A METHODOLOGY TO IDENTIFY SUCCESS CRITERIA FOR THE VIRGINIA TECH CORPORATE RESEARCH CENTER

by

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Thesis submitted to the Faculty of the

Virginia Polytechnic Insititute and State University

in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

in

Industrial and Systems Engineering

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December, 1991
Blacksburg, Virginia

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(ABSTRACT)

The study has two objectives: to develop a methodology to identify success criteria for the VT CRC and to communicate outputs (success criteria) to selected members of the VT CRC's stakeholders. A methodology is developed to identify success criteria based on the VT CRC's primary objectives. These primary objectives are: technology transfer and economic development.

The purposes of a methodology are to place the VT CRC within the framework of Virginia Tech's larger missions and then to identify success criteria. A methodology consists of seven steps. There are thirteen success criteria which have been identified by a methodology. A methodology is based on management systems engineering theories, concepts, and tools/techniques.

The study communicates outputs from a methodology by a questionnaire. Questionnaires will be sent to twelve selected members who are from the VT CRC, the university, tenants, and Town of Blacksburg. Their responses will be analyzed to decide whether these outputs are success criteria for the VT CRC and whether a methodology accomplishes its purposes.

Furthermore, a background of Virginia Tech and a concept of university-related research parks will be discussed. Included in a discussion of Virginia Tech are missions, a modern view of a land-grant university, and roles of the Virginia Tech Foundation. Included in a discussion of research parks are purposes, benefits, and drawbacks.

Acknowledgement

First, I would like to thank my mother (Sanpang Phusavat) who has always been supportive throughout my life. Further, I would like to share success of this research with the memory of my father (Piew Phusavat) whose dedication, honesty, and loyalty to Thailand have always motivated me to work hard throughout my life.

Furthermore, I would like to express my deepest gratitude to my advisor, Dr. Paul E. Torgersen for his advice, support, and direction for this research. His consistent dedication and leadership to the university, the Virginia Tech Corporate Research Center, and students have provided me an additional force to continuously and consistently work on this thesis. I also have to thank Dr. Wolter J. Fabrycky and Dr. C. Patrick Koelling for their time and recommendations.

There are other special people whom I would like to recognize for a completion and success of this thesis. The first two are Aunte Sue and Uncle Sian (Dr. Sue and Sian Poh) who have made me believe in myself. I also have to recognize my dear friend, Bill Hoehn for his support. Last but not least, I would like to thank my undergraduate advisor at Texas Tech University, Dr. Richard A. Dudek as a person who encouraged and provided me an opportunity to study in the field of industrial engineering.

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Chapter 1: Introduction

This chapter is intended to briefly introduce the topic: the development of the methodology to identify success criteria for the Virginia Tech Corporate Research Center. The chapter provides a research background, discusses research objectives, and the reasons for the topic selection. The background includes an overview of research parks. Then, the discussion will focus upon the objectives of this research. The reasons for the topic selection will be both a perceived obligation as a Virginia Tech student and a personal preference for this subject.

Section I: Research Background.

This research will develop a methodology to identify success criteria for the Virginia Tech Corporate Research Center (the VT CRC). Many university-related research parks, similar to the VT CRC, have been established since the 1950's. The words (a university-related research park, a research park, and a park) will be used interchangeably throughout this research. Some of these parks have claimed or have been claimed to be successful based on indicators used in real estate and financial ventures. These include: profit generated from rented spaces and/or number of buildings in the park.

Instead of concentrating on real estate oriented criteria like most parks, a new approach attempts to identify success criteria from objectives. The VT CRC will be assumed to help Virginia Tech accomplish

its missions. As a result, the methodology is designed to place the park within a university perspective and then to identify the park's success criteria based on its primary objectives. The proposed methodology is based on the park objectives as a subset of the university mission. However, due to many constraints such as time, consistency with research objectives, and scope of the thesis, the proposed methodology will only be applied to the VT CRC.

Although a research intention is to test the methodology at the VT CRC, there is an implication to other research parks as well. The reason is that this methodology may be applicable to other research parks in terms of helping them identify their set of success criteria, if the methodology is found to help identify success criteria for the VT CRC.

The sequence and structure of my thesis have been arranged in such a way that not only will all readers understand the purposes and the application of the methodology, but they will also understand Virginia Tech and the Virginia Tech Corporate Research Center as well. This research also addresses the concept of university-related research parks so that readers realize different purposes and objectives of university-related research parks.

The first chapter is the introduction which is intended to provide reasons for my selection of this topic and the objectives for my research. The first chapter also provides a brief overview of the remaining chapters.

The second chapter describes the university, Virginia Tech. The purpose of the second chapter is to have readers learn more about Virginia Tech from its past, present, and expected future activities. The understanding of these activities will help readers realize the significance of the VT CRC's success criteria and whether they are within the university missions. The chapter begins with the university history based on its missions and purposes. Later, the discussion involves the period of growth and the reshaping of the university to meet present and future challenges. The next section is the modern view of a land-grant university and how Virginia Tech attempts to become a successful land-grant institution. The last section will focus on the Virginia Tech Foundation and how it has helped link the university with the private and public sector.

The third chapter will provide an overview of the research park concept. This chapter addresses purposes and benefits of research parks. It will also include some current justifications of the park's success. The chapter will investigate how the concept of research parks relates to and benefits higher education. The relationship with the public and the private sector is included in this investigation.

The fourth chapter will concentrate on the the VT CRC including its missions, relationships, and contributions to the university and the surrounding community. The purpose of this chapter is to help readers better understand the VT CRC and how it can help the university fulfill its missions, especially in the area of research and extension. Included in the

chapter is a brief overview of the VT CRC's future planned development.

The fifth chapter will discuss the development of the methodology to identify success criteria for the VT CRC. A hypothesis will also be stated. Finally, the discussion will concentrate on the purposes and justifications of each step in the methodology. Included in the discussion are the sample and experimental design to test the hypothesis.

The sixth chapter will discuss the results after an implementation of the proposed methodology to support the hypothesis. The results involve: 1) success criteria that will be identified by the proposed methodology, 2) a questionnaire which is designed to capture selected members of the VT CRC stakeholders' opinions , and 3) their opinions. Stakeholders of the VT CRC include a person, people, or group of people who has/have a stake (in terms of responsibility, obligation, cooperation, and interaction) of well-being and operation of the VT CRC. These results will be interpreted in this chapter.

The last chapter is a summary of what has been accomplished and recommendations for future studies in this area. This chapter will be brief and be discussed within the context of research work.

Section II: The Research Objectives

This research is designed to accomplish the following two objectives.

1. The first objective is to develop a methodology to identify success

criteria for the VT CRC. Then a testable hypothesis will be developed based on this methodology. The underlying concept is whether the methodology can identify success criteria for parks by placing the VT CRC's objectives within the framework of Virginia Tech's larger missions. The success criteria are to be derived from the park's objectives. By placing objectives within missions, this methodology assures consistency between the VT CRC and Virginia Tech. Assumptions of the methodology will be discussed in more detail in the fifth chapter. Techniques are included in this methodology as well. They are: a context diagram and a data flow diagram. These techniques will be used with official documents such as the mission statement from the university and the VT CRC and will form steps in the methodology.

The benefit of success criteria is that the VT CRC can use them to monitor its progress toward its objectives. It should be noted that how the VT CRC plans to derive, portray, and apply success criteria are beyond the scope of this study.

2. My second objective is to communicate these success criteria to selected members of the VT CRC's stakeholders (such as the center administration, the university, tenants, and the community). To communicate means that a questionnaire will be sent to selected members asking them to respond whether outputs from the methodology should be success criteria of the VT CRC and whether each step within the proposed methodology helps the methodology accomplish its overall purpose. In other words, this objective will be accomplished by the use of the

questionnaire (more details in chapter 5).

Section III: Reasons for topic selection

Reason 1: This area is still in an early stage of development. There is no standardized methodology to help the VT CRC and other research parks identify their success criteria. Therefore, it is necessary to try to establish such a methodology. Also, there have been no publications or official documents concerning success criteria for the VT CRC since its establishment in 1983. As a result, it is important to identify success criteria for the VT CRC so that its administration can use them to monitor and improve the VT CRC performance. If the methodology is proved to accomplish its purposes, it may be used at other parks as well. The VT CRC provides the first step to test this effort.

Reason 2: The underlying concept of research parks is to link higher education with both the public and private sector. As an international student from Bangkok, Thailand, I believe that this concept will play a major role in Thailand's social and economic development. At this moment, Thailand is experiencing the need to change its social and economic structure from agricultural and labor-intensive products to the production of more capital and technology-intensive goods. The development and application of new technology based on cooperation among educational institutions, the private sector, and the public sector will likely help the country's ability to accomplish this change. At the moment, this concept is under study by the Royal Thai Government.

The other benefit to Thailand is the improvement of the public university system. The improvement can come from interaction with the private and public sector for a funding vehicle to learn, develop, and apply high technology developed domestically and abroad. The concept of research parks may become a new way to conduct and to improve research for the higher educational institution in the future. Hopefully, I will learn more about a concept of a research park so that I may be helpful for Thailand when it decides to establish one. The VT CRC provides a great opportunity to do just that. Therefore, my thesis will be beneficial to the VT CRC and possibly Thailand.

Chapter 2: The University

This chapter is organized into five sections. The first section provides a historical perspective of the university. This perspective includes some events leading to the establishment of Virginia Tech and the implication of the land-grant act, under which it was founded.

The second section will discuss the contributions of three presidents who helped shape the university: Dr. Julian A. Burruss, Dr. Walter S. Newman, and Dr. T. Marshall Hanhn.

The third section section discusses the university's missions. Information for this section comes from the two Self-Studies completed in the years 1975-76 and 1986-88. Discussion concentrates on the research and extension missions due to their direct relation with the VT CRC's objectives. Furthermore, the discussion also includes how the university attempts to fulfill these two missions.

The fourth section discusses the contemporary view of the land-grant university. The emphasis in the section is on changing expectations of both public and private entities toward university research and extension.

The last section provides an overview of the Virginia Tech Foundation. Emphasis is on the purposes of the Foundation and the relationship between it and the the VT CRC.

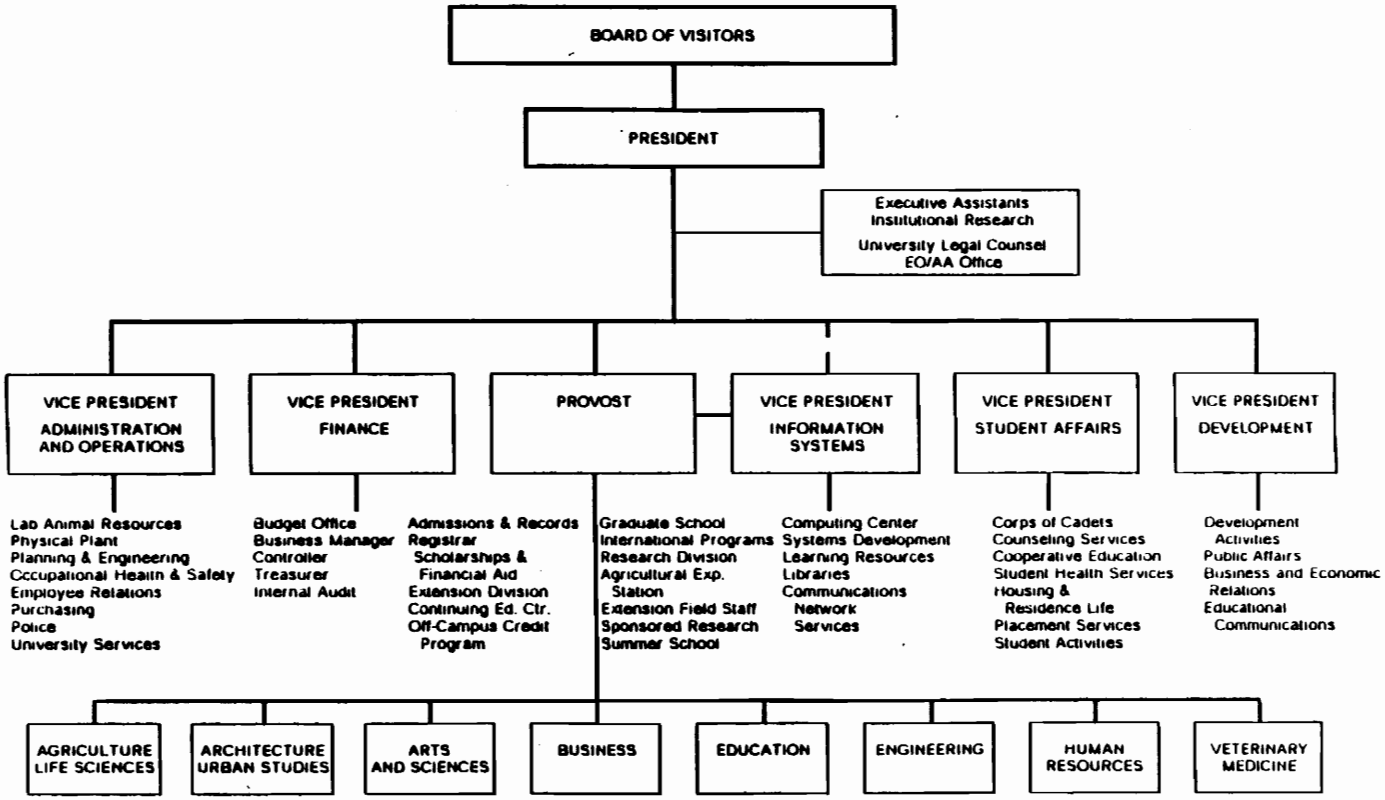


Figure 2-1: Organizational Structure of Virgnia Polytechnic Institute and State University (adapted from the University Self-Study of 1986-88).

Section I: Olin and Preston Institute and the Morill Act.

Virginia Polytechnic Institute and State university (VPI&SU) was established on March 18, 1872 as the Virginia Agricultural and Mechanical College. There were two major events that led to this establishment. The first event was the creation of the Olin and Preston Institute at Blacksburg in 1851 as a seminary "for the instruction of youth in the various branches of science and literature, and useful arts, and the learned and foreign languages"(Robertson, 1972: 6). This institution was administered by several Methodist leaders around the Blacksburg area and received a charter from the state in 1854. Due to financial difficulty prior to and during the Civil War, the institution was forced to close. After the war, several Methodist leaders tried to reopen the institution and attempted to secure more financial support. When the administration of the Institute learned of the newly enacted Morrill Act, they decided to seek funds for the institute.

The Morrill Act, known as the Land-Grant Act was passed in 1862. The act was designed to provide as follows (Westmeyer, 1985: 61):

"1. Support in every state for at least one college devoted to agriculture and the mechanic arts,

"2. Public lands or land script equal to 30,000 acres for each senator and representatives under the 1860 apportionment (a total of17,430,000 acres of public land),

"3. the funds, except for 10 percent which could be used initially to buy land for sites, to be set up as an endowment at no less than 5 percent interest,

"4. if not used, the funds to be returned to the federal government in five years."

In addition to the Morrill Act, Congress also passed three more relevant legislative acts. The Hatch Experiment Station Act, known as the Hatch Act, was passed in 1887 to "furnish annual appropriations of $15,000 to each state for the establishment of agricultural experiment stations at the land-grant institutions."(Westmeyer, 1985: 65) The Smith-Lever Act was passed in 1914 to authorize "the land-grant institution to offer extension work away from the campus and to set up the agricultural and home economics extension services"(Westmeyer, 1985: 65). Finally, the Bankhead-Johnes Act, passed in 1935, was designed to add "more funds to the annual appropriations for the support of A&M colleges to allow for agricultural research and for co-operative extension work"(Westmeyer, 1985: 65).

Under the leadership of the two trustees of the Olin and Preston Institute, Dr. Harry Black and Peter Henry Whisner, and support from State Senator John E. Penn and Delegate Gabriel C. Wharton, the bill to establish the Virginia Agricultural and Mechanical College at the Blacksburg campus was signed by Governor Gilbert C. Walker in 1872. The Blacksburg campus was appropriated two-thirds of the land-grant funds.

Since then, the Virginia Agricultural and Mechanical College has gone through several name changes. In 1896, the name was changed to Virginia Agricultural and Mechanical College and Polytechnic Institute. The name was then changed again in 1944 to Virginia Polytechnic Institute. Today, the official name (June 26, 1970) is Virginia Polytechnic Institute and State university, also referred to as Virginia Tech.

Section II: The Presidents

It is not possible to discuss the contributions made by all Virginia Tech's presidents. On the other hand, it will be helpful to address some major events that have shaped the university's mission and the relationship to the the VT CRC. As a result, three presidents will be discussed.

Dr. Julian A. Burruss was elected by the Board of Visitors as the University's eighth president. His presidency lasted from 1919-1945. When he assumed the post, Dr. Burruss issued a list of "six ultimate goals" (Robertson, 1964: 13) to guide and provide the direction of the school. These goals are as followed: "to do what Virginia needs to have done by this particular institution; to maintain highest standards in all endeavors; to provide a staff organization adequate to carry on the work efficiently; to provide a physical plant adequate for the work to be done; to so conduct the institution as to secure desired efficiency with the greatest economy; and to provide funds necessary for doing the job that is to be done"(Robertson, 1964: 13). The purpose included extending the

new-found knowledge beyond the campus boundary. More specific contributions were the establishment of the Engineering Experiment Station and the Engineering Extension Division.

Virginia Tech continued to grow in student enrollments, academic programs, and contributions to the surrounding community and the state. In 1947, the Board of Visitors elected Dr. Walter S. Newman to become the University's tenth President. His presidency lasted from 1947 to 1962. During these years, Dr. Newman guided the university through one of the most expansive periods in the school's history with a particular attention to research and graduate work. Many master and doctor of philosophy degree programs were introduced, especially in the College of Engineering. Noticeable achievements included a $350,000 grant from the Atomic Energy Commission to purchase a nuclear reactor simulator and the establishment of the Cooperative Program. Further, large scale research projects, other than those required by law, came into existence. Dr. Newman also helped create the Education Foundation to increase financial contributions from alumni and corporations to help finance some of the university's operations.

