowhead Research Park is a key component of a larger process of taking research ideas from the university community and transforming them into economic opportunities. ARP should be viewed as the physical and visible presence of NMSU's commitment to the wealth creation process. Without an active and successful research park, NMSU's creation of commercially viable intellectual property will continue to benefit firms and regions located mostly outside southern New Mexico and the state as a whole.

Five major actions are critical to the success of ARP and the attainment of the vision. First, a full-time dedicated management team should be employed. Second, additional buildings, services, and facilities should be provided to existing and potential tenants. Third, ARP needs to be transformed into an attractive place to locate. Fourth, the organizational structure should be changed in order for the director to provide efficient and consistent management of the facilities. And fifth, an entrepreneurial spirit should be developed at NMSU, implying a change in policies and procedures that would encourage faculty and staff to participate in this undertaking.

Failure to accomplish any of tasks lessens the probability of success in the park.

ARP should not be evaluated only on the basis of its ability to generate positive net cash flow, as it is unlikely that this will occur in the near future. The research park should be viewed as a relatively small investment that can produce large positive effects on the university and region. From the University's point of view, ARP can: expand opportunities for faculty development; expand real-world educational opportunities for students; transfer new expertise and knowledge to and from the university; facilitate the recruitment and retention of faculty, particularly in fields with high private sector demand; enhance the relationship between the university and the local and regional community; and increase the number of funding sources available to the University. From the local economy perspective, it can expand employment through the provision of goods and services to the park and through the increase in businesses that will be created and fostered by the existence of the park.

An investment in a research park is not without risk. These risks are similar to those other businesses face. There are business, financial, and political risks. These risks have varying effects on the pro forma cash flows, and the RPC will likely face several years of negative net operating cash flows. Expectations regarding technology transfer at the university and development of the research park should be kept reasonable. Successful university-related research parks in the United States have taken 15–20 years to build up their infrastructure and tenant base. "Success" should be defined carefully, and the definition should not rely solely on the cash flows generated by the research park.

Appendix A. Tenants

Academic Research Building – Tenants

The following is a list of the tenants of the Academic Research Building:

- NMSU Safety Training
- NMSU Purchasing Department
- NMSU Office of Grants and Contracts
- NMSU Sponsored Projects Accounting
- U.S.-Mexico Border Health Commission
- Border Epidemiology and Environmental Health Center
- National Park Service
- U.S.-Mexico Conflict Resolution Center
- UNO Project - Banner

Gensis Center – Tenants

Building A has 7,709 square feet of rentable space. As of July of 2004, 4,492 square feet were occupied representing a 58% occupancy rate. Tenants and occupied square feet are listed below.

Tenant	Square Feet Occupied
Recognition Solutions	220
U.S. Geological Survey	2,413
Conquest Machines	1,727
Zast Technologies	132
Available Office Space	3,217
Total Office Space	7,709

Building B has 7,398 square feet of rentable space. As of July 1, 2004, 5,246 square feet were occupied, representing a 71 percent occupancy rate. Tenants and occupied square feet are listed below.

Tenant	Square Feet Occupied
Southwest Analytical Services	1,318
Primate Research Lab Archives	132
MacKichan Software	956
LaSys, Inc.	1,154
NMSU Safety Training Lab	1,686
Available Laboratory/Office Space	1,486
Undeveloped Space	668
Total	7,398

Building C has 7,405 square feet of rentable space. As of July 1, 2004 all 7,405 square feet were occupied representing a 100 percent occupancy rate. Tenants and occupied square feet are listed below.

Tenant	Square Feet Occupied
Vice Provost for Research Services	3,014
NMSU Employee Health Services	2,454
NMSU Employee Health Services (under construction)	1,973
Total	7,405

Building D has 1,877 square feet of rentable space. As of July 2004, 1,877 square feet were occupied representing a 100 percent occupancy rate. This building houses the resident manager, the conference center, reception area, postal boxes and various office machines.

Tenant	Square Fee Occupied
Kenling, Inc.	192
Q-Cad	441
Management Offices and Amenities	1,244
Total	1,877

Appendix B. SWOT Analysis

Strengths

- Dry, warm climate at relatively high altitude
- Acreage adjacent to university (existing research suggests the closer the park to the affiliated university the better its chances of success)
- Cultural activities of university community and the City of Las Cruces
- NMSU has considerable water rights (necessary for some research and manufacturing)
- NMSU has scientific, engineering, agriculture, and business expertise
- ARP has access to a considerable amount of land
- Access to NMSU students for employment and research
- Area is inexpensive in most respects
- NMSU and the area have current ties to partners, and opportunities for potential partners, including: Physical Science Laboratory, Los Alamos National Laboratory, Sandia National Laboratories, New Mexico Institute of Mining and Technology, National Aeronautics and Space Administration, White Sands Missile Range, and the High Tech Consortium of Southern New Mexico.
- Access to major highways (Interstates 10 and 25) and an international airport
- I-2 connectivity with access to NASA and White Sands Missile Range
- Skilled work force of over 23,000 within walking distance to the park
- NMSU has the national recognition as a Carnegie Doctoral/Research University - Extensive
- On-site world class telecommunication network
- Ability to produce intellectual property (e.g., patents and licenses) from research

Weaknesses

- ARP lacks a dedicated manager who can market and organize the park
- Organizational structure (lines of communication and authority) are not well defined or efficient
- Undeveloped and unattractive landscaping
- ARP has limited business incubation capability
- No critical mass in local high tech industries
- Most NMSU graduates leave area after graduation (~90%)
- Local work force is unskilled
- Limited supply of venture capital
- Limited history of coordination and cooperation with venture capital firms
- Limited supply of buildings
- Irrigation District has easement through ARP property
- Existing agreements that limit growth potential
- Lack of investment funds required to properly develop research park

Opportunities

- X-Prize competition to take place in southern New Mexico
- Cluster analysis done and supported by the New Mexico State Economic Development Department
- Cluster analysis done and supported by NexGen (results similar to New Mexico Department of Economic Development
- Take advantage of the Bayh-Dole Act, which incorporates the federal government's push to transform intellectual property developed at government labs to commercialized property.
- Recent fossil fuel prices have renewed interest in making the existing energy system more reliable and in developing alternative energy sources.
- Increased interest in unmanned aerial vehicles
- Increased interest in information technology.

Threats

- Competition from other research parks
- Reliance on government funds and possible changes in funding priorities

Appendix C. Why a Technology Incubator?

The chief rationale for the more challenging approach of building and staffing a business technology incubator rather than a simpler multi-tenant structure is that research originating in the university requires development before it can become commercially successful. From its extensive case studies of leading universities in technology innovation, the Southern Growth Policies Board concluded that research parks and incubators are significant enablers of entrepreneurial activity and that physical space and incubator programs are essential to serve this need. Unless NMSU has suitable space for incubation, it will be unable to participate in this phase of the innovation process, and opportunities will go unexploited or will go elsewhere.