For fifteen years, Dr. Newman set the tone for the university's future development, especially in the area of research and extended the university's boundary beyond the campus. The Education Foundation would later prove to be an important tool for the university to link with the private sector. Dr. Newman outlined the university's direction which would eventually cover all three present missions of this institution.

> "By all reasonable standards... Virginia Polytechnic Institute is functioning as a public university in her educational contributions to the welfare of the state and the nation. As such, she has the responsibility of a state university for maintaining quality in higher education, for keeping open the door of educational opportunity, for advancing the frontiers of knowledge, for extending public service in adult and continuing education of all kinds, and for providing administrative leadership as needed, in a coordinated program of the total educational system of the Commonwealth. For these reasons, then, it is becoming increasingly more important that steps be taken toward establishing a public image of the institution which more adequately reflects the university operation covering collegiate and graduate education"(Kinnear, 1972: 403).

Virginia Tech still experienced periods of growth even after Dr. Newman's retirement. In 1962, Dr. T. Marshall Hahn Jr. was elected as the university's eleventh President. He was the university's president until 1975. During his presidency, Dr. Hahn actively implemented his vision of transforming Virginia Tech from a "technically oriented" institute to a "quality university education"(Robertson, 1964: 25). To support his vision, Dr. Hahn called for a self-study of the university and a re-examination of its missions. By the Fall of 1964, it was again concluded that "VPI's basic mission must include a quality resident instruction program for the youth in Virginia, coupled with supporting research and extension activities"(Kinnear, 1972: 434). Upon his recommendation, the Board of Visitors stated:

"The VPI Board of Visitors recognizes that the mission of VPI is to provide the best possible resident instruction for the qualified youth of Virginia and strong research and extension programs to serve the needs of the Commonwealth.

"The Board desires to develop facilities to accommodate students from Virginia high schools who have the ability to complete successfully a quality university education. In making plans to carry out this mission the board reached the following conclusions:

"1. The increasing number of quality high school graduates will necessarily result in substantial growth in the enrollment of VPI and the Board accepts its increasing significant obligation to the state, subject to the availability of funds.

"2. There is a growing demand for women educated in the programs of VPI, and this will be taken into consideration in the future development of the institution.

"3. Without loss of recognition of the importance of strengthening the undergraduate program, greater emphasis should be placed on strengthening the graduate programs and offering graduate degrees in all areas where the need is demonstrated"(Kinnear, 1972: 435-36).

To support a strong graduate program, Dr. Hahn realized that research first had to be strengthened because the success of graduate study was based on the discovery and application of new knowledge. The public and private funding were to be an important element for this success. In 1966, Virginia Tech established a Research Division to help organize how

the university would conduct research. The purpose of this establishment was to consolidate and broaden the role of the two existing research agencies: the Virginia Engineering Station and the Virginia Agricultural Experiment Station. Since then, Virginia Tech has established many research facilities on and off campus throughout the state. In 1966, the university also created the Extension Division. The purpose of the division was to create "the administrative and educational structure necessary to make available the total resources of the university to meet the diverse educational needs of the rapidly changing state"(Kinnear, 1972: 439).

Dr. Hahn's presidency was the most profound in Virginia Tech's history. The university began to realize its potential as a nationally competitive land-grant institution. Dr. Hahn gave Virginia Tech an expanded vision; one which would go beyond that of a regional school to become a national university ready to use its most important resources, personnel and knowledge to help solve the state and the nation's present and future scientific, technological, social and economic problems.

Section III: The Missions: Research and Extension

Since the Self-Study conducted during Dr. Hahn's presidency, Virginia Tech has gone through two more Self-Studies to evaluate the University's missions. The results of both indicated that Virginia Tech has become an important tool for the state; especially in the areas of social and economic development. The university is expected to be involved in the affairs and well-being of the state. As a result, administrations following Dr. Hahn

have attempted to incorporate expectations by the university's stakeholders into its responsibility and missions.

Two Self-Studies completed in 1975-76 and 1986-88 are relevant to the establishment and operation of the the VT CRC. From the Self-Study of 1975-76, the university summarized its purposes according to three goals which were designed to serve over the next ten years (University Self-Study, 1976: 9-10).

"1. Excellence depends, first and foremost, on the premise that outstanding professional performance is nurtured in an atmosphere maintaining individual opportunities, while simultaneously fostering cooperative relationships among individuals within the various academic units. Qualitative improvement to the point of excellence in the University's instructional, research, and extension missions is the objective of paramount importance.

"2. VPI&SU must be sensitive to the needs and best interests of the people it serves and must, within this framework, develop the sophistication to identify those programs that have high promise. With equal sophistication, it must recognize those that are no longer responsive. Thoughtful and continuing evaluation leading to decisions to strengthen, eliminate, and initiate programs will require the higher order of academic courage.

"3. The university must encourage each instructional, research, extension, and service unit continously to evaluate its mission and to develop a purpose compatible with the goals of the entire university."

Virginia Tech conducted another self-study during the years 1986 through 1988 to help guide itself toward the year 2000. The following are statements of Virginia Tech's mission which were approved by the Steering Committee of the Self-Study, the President, and the Board of Visitors. The second study has also identified roadblocks which the university must overcome to become a modern comprehensive institution for the state and the nation (University Self-Study, 1988: 1.8).

> "To achieve this mission, as the university moves toward the year 2000, it will identify and build on strengths across the university, forge innovative and mutually productive relationships with industry and government, manage resources efficiently, and establish a clear identity as a forward-thinking, high-quality institution that systematically guides and evaluates its future."

According the Self-Study of 1975-76 (University Self-Study, 1976: 327), research is defined as "the diligent and systematic inquiry or investigation into a subject or problem to discover or revise facts, theories, or applications." The study also classifies research as: discipline-focused, problem-focused, and research exploring facets of the human condition. Discipline-focused research "stresses precision, the meticulous documentation of facts, and the avoidance of value judgments." Problem-focused research "goes beyond the factual to emphasize concepts, analysis, synthesis, and interpretation." Exploring the human condition "establishes the basis for critical judgments."

The university is required to "pursue research as one of its major missions"(University Self-Study, 1976: 327). Furthermore, the university must "recognize certain requirements that are unique to academic institutions and differentiate university research from that conducted at other kinds of institutions"(University Self-Study, 1976: 327). The following are eight statements stemming from A Long Range Plan for Research at VPI&SU (the Mckeefery Task Force Report), July 10, 1971 (University Self-Study, 1976: 327).

"1. Research programs at a university are dependent on the present and future interests and capabilities of the faculty.

"2. Research programs should reflect the current state of knowledge.

"3. Research programs should be based in part on the need to find solutions to important practical problems.

"4. Research programs should provide the scholarly climate needed for graduate education leading to advanced degrees.

"5. Research programs at a university enhance the quality of undergraduate education.

"6. Research plans must take into consideration the expectations of those who provide the essential resources.

"7. Plans for research should be developed that will improve the general climate for research at the university.

"8. Persons planning for research should recognize that certain kinds of research activities are not suitable for a university environment."

To support the research programs, Virginia Tech, in 1966, established the Research Division whose authority, provided by the Virginia General Assembly, is "to conduct researches and investigations; to establish, publish, and distribute results in such forms as will tend to increase the economy, efficiency, and safety of the various enterprises and activities of interest to the state and the nation; and to promote the conservation and economic utilization of its natural and human resources (Code of Virginia, Title 23, Section 135.2)"(University Self-Study, 1976: 331).

In the Self-Study of 1986-88 (University, 1988: 5.35), the university, as a land-grant institute, "embraces both basic and applied research which are essential ingredients in the development of an accomplished and intellectually curious faculty and student body." Virginia Tech expects the research activities "will help to establish new technologies, will lead to the creation of new companies and jobs, and will increase the standard of living in the Commonwealth." Furthermore, the university also expects the research programs to "serve to finance many aspects of instruction, particularly in graduate programs by providing some of the means to acquire state-of-the-art equipment for laboratories." Virginia Tech has identified three categories of research:

1. Core Research is "supported by biennial state appropriation to match federal formula funds under the Hatch and McIntire-Stennis Acts, the Water Resources Research Act, and the Surface Mining Control and Reclamations Act." It is also"concerned with areas vital to the overall well-being of the economy of the State, and to the quality of lives of its citizens." Core Research emphasizes

"agriculture and forest productivity, food safety and quality and related customer problems, conservation of environmental and water resources, utilization of coal and other energy resources, and industrial and economic development concerns."

2. Sponsored Research is "less focused than Core research, since it represents whatever the Principal Investigator and the sponsor mutually agree to, as long as this conforms to guidelines for viable and reasonable research within the university. Such research may fall into the category of basic or applied research. Sponsors may be from private industry, state, and local government, or the federal government."
3. Departmental Research "includes an array of activities undertaken at the initiative of the faculty and is often tied to their academic assignments. It does not "necessarily have a direct sponsor, but relies on the resources normally available in the university."

Therefore, the trend of Virginia Tech's research mission is to encourage more interaction with private firms. This encouragement means more activities in the sponsored research area. As a result, the university must be careful about integrating the extension mission with the purpose of the sponsored research so that not only will the university and the sponsors will benefit from this cooperation, but the surrounding community is also benefited as well in terms of economic development.

From the Self-Study report of 1975-76 concerning the extension mission, it was an intent of the university to "extend its educational

resources" in response to the people's needs for the Commonwealth of Virginia, the nation, and the world (University Self-Study,1976: 261). Furthermore, the report also states that "the university has the legal authority and has developed an effective organization for extending the benefits of faculty knowledge and expertise, the findings of research, and the availability of its educational programs to clienteles both at home and abroad"(University Self-Study,1976: 261). Therefore, it was the university's objective for the extension mission to "enable the people of the state individually and collectively to improve their knowledge and skills in managing their resources and adapting to their environment" (University Self-Study,1976: 261).

In comparison with 1986-88 Self-Study report, Virginia Tech's basic objective of the extension mission had not been changed from the previous study. However, the university now emphasizes the state's economic development. This additional role occurs because the public is beginning to recognize the university's potential ability to impact regional, state, and nation economic development.

The extension service can influence the area of new scientific knowledge, application of that knowledge/other advanced technology, and problem-solving expertise. The result is that more people benefit from the extension mission, especially entrepreneurs and small private firms. The following are statements from the Self-Study of 1986-88 (University Self-Study, 1988: 9.12) concerning the University's extension mission. The basic extension mission of Virginia Tech as a land-grant institute involves

"conducting not-for-academic-credit educational activities for numbers of the general public." This mission also includes the responsibility of the university to help the general public receive "the appropriate information through certain university faculty and through field agents housed in offices located within counties and cities of the Commonwealth." Furthermore, "when the disseminated information meets the clientele's standards for credibility, the information can be applied (provided that, as the decision-maker, the clientele possesses access to the required complement of resources, the requisite managerial skills, and the authority to implement the necessary decision to act." "When clients apply the information disseminated, the extension work involved has produced the extension product- the implemented decision to act."

In the extension work area, there are a few crucial elements. They are: 1) the ability of the educational institution to conduct an effective research that can generate knowledge to address the social problems, 2) the ability to maintain the integrity of research data, 3) the ability of clients to receive, store, retrieve research data to useful information, and 4) the ability of the university and clientele to use that information to solve problems to benefit the society at large such as the aspect of economic development.

In spite of new expectations by the public and private sector, the university still does not fully meet those challenges. The Self-Study of 1986-88 indicates areas where the university must improve to respond with this new role in the extension mission. The areas are as followed

(University Self-Study, 1988: 9.4):

- "A need for the organization and funding arrangements of the university to be structured so as to encourage multidiscipline problem solving,
- "A need to define the role of the university in economic development,
- "A need for an in-depth examination of the model for delivering extension information,
- "A need to broaden the funding base for cooperative extension work and continuing education activities to provide more program stability,
- "A need to increase the level of operating funds, support staff, graduate assistants, and other resources for the university to deliver programs more effectively."

The result of the two studies indicates the attempt by Virginia Tech to broaden its obligation and responsibility. This result emphasizes the level of interaction among the university and its stakeholders due to an increasing level of expectation about the university's ability to help the state. Although the basic missions of Virginia Tech has not changed, the finding of new knowledge (research), the dissemination of knowledge (instruction), and the application of knowledge (extension); the means to accomplish these goals have changed. The university must now play an active role in society. The university, according the Self-Study of 1986-88, must be able to take an advantage of its important resources such as knowledge about state-of-the-art technology, personnel who

possess expertise about how to utilize that knowledge, and the vast open space near the campus. With this in mind, Virginia Tech must fulfill its purpose as a modern day land-grant institution by fully and effectively utilizing these resources.

Section III: The Modern View of the Land-Grant Universities

To understand how Virginia Tech attempts to fulfill its mission as a land-grant institute, the discussion must include how the land-grant universities have developed to become an important tool for states to use to solve social and economic problems. When the Morrill Act was approved in 1862, it was designed for a state to establish at least one university which "would provide upper-level education for the masses especially in agriculture and mechanical arts"(Schuh, 1986: 2). However, it should be noted that the concept of a land-grant university was not designed to limit universities to study only in the area of agriculture and mechanical arts. The reason for establishment of the act was the lack of private universities which could sufficiently respond to the need for the agricultural and mechanical arts education.

Schuh further points out that there was a need to have state universities which would be able to continuously generate new knowledge and apply that knowledge to solve problems in those two areas. In other words, the government would establish the upper-level educational institutions which would act as "an agent of economic change and economic development"(Schuh, 1986: 2). Essentially, the universities

would be responsible for "addressing the problems of society, and applying the tools of science and technology to the solution of those problems"(Schuh, 1986: 4). Furthermore, the means to achieve the mission in a land-grant university would be "individual faculty and staff"(Schuh, 1986: 4).

Today, this concept encompasses all three missions of Virginia Tech. On the other hand, Virginia Tech still has to adjust to changes in the society. The university must be able to effectively utilize its research program to respond to many social and economic changes. Such changes are, for example, the demand for engineers to apply high technology for new and/or improved products and services, an increase in the international trade and competition, and the declining public and private support for the basic research. The university must also compete with a growing number of research organizations or a research department in organizations. Therefore, there is a need for a university to develop, consult, and commercialize knowledge to generate revenue in response to a decline of public and private money. These changes mean more interaction between a university and entrepreneurs/small firms

The new challenge for any modern land-grant university is the ability to "integrate the basic and the applied research"(Schuh,1986: 9). In other words, to overcome those changes, a modern land-grant institute today depends on the ability to utilize and relate between the new and specialized knowledge created by basic and applied research activities to solve social and economic problems.

At the present time, much research is being conducted far from problems that the society is facing. To meet the new expectations, the land-grant institute must have an extension agent to effectively and successfully transfer new and specialized knowledge to the society. This opportunity can be accomplished by the creation of a closer and stronger partnership between the private sector and the university. This partnership can be expected more in terms of sponsored research.

The new research partnership benefits both participating firms and universities. Benefits are derived from the opportunity for the new technological innovations to be developed and commercialized to a new product and service. Benefits will also help the universities by bringing new resources (human and capital) to conduct of basic and applied research. Crosson (1988: 73) argues that the partnership is begun because the industry, especially the small to medium sized firms, is concerned about international competition over their products or services. As a result, industry has to concentrate on higher technologically innovative products. Small industry also realizes that knowledge to develop such products comes mainly from universities due to its limited resources to do research and development by themselves.

On the other hand, universities are also concerned about their dependency on the federal and state government for research funding. Therefore, through the 1980's and the future, the universities have begun to reduce this uncertainties by cooperating more with industry so that universities can stabilize the level of financial support for their research.

There are other benefits to the society as well. According to Crosson (1988: 75), the benefits are a more productive industry, a creation of jobs to produce innovative products, and an economic development surrounding the campuses.

As a land-grant university, Virginia Tech must be able to overcome these obstacles in order to successfully accomplish its missions. If it can, then the university can respond effectively to needs in community. This response is not only the responsibility but also an obligation as well since 1872.

Section IV: The Virginia Tech Foundation, Inc.

The Virginia Tech Foundation was established in 1948 under the name VPI Educational Foundation. The Foundation's purpose is to "work toward increasing gifts and endowments made to the college"(Robertson, 1964: 20). The Foundation operates as "a tax-exempt, not-for-profit corporation to receive, manage, and disburse private gifts in support of the university programs"(Universtiy Self-Study,1988: 3.10).

Historically, the Foundation was needed to help the university increase interaction with its former students and private enterprises. From this interaction, the Foundation has been able to attract funding and support from private sources in order to assist the university operation. The funding has been distributed in the area of research and instruction to fulfill missions and to respond to changes in society. Virginia Tech has

relied on the funding from the Foundation to support many of its new programs.

In the Foundation's Annual Report of 1984-85, it is stated that the Foundation helps the university "plan new programs to educate young men and women to be leaders in many fields" by funding Academic Programs and Student Financial Assistance. The Foundation also supports university programs so it can conduct or experiment with innovative research. This leads to advanced techniques and devices by enabling the provision of supportive atmosphere. The supportive atmosphere may help the university's faculty, staff, and graduate students to stimulate questions, to formulate solutions to those questions, and to encourage cooperation with the public and private sector to apply those solutions concerning social and economic well-being.

Even though funding is the most obvious or tangible contribution the Foundation makes to the university, the Foundation also plays a role in linking the university with people outside the university. The Foundation persuades many private enterprises to visit the school each year especially to observe and to invest in the university's research programs.

As a result, the Foundation has proved to be a key player, enabling Virginia Tech to accomplish its missions. Today, Virginia Tech is attempting to increase its role and involvement in the society. This attempt, however, cannot be accomplished with the support of public funding alone. Also the funding from alumni by itself is not sufficient. To

sustain such an extensive effort, the funding has to come from private sources as well. As a result, the Foundation is a key to bringing industry closer to the university so that the new partnership, discussed in the previous section, can be established.

In a later chapter, the Foundation will be seen to be an important player helping establish the Virginia Tech Corporate Research Center. The reasons are that the Foundation is a capital provider and a networker to bring private firms and interested individuals to locate and/or to invest in the VT CRC.

Chapter 3: The University-Related Research Parks

This chapter is organized into four major sections. The first section will attempt to define or describe what university-related research parks from a university perspective.

The second section will discuss purposes of, and contributions from, the park. This section will reflect the park's benefits to its stakeholders. Included in this section is a discussion of various types or forms of parks.

The third section will provide a means of justifying park success based on present measures. These measures are widely used in the industry and universities.

The last section will discuss drawbacks and obstacles of research parks. This aspect is necessary because people tend to focus on the positive or beneficial side of research parks without considering some negative aspects of research parks. This section will address what a prospective-research park builder must consider to ensure survival and success of research parks.

Section I: The Definition of UniversityRrelated Research Parks

Even though it seems that the research park concept is a recent development, the first parks were created in the early 1950's. Today, there are approximately 120 university-related research parks in the U.S.

The first four parks, established during the years 1950 and 1951, were the Cornell Research Park located in New York; Research Triangle Park, located in North Carolina; Stanford Research Park located in California; and Swearingen Research Park located in Oklahoma (Goldstein and Luger[2], 1990: 1.2-1.5). Since then, many universities have established research parks with most in existence today having been created after 1981.

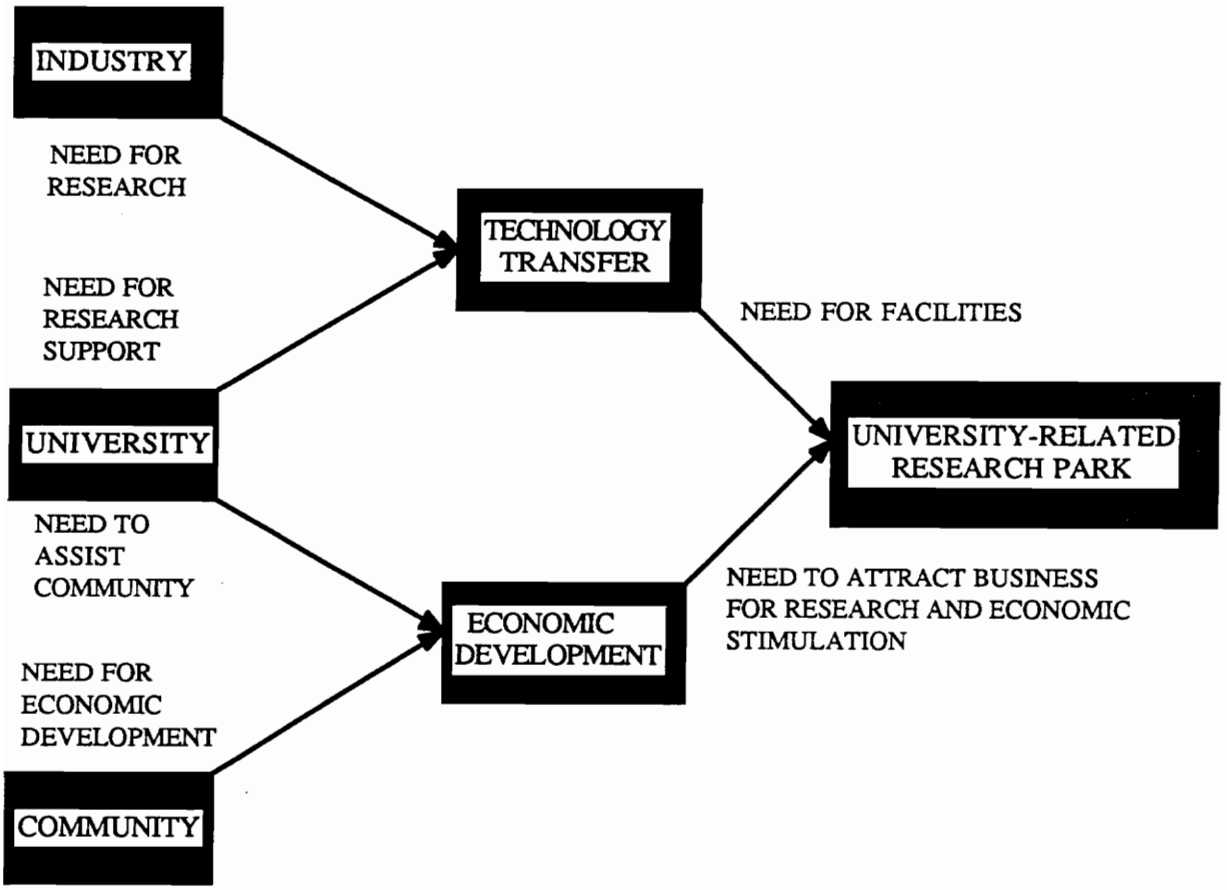


Figure 3-1: The conceptual framework of a university-related research park (Adapted from C. Lee).

The university-related research park is defined throughout this study as the entity, as an affiliate under assumptions of framework of the university, to help the university accomplish its missions by partnership and cooperation with both the public and private sector. Partnership and cooperation are based on the work of basic and applied research to develop new and innovative products or processes. The underlying concept is that the public and/or private sector chose to locate near the university because of "easy access to the school's faculty and computer experts (faculty members are often asked to provide consulting assistance to tenant companies), its graduate students, and- perhaps most important of all- the basic research that is being done by universities"(Everhart, 1990: 124).

Other definitions reflect the commercial or real estate perspective. For example, the park can be defined as "organizational entities that sell or lease spatially contiguous land and/or buildings to business or other organizations, whose principal activities are basic or applied research or development of new products or processes"(Goldstein and Luger[2], 1990: 1.9). According to Everhart (1990: 125), research parks are "basically real estate ventures that have a contractual and/or formal operational relationship with a university or other institution of higher education." Furthermore, Everhart also elaborates his description of the research park by identifying high-technology research and closeness to the university as primary reasons for tenants to select the park. On the other hand, M. Franco (1985: 3) provides the argument that a research park is "essentially an industrial park that emphasizes science-related activities."

Association of university Related Research Parks has officially defined university-related research parks as:

"A property-based venture which:

- has existing or planned land and buildings specially designed for private and public research and development facilities, high technology and science based companies and support services; AND,
- has a contractual and/or operational relationship with a university or other institution of higher education; AND,
- has a role in promoting research and development by university in partnership with industry, assisting in the growth of new ventures, and promoting economic development; AND,
- has a role in aiding the transfer of technology and business skills between the university and industry tenants."

Although definitions of university-related research parks can be stated from several perspectives, each view still reflects many similar underlying concepts and involves similar elements of research parks.

These underlying concepts are:

- Importance of partnership and cooperation between the university and the public or private sector.
- Importance of research and development for purposes of application and commercialization over the manufacturing or production of new products or processes.
- Development and/or utilization of the university's resources such as facilities, laboratories, land, faculty, and other personnel.

- Stimulation of economic activities surrounding research parks.

These similar elements are:

- University.
- Public sector: federal, state level, and local levels.
- Private sector: entrepreneurs and small to large-size firms.
- Community.

It should be noted that this section is intended to provide the best descriptive definition of the research park based on the university perspective. Nevertheless, this definition does not deviate much from other definitions based on various opposing views.

Section II: Purposes and Benefits

The goal of this section is to describe common types of research parks that are existing today. This goal is accomplished by providing the most common purposes and benefits which have led to the popularity of research parks. Since 1982, approximately 84 new research parks have been created, compared to 28 research parks that were established during the years 1960 to 1982.

The rapid growth of research parks can be attributed, in part, to the need for increased funding by the universities. Research parks can respond to this need because of a revenue generated back to the university (if they are successful). Revenue comes mainly from rent paid

by tenants, income from patent rights, and sponsored research programs. Since the early 1980's, more and more universities in the U.S. have faced a reduction in federal and state funding. This affects their ability to support operations, especially in research programs. According to Dr. P. Torgersen, the President of the VT CRC (Everhart, 1990: 125), "the decline in public dollars for research and industry's thirst for new and profitable ideas, coupled with the university community's desire to further diversify and enhance its economic base, have made the research park a popular economic tool." Dr. Torgersen (Everhart, 1990: 126) further explains that this rapid development of research parks is also caused by the desire to commercialize "'faculty and graduate research, along with the increased focus of business in keeping ahead of their markets through development of new commercial technologies.'"

Causes of this growth can also be viewed from the public sector's perspective. Due to the requirement to support university research programs, research parks are an alternative way to help conduct more effective research. The research park can be a place to help faculty conduct large-scale cooperative research when a university's building space is not sufficient.

The cause of the growth of research parks may be analyzed from a community perspective. Many communities in the U.S. are in economic decline. As a result, the research park is focused as a tool to improve and reconstruct their economic structure, especially in the regions with a high concentration of heavy and/or manufacturing industry. Research and

development may be an alternative means to help existing business survive, or to attract new business to the community. According to data gathered by the Royal Thai Government for its efforts to establish a research park, there is a correlation between the level of research and development expense and the rate of a company's growth, especially in service and high-technology industry. Furthermore, the same data suggests that 86% of the jobs created in the U.S. during the years 1982-1984 have resulted from the efforts of small entrepreneurs or small firms with less than 100 employees.

To better understand the concept and reasons for the growing number of research parks, the purposes and benefits of the parks must be clearly stated. Since all research parks have at least four common stakeholders: the university, the public sector, the private sector, and the community; this research then organizes the potential contributions of the parks into four areas. However, readers cannot ignore that each park may place more emphasis than others on certain areas of contributions depending on the university's missions or policies. These contributions are merely common purposes or benefits that have already been identified by many authors.

I. The common purposes and expected benefits to the university.

For the university:

- To provide another source of funding for research programs.
- To generate revenue to support university operation.
- To help the university conduct and improve applied research.

- To increase the level of interaction and cooperation with potential sponsors for research programs.
- To improve the overall educational environment within the university.

For the faculty and graduate students:

- To provide an opportunity for faculty and graduate students to learn and solve contemporary problems facing both the public and private sector.
- To retain and attract quality faculty and graduate students.
- To help develop and improve research skills for faculty and graduate students.
- To help graduate students become familiar with prospective employers.
- To help commercialize or patent the outputs of research by faculty and graduate students.

II. The common purposes and expected benefits to the public sector.

- To centralize the channels of communication for research work within the university.
- To help save time and money by providing a location that helps coordinate the efforts between the the university's personnel and the public agencies.
- Increased access to the univeristy's facilities such as the library and computer center.

III. The common purposes and expected benefits to the private sector.

For the entrepreneurs and small-sized firms:

- Increased access to the university's facilities such as the library and computer center.
- To provide an opportunity and a supportive environment to conduct key research to develop new products or processes.
- To provide an opportunity for licensing the development of new products or processes.
- To provide an opportunity to interact with students who may be potential employees.
- To reduce the mortality rate for new firms.

For the large corporations:

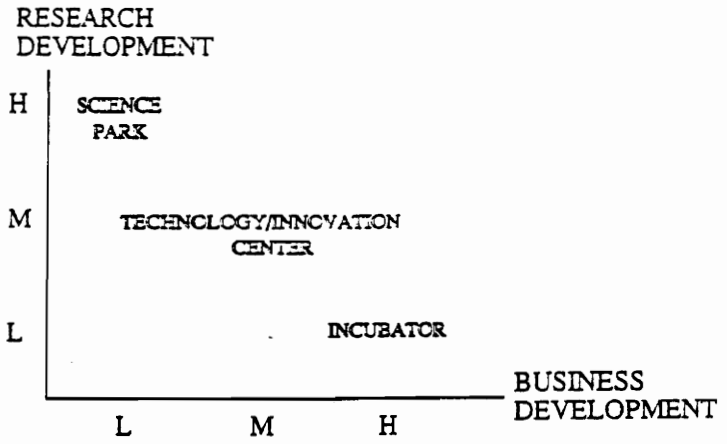
- Increased access to the university's facilities such as the library and computer center.
- To help save the cost of building research facilities.
- To provide a training opportunity for their personnel.
- To provide an opportunity for licensing the development of new products or processes.
- To provide an opportunity to interact with students who may be potential employees.
- To enhance the overall image and goodwill within the university and the community.

IV. The common purposes and expected benefits to the community.

- To provide another source of economic development.

- To attract new businesses to the community.
- To help generate jobs and income for the community.
- To help train unskilled workers.
- To attract skilled workers to the community.
- To promote business activities surrounding the park such as retail stores, restaurants, and land development.
- To promote housing industry.

Due to different emphasis and priorities of purposes and benefits, university-related research parks can be classified into three type (which are to be presented in terms of their high, medium, or low emphasis on research development and business development).



LINKING RESEARCH TO BUSINESS DEVELOPMENT

Figure 3-2: Three major forms of research park (Adapted from the Inception Report).

These types are stated in the 1990 Inception Report submitted to the Royal Thai Government by the Asian Institute of Technology and Thammasat university. However, all three types or forms still have the basic elements which make up university-related research parks. These elements are the underlying concepts, four major stakeholders, and common benefits from the park. The three types or forms of research parks are as follows:

I. The Science Park. The science park is "research and development oriented with a work force which is principally professional or technical." The science park depends on active public sector involvement. It focuses mainly on research for new technology development. On the other hand, it does not concentrate on the commercial aspects of research work or the commercial return for funds spent.

II. The Technology Park. The technology park has "wider range of activities of applying research and development to high technology and manufacturing prototype." The innovation or development center is an example of a technology park. However, the center is more specific than the typical technology park in terms of research and/or technologies to be applied for specific purposes. The technology park provides a balance between research applications and business development. In other words, this type of research park emphasizes cooperation between the university and both the public and private sector.

III. The Incubator. The incubator concentrates on "small business development with some emphasis on technology." This type of research park depends on the ability for entrepreneurs or start-up firms to use university resources and expertise such as faculty, graduate students,

office/lab spaces, services, library, and computer center. Return from the incubator is mainly community economic development. Furthermore, the university can also expect "spin-off" companies created by university personnel to grow in this form of research park. In other words, business development is an important aspect of the incubator.

Section III: Current Techniques to Measure a Park's Success

One of the most difficult aspects about the concept of the university-related research park is that there is no consensus about how to define success for a research park. The reason is that each park has different objectives and priorities depending on the university's missions or policies. As a result, each park cannot be measured with the same set of criteria as others. If the proposed methodology identifies success criteria for the VT CRC, one of the most important implications will be that other research parks should attempt to apply this methodology. However, first, success and success criteria must be defined so that readers are able to judge whether outputs from the methodology are success criteria which would help the VT CRC become successful.

Success is defined in this research as a measure of extent to which the VT CRC meets its objectives. Success criteria are defined as measurement criteria for the VT CRC to assess progress toward its objectives.

Although there is no acceptable definition for success and success criteria, these two terms defined in this research do not contradict other

definitions in the literature. According to Goldstien and Luger[2] (1990: 3.17), the success of a research park depends on "whether the goals established for the park are being met, specifically, on whether the means used to achieve those goals are appropriate." M. Franco (1985: 79) defines success criteria as "a series of factors which appear to play significant roles in parks generally viewed as successful." In other words, success criteria are factors that are acceptable and have been derived from already considered successful parks. Furthermore, according to the Inception Report (1990), success criteria are defined as key factors that can be identified by expert or experienced personnel such as managers to help the park realize important factors to meet its objectives.

Lack of consistent and uniform definitions of success and success criteria have led to the development of many indicators which attempt to rank or rate the success of the parks. Many indicators are derived from financial indicators or from real estate indices. There are, for examples, number of tenant companies, number of people employed by tenant companies, the amount of spaces offered or developed in the park, types of business or research in the park.

Nevertheless, there have been some attempts to identify success criteria which are generally acceptable or have been used as a benchmark for park success. These factors have been identified by expert opinion or through the study of research parks which are considered as models for new parks to be established. The following are examples of a set of such success criteria.

According to C. Evans (Association of University Related Research Parks), the Director of the university of Utah Research Park, important factors in park success are:

- Clear objective
- Impressive or unique site and location
- university support
- Simple and efficient administration
- Modest cost of development
- High standards
- Realistic expectations

According to M. Franco (1985: i-iv), who has analyzed the role of sixteen separate factors that have been identified in the literature as prevailing elements of successful university-related research parks in terms of longevity, research impact, and size, success criteria are:

- Long-term growth objectives
- Clear park development plan
- Well-defined facilities management philosophy
- Promotional strategies
- Strategies by park to encourage interaction
- Clear understanding of the university's role
- Clear understanding of the park's role
- Mutual interests/strengths
- Clear institute commitment to cooperate
- Individual personnel interactions
- Facilities/equipment sharing strategies

- Government support
- Regional economic conditions
- Community involvement
- Quality-of-life considerations
- Unique conditions

According to the Inception Report (1990) concerning the feasibility study of the establishment of science and technology parks in Thailand, the success criteria are:

- Accessible location
- Good infrastructure
- Financial incentives
- Mix of professionals (technologists, social scientists, and other specialists)
- Access to overseas expertise and consultants
- Good publicity and promotion
- Interaction with users
- Free of constraints
- Good project management and organization
- Strong local and regional support
- Full participation of women as part of an overall human resource strategy
- Selection of proper technologies
- A good entrepreneurial environment

Section IV: Drawbacks and Obstacles for Parks to Consider

Drawbacks and obstacles of research parks are important aspects that people tend to overlook when considering an establishment of one. Most people seem to be interested in the positive side of research parks. They tend to focus on benefits and ignore drawbacks of research parks.

When there is a plan to establish a park, some drawbacks and obstacles must be considered. According to Everhart (1990: 135), many people in universities feel that "research parks will distort the primary mission of their schools." Their concerns also include the idea that "faculty will neglect their teaching and basic research responsibilities in their enthusiasm for work on industrial research or to pursue their own entrepreneurial interests." Furthermore, Everhart (1990: 135) also presents arguments from members of the Association of university Related Research Parks that academic freedom may be "compromised because faculty and graduate students will not be able to share freely the results of company-sponsored research."