Job and wealth creation in the 21st Century are strongly linked to entrepreneurship and emerging businesses. While New Mexico leads the nation in per capita scientists and engineers, it lags in most economic measures. Universities and research laboratories, as generators of new knowledge, have encountered a "chicken or egg" problem in attempting to convert new knowledge into commercial products. Typically, inventions in the laboratory require further development before becoming commercially viable. Established companies are reluctant to take on the uncertainty that surrounds these efforts. Thus, technologies do not get developed because their commercial potential is not assured, and their commercial potential is not assured because they are not developed.

Consequently, universities and scientific laboratories throughout the world have established technology incubators in which start-up firms can perform the needed development work and find markets for the results. Technology incubators are business incubators with a high-tech focus. For clarity, they often are called technology business incubators. They account for about 37 percent of all business incubators. Academic institutions are the most frequent sponsors of business incubators. Technology incubators place start-ups in a nurturing environment with access to such benefits as flexible space, high-speed internet connections, networking and collaboration with university scientists and other tenants, mentors, seed capital providers, entrepreneurial talent, legal services, accounting services, business planning and other assistance, routine business services, and student employees and interns. Providing such benefits for start-ups in an NMSU facility would not preclude hosting other tenants, at least until the incubator portion is full. In contrast, a multi-tenant building with limited common services would be unable to provide the assistance that start-ups typically need to survive and succeed.

Even communities without direct connections to major research universities are forming business incubators that assist start-ups that may or may not have a high-tech emphasis. Such incubators often are referred to as "mixed use" incubators. In 2001, Chuck Wellborn conducted a thorough study of business incubation in New Mexico for the New Mexico Economic Development Department. After examining the success records of business incubators and companies that "graduate" from them, he concluded that New Mexico should increase its number of business incubators, including incubators in rural New Mexico and high unemployment areas, and provide incubator assistance for technology-based businesses. According to Wellborn, it cannot be overemphasized that "successful business incubation requires far more than just a multi-tenant facility and a shared copy machine." Specifically with regard to Las Cruces and the Genesis Center, he stated, "As in the case of Albuquerque, the absence of an incubator program in Las Cruces, with its proximity to NMSU and White Sands Missile Range, means opportunities for technology-based economic development in this area are not being maximized."

The Council on Competitiveness, which conducted a study of competitiveness in central New Mexico, argues that, while the federal government provides research dollars, state and local governments provide the environment where innovation occurs. Innovation and entrepreneurship are especially important in wealth creation, particularly in a state that is heavily reliant on government employment. The Council recommends that state, regional, and local entities establish research and industrial parks and business incubators that encourage innovation-based competition. Further, universities and research facilities, given their central role in driving innovation and economic development, should participate actively in cluster development and create institutions to support collaboration between academia and industry clusters. They should support company start-up efforts by professors and students through mentorship, entrepreneurial education, and financing.

The first consensus priority emerging from the New Mexico First Town Hall meeting in Spring 2004 was increased collaboration among current and/or new support centers. A "dream team" approach at NMSU would form a partnership uniting the efforts of the technology business incubator, the research park, PSL, the Vice Provost for Research, the Vice Provost for Economic Development, Arrowhead Center, Inc., the Entrepreneurial Center, the Small Business Development Center, MTech, Technology Ventures Corporation, New Mexico Institute of Mining and Technology, local law firms, local accounting firms, economic development organizations, and other participants.

Examples of Existing Business Incubators

The National Business Incubation Association (NBIA) reports that business incubation is a proven model for furnishing entrepreneurs with the expertise, networks, and tools they need to make their ventures successful. Incubation programs, says the NBIA, diversify economies, commercialize technologies, create jobs, and build wealth. NBIA surveys indicate that in a single year (2001), incubators in North America helped more than 35,000 start-up companies that provided full-time employment for nearly 82,000 workers and generated annual earnings of more than $7 billion.

Business incubation reduces risk—87 percent of all companies that have graduated from incubators are still in business. (Of course, incubators tend to be selective about which ventures they let in, so there is bound to be some selection bias in this statistic.) There are approximately 1,000 business incubators in North America, up from 587 in 1980. The NBIA estimates that 60 percent of business incubators are self-supporting or could be self-supporting if subsidies stopped. The NBIA also estimates that for every dollar of annual public investment provided to an incubator, clients and graduates of the incubator generate approximately $30 in local tax revenue alone. Its member incubators report that 84 percent of incubator graduates remain in their communities and continue to generate returns on investment. Publicly supported business incubators create jobs at a cost of about $1,100 each while other publicly supported job creation efforts commonly cost more than $10,000 per job created. On average, for every two jobs created by an incubator company an additional job is created in the community.

Iowa State University, which is larger than, but similar in mission to NMSU, launched the Iowa State Innovation System (ISIS) in 1986 and moved it to the ISU Research Park in 1987. Iowa State has no medical school but does have a veterinary medicine school. The university is a leader in technology licensing revenue. Its comprehensive incubator services are provided through an entrepreneurship center and the Small Business Development Center (SBDC). The incubator also

features student business laboratories, in which students from any major can learn to solve real business problems for real companies. The annual ISIS budget is $240,000, supported by tenant rent (44%), university support (33%), and state grants (23%). Of the 61 companies established since 1987, 19 are currently located at the research park, 17 have relocated, most within Iowa, 9 have merged or have been acquired, and, since 1995, only 1 has failed. Twenty-six new companies have emerged from licensing of ISU patents.

One of the most aggressive universities in pursuing technology incubation as part of a research park is Purdue University. The research park broke ground this spring on a 60,000-square-foot addition to its five-year-old flagship business incubator. This addition will double the size of the facility. The anchor tenant, a life sciences venture developing Purdue-licensed cancer detection and treatment technologies, will occupy 15,000 square feet. Purdue attributes the success of the park's incubated businesses in part to the Purdue Gateways Program, which connects start-ups early in their development with mentors who help them identify market prospects, develop prototypes, launch marketing activities, and develop financial resources. A task force of accountants, attorneys, and bankers also work with new ventures as part of the program. About 40 companies are currently in the incubator.

Virginia Tech KnowledgeWorks is a new technology business incubator that is being added to a relatively mature research park, the Virginia Tech Corporate Research Center. Its "members" typically fall into one of three categories: start-ups; spin-outs; and ramp-ups. It defines start-ups as newly formed companies designed to address a particular marketplace opportunity. A successful existing company may spin-out a department, a division, or a technology to an independent enterprise, to provide an environment more conducive to entrepreneurial activity. A ramp-up is a struggling company that needs help in gaining fresh momentum for a breakout. The research park considers the incubator important enough to initiate even without permanent facilities, which are scheduled for completion in the spring of 2005.