Other possible problems are that the establishment of the research parks also depends on the nation's economy. At the present time, a university may find that obtaining a loan to develop a park is difficult and could be a lengthy process which might delay the plan to establish the park. The concept of research parks also requires long-term cooperation between the university and the public and private sector. However, public-sponsored research may be uncertain at this moment due to

federal and state budget problems. Furthermore, the common practice of relying on short-term profits may contradict with this requirement. The private sector may also be reluctant to invest a large sum of capital or to commit to large-scale research projects because of limited commercial applicability of results and the time taken to produce outputs. Although, according to Lugar and Goldstein, the research park can help reduce the mortality rate of new firms or entrepreneurs from 90% to 50%, this number is still very high and may threaten a university attempt to recover its investment.

The community also has to actively participate in the first stage of establishing the park. The community must realize that it cannot wait for benefits without taking any action. Everhart (1990: 135) emphasizes that selling the idea of the research park to community leaders is a prerequisite before other steps can be taken on the the park.

Establishment of the research park requires a careful analysis of both the positive and negative side of the park. The university must realize that even though the park is an attractive solution to respond to its needs, it must also consider any possible drawbacks as well. This consideration will allow for correct selection or rejection of the park and other alternatives.

Chapter 4: The Virginia Tech Corporate Research Center (the VT CRC)

The chapter is organized into five sections. The first section will discuss the background of the the VT CRC, based on the VT CRC official documents. Included are reasons to establish the the VT CRC.

The second section concentrates on the Center missions and objectives. Two primary objectives (economic development and technology transfer) will be carefully discussed so that readers understand these two terms.

The third section will discuss expected benefits of the the VT CRC. This section is designed so that readers understand expectations from the Town of Blacksburg and its surrounding counties. These expectations need to be stated to illustrate consistency with the VT CRC objectives.

The fourth section will explain what classification of university-related research parks that the VT CRC is considered to belong. The discussion in this section also includes benefits of this type of research park.

The fifth section will focus on future development plans for the VT CRC prepared by its administration. These plans have been approved by the VT CRC's Board of Directors. The purpose of the last section is to explain the future direction of the VT CRC.

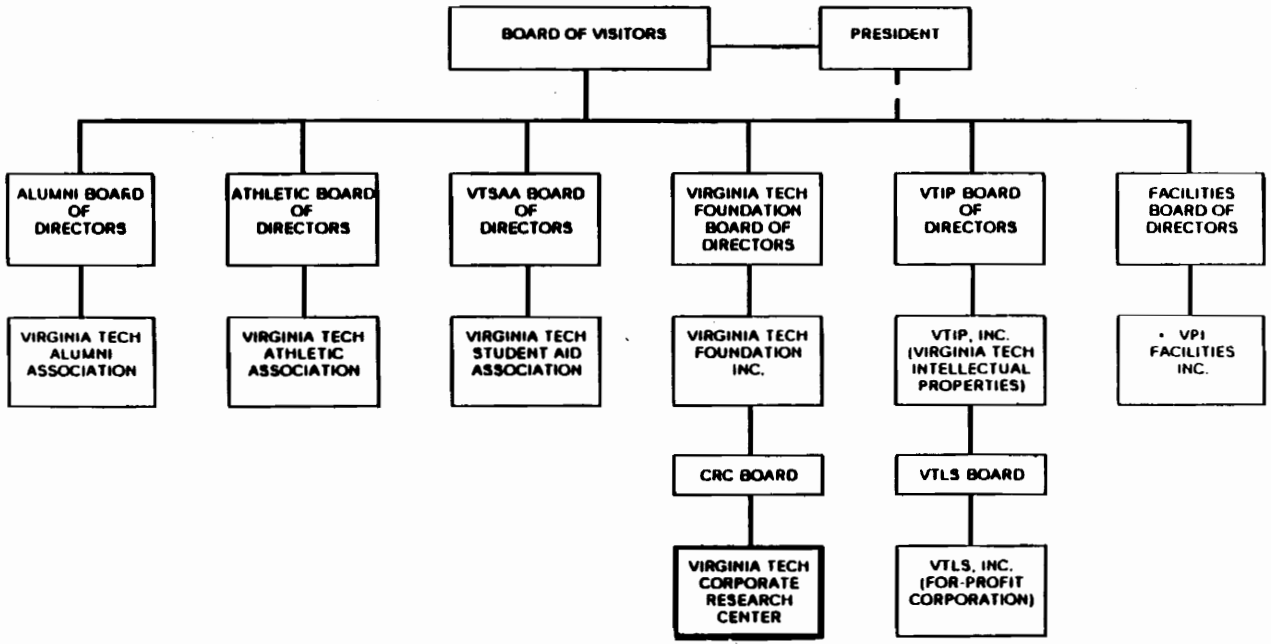


Figure 4-1: The relationship between the VT CRC and the university.

(Adapted from University Self-Study of 1986-88)

Section I: History and Current Background

The Virginia Tech Corporate Research Center was established in 1985 as a wholly owned subsidiary of the Virginia Tech Foundation. According to the proposed strategic plan (1990: 2), the the VT CRC evolved from the study conducted by the university in 1983. The purpose of the study was "to explore economic development opportunities available to Virginia Tech." The study group, mainly the university's administrators and deans, recommended the establishment of the research park attached to the university as "a stimulus for economic development in the region through spin off opportunities for faculty research."

The the VT CRC was designed to encourage high-tech business or other businesses which might have an ability to cooperate and utilize research capacity at Virginia Tech. The VT CRC was intended to play an incubator role, if necessary, to attract such businesses. It should be noted that an entrepreneur is not the only tenant the VT CRC is seeking. Other groups include (Quarterly meeting, 1991: 14):

- Corporations and/or government agencies with existing research relationships with Virginia Tech.
- Alumni within corporations and government agencies who may have influence over such matters.
- Key faculty members most likely to develop companies or research operation that would locate in the park.
- Virginia Tech students most likely to become future prospective tenants.

The primary attractions to locate inside the the VT CRC are: 1) excellent research and academic programs at Virginia Tech and 2) the tenants' ability to access the University's resources such as faculty, students, and facilities. Furthermore, the allowed activities inside the VT CRC also fit with these attractions. According to M. Holliman (1986: 18-21), the activities allowed in the VT CRC are "the design, development, and prototype testing of new processes and products, as well as the laboratories, offices, and similar facilities that support such work." The following are activities that would not be allowed inside the VT CRC. These activities are manufacturing, assembly, and distribution activities.

Initially, the the VT CRC spent $3.9 million with $3.3 million from industrial development bonds and $600,000 in a federal grant from the Economic Development Administration. Initial spending was on a building, access and internal roads, and water and sewer lines. The first building, called the Innovation Center, has a size of 22,000 square feet. The building was designed to accommodate small business and/or entrepreneurs needs.

Presently, there are 16 private firms and three university departments operating in the VT CRC. A total of 500 workers are employed in four fully-leased buildings. Currently, the VT CRC has two 20,000 square foot office/research facilities, the 20,000 laboratory research building, and the 50,000 square foot Information Systems building. The VT CRC has invested $14 million.

The growth of the VT CRC in the past six years has indicated strong cooperation with Virginia Tech and its Foundation. This can be illustrated in terms of the funding vehicle provided by the university and the Foundation for the VT CRC, policies to emphasize applied research, and an upgrade of the Virginia Tech Airport to accommodate corporate jets. Furthermore, the cooperation between the VT CRC and the public sector has also been stressed as a key element for this rapid growth. The public sector includes all levels of government: 1) local (Town of Blacksburg), 2) regional (Montgomery County and the New River Valley Development Commission), 3) state (Department of Housing and Community Development and Department of Economic Development), and 4) federal (Economic Development Administration of the Department of Commerce).

Section II: Missions and Objectives of the VT CRC

As discussed in Chapter 3, university-related research parks are dependent upon university's policies. In 1983, Virginia Tech conducted a feasibility study to establish a research park near the campus. The study concluded that there were economic development opportunities for such a park due to the strength of research activities and a concentration of quality research personnel at Virginia Tech.

Furthermore, Virginia Tech has a responsibility to extend and disseminate knowledge developed by its research programs to the local, state, and nation. The VT CRC is a tool to partially fulfill that responsibility.

On October 16, 1990, the CRC's Board of Directors approved the VT CRC mission statements and objectives.

"The Virginia Tech Corporate Research Center, Inc. was established in1985 by the Virginia Tech Foundation, Inc. to enhance research opportunities for Virginia Polytechnic Institute and State university, hereinafter referred to as 'Virginia Tech.'

"The Corporate Research Center is comprised of 120 acres of land adjacent to the Virginia Tech Campus and Airport. Developed by the Foundation, its purpose is to provide an appealing physical environment to attract those who can benefit from the resources of the university and offer mutual support to the university's research mission. The Center is positioned to seek as tenants research and development interests which desire a physical location near Virginia Tech to enjoy the collaboration of the university's noted faculty and draw from its large number of qualified graduate students.

"It is the intent of the Virginia Tech Corporate Research Center to broaden the boundaries of the university and provide a direct link between higher education and economic development through two distinct efforts:

"First, accelerating technology transfer by facilitating the commercial development of research activities conducted within university laboratories and offering opportunities to faculty to commercialize their research efforts.

"Second, stimulating economic development by expanding job and career opportunities within the larger university community by taking an aggressive, pro-active role in regional and state economic

development activities resulting in employment opportunities for faculty spouses and graduate students; attracting of investment; and enhancement of the tax base.

"To this end, the Board of Directors of the Corporate Research Center, shall promulgate a long range business plan to ensure the successful development, marketing and ongoing operation of the Center. The Plan shall be subject to the established Articles of Incorporation and Bylaws of the Corporate Research Center, Inc. The Plan shall include, but not be limited to, the following objectives:

- "Enhancing the stature, quality, and reputation of the university through increasing corporate, government, and incubated research relationships through tenancy in the Center.
- "Bringing faculty research to commercial reality through developmental programs in the Center.
- " Creating and maintaining attractive sites, buildings, and physical environs for laboratories, offices, and other uses in basic and applied research, quality control, and testing.
- "Increasing opportunities for placement of advanced graduates, graduates, and cooperative students.
- " Facilitating economic development activities throughout the university by matching the needs of business with the research and professional capabilities of Virginia Tech.
- "Working closely with economic development officials in the region and commonwealth in securing new, and enhancing established business and industry.

- "Communicating economic development opportunities and concerns to faculty and administration.
- "Assisting the university in the identification of business and industry educational requirements.
- "Supporting tenants and entrepreneurs seeking ongoing university relationships during their start up phases.
- "Retiring debt through the successful leasing of land and buildings in the Center."

In summary, there are two primary objectives for the VT CRC : technology transfer and economic development. As a result, both terms will be discussed in more detail so that when applying the proposed methodology (which is based on primary objectives of parks) to identify success criteria, readers will be able to understand justification of selecting those criteria. The discussion will be an extensive definition and a process of these two terms. Furthermore, expected outcomes from both the VT CRC primary objectives will be stated. As a result, success criteria, identified by the proposed methodology, for technology transfer and economic development will be easily understood by readers.

Technology transfer can be defined in many ways. For example, Souder, Nashar, and Padmanabha (1990: 5) have defined technology transfer as "the managed process of conveying a technology from one party to its adoption by another party." They further describe conveying as "a systematic interpersonal process of passing the control of a technology from one party to another" and adoption as "strong emotional

and financial commitments to routine use." Without conveying and adoption, technology transfer will fail.

Russon and Herrenkhol (1990: 21) also provide a definition of technology transfer as transmitting new users a knowledge which is derived from scientific and engineering research so that they can transform such the knowledge into new products or processes. On the other hand, Schoenecker, Myers, and Schmidt (1989: 28) provide the definition according to the land-grant university's perspective. They have defined technology transfer as "the movement of technical ideas and know-how from a conceiving organization to a user organization at any stage of research and development." They further emphasize that the adaptation of technology must be suitable to the users' requirements and purposes. The transfer process must also be planned and purposeful.

Summarizing all definitions, the primary outcomes of technology transfer are: 1) new and knowledgeable users, 2) an ability for these users to utilize transferred knowledge for a development of new products or processes, and 3) new products or processes which have better quality and/or broader application.

However, to accomplish these outcomes, the process of technology transfer (in the context of the VT CRC operation) must be understood. This process is adopted by Schoenecker, Myers, and Schmidt (1989: 29).

The sequence of the technology transfer process is:

I. Basic Research.

II. Applied Research.

III. Development.

IV. Testing/Evaluation.

V. Commercialization.

For the VT CRC perspective, knowledge can be derived by the basic and applied research activities at Virginia Tech. Both public and private sectors may sponsor these activities with Virginia Tech under an assumption that these activities fit both sectors requirements. The role of the VT CRC is being a channel or facilitating meetings between the university and sponsored parties. For a development's role, the VT CRC provides supportive environment and facilities to conduct research and development. R&D includes designing, developing, and enhancing the applications and usefulness of the knowledge. A supportive environment provided by the VT CRC for testing and evaluation is also important for the successful development of new products or processes. The VT CRC must also help tenants in their capability to commercialize their research efforts.

For economic development, many questions have been raised concerning the type of impacts university-related research parks can have to their surrounding communities or regions. The reason for these questions is that there is no acceptable definition for this term (economic development). When discussing economic development, more jobs and

higher incomes are thought to be only outputs of economic development. However, they are only parts of a larger outcome of economic development. The theory, to be discussed, will explain outcomes and a process of economic development.

The VT CRC role of economic development fits a description of the Entrepreneurship, Seedbed, and Regional Creativity Theories. According to the theories described by Goldstein and Lugar[1] (1990: 67-68), the VT CRC role is "to serve as a seedbed or focus of creativity for the region" by fostering self-generated growth. They further summarize that primary economic and social benefits of a research park are achieved when research parks are able to provide supportive environment for business development by promoting innovation for entrepreneurs. The innovation process is supported by research activities with quality personnel from the university.

There are two major phases in the theories. Goldstein and Lugar[2] (1990: 2.11) describe the first phase as the institutional phase which the park "attract major research facilities, add services and support operations, and develop a critical mass of scientists and innovators who begin to interact." The second phase is the entrepreneurial phase. This phase is concluded by Goldstein and Lugar[2] (1990: 2.12) when "scientists and engineers, singly or in teams, spin off new enterprises, usually located in the same region."

An incubator is introduced to support the two phases by providing spaces and supportive environment to help start-up companies survive at the beginning of their business lifes. The detail about the incubator concept will be discussed in the later section.

There are two types of economic impact that the Entrepreneurship, Seedbed, and Regional Creativity Theories can bring to the region. Goldstein and Lugar[1] (1990: 69) stated the first impact as the primary (economic growth) impacts and the second impact as the secondary (economic structure) impacts. The most important contribution to the region's economic development is a growth of R&D activities. These activities are: 1) utilization of skilled work force, 2) research activities with the university, 3) information sharing within the premise of research parks.

The first impacts can induce the growth in terms of:

- R&D activity.
- Manufacturing activity.
- Business services and headquarter function activity.
- Retail and consumer services activity.
- Productivity of region's firms.
- Loss of existing businesses.

The distributive dimensions of primary impacts are:

- Industry sector.
- Occupational category: skill, educational requirements.
- Enterprise/ownership type: single plant, locally owned VS multilocation firms.

- Labor force segment: sex, race, age, and prior residential location.
- Spatial incidence.

The secondary impacts or changes in region are stated:

- Economic stability.
- Enterprise/ownership mix.
- Productivity.
- Mix of products by position on product cycle.
- Wage structure.
- In-and out- migration pattern.
- Labor force participation rate.
- Structural unemployment rate.
- Incidence and rate of poverty and underemployment.
- Labor-management relations and collective bargaining environment.
- Level of income inequality.
- Spatial form.
- Land and housing prices.

As for an incubator-affiliated with the university like the VT CRC, the goals of economic development are (Allen, 1985: 4):

- Job creation within the university's region.
- New firms creation by student, alumni, faculty, or entrepreneurs.
- Attracting quality researcher to promote the commercialization of research works.
- A supportive environment for tenants inside the park.
- Economic diversification in the university's region.

- Tax base expansion for the university's region.
- A positive development image and business image for the university and the region.

Section III: Expected Benefits

With the announcement of a feasibility study for a research park (the the VT CRC), there were expectations on the campus and in the surrounding community. People in Blacksburg and the Montgomery County expected the the VT CRC to create jobs and to stimulate the local economy. The center was also expected to attract companies inside and outside the region. New companies would generate jobs and pay relatively higher wages and salaries to local work force. Furthermore, these new firms would expand tax base for the local government.

According to M. Holliman (1986: 20), when operating with 100 percent occupancy in CRC's long-term plan, estimated 1,250 permanent jobs would be created in the center and its surrounding community. The VT CRC was projected to bring additional income of approximated $50 million annually, including retail and other service-related businesses, to the local economy.

Because of these expectations and strong anticipation for the center's success, it is important to identify success criteria for the VT CRC. Furthermore, having received strong support by the local and state authority, it is necessary that the VT CRC fulfills its primary objectives to

satisfy their expectation and anticipation. Realizing success criteria is critical to achieve this responsibility. The proposed methodology will help identify these criteria for the VT CRC.

Section IV: The Concept of Incubator

There are two purposes for this section. The first purpose is to further gain better understanding of the VT CRC's operation and objectives. The second purpose is that classifying the VT CRC will help understand outputs from the proposed methodology because CRC's stakeholders can realize what important success criteria should be for the VT CRC. Before classifying what type of research parks the VT CRC belongs, major characteristics of the VT CRC must be stated. Identifying these characteristics is necessary so that a corrected classification can be made.

The following are major characteristics of the VT CRC (identified from CRC's documents such as the Strategic Plan and the Quarterly Meeting):

1. Offering the physical environment, including buildings, laboratories, and office spaces, for prospective tenants.
2. Providing opportunities and supporting advices and services for entrepreneurs who seek the relationship with the university during their start-up phase. (The advices and services are market research, business plan development, incorporation, icensing, financing, marketing, accounting, and venture capitals.)
3. Matching and coordinating the knowledge and expertise of the university with the business needs.

An incubator is defined as "either an organization or a network of organizations providing individuals with skills and knowledge about business operations and opportunities, and motivating individuals to start a business"(Allen, 1985: 3). There are four approaches to develop incubators (Refered to M. Mclean's "different approaches to incubator development"(Allen, 1985: 8). The reason of different approaches is that each approach is designed to respond to a diversity of problems.

The first strategy is the university-sponsored strategy. This strategy look at incubators as a means to capitalize and to commercialize the university's research programs, to attract quality researcher and students to the university, and to strengthen the relationship with industry and the local area.

The second approach to develop incubators is made possible by the private sector. In this approach, incubators are perceived to generate profits back to the private investors.

The third form of incubators is the publicly-sponsored incubators. The purpose of this approach is to use incubators to nurture small businesses and entrepreneurs. The objective is that eventually these firms will create jobs, raise the region's standard of living, and increase tax revenues to the government.

The fourth approach is accomplished by the community-based nonprofits strategy. This strategy establish incubators to revive the declining community industry and overall economy.

The primary function of incubators is to incubate which means "to maintain under prescribed and controlled conditions an environment favorable for hatching or developing"(Smilor and Gill, 1986: 3). Therefore, incubators are designed to help small start-up firms survive at the early stage of the business development by providing supportive condition and environment. The purpose of having an incubator is "to maximize the potential of entrepreneurial talent within a community by providing entrepreneurs with services and support that complement their natural talents and enable them to expand potential"(Smilor and Gill, 1986: 11).

However, to be able to classify the VT CRC as an incubator, critical dimensions of incubators must be clarified. There are four dimensions of incubators according to D. Allen(1985: 3). The first dimension is the support networks for entrepreneurship. These networks are composed of individuals from public organizations such as universities and development agencies, and private organizations such as business services providers and financial intermediaries, that assist entrepreneurs and small business managers with the start-up and early stage growth of their firm"(Allen, 1985: 3).

The second dimension is multi-tenant facilities. The purpose of such facilities is to create space for small users, thereby "providing more affordable rent than could likely be afford by a small business located in a single purpose (typically larger) building"(Allen, 1985: 3).

The third dimension is consulting and management service providing to small business clients. Such services are, for examples, accounting, municipal economic development agencies, marketing, and financial management.

The fourth dimension is logistical, physical, and support services. Such sharing services are, for examples, word processing, conference room, photocopying, and fax machine.

Even though the VT CRC may not be a completed incubator according to those four dimensions, the VT CRC operates and has objectives as an incubator. The VT CRC was established in 1985 to help start up new businesses by taking advantages from research and technical strength at Virginia Tech. It offers spaces and shared basic services. It should be noted that the VT CRC does not provide capitals and other intermediate financial assistance for new businesses. The reason is that new start-up businesses are not the only targeted market of the VT CRC. There are other targeted audiences of the VT CRC as well.

Section IV: Future Planning and Development

The purpose of this section is to outline what the VT CRC plans to do in the future to fulfill its objectives. According to the VT CRC's five-year strategy plan, the administration has divided its objectives by targeted audience. These audiences are: 1) prospective tenants; 2) faculty/university community; 3) alumni; 4) students; civic, business and

economic development organizations; 5) tenants and professional organizations. The five-year strategy proposes:

- to create data base to be shared by all interested parties.
- to interact more closely with potential Virginia Tech faculty.
- to improve CRC's image and increase the public and business awareness of the VT CRC.

On the other hand, it is necessary to introduce briefly a future strategy because this strategy was designed to help the VT CRC fulfill its primary objectives. The VT CRC's objectives are:

I. For prospective tenants:
   1. Acquire pre-leasing commitments for 75 percent occupancy of Research Building III.
   2. Increase awareness of and active interest in the Corporate Research Center among all target corporations/agencies.
   3. Broaden target list to include additional research disciplines, target organizations and geographic areas by end of FY 1992.
   4. Develop uniform procedures and response and follow-up plans for prospect contact.

II. For faculty/university community:
   1. Substantially increase awareness and understanding of the the VT CRC among target faculty members.

III. For alumni:
   1. Alumni in positions of influence in target prospect organizations will be contacted individually through direct mail and personal contact.

2. Alumni as a group will be reached in several ways, directly and indirectly with a more general message about the VT CRC, its purpose, accomplishments and benefits.

IV. For students:

1. Establish awareness among target graduate and undergraduate students about the the VT CRC, its purpose, accomplishments and potential benefits for them.

V. For civic, business and economic development organizations:

1. Increase awareness among target groups within the Commonwealth of Virginia, the U.S., and where appropriate, off shore about the the VT CRC, its accomplishments and potential benefits.

VI. For tenants:

1. Continue to increase levels of tenant satisfaction with the the VT CRC.
2. Increase tenant awareness of the VT CRC plans, accomplishments and other tenants.
3. Equip tenants to become ambassadors and "salespeople" for the the VT CRC.
4. Establish regular avenues for tenant input.

VII. For professional organizations:

1. Increase awareness the the VT CRC, its positioning and accomplishments among the membership of target professional organizations.

Chapter 5: Research Methodology

This chapter is organized into six major sections. The first section will concentrate on an appropriate definition of research. The section also includes the definition of a methodology.

The second section will focus on the classification of this study efforts. The research process of this study will be included in this section.

The third section will discuss the hypothesis. Each step in the methodology and its purposes and characteristics are also included. Furthermore, the third section also contains the conceptual research model and assumptions about the research.

The fourth section will provide details about the experimental design and how to analyze and interprete the findings of this research. The type of validity used in this study will also be discussed.

The fifth section attempts to justify efforts and activities taken for this study as a research work. Seven characteristics of research from Leedy will be discussed for this justification.

The last section will briefly discuss the foreseeable roadblocks limitations of this study.

Section I: Definitions of Research

Research is defined as "the diligent and systematic inquiry or investigation into a subject or problem or revise facts, theories, or applications"(University Self-Study, 1976: 329). Research also involves "a controlled experiment conducted in a laboratory, or the careful observation and interpretation of events over which the investigator has no control"(University Self-Study, 1976: 329).

Another definition of research is"the manner in which we attempt to solve problems in a systematic effort to push back the frontiers of human ignorance or to confirm the validity of the solutions to problems others have presumably resolved"(Leedy, 1980: 4). Furthermore, Leedy (1980: 4) states that research is "a way of looking at accumulated facts so that those data become meaningful in the total process of discovering new insights into unsolved problems and revealing new meanings." He also identifies seven characteristics of this process. However, they will be discussed in the fifth section.

A definition of a methodology must also be stated to justify the use of this term for this study. According to Acar (Kurstedt, 1990), a methodology is "the study or science of method." It is an "overall worldview, meaning and action system governing research activities in fields of inquiry." Its purpose is to "establish global perspective." This definition of a methodology is suitable for this study's objectives since it attempts to create a new perspective concerning how to identify success

criteria for the VT CRC.

The new perspective includes a systematic effort to identify success criteria for the VT CRC. This effort is different from present attempts to identify success criteria. The new perspective relies on the effectiveness of identification of success criteria based on the center's objectives (not by the expert opinion).

Section II: Classification of Research

This research can be categorized into many different types or classifications. According to Isaac and Michael (1971: 14), there are nine basic methods of conducting research. These are: 1) Historical, 2) Descriptive, 3) Developmental, 4) Case and Field, 5) Correlational, 6) Causal-comparitive, 7) True experimental, 8) Quasi-experimental, and 9) Action. They further provide the rationale for each method. For example, the purpose of historical research is "to reconstruct the past objectively and accurately, often in relation to the tenability of an hypothesis." Descriptive research's purpose is "to describe systematically a situation or area of interest factually and accurately."

However, the most suitable term to describe this study is "action research." According to Isaac and Michael (1971: 27), the purpose of action research is "to develop new skills or new approaches and to solve problems with direct application to the classroom or working world setting." To further justify this term, characteristics of action research

should be stated. Isaac and Michael characterized action research as follows. Action research:

> "1. is practical and directly relevant to an actual situation in the working world. The subjects are classroom students, the staff, or others with whom you are primarily involved.
>
> "2. provides an orderly framework for problem-solving and new developments that is superior to the impressionistic, fragmentary approach that otherwise typifies developments in education. It also is empirical in the sense that it relies on actual observations and behavioral data.
>
> "3. is flexible and adaptive, allowing changes during the trial period and sacrificing control in favor of responsiveness and on-the-spot experimentation and innovation.
>
> "4. while attempting to be systematic, ... lacks scientific rigor because its internal and external validity is weak. Its objective is situational, its sample is restricted and underrepresentative, and it has little control over independent variables. Hence, its findings while useful within the practical dimensions of the situation, do not directly contribute to the general body of educational knowledge."

Furthermore, this study can be thought as exploration in terms of an attempt to develop a systematic methodology to identify success criteria for university-related research parks. Emory (1980: 84) defines an exploratory research as the development of "some hypothesis for testing or some investigative questions for future research." In other words, it is an exploratory attempt to break away from the use of expert opinion or

experience to help identify the VT CRC success criteria. On the other hand, this methodology is new and has never been tested; therefore, it is difficult to predict the effects of this methodology.

Before discussing the thesis's hypothesis, steps in a research process of this study must be clearly stated so that readers are able to understand a sequence for the rest of this chapter. More details about each step will be discussed later in the chapter. To conduct research, the following steps must be taken:

Step 1: Establishing the hypothesis. The development of the hypothesis will be based on Virginia Tech, the VT CRC, and the VT CRC primary objectives.

Step 2: Developing the methodology based on the hypothesis. The proposed methodology consists of seven steps. The methodology will test a truthfulness of the hypothesis.

Step 3: Implementing or testing the methodology. Success criteria will be identified by the methodology. The questionnaire will be developed and be distributed to selected members of the VT CRC stakeholders to secure their opinions about the hypothesis.

Step 4: Validating success criteria and the methodology. Due to the dependency on expert judgement for this research, success criteria will apply a face validity method. The methodology will use a content validity method.

Step 5: Making a conclusion concerning the hypothesis.

Section III: The Assumptions and Hypothesis

I. Assumptions

Before discussing the hypothesis, some assumptions must be stated. These assumptions are also necessary for the development of the methodology to identify success criteria for the VT CRC and to ensure a consistency with the study's objectives. The assumptions are:

I. The VT CRC was established as the university-related corporation to facilitate all or some of larger missions of Virginia Tech.

II. The VT CRC's primary objectives are derived from Virginia Tech's larger missions and responsibility.

III. Primary users of the proposed methodology are the VT CRC president and/or director.

IV. The VT CRC must have its primary objectives officially approved prior to an implementation of the proposed methodology.

II. Hypothesis

The hypothesis is as follows. Success criteria for the VT CRC can be identified from its primary objectives which are placed within the framework of Virginia Tech's larger missions by the proposed methodology. Identification of success criteria can be accomplished through the application of data flow diagrams to model the VT CRC primary objectives. The success criteria will be the "flow" entities shown in the diagram. More detail will be discussed later in this section.

Before describing the methodology in more detail, it should be noted that expected outputs of the methodology are success criteria. This methodology is not intended to help rank the importance of each criterion.

The proposed methodology consists of the following steps. Expansion of these steps will be discussed subsequently in this section.

Step 1: Identifying stakeholders for Virginia Tech.

Step 2: Identifying Virginia Tech primary missions (relating to the VT CRC operation).

Step 3: Applying a context diagram to identify relationships between Virginia Tech's stakeholders and primary missions.

Step 4: Identifying stakeholders for the VT CRC.

Step 5: Identifying the VT CRC's primary objectives.

Step 6: Applying a context diagram and data flow diagrams to illustrate how the VT CRC should attempt to accomplish its primary objectives.

Step 7: Identifying success criteria from the flows in the data flow diagram.

To better understand how to develop the methodology, the purposes and usefulness of each step will be stated and clarified. Characteristics of important techniques such as a context diagram and a data flow diagram will be discussed Also included in this discussion are benefits of success criteria. The following are details and purposes of each step:

Step 1: Identifying stakeholders for Virginia Tech.

It is necessary to delimit the domain of responsibility of the university. The primary purpose of the first step is to identify boundaries of the university so that readers are able to realize the roles of the university in its surrounding environment. It is also crucial to ensure consistency between Virginia Tech's stakeholders and the VT CRC's stakeholders because the VT CRC is established to help the university accomplish its missions. The first step can be accomplished by an analysis of university documents such as the self-study or the mission statement.

Step 2: Identifying Virginia Tech's primary missions (relating to the VT CRC operation).

After having recognized its stakeholders, the university's missions must be identified. The purpose of the second step is to ensure consistency between the university's missions and the center's primary objectives. Since the university establishes the center to help implement its policy, the center's objectives must fit within the framework of the university's missions. This second step can be easily accomplished by using university documents such as the self-study.

Step 3: Applying a context diagram to identify relationships between Virginia Tech's stakeholders and primary missions.

The purpose of the third step is to use the context diagram to link and relate the stakeholders with the university's missions. This step is necessary because the university's missions are designed to meet

expectation by stakeholders. The documents published by the university may be used to illustrate how the university accomplishes its missions.

The context diagram is used to achieve this step because it helps place the domain (the university) in context with its environment (its stakeholders). First, the diagram identifies stakeholders with which the university must interact. Second, the diagram helps identify the type of interaction between the university and its stakeholders.

Note: To identify how the university interacts with its stakeholders requires understanding and modification from detail of the university's missions based on user's judgement.

Step 4: Identifying stakeholders for the VT CRC.

This step is similar to Step 1, but is for the VT CRC, not the university. Furthermore, the surrounding environment of the center should be consistent with the university even though stakeholders may not be the same. It should be noted that Virginia Tech's documents concerning historical background or annual report to interested parties may be used to help model during the fulfillment of this step.

Step 5: Identifying the VT CRC's primary ojectives.

The purpose of this step is to place the center's missions within the framework of the university's missions. By identifying the primary objectives, stakeholders of the VT CRC and Virginia Tech are able to judge whether these objectives are within larger missions of the universtiy. This step may be accomplished by the use of center's documents such as the mission statement and the university mission statement.

Step 6: Applying a context diagram and data flow diagrams (DFD) to illustrate how the VT CRC should attempt to accomplish its primary objectives.

The purpose of this step is to link and relate the center's stakeholders to the center's objectives. DFD is used to illustrate what should be done to accomplish the center's primary objectives. Published or official documents concerning the functions of the center may be used to model DFD. On the other hand, knowledge in specialized areas such as technology transfer or economic development may also be helpful to complete this diagram.

To further explain what the data flow diagram is, the concept of charting and flow diagramming must be understood. Charting is a way to communicate ideas and/or problems among interested parties. Kurstedt (1991) describes the purpose of charting as the way to help "gather information, make sure its complete, verify its accuracy, and communicate the ideas we've charted." Furthermore, Kurstedt (1991) explains that the purposes of flow diagramming are to identify the steps in, or the flow of, a process, and what comes before (predecessor) and what comes after (successor). The benefits of the concept of flow diagramming are to ensure consensus among interested parties and to arrange the steps of how the university attempts to accomplish its missions correctly and completely.

According to E. Yourdon (1989: 140), the data flow diagram is "a modeling tool that allows us to picture a system as a network of functional

processes, connected to one another by "pipelines and holding tanks of data." On the other hand, data flow diagrams can also be used to model the entire organization for business or strategic planning. As a result, the data flow diagram is selected to portray the flow of functions of the VT CRC.

Data flow diagrams have many purposes. Kurstedt (1991) states that the primary purpose of this diagram is to trace and capture "the flow of information" in and out of the domain, in this case the university. Furthermore, the data flow diagram is designed to help communicate the entire process the university uses to accomplish its missions. The diagram can also be used to help identify success criteria for university-related research parks. This aspect will be discussed in step 7.

According to Yourdon (1989: 142), data flow diagrams have many components. These components are the process, the flow, the store, and the terminator. The process shows "a part of the system that transforms inputs into outputs; that is it shows how one or more inputs are changed into outputs." The flow is used "to describe the movement of chunks, or packets of information from one part of the system to another part" (Yourdon, 1989: 143). The store is used "to model a collection of data packets at rest"(Yourdon, 1989: 149). The terminators represent "external entities with which the system communicates"(Yourdon, 1989: 155). Throughout this research, terminators will be called stakeholders. The reason for this change is that the name stakeholder is more understandable for this study. The stakeholders are external entities

outside the boundary or domain of responsibility of the system being modeled.

Note: To identify how the VT CRC interacts with its stakeholders requires understanding and modification of processes of the VT CRC's primary objectives based on user's judgement.

Step 7: Identifying success criteria from the flows in the data flow diagram.

The purpose of this step is to identify success criteria for the VT CRC. Success factors are the flows illustrated in the data flow diagrams. The justification to use the flows as success criteria is that they describe actions needed to be taken by stakeholders to help the center fulfill its objectives.

There are many benefits from realizing success criteria. The primary benefit gained from early identification of success criteria is that the VT CRC president and/or director can easily derive the performance indicators from each criterion. These indicators can be used by the center to assess its performance. Furthermore, these criteria can help the center management develop plans or policies to accomplish its objectives. Plans and policies will be used to assure the VT CRC success.

The success criteria to be identified by the methodology would also have one important benefit. They help ensure that consistency is maintained between the VT CRC policy and the direction of the university since the park objectives are placed within the framework of university's missions (if the methodology is proved to accomplish its purpose).

Section IV: The Experimental Design to Test and Validate the Hypothesis.

To test the methodology at the VT CRC; first, the population (all stakeholders) of the VT CRC must be defined. Then, some members of the stakeholders will be selected to represent the VT CRC's population. Furthermore, these members of the VT CRC stakeholders will be given a questionnaire designed to secure their opinion about whether outputs from the methodology are success criteria. Furthermore, within the same questionnaire, selected members will be asked to provide their opinions about whether each step in the methodology helps the methodology accomplish its overall purpose.