New Mexico has several business incubators, some more technology-oriented than others. The Quality Center for Business at San Juan College in Farmington is frequently mentioned as a good example of a partnership among community organizations that provides comprehensive incubator services through its Enterprise Center. Opened in 1999, with funding that included a $1 million grant from the U.S. Economic Development Administration, the Center web site lists a dozen tenants as of this writing. It offers through its web site 21,800 square feet of rental space, including offices ranging from 125 to 555 square feet and industrial space with overhead doors and high ceilings, ranging from 1100 to 4400 square feet. Space rent includes utilities (office spaces only), basic phone service, and shared high-speed Internet access. Mail service, photocopying, and basic office support services—including a receptionist—are provided for tenants.

The Santa Fe Business Incubator has a 30,000-square-foot facility and offers "a professional, affordable workspace and facility, onsite business workshops and seminars, experienced business advisors, business library and resource room, networking opportunities, receptionist and facility-based services, equipment (photo-copier, fax, audio-visual equipment, etc.), mail and parcel delivery, flexible office and manufacturing space, short-term leases, high-speed T1 connections, conference and lunchroom facilities, and ample free parking." Twenty-one "clients" in a broad spectrum of business sectors are listed currently on the SFBI web site.

Appendix D. Technology Commercialization

You Can't Afford to Do It, and You Can't Afford Not to Do It

University technology commercialization, facilitated and even obligated by the Bayh-Dole Act, is an integrated process of which technology business incubators and research parks are a part. The University of Wisconsin, one of the leaders in licensing technology, considers its patent-management organization, the Wisconsin Alumni Research Foundation (WARF), to be one of three major entities in its technology transfer process; the University Research Park is another. The process begins with an invention or discovery, proceeds to an "invention disclosure," then to intellectual property protection and a typically difficult judgment of commercial potential, on to further technological development, and finally to a saleable good, service, or process. In return for its intellectual property rights, the university or an affiliated entity licenses a patent on an exclusive or a non-exclusive basis to an existing or start-up company or accepts an equity position. (The scientist/ inventor receives a return according to a formula that usually is stated in the institution's intellectual property policy.

Established companies often eschew the technological development phase because they perceive it as too risky. Thus, many universities have technology business incubators to enable entrepreneurial start-up companies to perform this work. Ideally, these new companies graduate to a nearby research park, where further research and development take place amid a beehive of relationships among new companies, established companies, university scientists and students, venture capitalists, and service providers.

The entire process is something of a conundrum. A university cannot afford to get into it and cannot afford to stay out of it. University regents and other leaders will be condemned when if they do it and condemned if they don't. There is wide disagreement on how to measure true success or failure. While an active program of technology commercialization is viewed as one answer to institutional financial challenges, the literature warns that only a few big player universities have hit technology commercialization "homeruns," and those homeruns have been few and far between. At the same time, universities who don't get into the game risk relegating themselves to "second-class," teaching-only status. Probably the only reasonable approach is not to pin all hopes on the financial results but to look beyond licensing revenues and equity interests for other benefits, such as the continuing networking synergies that are established between campus researchers and students and the business community. After all, annual gross revenues from a university's technology transfer activities generally amount to less than three percent of research expenditures by the university and an infinitesimal percent of the total university budget. Nevertheless, bringing discoveries to a form that is useful to the public is a worthwhile goal, and there is evidence that universities are better at this than are other entities, such as the federal government.

Cultivating an Atmosphere for Innovation

The most important factor influencing the number of license agreements is the number of inventions, and the most important factor influencing the number of inventions is faculty quality. The Southern Growth Policies Board studied a dozen leading universities in the technology transfer field and produced a report in 2002 titled *Innovation U.* Also in 2002, the Research Triangle Institute, in conjunction with the University of North Carolina and the National Science Foundation, released a study of key factors in "successful" technology transfer. A

summary of this report appears in Appendix G. Of particular interest is the key factor of "cultivating an atmosphere for innovation."

A successful commercialization process requires university scientists to have a "technology transfer mindset." They should be open to commercialization while they perform their research. They should know how to disclose inventions properly and how to protect intellectual property. At a minimum, they should be aware of technology transfer and whom to call for help so that the university can protect and commercialize its innovations. Some universities have even begun to consider participation in technology commercialization activities as part of tenure and promotion decisions. Others, such as Wake Forest, have had some success with revisions to their royalty sharing formulas and with various outreach methods to faculty, including workshops, presentations, and mentoring opportunities. At NMSU, moving to a higher level of activity in the technology commercialization arena will require some attention to nurturing such a culture.

Appendix E. Measures of Success for Research Parks

Research park management should be accountable to the governing board for achieving the park's objectives. There is, however, no established consensus on how to measure research park success or failure. One thing that is clear is that rents received are only a part, and often not the most significant part, of the benefits of operating a research park. Some measures of research park and technology business incubator benefits and successes that turn up in the literature are as follows:

- Rent revenue for the period
- Number of square feet leased out
- Percentage of total rentable space leased out
- Number of companies in the park at period-end
- Number of new companies admitted during the period
- Number of student internships generated
- Number of faculty members consulting with park companies
- Number of incubator tenants graduated (total) during the period
- Number of incubator tenants graduated to the research park during the period
- Number of incubator tenants graduated to the local community during the period
- Number of incubator tenants graduated to locations elsewhere within New Mexico during the period
- Number of persons employed by park tenants
- Number of university alumni employed by park tenants
- Net number of employees added by park tenants during the period
- Average salaries of park tenant employees
- Number of invention disclosures generated from collaboration between university faculty and park tenants
- Number and dollar volume of grants and contracts generated by relationships between university and park tenants
- Amount of research and development expenditures by park tenants
- Amount of increase in university research and development expenditures attributable to faculty relationships with park tenants

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Appendix G. Annotated Bibliography of Technology Transfer and Research Park Articles

A review of best practices in university technology licensing offices

Michael F. Allan (vice-president of technology assessment for First Principals, Inc., Cleveland Ohio), 2001, copyright, Michael F. Allan.

Many methods and modes of operation in the technology licensing office (TLO) of major universities are similar. Reputation of the institution and quality of the faculty are important factors in the effectiveness, by any measure, of the technology licensing office. Small but important distinctions have been observed from one organization to another. Each characteristic must be considered in the macro- and microenvironments in which the TLO functions. Together, these conclusions provide the basis for recommendations for new and existing TLOs to consider.

Supplementary comments:
The report centers around 5 major topics:

OPERATIONS

- The only outsourcing appeared to be the use of external patent law firms.
- TLOs seemed to do little marketing of their technologies beyond web-based postings.
- Case-management style ("cradle to grave" approach by one person) is used by many TLOs. But this requires very skilled individuals with broad experience. This leaves little time for marketing an institution's IP. Staffing announcements do not appear to address this issue but focus on subject backgrounds, not functional (e.g., marketing) backgrounds.

ECONOMIC IMPACT

- Economic impact overall of university licensing activities is substantial.
- BUT, there is little correlation between budgets, number of patents, or other quantitative measures and the degree of success a TLO will have in terms of generated income.
- The dual objectives of being a service center for the university and also a profit center are, in many instances, unattainable.
- Yale University reviewed its 850 invention disclosures from 1982-1996 and learned:
  - ONE percent (10 of 850) of total disclosures led to 70 percent of $20.4 million received.
  - FOUR percent (33 of 850) of disclosures accounted for 90 percent of total licensing income.
  - 88 percent (748 of 850) of disclosures generated less than $10,000 each, the approximate cost for processing one invention disclosure.
- Thus, a key focus for TLOs is to decide how to allocate development efforts, since not all disclosures offer equal promise of success.

COMMERCIALIZATION INITIATIVES

- Outreach to the business and entrepreneurial community is on the rise, particularly in state-funded universities and in universities not normally known as top tier schools.
- TLO policies are, in general, thorough and well-done, although the author feels that faculty inventors need pocket guides, condensed versions, summaries, etc.
- AUTM has a strong set of courses about technology licensing.
- COGR also has developed useful tutorial and overview of technology transfer.

SUCCESS STORIES

- Obvious ones: Palo Alto, Cambridge. But, internationally in Japan and Germany, Bayh-Dole is frequently mentioned for tech transfer.
- Formal technology development and business incubation programs are common to all universities surveyed.
- Note that only one in 10 new ventures succeeds. This reality must be kept in mind to reign in overly optimistic politicians and high-level administrators.

TRENDS AND ISSUES:

- "Later stages of technology commercialization should receive more emphasis by TLO operations." This comment is based on author's opinion of background of TLO staffs and extent of experience with complex business-development issues.

RECOMMENDATIONS:

- Capitalize on potential success quickly, by means of practices such as those exhibited by Yale's Office of Cooperative Research.
  - Identify and assess inventions quickly.
  - Focus on those with greatest promise for success.
- Broaden the base of resources available to staff to enable maximum performance levels by maintaining awareness of external organizations in for-profit and nonprofit sectors.
  - Survey a variety of law firms, technology marketing organizations, and professional societies for their potential to provide labor-saving services.
  - Appropriate staffing levels
  - Monitor legislation
- Manage expectations of all stakeholders by establishing effective tools and communications systems.
- Increase familiarity with business-incubation issues and include them in the scope of TLO policies and operations.
  - Consider membership in National Business Incubator Association and Association of University-Related Research Parks.
- Make the most of networking opportunities, training programs, and other membership benefits. Among many organizations, the following are particularly relevant to the TLO professional:
  - AUTM regional meetings
  - AUTM's annual licensing survey
  - Licensing Executives Society. Excellent training and continuing education programs.

RTI International, "Key Factors in the Successful Evolution of Technology Transfer at Wake Forest University," Research Triangle Institute, University of North Carolina (September 16, 2002).

Abstract: In support of the North Carolina Technology Development Initiative (NCTDI), RTI International (a trade name of Research Triangle Institute) studied the evolution of technology transfer methodologies at Wake Forest University (WFU). Using a review of the literature and a series of interviews with key individuals, RTI developed the following seven key success factors related to the evolution of the WFU technology transfer function:

1) Strong administrative support.
   a) Top level buy-in is critical—researchers will dispute some things.
   b) Keep expectations in check. Talk about start-ups after they are started and deals after they are signed.
2) Organizational structure.
   a) Report high, no lower than one level down from the president.
   b) Report on the financial side, not the research side of the university.
   c) Ensure that the same person does not lead both the research office and the tech transfer office.
   d) Set up the office of tech transfer as a self-supporting entity—helps isolate it from criticism that it is cutting into people's paychecks.
   e) Develop a plan for the first five years and follow it.
   f) Focus on your core competency—making deals.
3) Adequate resources
   a) Secure enough money at the outset to pay good people competitively—better to partner with another university than to hire second-tier people.
   b) Provide a business incubator to help inventors.
   c) Use business students as interns.
4) Adequate staffing.
   a) Hire a director with solid experience in licensing and developing start-ups specifically in a university setting—if you can't do this, outsource all the work; too much is at stake to risk a false start.
   b) Expect to pay top-rate professionals top-rate salaries.
   c) Hire someone familiar with innovation in your local area and with connections to venture capital and industry talent.
   d) Do not attempt to grow someone into the tech transfer position; PhD in science buys some cooperation with the inventors.
   e) Hire someone comfortable with making cold calls—a key part of the job.
5) Cultivate an atmosphere for innovation. (Document has 14 specific recommendations on how to do this.)
6) Risk acceptance.
   a) Start with a base of licensing technology and build from there.
   b) Be patient and willing to accept a certain level of risk.
   c) Plan for 3 to 5 years before the first success.
   d) Be open to taking equity in a start-up.

e) Adopt a portfolio approach (pursuit of 10 technologies yields 1 to 2 deals in the medical field, which is generally a more fertile field for revenue generation than the physical sciences).

7) Commercialization process and strategy.
   a) Allocate money for speculative patent filing.
   b) Be willing to cut losses and stop a commercialization project midstream to save money in the long term.
   c) Allocate money to provide support services for start-ups (e.g., CEO salary, business plan assistance).
   d) Pursue lots of deals; only one or two annually will not cut it.
   e) Commit to start-ups.
   f) Secure pre-seed and venture funding for new technologies.
   g) Adopt a database for sound record-keeping.
   h) Monitor legal expenses to keep them in check.

A list of suggestions based on the success factors and the combined experiences of the professionals affiliated with the tech transfer function is included in a recommendation section at the end of the document. Some of them are included above. WFU's tech transfer is primarily related to its medical school, but the suggestions are germane to tech transfer in general.

University research and offices of technology transfer

Gregory Graff, *Amir Heiman*, and *David Zilberman*. **California Management Review** Berkeley: Fall 2002. Vol. 45, Iss. 1, p. 88-115

All researchers pursue a combination of fame, fortune, and freedom regardless of whether they are "academic" or "corporate." It is the different alignments of incentives and constraints that induce academic researchers to have a comparative advantage in some kinds of innovation and those in commercial R&D to have a comparative advantage in other kinds of innovation. This results in a division of innovative labor and creates opportunities for gains to be made from trade in technologies. This article examines the business of technology transfer. The extent of university patenting is still very small relative to industry, and technology transfer revenues are still very small relative to university research budgets. While university technology transfer is growing rapidly, the policy foundations and the marketing models on which it is built will need to evolve further to better fit the underlying economic realities of the dynamic technological innovation processes they are intended to promote.

- Very good summary of OTT efforts over the years.
- Includes summary data from AUTM on patents and licensing income.
- Major conclusions:
  a. Marketing university research to existing companies not very productive due to (a) too much uncertainty, (b) lack of incentive, and (c) "not in my shop" syndrome. Therefore, marketing to startups may be the best thing to do.
  b. Licensing income has grown tremendously, but is still just a very small factor in university budgets (let alone research expenditures).
  c. Situation will probably stay that way due to university comparative advantage in the "F" of Freedom – university autonomy as original and creative institution.
  d. Distribution of licensing revenues is highly skewed. Small number of inventions earn most of the returns. Also, small number of academic fields generate most of the patents and licensing revenues.
  e. OTTs may join together to serve multiple universities.
  f. Universities might benefit by privatizing OTTs to encourage competition and transform a university bureaucracy into a truly entrepreneurial outfit.