Before identifying the VT CRC's population, the following must be understood: the definition and purposes of the population and an approach used to identify the population. L. Ott (1988: 3) defines a population as "the set of all measurements of interest to the sample collector." The VT CRC's population then is all possible groups of stakeholders for whom the methodology is designed.

The purpose of identifying the VT CRC's population is that the population of the VT CRC must be clearly defined before selecting a sample so that meaningful statistical analysis methods can be employed. A context diagram will be used to identify all possible stakeholders of the VT CRC. After having applied the context diagram, the following is the identified population of the VT CRC.

I. VT CRC's Board of Directors
   - All members

II. VT CRC's management
   - Top management and policy makers

III. Virginia Tech Foundation's Board of Directors
   - All members

IV. Tenants or occupants in the center
   - Top management and/or policy makers

V. Town of Blacksburg
   - Board of Supervisors
   - Department of Economic Development
   - Banks and retail stores
   - Housing and other-related construction industry

VI. Montgomery County and New River Valley

VII. Virginia Polytechnic Institute and State University
   - Board of Visitors
   - The President
   - Administration: Provost, Vice President for Development, and Deans of Colleges

On the other hand, readers must understand the definition and purpose of the VT CRC's sample and how its opinion can be used to make an inference about the hypothesis. According to Ott (1988: 3), a sample is "any subset of measurement selected from the population." Although this research is interested in the opinions of CRC's population (concerning whether the factors identified by the methodology are actually success

criteria for the VT CRC), asking the entire population's opinion is not practical (too costly and too time-consuming). As a result, a sample (a group of selected members) will be used to represent the entire population of the VT CRC.

Before discussing validity for the methodology and its outputs, purpose and characteristics of the questionnaire must be explained. The questionnaire is designed to secure selected members of the VT CRC stakeholders' opinions about whether outputs from the methdology are perceived to be success criteria for the VT CRC and steps in the methodology helps the methodology accomplish its overall purpose. The overall purpose of the methodology is to place the VT CRC within the framework of Virginia Tech and then identify its success criteria. The data contained in the questionnaire should indicate opinions expressed by selected members.

To be able to analyze those data, expressed opinions will be categorized into the interval scale. The purpose of this scale is that it can better support conclusions to be made for the hypohtesis. It should be noted this assumption has always been acceptable, especially to data that the questionnaire contains. Furthermore, readers should realize that distances among respondents' opinions are also assumed to be the same. Therefore, the scale of the questionnaire is as followed: Strongly Disagreee = 1, Disagree = 2, Agree = 3, and Strongly Agree = 4. This scale is used to differentiate opinions of selected members and to eliminate a tendency to provide a "no opinion" response.

As stated in steps of the research process, an ability to analyze and interpret data in questionnaires is the next step following a completion of distributing and receiving questionnaires. Since, this research tests the hypothesis by implementing the methodology to validate the claim of the hypothesis, it is important to select an appropriate type of validity for outputs of the methodology and the methodology itself. Therefore, this section will divide the issue of validity into two areas: the proposed methodology and outputs from the proposed methodology.

I. The proposed methodology

The validity method examined for the methodology is content validity. Content validity is based on the representativeness of the measurement (Walizer and Wienir, 1978: 410). It involves judgement of content of each step in the methodology. Content validity relies on the role of expert judgement to determine whether the content of each step helps the methodology accomplish its overall purpose.

There are three basic steps in determining content validity.

Step 1: Determining and listing an overall purpose of the proposed methodology.

Step 2: Determining and listing all purposes of each step in the proposed methodology.

Step 3: Assessing how well each step helps the proposed methodology accomplish its overall purpose by constructing questions and asking selected members to provide their opinions.

To make an inference whether the methodology is content valid, the scale used in the questionnaire should indicate the number between 3.0-4.0 or between "agree" and "strongly agree" opinion. Content validity for the proposed methodology means that the methodology is judged by experts to be able to fulfill its purpose.

II. Success criteria

The validity method examined for success criteria is face validity. Face validity is "the most basic kind of assessment of validity(Walizer and Wienir, 1978: 408). It is the use of common sense and experience to judge whether outputs from the proposed methodology are generally perceived to be success criteria for the VT CRC according to the definition of success criteria in this research.

There are two basic steps in determining face validity.

Step 1: Stating clearly in each question in the questionnaire that it contains an output from the methodology.

Step 2: Asking selected members to provide their opinions whether they perceive it to be a success criterion for the VT CRC.

The higher number (3.0- 4.0) for each question would indicate that an output is perceived to be a success criterion for the VT CRC. An output which receives less than "agree" opinion will not be recommended for the VT CRC to use to measure its progress toward its objectives. The sixth chapter will discuss an interpretation of these results from questionnaires and a conclusion concerning the hypothesis.

Section V: The Justification of Research.

There are two criteria to justify a successful and meaningful research. One is an ability to make a conclusion concerning the hypothesis based on validated evidence. This criterion is accomplished by the use of the questionnaire. The other is an ability to clarify efforts and activities taken to be parts of a research process. Leedy (1980: 4) views research as a problem-solving process. He further specifies seven characteristics in this process to help guide new researchers.

To meet the second criterion for research, each characteristic will be discussed in the context of efforts and activities from the beginning of the study.

I. Research begins with a problem in the form of a question in the mind of researcher.

- Are expert opinion and/or success criteria derived from generally perceived to be successful research parks only ways to identify sucess criteria for the VT CRC?
- Is it possible to derive success criteria from primary objectives of the VT CRC?
- Is there a need for the VT CRC to realize its success criteria?
- Can management systems engineering be applied to identify success criteria for the VT CRC?

II. Research demands the identification of a problem stated in clear unambigious terms.

- The VT CRC has not had a standardized way to identify its

success criteria so that it can use these criteria as measures to assess its progress toward its objectives.

- The VT CRC does not have its success criteria.
- The VT CRC must realize its success criteria because it has objectives to fulfill, and this fulfillment requires a realization of success criteria.

III. Research requires a plan.

- The plan is to use knowledge, theories, concepts, and tool/techniques in the management systems engineering program offered by Department of Industrial and Systems Engineering to develop a methodology in order to identify success criteria for the VT CRC.
- The plan is to first identify the study's objectives and then to limit the scope of the study to fit these objectives.

IV. Research deals with main problems through appropriate subproblems.

- Main problems:

1) Is it possible to develop a methodology to place the VT CRC within the framework of the university and then to identify success criteria based on the VT CRC primary objectives?
2) Are outputs from the methodology perceived to be success criteria of the VT CRC?

- Subproblems:

1) How to develop sound and supportive assumptions to help accomplish the study's objectives.

2) How to develop steps in the methodology which have to be consistent with assumptions and to include knowledge, theories, concepts, and tool/techniques from management systems engineering.

3) How to develop and test the hypothesis which is designed to solve main problems.

4) How to justify and interprete a result concerning the hypothesis after having tested the proposed methodology.

V. Research seeks direction through appropriate hypothesis and is based upon obvious assumptions. An assumption is a condition which is taken for granted and without which research effort would be impossible.

- Underlying assumptions are based on users of the methodology and situation or condition of the VT CRC which the methodology is used.
- The hypothesis is designed to investigate main problems.

VI. Research deals with facts and their meanings.

- The VT CRC needs to have success criteria to be able to measure its progress toward its objectives, especially when the VT CRC is planning for future expansion. Furthermore, each research park is unique and depends on its objectives. Therefore, success criteria which have been identified earlier may not be useful for the VT CRC. As a result, there is a need for the VT CRC to have its own set of success criteria and the systematic methodology to help it identify those criteria.

VII. Research is circular.

- There is always a possibility for anyone to modify the proposed methodology based on appropriate combination and/or elimination of certain steps if necessary.
- Furthermore, the proposed methodology can be implemented at other parks in order to illustrate its reliability for identifying success criteria for research parks.

Section VI: Roadblocks and Limitations of This Research.

It should be emphasized that the proposed methodology is the first study to attempt to develop a systematic way or methodology to identify success criteria for the VT CRC. As a result, it is almost unavoidable for the methodology to encounter some roadblocks and to have a few limitations. Roadblocks are any obstacles this research faces before reaching its objectives. Limitations deal mainly with the difficulty of interpretation and application of the methodology. This section is intended to address both roadblocks and limitations. It should be noted that some problems cannot be solved completely even though they are recognized and are addressed. The following are foreseeable roadblocks and limitations.

The first roadblock is the inability to effectively place the real world practices on the VT CRC primary objectives (technology transfer and economic development) into the idealistic model (or what the VT CRC

should do to accomplish those primary objectives). Even though the data flow diagram is designed to capture all activities relating to both technology transfer and economic development, this technique still fails to include all informal or unofficial efforts or actions being taken by the VT CRC to fulfill these two objectives. As a result, during the design of the questionnaire, a question, asking the VT CRC stakeholders to provide what other success criteria that the methodology has failed to identify, is included to overcome this roadblock.

The second roadblock is the inability to completely justify the level of DFD used for modeling the technology transfer and economic development processes. The reason is that the data flow diagram may have as many level as requested. As a result, there is no rule or acceptable level numbers of the flow of the data. Therefore, to overcome this roadblock, users of this methodology and outputs from the methodology must be defined. According to an assumption stated earlier, users are the VT CRC president and/or director. This assumption is consistent with Yourdon (1989: 168) statement which describes that majority of people, especially in high-level executives only look at the context diagram and perhaps at Figure 0. The sixth step of the methodology is designed to provide both figures.

The first limitation is the inability to completely assure that all the VT CRC stakeholders are fully knowledgeable about the VT CRC operation. This limitation effects an ability to randomly and independently select members of the center stakeholders to be asked to complete the

questionnaire. To overcome this, the study selected twelve members whom are known to have actively and extensively interacted with the VT CRC. These members are from the university, the center, tenants, and Town of Blacksburg. Although a statistical analysis is important, it may be insignificant as a result of not being able to randomly and independently select a sample from the VT CRC's population.

The second limitation is the inability to completely assure that the questionnaire is the best measure or instrument to secure opinions of selected members. In other words, this study cannot explicitly state that responses by selected members are free from error due to how the questions in the questionnaire are worded and/or interpreted. In general practice, internal consistency reliability estimate would be calculated to illustrate "the degree of homogeneity (that is, similarity) of measurement by all parts of a measure"(Gatewood& Feild, 1990: 172). However, due to the fact that selected members were not chosen randomly and independently, this reliability estimate technique cannot be used. If these selected members could be chosen randomly and independently under an assumption that they are knowledgeable about the VT CRC operation, a calculation of internal consistency reliability estimate would have been strongly recommended to better support and assess validity of the methodology and its outputs.

By having recognized and having addressed roadblocks and limitations, I hope to help a reader, who may be interested in this subject, reduce his/her time and efforts to identify similar problems.

Chapter 6: Results and Conclusions.

This chapter is organized into three sections. The first section is an illustration of results after having implemented the proposed methodology. Included in this section are outputs of all seven steps in the proposed methodology.

The second section will state and describe results from questionnaires which were sent to selected members of the VT CRC stakeholders. The results will be portrayed in table format so that readers will be able to compare how each member answers questions within the questionnaire.

The third section is probably one of the most important sections in this study. Conclusions and implications concerning the methodology, success criteria, and the hypothesis will be made.

Section I: Results from an Implementation of the Proposed Methodology.

This section is designed to illustrate outputs of all seven steps within the methodology. Before providing details of each step, it should be noted that purposes and expected outputs from each step have already been discussed in the fifth chapter. The follow are results of outputs from each step in the methodology. It should be noted that only the final version of data flow diagrams, context diagrams, and success criteria are illustrated.

Step 1: Identifying stakeholders for Virginia Tech.

I. Public sector
   1. Town of Blacksburg
   2. Montgomery County and New River Valley
   3. Commonwealth of Virginia
   4. The federal government

II. Private sector
   1. Local business and firms
   2. Regional business and firms
   3. National and multinational business and firms

III. University-related corporations
   1. Alumni Association
   2. Athletic Association
   3. Student Aid Association
   4. Virginia Tech Foundation, Inc.
   5. VTIP
   6. VPI Facilities

IV. University's personnel
   1. Board of Visitors
   2. Administration

V. Faculty

VI. Students
   1. Undergraduate
   2. Graduate

Step 2: Identifying Virginia Tech's primary missions (relating to the VT CRC operation).

I. Research

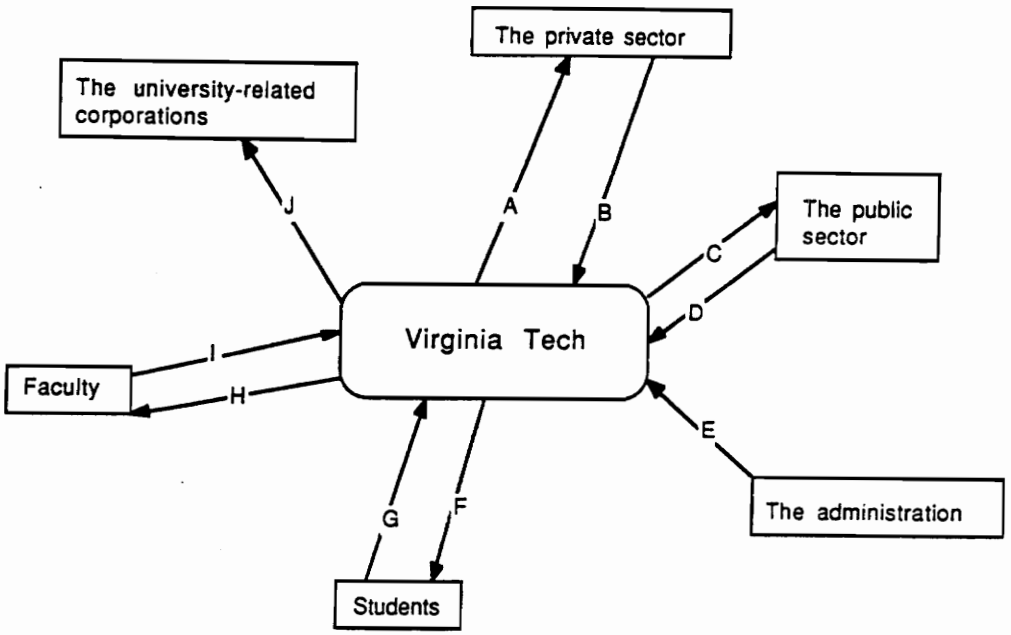
1. To increase capability of faculty.
2. To build supportive environment to conduct research.
3. To investigate and find solutions for pratical problems.
4. To emphasize current state of knowledge, techniques, and equipments.
5. To increase quality of instruction and instruction programs.
6. To meet expectation of customers.
7. To create new companies and jobs.
8. To increase standard of living.

II. Extension

1. To extend educational resources and appropriate information to meet the public needs.
2. To improve knowledge and skills in managing their resources and adapting to their environment.
3. To emphasize the interaction, cooperation, or partnership with outsiders.
4. To assist economic development by utilizing educational resources.
5. To increase operating funds to support staff and related students.

Step 3: Applying a context diagram to identify relationships between Virginia Tech's stakeholders and primary missions.

A. = Providing research capabilities.
B. = Funding research programs.
C. = Fulfilling land-grant obligation.
D. = Funding policy.
E. = Shaping direction and policy.
F. = Providing educational opportunity.
G. = Contributing to research productivity.
H. = Supporting faculty's activities.
I. = Teaching research, and extension activities.
J. = Shaping policies.



Step 4: Identifying stakeholders for the VT CRC.

I. VT CRC's Board of Directors
   1. All members

II. VT CRC management
   1. The President
   2. Director

III. Virginia Tech Foundation's Board of Directors
   1. All members

IV. Tenants
   1. Existing tenants
      - Top management or program directors
   2. Potential tenants

V. Local government
   1. Town of Blacksburg
      - Board of Supervisors
      - Department of Economic Development
      - Local business and retail stores
      - Housing and other construction-related industry
   2. Montgomery County and New River Valley

VI. Virginia Polytechnic Institute and State University
   1. Board of Visitors
   2. Administration

VII. Reseach faculty

Step 5: Identifying the VT CRC's primary objectives.

I. Technology transfer

1. Basic research.
2. Applied research.
3. Development.
4. Testing/evaluation.
5. Commercialization.

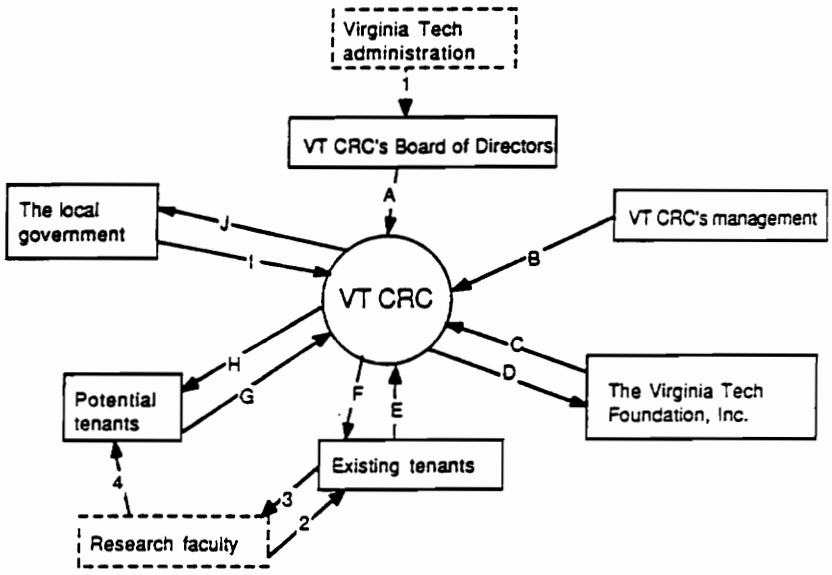
II. Economic development

1. Acquiring and upgrading land.
2. Making plots available for building sites or building available for space renting.
3. Adding services and supporting operation of incubator.
4. Developing a critical mass and attracting tenants to building or to put up building
5. Expanding tax base & generating employment and career opportunity by spinning off new business or expanding existing business.

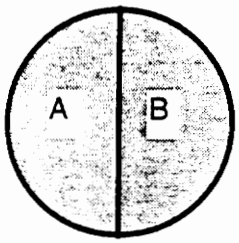
Step 6: Applying a context diagram and data flow diagrams to illustrate how the VT CRC should attempt to accomplish its primary objectives.

A. = Establishing policies.
B. = Managing.
C. = Providing financial assistance.
D. = Retiring debt.
E. = Conducting research and paying rent.
F. = Providing opportunity and supportive environment.
G. = Inquring about research opportunity.
H. = Networking and responding to inquiries.
I. = Stimulating economic development.
J. = Supporting the VT CRC operation.

1. = Suggesting policy.
2. = Research capability.
3. = Employment and facility support.
4. = Potential research capability.



Partitioning the VT CRC:

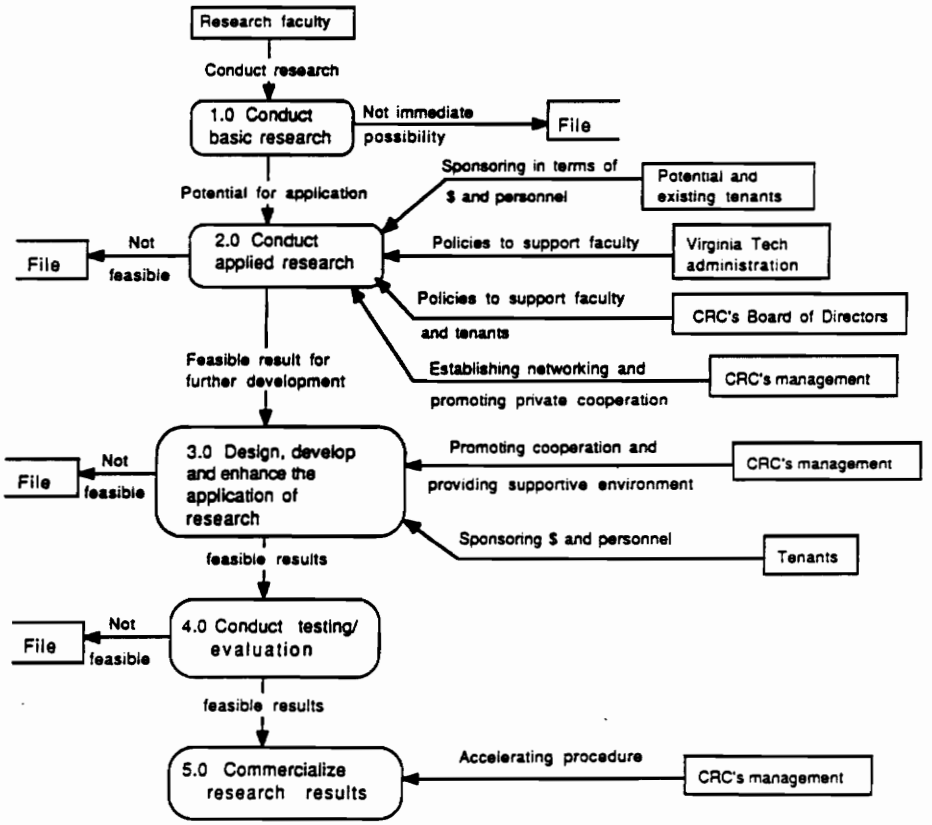


A. = Technology transfer

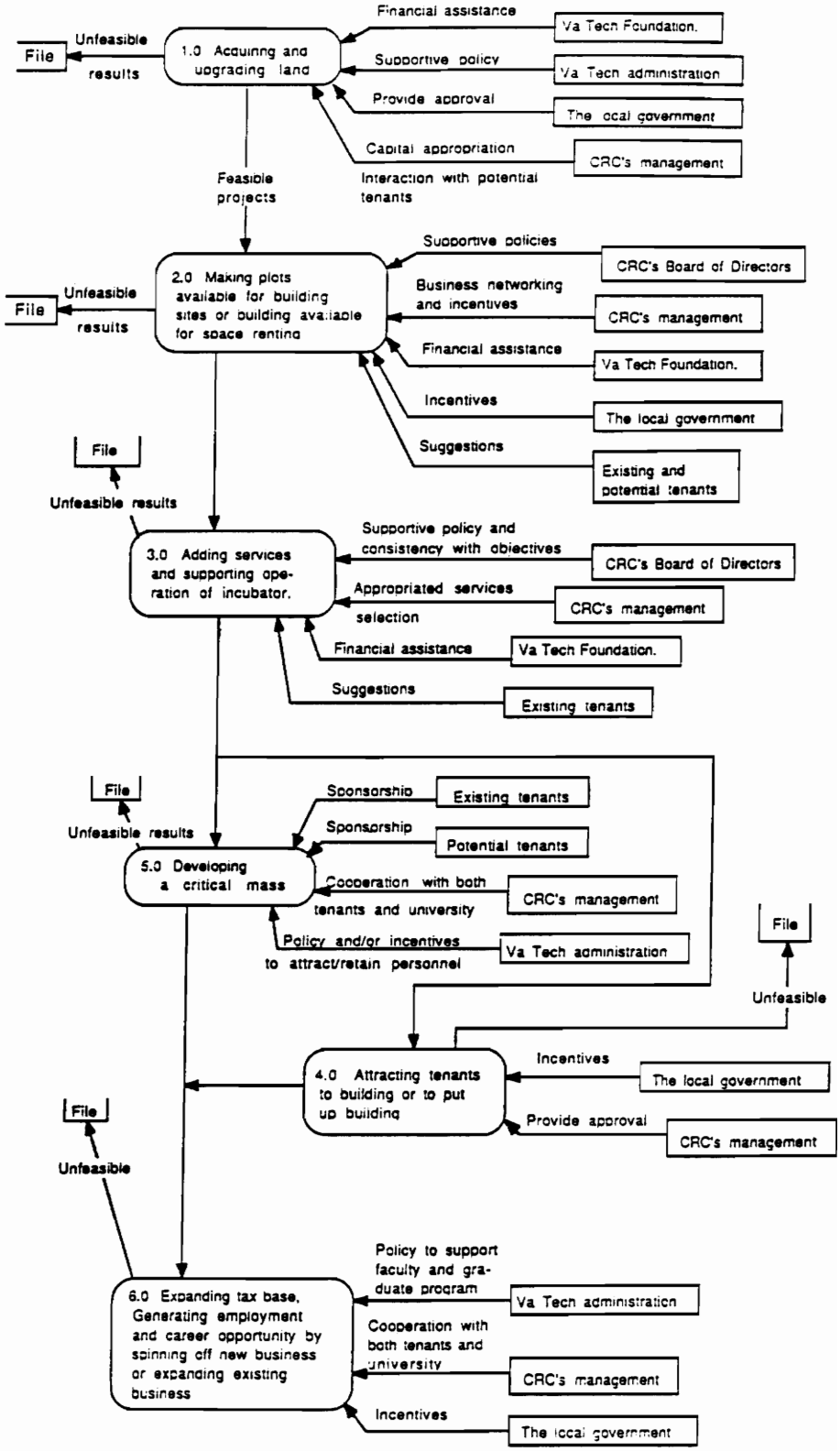
B. = Economic development

Note: Partitioning is used to derive the data flow diagram for each the VT CRC primary objectives.

For technology transfer:



For economic development



Step 7: Identifying success criteria for the VT CRC from the flows in the data flow diagrams.

For technology transfer.

1. The VT CRC has some number of qualified personnel conducting research within the center, including some also from the university such as faculty and/or students. **[Qualified personnel]**
2. The VT CRC has potential and existing actively engaged in research that may lead to commercial realization. **[Potential and existing tenant research and activity]**
3. The VT CRC has clear objective(s), which are derived from university policy. **[clear objective(s)]**
4. The VT CRC has criteria to select tenants to be attracted into the center. **[Appropriate tenant based on the center objectives]**
5. The VT CRC director has an established network and is actively cooperating and interacting with industry including potential and existing tenants. **[Networking with potential and existing tenants]**
6. The VT CRC has and provides a supportive environment, e.g., laboratory facilities, conference rooms, etc, to help tenants conduct reseach. **[Supportive environment for research]**
7. The VT CRC offers assistance that permits an acceleration of the commercialization of research ideas or products. **[Accelerated procedure for commercialization]**

For economic development.

1. The VT CRC has secured and may continue to secure financial assistance during the phases of 1) acquiring and upgrading land, 2) making plots or buildings available, and 3) adding services and supporting operations within the center. **[Sound financial assistance]**
2. The VT CRC has a consistently supportive policy and/or incentives from both Virginia Tech and the VT CRC to demonstrate a commitment to attract and/or retain research faculty. **[Consistent policy and/or incentives]**

3. The VT CRC has support from the local government in terms of providing approval for acquiring and upgrading land, ofering incentives to attract potential tenants, and providing financial support for the center. [**Local government's support**]
4. The VT CRC consistantly establishes a budget and operates within that budget. [**Sound financial operations**]
5. The VT CRC has a continous interaction among the VT CRC management, research faculty, and potential and existing tenants. [**Strong business and research relationship**]
6. The VT CRC has potential and existing tenants involve and participate in the VT CRC operation such as services to be offered based on needs and the center objectives) and development of personnel from the university, especially graduate/undergraduate students. [**Potential and existing tenants involvement**]

Section II. Results from Questionnaires.

The purpose of this section is to portray responses (results) from questionnaires. The table format is selected to illustrate results of questionnaires. Before discussing these results, abbreviations used in the table, names of selected members of the VT CRC, and description of each question in the questionnaire will be stated.

Furthermore, question 21, asking selected members to add other success criteria which the methodology has failed to identify, will not be included in the table. Question 21 will be summarized and be presented in the appendices.

The following are abbreviations used in the table:

- SD = Strongly Disagree,
- D = Disagree,
- A = Agree, and
- SA = Strongly Agree.

The following are names of selected members of the VT CRC stakeholders:

- Ray Smoot: the university, Vice President of Business Affairs and Treasurer.
- Gary Hooper: the university, Vice Provost of Research and Dean of the Graduate School.
- Laurie Martinson: the university, Administrative Intern.
- John Muffo: the university, Director, Program Review and Outcomes Assessment.

- Fred Meade: the VT CRC, Director.
- Rod Hall: the VT CRC, Business Manager.
- Doug Goldsmith: tenant, Envirotech.
- Ron Simpson: tenant, Management Systems Laboratory.
- Chris Thompson: tenant, Recognition Research.
- George Nichols: tenant, Virginia Tech Library Systems.
- Ron Secrist: Town of Blacksburg, Town Manager.
- Roger Hedgepeth: Town of Blacksburg, Mayor.

The followings are questions asked in the questionnaire:

Question 1: Do you think "qualified personnel" is a success criterion for the VT CRC? This implies that the VT CRC has some number of qualified personnel conducting research within the center, including some also from the university such as faculty and/or students.

Question 2: Do you think "potential and existing tenant research funding and activity" is a success criterion for the VT CRC? This implies that the VT CRC has potential and existing tenants actively engaged in research that may lead to commecial realization.

Question 3: Do you think "clear objective(s)" is a success criterion for the VT CRC? This implies that the VT CRC has clear objective(s), which are derived from university policy.

Question 4: Do you think "appropriate tenants based on the center objectives" is a success criterion for the VT CRC? This implies that the VT CRC has criteria to select tenants to be attracted into the center.

Question 5: Do you think "networking with potential and existing tenants" is a success criterion for the VT CRC? This implies that the VT CRC has an established network and is actively cooperating and interacting

with industry including potential and exsisting tenants.

Question 6: Do you think "supportive environment for research" is a success criterion for the VT CRC? This implies that the VT CRC has and provides a supportive environment, e.g., laboratory facilities, conference rooms, etc, to help tenants conduct research.

Question 7: Do you think "accelerated procedure for commercialization" is a success criterion for the VT CRC? This implies that the VT CRC offers assistance that permits an acceleration of the commercialization of research ideas or products.

Question 8: Do you think "sound financial assistance" is a success criterion for the VT CRC? This implies that the VT CRC has secured and may continue to secure financial assistance during the phases of 1) acquring and upgrading land, 2) making plots or buildings available, and 3) adding services and supporting operations within the center.

Question 9: Do you think "consistent policy and/or incentives" is a success criterion for the VT CRC? This implies that the VT CRC has a consistently supportive policy and/or incentives from both Virginia Tech and the VT CRC to demonstrate a commitment to attract and/or retain research faculty.

Question 10: Do you think "local government's support" is a success criterion for the VT CRC? This implies that the VT CRC has support from the local governemnt in terms of providing approval for acquring and upgrading land, offering incentives to attract potential tenants, and providing financial support for the center.

Question 11: Do you think "sound financial operation" is a success criterion for the VT CRC? This implies that the VT CRC consistently

establishes a budget and operates within that budget.

Question 12: Do you think "strong business and research relationship" is a success criterion for the VT CRC? This implies that the VT CRC has a continous interaction among the VT CRC management, research faculty, and potential and existing tenants.

Question 13: Do you think "potential and existing tenants involvement" is a success criterion for the VT CRC? This implies that the VT CRC has potential and existing tenants involve and participate in the VT CRC operation such as services to be offered (based on needs and the center objectives) and development of personnel from the universtiy, especially graduate/undergraduate students.

Question 14: Do you think the first step: "identifying stakeholders for Virginia Tech" is necessary for the proposed methodology to accomplish its purpose? The purpose of this step is to identify a boundary of Virginia Tech so that readers are able to realize the university role concerning its surrounding environment.

Question 15: Do you think the second step: "identifying Virginia Tech's primary missions (relating to the VT CRC operation)" is necessary for the propsoed methodology to accomplish its purpose? The purpose of this step is to insure consistency between Virginia Tech and the VT CRC and to provide a larger picture of how the VT CRC may be used to help Virginia Tech accomplish its missions.

Question 16: Do you think the third step: "applying a context diagram to identify relationship between Virginia Tech stakeholders and primary missions" is necessary for the propsoed methodology to accomplish its purpose? The purpose of this step is to link and relate stakeholders

with Virginia Tech missions. The context diagram is used to identify a relationship between the university and its stakeholders.

Question 17: Do you think the fourth step: "identifying stakeholders for the VT CRC" is necessary for the proposed methodology to accomplish its purpose? The purpose of this step is to insure consistency between the VT CRC and Virginia Tech's environment.

Question 18: Do you think the fifth step: "identifying the VT CRC primary objectives" is necessary for the proposed methodology to accomplish its purpose? The purpose of this step is to insure consistency between the VT CRC and Virginia Tech and to place the VT CRC objectives within the framework of Virginia Tech missions.

Question 19: Do you think the sixth step: "applying a context diagram and data flow diagram to illustrate how the VT CRC should attempt accomplish its primary objectives" is necessary for the proposed methodology to accomplish its purpose? The purpose of this step is to link and relate the VT CRC stakeholders with its objectives. The data flow diagram is used to illustrate what should be done for the VT CRC to accomplish its objectives.

Question 20: Do you think the seventh step: "identifying success criteria from the flow in the data flow diagram" is necessary for the proposed methodology to accomplish its purpose? The purpose of this step is to justify success criteria for the VT CRC based on its objectives and its interaction with its stakeholders. The flow in the data flow diagram is used to identify actions that the center and its stakehoders need to take for the center to accomplish its objectives.

The following is the table summarizing results of all questions (except question 21). The results are opinions from all twelve selected members. The table indicates numbers of selected members in each answer option.

Table 6-1: Summary of Questionnaires

Question #	SD	D	A	SA	No Answer
1. Qualified Personnel			7	5	
2. Tenant research			4	8	
3. Clear objective(s)		2	6	4	
4. Appropriate tenant		1	10	1	
5. Networking			6	6	
6. Environment			3	9	
7. Acceleration			5	6	1
8. Sound financial			9	3	
9. Consistent policy		3	6	3	
10. Local government		3	4	5	
11. Sound financial			7	5	
12. Business relation			5	7	
13. Tenant involvement			9	3	
14. The first step		3	6	1	2
15. The second step		2	5	4	1
16. The third step		6	4	2	
17. The fourth step		1	9	1	1
18. The fifth step		3	4	5	
19. The sixth step		4	5	2	1
20. The seventh step		2	7	2	1

Section III: Conclusion and Implication of Research.

Before making a conclusion concerning the hypothesis, it is important to first arrange and illustrate results from questionnaires. This includes content validity for each step in the proposed methodology and face validity for each success criterion. Then, a conclusion concerning the hypothesis can be made.

I. The methodology:

Table 6-2: Illustration of Content Validity

(from 4.0 scale)

Step 1 (from question 14):	(1x0) + (2x3) + (3x6) + (4x1) = 6+18+4 = 28:	28/10 = 2.8
Step 2 (from question 15):	(1x0) + (2x2) + (3x5) + (4x4) = 4+15+16 = 35:	35/11 = 3.2
Step 3 (from question 16):	(1x0) + (2x6) + (3x4) + (4x2) = 12+12+8 = 32:	32/12 = 2.7
Step 4 (from question 17):	(1x0) + (2x1) + (3x9) + (4x1) = 2+27+4 = 33:	33/11 = 3.3
Step 5 (from question 18):	(1x0) + (2x3) + (3x4) + (4x5) = 6+12+20 = 38:	38/12 = 3.2
Step 6 (from question 19):	(1x0) + (2x4) + (3x5) + (4x2) = 8+15+8 = 31:	31/11 = 2.8
Step 7 (from question 20):	(1x0) + (2x2) + (3x7) + (4x2) = 4+21+8 = 33:	33/11 = 3.0

Conclusion: The result appears that the methodology is content valid, even though some steps receive less than 3.0 or "agree" opinion in this scale. In other words, the methodology has accomplished its purpose according to opinions provided by selected members. Nevertheless, many respondents expressed difficulty in understanding the concept of delimiting domains of responsibility and the usefulness of a context diagram and a data flow diagram. They also indicate that they would have selected a "no opinion" option if provided in certain questions.