Spin-offs from research centers at a research university

Morten Steffensen, *Everett M Rogers*, and *Kristen Speakman*. **Journal Of Business Venturing** New York:Jan 2000. Vol. 15, Iss. 1, p. 93-111

Findings from an investigation of the role of 6 spin-off companies (from research centers at the University of New Mexico) in the process of technological innovation and technology transfer are reported. The relationship between a spin-off and its parent organization (in this case, a university research center) is a key factor in the survival and growth of a new company that spins-off of a research university. Spin-offs represent a means of technology transfer and create jobs and wealth.

- Examines 6 spin-offs from UNM research centers (total of 55 centers at UNM).
- UNM's office of technology transfer: Science and Technology Corporation (STC), founded in 1995.
- President of STC is also responsible for UNM's Science and Technology Park, which houses the UNM Incubator and several research centers.
- Patents at UNM increased from 200 to 475 during 1986-1996. But, STC slows the spin-off process due to routinization and negotiation process.
- Research centers established by entrepreneurial faculty members.
- Technology transfer occurs through various channels:
  - Research publications.
  - Employment of former graduate students and/or research staff by private companies and other organizations.
  - Licensing of patents.
  - Establishment of spin-off companies.

University Technology Transfer: Do Incentives, Management, and Location Matter?
Joseph Friedman, and *Jonathan Silberman*. **Journal Of Technology Transfer: Symposium on the Economic and Managerial Implication of**
Indianapolis: Jan 2003. Vol. 28, Iss. 1, p. 17

University technology transfer activities are increasingly important as a source of regional economic development and revenue for the university. We use regression analysis, a two-stage model, and the most recent data to examine the determinants of technology transfer. Our analyses strongly support four factors, not previously examined in the literature, enhancing university technology transfer: greater rewards for faculty involvement in technology transfer, location of the university in a region with a concentration of high technology firms, a clear university mission in support of technology transfer, and the experience of the university's technology transfer office.

- VERY INTERESTING empirical study examining factors affecting the output of Technology Transfer Offices (TTO).
- TTO output is most commonly measured as number of licenses signed. Other measures of output are: amount of royalties, number of licenses with equity, and number of start-ups companies.
- Data are from 1997-1999.
- The study was conducted using a 2-stage model. The first stage involved explaining the number of invention disclosures (IDs), while the second stage explained TTO outputs (licenses).
- The #1 variable affecting IDs is FACULTY QUALITY (as measured by the average faculty quality rating for all scientific departments based on a National Research Council report in 1995). Higher faculty quality leads to more IDs, and this leads to more licenses.
- Additionally, the number of science departments offering PhDs, the amount of Federal research grants, and the amount of industry research grants also positively affects the number of IDs.
- The results regarding TTO output (number of licenses generated):
  - The HIGHER the royalty income provided to inventor(s), the GREATER is TTO output (licenses). Interestingly, the MORE the royalties are split between the inventor and the department/college, the FEWER the licenses generated.
  - The GREATER the experience of the TTO, the MORE licenses are signed. Experience is measured by AGE of the TTO. It typically takes 3 to 7 YEARS after a license is signed before royalty income is generated.
  - The GREATER the focus of the TTO on licenses, the MORE licenses will be signed. Focus is measured as clarity of royalty distribution policies.
  - The GREATER the organizational leadership that promotes TT, the MORE licenses will be signed. Leadership is measured (subjectively) by reading the TTO's mission statement. If it is (a) readily available on the University's web site, (b) short and to the point, (c) includes the words "licensing, royalty, financial return," (d) does not have multiple other objectives, and (e) includes a statistical report on TTO outcomes, then the TTO was deemed to have GREATER organizational leadership. (As another, more objective, variable, the study just used whether the web page included a statistical report.)

- The BETTER located is a university with respect to a "Tech Pole," the MORE licenses are generated. A "Tech Pole" is defined by the Milken Institute and is characterized by a relatively high concentration of technology firms, industry research, and an entrepreneurial climate. Interestingly, for 1999, Albuquerque is ranked #7 on this list. Las Cruces is #230 (out of 315) on the list. By the way, the 2004 State Technology and Science Index has been released (see http://www.milkeninstitute.org/publications/publications.taf?cat=ResRep&function=detail&ID=304). It shows New Mexico as #14 in the U.S., up from #20 in 2002.
- Additional results included a dummy variable for a top 25 Business Week Business School and a top 25 Success Magazine Entrepreneurship program. They were significant but high correlations noted with Tech-Pole index.
- Bottom line: The most important factor influencing license agreements from the TTO is the number of inventions. And, the most important factor influencing inventions is faculty quality. The elasticity is 1.0. Thus, increasing faculty quality will yield a one-to-one return on invention disclosures, which will in turn result in more license agreements from the TTO.

The Cabral-Dahab Science Park Management Paradigm: An introduction *Cabral, Regis*. **International Journal Of Technology Management**
Geneva:1998. Vol. 15, Iss. 8, p. 721-725 (5 pp.)

The Cabral-Dahab Science Park Management Paradigm has posed an important challenge to researchers, managers, and policy-makers. While traditional organizational forms and systems encounter difficulties in the global economy, the science park, when properly managed, offers a potentially successful university-industry interface. The 10 points of the Cabral-Dahab Paradigm provide guidance for success.

Supplemental Comments:

This is a very short, introductory paper that is at the beginning of a special issue on Science Parks. Most of the papers in this issue do not seem relevant. But, this paper included here as an introduction.

The 10 points in the Paradigm: A Science Park must:

1. Have access to qualified research and development personnel in the areas of knowledge in which the park has its identity.
2. Have access to a market for its products and services.
3. Have the capability to provide marketing expertise and managerial skills to firms, particularly SMEs, lacking such a resource.
4. Have the capability to protect product or process secrets, via patents, security, or any other means.
5. Have the capability to select which firms will enter the park and which will be rejected. Two possible selection criteria are firm's market potential and firm's coherence with the science park identity.
6. Have a clear identity, quite often expressed in the choice of name for the park.
7. Have a management with established or recognized expertise in financial matters, and which has presented long-term economic development plans.
8. Have the backing of powerful and dynamic national and local economic actors, for instance funding agencies or political institutions.
9. Include in its management an active person, with power of decision and with highly visible profile, who is perceived by relevant actors in society as embodying the interface between academia and industry, long-term plans, and good management—"Mr./Ms. Science Park."
10. Include a prominent percentage of consultancy firms, as well as technical services firms, including laboratories and quality control firms.

A case study of the Virginia Tech Corporate Research Center in the context of the Cabral-Dahab Paradigm, with comparison to other U.S. research parks *Echols, Ann E*, and *Meredith, Joe W.* **International Journal Of Technology Management** Geneva:1998. Vol. 15, Iss. 8, p. 761-777 (17 pp.)

The Cabral-Dahab Paradigm is evaluated by applying its 10 conditions for success to the Virginia Tech Corporate Research Center and to 18 randomly selected U.S. university-related research parks. The VTCRC, in collaboration with the university, advances the research and technology transfer missions of Virginia Tech, forming lasting partnerships and developing valuable new products. Over 1,100 people are now employed at the VTCRC. How other university-related research parks value the elements of the Cabral-Dahab Paradigm is addressed. The Cabral-Dahab Paradigm is, in general, supported by an analysis of the single case and by the survey of other university-related research parks.

Some characteristics of Virginia Tech:

- Land grant university.
- Ranks in top 50 universities for total dollars spent on research ($165 million as of 19??)
- Ranks in top 10 for industry-sponsored research.
- Located in small rural town (Blacksburg), population 25,000
- Has 1,424 full-time faculty, 5,000 graduate students, 20,500 undergraduates.

The VTCRC is a very successful research park. Some characteristics of the VTCRC:

- Incorporated on July 1, 1985.
- Has fostered growth of over 22 new companies.
- 22 faculty entrepreneurs, 48 outside firms, 9 public entities located at VTCRC.
- 1,100 people employed in VTCRC, with combined payroll over $8 million.
- Has 25 buildings on 120 acres and is in first phase (as of date of article). Subsequent phases will increase acreage to 300.
- Initial, start-up support for infrastructure included $600,000 grant from Economic Development Assistance Program of U.S. Department of Commerce. Since then, it has had NO federal or state investment or any funding partners. The park as been completely developed by the Virginia Tech Foundation.

The Cabral-Dahab Paradigm includes 10 points. Elements that the authors (one of whom is the President of the VTCRC), felt were satisfied by the VTCRC are:

Element 1: Access to qualified research and development personnel by structuring the park to be adjoining to the university.

Element 3: Capability to provide marketing and management skills to firms lacking these resources.

Element 4: Having VTIP (Virginia Tech Intellectual Property) established to control discoveries made by university researchers.

Element 5: Being able to select firms entering the park to maintain tenants in terms of VTCRC's identity.

Element 6: Having a clear park identity in terms of a consistent graphic image/logo.

Element 7: Having a management team that has financial expertise and visions of long-term economic plans.

Element 9: Having a visible park manager who embodies the interface between academia and industry (NOTE: This is Joe Meredith, one of the co-authors. The authors point out that he is a "technologist" and remark that this fact is important.)

Element 10: Having a mix of firms in the park: consultancies, technical service firms, and laboratories that synergistically work together, focusing on clean technologies.

Also in this paper, the authors examine other university research parks to determine how they value the Cabral-Dahab Paradigm. The Paradigm is, in general, supported by their survey research of other university-related research parks.

Technology transfer and universities' spin-out strategies
Andy Lockett, *Mike Wright*, and *Stephen Franklin*.
Small Business Economics Dordrecht:Mar 2003. Vol. 20, Iss. 2, p. 185

Universities may seek to transfer technology from the public to the private sector, and therefore capture the benefits of commercialization, through a number of different mechanisms. This paper examines the option of using technology-based spin-out companies. Based on a survey of technology transfer/business development officers at 57 UK universities, their strategies to promote the creation of spin-out companies and how they then manage the development of these companies are examined. The analysis focuses on the difference between those universities that have been most active in the area and those that have been least active. The results indicate that the more successful universities have clearer strategies toward the spinning out of companies and the use of surrogate entrepreneurs in this process. In addition, the more successful universities were found to possess a greater expertise and networks that may be important in fostering spin-out companies. However, the role of the academic inventor was not found to differ between the more and less successful universities. Finally, equity ownership was found to be more widely distributed among the members of the spin-out company in the case of the more successful universities.

Supplementary Summary Comments: Abstract covers conclusions well. Article contained comment that licensing technology to existing companies is more common than spinning off new companies but that the latter seems to produce a greater long-run average return. "Surrogate entrepreneur" is someone other than the academic inventor.

Devol, R., "Blueprint for a High-Tech Cluster: The Case of the Microsystems Industry in the Southwest," Milken Institute (August 8, 2000) (http://www.milkeninstitute.org/publications/publications.taf?function=detail&ID=46&cat=PBriefs).

Abstract: This study is based upon a preliminary draft, which was delivered as a presentation at the 2nd Annual Conference on the Southwest as a Region of Innovation on June 27, 2000, in Albuquerque, New Mexico, "Making the Southwest the Foundry for the Microsystems Industries of the Future." I would like to thank Sandia National Laboratories for commissioning this study and their support.

Technology and knowledge-driven innovation are critical to wealth creation and overall economic vibrancy in our New Economy. Where clusters of emerging technologies form will play a key role in determining economic winners and losers of the first half of the 21st century. As economic activity becomes more knowledge-based, those regions with leading clusters will experience greater economic growth. Because knowledge is generated, transmitted, and shared more efficiently in close proximity, economic activity based on new knowledge has a high propensity to cluster within a geographic area.

This paper offers a blueprint for developing regional high-tech clusters using the case of the microsystems industry in the Southwest United States. It discusses development strategies for high-tech clusters in general, then for the microsystems industry in particular. Finally, it sets out specific actions required to establish a Microsystems cluster in any given region.

Microsystems is a newly formed, evolving collection of technologies including micro-electronics, MEMS (Micro Electro Mechanical Systems), and optoelectronics. An emerging application area is gene chips and related DNA analysis tools. Radio Frequency MEMS could revolutionize cellular phone and other wireless applications by replacing classical microwave circuit receivers. Opto-electronics is a series of technologies that could vastly expand the bandwidth of our communications capabilities at a minimal investment.

The geographic winner of these convergence technologies and innovations has not been determined and is not preordained. The Southwest has considerable research and innovation competencies, but has several geographic competitors. Key challengers are Michigan, Central New Jersey, the Boston area, Greater Dallas, Southern Florida, and, perhaps its most formidable, Silicon Valley. First-mover advantages in forming new industry clusters that relegate established technologies into near obsolescence (i.e., potentially disruptive technologies, such as Microsystems), could be long enduring.

USC's technology incubator

Joel C Stevenson, *Martha Wetterhall Thomas*.

Business And Economic Review Columbia:Jan-Mar 2001. Vol. 47, Iss. 2, p. 11-14 (4 pp.)

The USC Columbia Technology Incubator was officially opened in November of 1998. It is managed by The South Carolina Research Institute (SCRI), the university-connected research foundation. The incubator's resource specialties are office space, labs, service provider networks, and software networking. Funding for the incubator comes from USC and private donations. To be accepted into the incubator, a company must need interaction with the university, be a technology-based company with a business plan, and have growth potential and team-building capabilities.

Supplementary Summary Comments:

- National Business Incubation Association (NBIA) description of business incubation:

  Business incubation is a dynamic process of business enterprise development. Incubators nurture young firms, helping them to survive and grow during the start-up period when they are most vulnerable. Incubators provide hands-on management assistance, access to financing, and orchestrated exposure to critical business or technical support services. They also offer entrepreneurial firms shared office services, access to equipment, flexible leases, and expandable space—all under one roof.

- Advanced Technology Development Center (ATDC) in Atlanta, birthplace of MindSpring.com, held out as successful business incubator, along with Austin Technology Incubator and Louisiana Business and Technology Center. States following characteristics of successful business incubators:
  - Interaction between companies.
    - Common areas.
    - Conference room w/kitchen access.
  - Support from academia, government, business.
  - Students play key role in helping companies.
  - Staffing typically low.
  - Business topic workshops.

University venturing: Technology transfer and commercialisation in higher education
Raymond Smilor, and *Jana Matthews*. **International Journal of Technology Transfer & Commercialisation**
Geneva:2004. Vol. 3, Iss. 1, p. 111-128

This study identifies the forces and factors affecting technology transfer and commercialisation at universities. It assesses successful technology transfer and commercialisation programs and summarises the 'best practices' of five universities: Georgia Tech, North Carolina State, The University of Florida, The University of Texas at Austin, and Virginia Polytechnic Institute. The paper identifies several forces that are driving universities to be more involved in economic development and more engaged in the commercialisation of technology. The benchmarking study focuses on the role of leadership in these institutions and the need to embrace technology transfer and commercialisation, reviews how each university supports technology transfer initiatives, highlights innovations to facilitate technology transfer, and describes how the universities utilise technology transfer to support the economic development of their regions and states. The study concludes with lessons learned and a comparison of the universities that comprised the benchmarking study. [PUBLICATION ABSTRACT]

Note: Requested through Interlibrary Loan, but it hasn't come through yet.

Executive forum: University technology transfer to entrepreneurial companies
Scott Shane. **Journal Of Business Venturing** New York: Oct 2002. Vol. 17, Iss. 6, p. 537-552

University research and technology transfer to entrepreneurial companies is important and increasing. However, no single document summarizes the ways in which university technology interactions with entrepreneurial firms differ from those with large, established organizations. A study reviews 4 dimensions of university-entrepreneurial firm collaboration: (1) industry-sponsored contract research, (2) consulting, (3) technology licensing, and (4) technology development and commercialization—of which practitioners involved in university-private sector technology inter-action need to be aware. Entrepreneurial companies are less likely than established companies to engage in contract research. The proportion of contract research funded by entrepreneurial companies at research universities is minuscule. Government agencies provide 70 percent of funding, and foundations, and large firms fund most of the remainder. Consulting arrangements with entrepreneurial firms require more intense involvement by faculty than consulting arrangements with large firms. Technology licensing by entrepreneurial firms depends on complementary mechanisms to provide financing.

Supplementary comments:

This is an interesting article reviewing the four dimensions of university-entrepreneurial firm collaboration. What is perhaps equally interesting is what the author states we DON'T know much about through formal research:

1. The differences between entrepreneurial companies generated by universities and entrepreneurial companies seeking univer-sity assistance.
2. The differences between different types of entrepreneurial companies (e.g., venture-capital-backed versus bootstrapped companies).
3. Differences across industries.
4. Differences across types of universities (e.g., private vs. public).
5. Differences across stage of development (e.g., early stage [prototype] vs. late stage [actual products to sell]).
6. One-time versus repeat firms

Equity and the technology transfer strategies of American Research Universities
Maryann Feldman, *Irwin Feller*, *Janet Bercovitz*, *Richard Burton*.
Management Science Linthicum:Jan 2002. Vol. 48, Iss. 1, p. 105-121 (17 pp.)

American universities are experimenting with new mechanisms for promoting the commercialization of academic research and generating revenue from university intellectual property. This paper discusses mechanisms available to universities in managing the commercialization of intellectual property, considering equity as a technology transfer mechanism that offers advantages for both generating revenue and aligning the interests of universities, industry, and faculty. Employing data from a national survey of Carnegie I and Carnegie II institutions, the recent rise in university equity holdings is documented. A model is presented and estimated that considers the university's use of equity to be a function of behavioral factors related to the university's prior experiences with licensing, success relative to other institutions, and the organization of the technology transfer office, as well as structural characteristics related to university type.

Supplementary Summary Comments:

- Equity position is an alternative to more traditional licensing of technology to companies. (Licensing can grant various degrees of exclusivity to the rights of company to control intellectual property. Trend is toward increasing use of nonexclusive licenses with stipulated limits on technology application, geographic scope, or terms of use. See Blumenstyk article in "NewsItems etc." directory of arpc drive.)
- Licensing
  - Advantages.
    - Symbolic importance—attests to capability of university of serve as engine of growth for national and local economies.
    - Large portfolio of active licenses is tool for recruiting and retaining research faculty.
  - Disadvantages
    - Many universities disappointed by licensing revenue stream.
    - Most licensed technology requires significant developmental work.
    - Rule of thumb in university tech transfer: For every 100 invention disclosures to the university tech transfer office, 10 patents and 1 commercially successful product result. Distribution of licensing revenues is highly skewed with a few big commercial successes generating large returns for a small number of universities.
    - Biomedical invention accounts for a substantial share of academic licenses, and commercialization of these products requires navigating the FDA approval process, which takes an average of 10 years.
    - Industry has concerns about university refusal to transfer patent ownership to company, university policies regarding delay of publication, and obtaining faculty cooperation for further develop-ment of the technology.
- Equity
  - Advantages
    - Opportunity cost of foregone licensing revenues is low.
    - Conserves cash of cash-strapped start-up enterprises.

- For multi-project companies, share price is based on other company activities besides the individual technology in question.
- Increases upside revenue potential to university.
- Improves alignment between institution's interests and those of the firm.
- Relatively simple to negotiate compared with complex license agreements in presence of typical extreme uncertainty that exists with early-stage technology.
- Perception that holding equity demonstrates university's entrepreneurial spirit; also, research indicates firms report "halo effect" of having universities as stockholders.
- Equity held by faculty member gives incentive to continue to work with the company on the technology.

o Disadvantages
- Increases downside revenue potential to university.
- Lack of steady cash flow.
- Perception that holding equity may increase university's potential liability.

How do university inventions get into practice?

Jeannette Colyvas, *Michael Crow*, *Annetine Gelijns*, *Roberto Mazzoleni*, *et al*. **Management Science** Linthicum:Jan 2002. Vol. 48, Iss. 1, p. 61-72 (12 pp.)

This paper examines in detail a considerable number of cases of university inventing to better understand the nature of the projects that led to inventions reported in invention reports, the motivations for the research, and the processes and mechanisms involved in connecting with industry for technology transfer. The cases that form the basis of this report are of inventions created at Columbia University and Stanford University. This study is restricted to a set of inventions for which the universities sought and obtained intellectual property rights, typically in the form of patents.

Supplementary comments:

While it has been commonly reported that university patenting has risen considerably following Bayh-Dole, the real story is more complicated because of the following two trends:

(1) The 1980s and 1990s saw a rise of whole new areas of research (e.g., molecular biology and genetic engineering, and computer technology), (i.e., how computers were used in research and software development). These two broad areas were extremely interesting to industry and so led to lots of patenting.

(2) Patent Office and court decisions increased the range of research results that were patentable, particularly in biotech-nology.

So, Bayh-Dole served to accelerate and magnify trends that were already occurring.

The authors conclude that "both the role of patents and the role of the university technology transfer offices, varies significantly from case to case. In some cases, it is unlikely that technology transfer would have occurred absent intellectual property rights. In others, intellectual property rights did facilitate universities earning royalty income, but the technology would have been used in industry even absent patenting and licensing by the university. Similarly, in several of our cases, the university technology transfer offices did assist in bridging the divide between the lab and marketplace, but in others the divide was not that big to begin with."

The authors note: "In none of these 11 cases did an expectation of financial returns for the scientists, or for the university, appear to have played a significant role in motivating the research."

"It is important to recognize . . . the researchers involved were members of a community, a network of scientists, that involved people from the industries that likely could benefit from successful research results."

In one case in which there was a wide divide between the university and industry, the technology never got transferred!

Therefore, in the cases studied, the role of the technology transfer office was NOT to develop links between the university and industry (those links were already developed). Rather, it was to monitor, facilitate, and regulate the transactions between parties who already knew each other.

For "embroynic" inventions (those that need substantial more work to develop), it was almost never clear in advance which firm would show the initiative and have the capability to do

successfully the needed additional work. Some firms would start and then become unenthusiastic and drop out. Therefore, for embryonic technologies, "strong" exclusive licenses can have a real cost, although intellectual property rights and exclusivity are more important in order to induce firms to undertake the additional work.

So, if the TTO did not really participate in "selling" the technology, what did it do?

(1) Worked out arrangements for the licensing.
(2) Arrangements for industry funding of research.
(3) Patent application process complex and time consuming.
(4) Difficult questions in defining and protecting universities' interests in the transactions.

Conclusion 1: IP does not always have to be protected (via patents), because some inventions are ready for industry "off the shelf." Question for future research: How often is that the case?

Conclusion 2: TTO marketing activities are most important when existing links between academia and industry are weak.

Observation: Technology was "transferred" even before Bayh-Dole. An early 1990s survey (Cohen et al, 1998) asked industry of the most important channels through which they benefited from university research. In most industries, the most often cited channels were (a) publications, (b) open scientific communication more generally, and (c) consulting. In very few industries did licensing of university patents come up as an important channel.

Final observation: Generating university revenues was NOT a central argument of Bayh-Dole. However, NOW, it IS an important objective of universities in their patenting and licensing policies. The tradeoffs and conflicts between maximizing university revenue and maximizing technology transfer (broadly speaking) need to be recognized and are areas of future research.

Critical Factors for Science Park Management: The North American and European Experience
Yuehua Zhang, Proceedings, Hawaii International Conference on Business, Honolulu, 2003.

Abstract: The science park phenomenon started half a century ago. Comprehensive studies concerning science park management emerged two decades later. Aiming at probing science park management strategies, the present study examines the experience of science park management reflected by the literature, which happens to focus on earlier parks in North America and Europe. This paper extracts their key success factors and synthesizes them into three groups: location factors, park preparation, and a professional management team. Findings reflect that park location factors caught the earliest attention. Intangible aspects of science park manage-ment such as marketing, services, and the quality of park management team were emphasized in the third decade of science park development. This implies that good park administration is no less important for a science park than a strategic location, but this was realized later; or good park administration is the critical factor after a good location has been selected. In either case, good park administration should be decisive for park success.

Supplementary comments:

The portion of this study that deals with North America notes that "research park" is the popular term for science parks in the United States and reports the following critical success factors found in various studies:

From a 1970 study:

1) Logical tie between tenants' activities and university's faculties and graduate programs.
2) Significant university services considered by park tenants to be important in their decision to locate in the park.
    a) Computer services.
    b) Convenient restaurant, motel, post office, bank.
3) Appropriate research park management policies.
    a) Physical layout of site enables expansion of tenants' facilities.
    b) Controls and restrictions are established and enforced to retain park aesthetic quality.
    c) Cost of site is competitive with alternative sites available.
4) Favorable geographic and environmental factors important to tenants.
    a) Suburban residential area within commuting distance.
    b) Adequate housing in medium price range.
    c) Good public schools.
    d) Established graduate school with significant research programs.
    e) University programs to provide library services, continuing education opportunities, and graduates for possible employment by tenants.
    f) Skilled technicians in the area.
    g) Jet airport in the area.
    h) Community cultural offerings.
    i) Urban center within 50 miles.

From a 1982 study:

1) Confirmation of factors from 1970 study above.
2) Availability of special facilities, such as jogging paths, restaurants, health clubs, recreational facilities, and a wide variety of shops.
3) Availability of low-cost incubator space.
4) Availability of sufficient financing from a variety of sources for spin-off companies.
5) Graduate programs in business, mathematics, science, and engineering.

From a 1983 study:

1) Confirmation of factors from 1970 study above.
2) Formal and clear covenants governing activities within the research park.
3) Rigorous performance standards regarding noise, smoke, fumes, vibration, glare, radiation, etc., to ensure high quality of research park.
4) Availability of university interested in working with private sector firms in collaboration or support roles.
5) Well-organized management, a highly professional and full-time executive director and staff, and a marketing program that extends across the community.
6) Park management has considerable flexibility with regard to land use and activities allowed subject to covenants.
7) Study notes that periods of park development have been much longer than normally thought and in virtually every case have involved a minimum of 20 to 25 years.

From a 1985 study:

1) Desirable living environment, where scientists want to live.
2) Presence of a major technological university.
3) Major industrial research facilities in the park or nearby.
4) Skilled labor force.
5) Study concludes that if any of the above four factors is missing, the community will ave difficulty in developing a research park and that the attitudes and actions of the local community are a large factor in the success of a park. The community includes government, utility companies, educational institutions, financial institu-tions, and local organizations.

From a 1991 study:

1) Parks that provide amenities to park businesses appear to have been more successful than others, all else being equal.
2) Regions that are most likely to host successful research parks are those with such factors as:
    a) An existing base of research and development and high-tech activity.
    b) One or several research universities, medical schools, and/or engineering institutes.
    c) Good air transportation services.
    d) Well-developed network of infra-structure and business services.
    e) Forward-looking and effective political, academic, and business leaders.
3) Study notes that items (a) through (e) above under (2) need not all be present at the outset but need to be developed along with the park.