Implication: The cause of this study's inability to explicitly claim content validity for the methodology is a variation of understanding and knowledge of management systems engineering theories, concepts, and tools/techniques which were built into the methodology. For the study to have come to a more decisive conclusion, a modification or a redesign of the questionnaire concerning the methodology may have been necessary. Results of an implementation of the methodology should have been attached to illustrate how the methodology works.

II. Success criteria:

Table 6-3: Illustration of Face Validity

(from 4.0 scale)

Criterion 1 (from question 1): (1x0) + (2x0) + (3x7) + (4x5) = 21+20 = 41:	41/12 = 3.4
Criterion 2 (from question 2): (1x0) + (2x0) + (3x4) + (4x8) = 12+32 = 44:	44/12 = 3.7
Criterion 3 (from question 3): (1x0) + (2x2) + (3x6) + (4x4) = 4 +18+16 = 38:	38/12 = 3.2
Criterion 4 (from question 4): (1x0) + (2x1) + (3x10) + (4x1) = 2+30+4 = 36:	36/12 = 3.0
Criterion 5 (from question 5): (1x0) + (2x0) + (3x6) + (4x6) = 18+24 = 42:	42/12 = 3.5
Criterion 6 (from question 6): (1x0) + (2x0) + (3x3) + (4x9) = 9+36 = 45:	45/12 = 3.8
Criterion 7 (from question 7): (1x0) + (2x0) + (3x5) + (4x6) = 15+24 = 39:	39/11 = 3.6
Criterion 8 (from question 8): (1x0) + (2x0) + (3x9) + (4x3) = 27+12 = 39:	39/12 = 3.3
Criterion 9 (from question 9): (1x0) + (2x3) + (3x6) + (4x3) = 6+18+12 = 30:	36/12 = 3.0
Criterion 10 (from question 10): (1x0) + (2x3) + (3x4) + (4x5) =6+12+20= 38:	38/12 = 3.2
Criterion 11 (from question 11): (1x0) + (2x0) + (3x7) + (4x5) = 21+20 = 41:	41/12 = 3.4
Criterion 12 (from question 12): (1x0) + (2x0) + (3x5) + (4x7) = 15+28 = 43:	43/12 = 3.6
Criterion 13 (from question 13): (1x0) + (2x0) + (3x9) + (4x3) = 27+12 = 39:	39/12 = 3.3

Conclusion: All success criteria, identified by the proposed methodology are face valid. The reason is that all of them have their scale numbers

between 3.0- 4.0. These numbers indicate that all success criteria receive "agree" and/or "strongly agree" responses from selected members. In other words, according to their judgement, selected members have perceived that all thirteen outputs from the proposed methodology are success criteria for the VT CRC.

Implication: The implication is that the VT CRC can use these outputs from the methodology in combination with criteria proposed by other authors and selected members (see Appendix A and C) as its success criteria. However, numbers associated with face validity cannot be analyzed as a ranking of success criteria in terms of their importance and contribution to the VT CRC's success. These numbers only indicate that all thirteen outputs can be used as success criteria for the VT CRC. Furthermore, selected members were not chosen randomly and independently. Therefore, this study cannot make a generalized conclusion about the level of importance for each success criterion. However, "potential and existing tenant research funding and activity," "networking with potential and existing tenants," "supportive environment,""accelerated procedure for commercialization," and "strong business and research relationship," must be better planned, managed and/or initiated due to their high level of agreement that these outputs are success criteria for the VT CRC.

III. The hypothesis:

Conclusion: According to earlier conclusions of the proposed methodology and its outputs, the hypothesis is a true statement. As stated, the

hypothesis of this study is that success criteria for the VT CRC can be identified from its primary objectives by the proposed methodology which places the VT CRC within the framework of Virginia Tech's larger missions.

It should be noted that this conclusion about the hypothesis is based only on the validity of the proposed methodology and its outputs. In other words, there are two requirements to reach this conclusion. The first requirement is that the proposed methodology must be content valid. The other requirement is that outputs from the proposed methodology are face valid. If these two requirements are true, the hypothesis must be true. The next chapter will discuss implications (in the context of recommendation) resulting from the conclusion of the hypothesis.

Chapter 7: Accomplishments and Recommendations.

This chapter is organized into two sections. The first section will discuss accomplishments in the context of this research work. There are four major accomplishments which will be explained in the first section.

The second section will discuss recommendations. These recommendations will also be in the context of the continuity of this research. In other words, all recommendations are based on research accomplishments.

Section I: Accomplishments.

There are four major accomplishments of this research. It should be noted that there are other accomplishments as well but they are of a personal nature and will not be discussed in this research.

The first achievement is that this study fulfills its objectives. The first objective is to propose a methodology to identify success criteria for the VT CRC. This study proposes the seven-step methodology. After having been implemented, the results are: 1) the methodology is content valid and 2) outputs from the methodology are success criteria for the VT CRC. Therefore, the first objective is accomplished. The second objective is to communicate success criteria (outputs from the methodology) to selected members of the VT CRC stakeholders. The questionnaire was used to fulfill this second objective.

The second accomplishment is that this research is the first attempt to establish a systematic effort similar to the proposed methodology to identify success criteria for the VT CRC. Although the proposed methodology may have failed to identify all success criteria (according to selected members of the VT CRC stakeholders), the methdology still has produced many criteria which will be beneficial to the VT CRC. The important aspect of this accomplishment is that this research has provided the methodology and success criteria that the VT CRC is always able to use and modify.

The third achievement is in the emphasis placed upon the relationship between the university and the VT CRC. All too often university-related research parks are seen as real estate ventures established by universities to mainly attract research funding from the public and private sector. Although attracting research grants, generating revenue back to the university, and stimulating economic activities around the center are objectives of the VT CRC, the relationship between the university and the center is most important. The proposed methodology is designed to emphasize this relationship. The important aspect of this accomplishment is that this research has increased awareness of this relationship among key selected members of the VT CRC stakeholders.

The fourth accomplishment is that this research has integrated concepts, theories, and tools/techniques in management systems engineering program offered by the Department of Industrial and Systems Engineering. The methodology is based on the design, development,

implementation, and integration of the management system model (Kurstedt, 1991), the performance measurement concept, the context diagram, and the data flow diagram. The important aspect of this accomplishment is that this research can be categorized as an engineering study.

Section II: Recommendations.

The purpose of this section is to provide readers, who may be interested in a related study, suggestions regarding future areas to research. These ideas are continuous from what this research has accomplished. However, they were not within the scope of this study. As a result, these ideas were not investigated.

The first recommendation is to further derive performance indicators for each success criterion. It must be understood clearly that success criteria only provide the VT CRC areas to consider when it tries to assess its progress toward its objectives. To measure this assessment, performance indicators will be necessary. Therefore, the VT CRC should derive those indicators to fully utilize success criteria.

The second recommendation is to rank success criteria identified by the methodology. The ranking will help the VT CRC during its planning to accomplish its objectives because the ranking will help the VT CRC better appropriate its resources.

The third recommendation is a longitudinal study to investigate the effect of success criteria to the VT CRC operation. The study may include an annual questionnaire to find out whether selected members of the VT CRC stakeholders' perception about success criteria has changed. The purpose of this recommendation is to ensure a continuous effort by the VT CRC to utilize the proposed methodology and success criteria.

The fourth recommendation is to further apply and implement the proposed methodology at other university-related research parks. In other words, the cross-sectional study of the proposed methodology is recommended. The purpose of this recommendation is to investigate whether the hypothesis would be accepted and/or rejected at other research parks.

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Appendix A

Comparison of Success Criteria Identified by A Proposed Methodology with Others (in Chapter 3)

The proposed Methodology	C. Evans (U. of Utah)	M. Franco (U. of Rochester)	Asian Instutute of Technology and Thammasat U. (Thailand)
Clear objective(s)	Clear objective	Long-term growth	
		Clear park development	
		Clear understanding of the park's role	
Consistent policy and/or incentives with the university	University support	Clear understanding of university's role	
Supportive environment for research	Impressive or unique site and location	Facilities/equipment sharing strategies	Access to overseas expertise and consultant
		Unique conditions	Accessible location
		Quality-of-life consideration	Good infrastructure
		Well-defined facilities Management philosophy	Selection of proper technologies
			A good entrepreneurial environment
			Free of constraints
Sound financial assistance	Modest cost of development		
Sound budget operations	Simple and efficient administration		Good project management and organization
Networking with potentail and existing tenants		Mutual interest and strengths	

The proposed Methodology	C. Evans (U. of Utah)	M. Franco (U. of Rochester)	Asian Instutute of Technology and Thammasat U. (Thailand)
Qualified personnel		Individual personnel	Mix of professionals
			Full participation of women as part of an overall human resource strategy
Potential and existing tenants research activity			
Potential and existing tenants involvement		Clear institute commitment to cooperate	Interaction with users
		Strategies by park to encourage interaction	
Local government support		Government support	Strong local and regional support
		Community involvement	Financial incentives
Accelerated procedure for commercialization			
	Realistic expectations		
		Promotional strategies	Good publicity and promotion
		Regional economic condition	

Appendix B

A Copy of the Questionnaire Sent to Selected Members of the VT CRC Stakeholders

INDUSTRIAL AND SYSTEMS ENGINEERING
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

PAUL E. TORGERSEN
John W. Hancock, Jr. Chair
President, Virginia Tech
Corporate Research Center

MEMO TO: Ray Smoot
Gary Hooper
Fred Meade - CRC
Laurie Martinson
Rod Hall - CRC
Doug Goldsmith - Envirotech
Ron Simpson - MSL
Chris Thompson- Recognition Research
George Nichols - VTLS
John Muffo - Institutional Research
Ron Secrist - Blacksburg Town Manager
Roger Hedgepeth - Blacksburg Mayor

FROM: Paul E. Torgersen

SUBJECT: Kongkiti Peter Phusavat
M.S. Thesis Questionnaire

DATE: October 30, 1991

With this, I would like to introduce Peter Phusavat and subsequently request a few minutes of your time.

Peter is from Thailand. He will soon be completing his M.S. degree and he is interested in research parks ... our Corporate Research Center and possibly research parks in his own country. His thesis is an attempt to develop criteria for the assessment of the success of a research park. Now he would like to contrast the criteria he has established with some third party judgements.

Your opinions will be requested thru the response to a questionnaire he will shortly be sending you. I hope you can give him a few minutes of your time.

MPD/jbs

Blacksburg, Virginia 24061

Phone: 703 231-3049
Fax: 703 231-3322

Nov 1, 1991.

Dear:_____

My name is Peter Phusavat. I am a graduate student in the management systems engineering program in the Industrial and Systems Engineering department. I am currently conducting research for Dr. Paul Torgersen as partial fulfillment of the requirements for my Master of Science degree. I hope to propose a methodology to identify success criteria for the Virginia Tech Corporate Research Center. This methodology might also prove useful for other research parks.

Dr. Torgersen and I have identified twelve individuals, including yourself, and we are requesting that those individuals complete a questionnaire. We hope to receive responses from tenants, individuals associated with the administration of the VT CRC and those in a leadership position within the community.

Please return the questionnaire to Dr. Torgersen. Call me at 231-7058 if you have questions.

Thank you very much for your thought, consideration, and time.

Respectfully yours

Peter Phusavat

The purpose of this questionnaire is to secure your opinion concerning the Virginia Tech Corporate Research Center (VT CRC) and its objectives. My thesis is proposing a methodology to identify success criteria for the VT CRC. We are now communicating these success criteria to a limited sample of VT CRC stakeholders. You are a selected member of that sample. A stakeholder of the VT CRC may be a person, persons, a group of persons who have a stake (responsibility, obligation, cooperation, and interaction) in the organization's operation.

Your opinion will be used to analyze whether these success criteria are generally perceived to be criteria for the VT CRC in its progress toward objectives. The proposed methodology has identified 13 such success criteria.

You opinion will also be used to analyze whether each step in the proposed methodology is helpful. The proposed methodology consists of seven steps.

Each of the first 13 questions will relate to success criteria for the VT CRC. Each of the next seven questions will refer to the methodology itself.

Your response to these 20 questions should be Strongly Disgree, Disagree, Agree, or Strongly Agree.

One last question will ask for your opinion concerning other success criteria the VT CRC should consider.

Note:

I. The potential tenants are those that the center president and/or director are, at the moment, hoping to bring to the center.

II. Existing tenants are those now located in the center.

III. Research faculty are of the larger university, and probably in areas of agriculture, engineering, and science.

IV. Success is a measure of extent the VT CRC meets its objectives.

Please select one of answer options provided except question 21.

The follow questions refer to success criteria identified by the proposed methodology.

1. Do you think "qualified personnel" is a success criterion for the VT CRC? This implies that the VT CRC has some number of qualified personnel conducting research within the center, including some also from the university such as faculty and/or students.

Strongly disagree Disagree Agree Strongly agree

2. Do you think "potential and existing tenant research funding and activity" is a success criterion for the VT CRC? This implies that the VT CRC has potential and existing tenants actively engaged in research that may lead to commercial realization.

Strongly disagree Disagree Agree Strongly agree

3. Do you think "clear objective(s)" is a success criterion for the VT CRC? This implies that the VT CRC has clear objective(s), which are derived from university policy.

Strongly disagree Disagree Agree Strongly agree

4. Do you think "appropriate tenants based on the center objectives" is a success criterion for the VT CRC? This implies the VT CRC has criteria to select tenants to be attracted into the center.

Strongly disagree Disagree Agree Strongly agree

5. Do you think "networking with potential and existing tenants" is a success criterion for the VT CRC? This implies the VT CRC director has an established network and is actively cooperating and interacting with industry including potential and existing tenants.

Strongly disagree Disagree Agree Strongly agree

6. Do you think "supportive environment for research" is a success criterion for the VT CRC? This implies the VT CRC has and provides a supportive environment, e.g., laboratory facilities, conference rooms, etc, to help tenants conduct research.

Strongly disagree Disagree Agree Strongly agree

7. Do you think "accelerated procedure for commercialization" is a success criterion for the VT CRC? This implies the VT CRC offers assistance that permits an acceleration of the commercialization of research ideas or products.

Strongly disagree Disagree Agree Strongly agree

8. Do you think "sound financial assistance" is a success criterion for the VT CRC? This implies the VT CRC has secured and may continue to secure financial assistance during the phases of 1) acquiring and upgrading land, 2) making plots or buildings available, and 3) adding services and supporting operations within the center.

Strongly disagree Disagree Agree Strongly agree

9. Do you think "consistent policy and/or incentives" is a success criterion for the VT CRC? This implies the VT CRC has a consistently supportive policy and/or incentives from both Virginia Tech and the VT CRC to demonstrate a commitment to attract and/or retain research faculty.

Strongly disagree Disagree Agree Strongly agree

10. Do you think "local government's support" is a success criterion for the VT CRC? This implies the VT CRC has support from the local government in terms of providing approval for acquring and upgrading land, offering incentives to attract potential tenants, and providing financial support for the center.

Strongly disagree Disagree Agree Strongly agree

11. Do you think "sound financial operations" is a success criterion for the VT CRC? This implies the VT CRC consistently establishes a budget and operates within that budget.

Strongly disagree Disagree Agree Strongly agree

12. Do you think "strong business and research relationship" is a success criterion for the VT CRC? This implies the VT CRC has a continous interaction among the VT CRC management, research faculty, and potential and existing tenants.

Strongly disagree Disagree Agree Strongly agree

13. Do you think "potential and existing tenants involvement" is a success criterion for the VT CRC? This implies the VT CRC has potential and existing tenants involve and participate in the VT CRC operation such as services to be offered (based on needs and the center objectives) and development of personnel from the University, especially graduate/undergraduate students.

Strongly disagree Disagree Agree Strongly agree

The follow questions refer to the proposed Methodology utilized to identify and develop success criteria for the VT CRC.

14. Do you think the first step: "identifying stakeholders for Virginia Tech" is necessary for the proposed methodology to accomplish its purposes? The purpose of this step is to identify a boundary of Virginia Tech so that readers are able to realize the university roles concerning its surrounding environment.

Strongly disagree Disagree Agree Strongly agree

15. Do you think the second step: "identifying Virginia Tech's primary missions (relating to the VT CRC operation)" is necessary for the proposed methodology to accomplish its purposes? The purposes of this step is to insure consistency between Virginia Tech and the VT CRC and to provide a larger picture of how the VT CRC may be used to help Virginia Tech accomplish its missions.

Strongly disagree Disagree Agree Strongly agree

16. Do you think the third step: "applying a context diagram to identify relationships between Virginia Tech stakeholders and primary missions" is necessary for the proposed methodology to accomplish its purposes? The purpose of this step is to link and related stakeholders with Virginia Tech missions. The context diagram is used to identify a relationship between

the university and its stakeholders.

Strongly disagree Disagree Agree Strongly agree

17. Do you think the fourth step: "identifying stakeholders for the VT CRC" is necessary for the proposed methodology to accomplish its purposes? The purpose of this step is to insure consistency between the VT CRC and Virginia Tech environment.

Strongly disagree Disagree Agree Strongly agree

18. Do you think the fifth step: "identifying the VT CRC primary objectives" is necessary for the proposed methodology to accomplish its purposes? The purposes of this step is to ensure consistency between the VT CRC and Virginia Tech and to place the VT CRC objectives within the framework of Virginia Tech missions.

Strongly disagree Disagree Agree Strongly agree

19. Do you think the sixth step: "applying a context diagram and data flow diagram to illustrate how the VT CRC should attempt accomplish its primary objectives" is necessary for the proposed Methodology to accomplish its purposes? The purposes of this step is to link and relate the VT CRC stakeholders with its objectives. The data flow diagram is used to

illustrate what should be done for the VT CRC to accomplish its objectives.

Strongly disagree Disagree Agree Strongly agree

20. Do you think the seventh step: "identifying success criteria from the flows in the data flow diagram" is necessary for the proposed Methodology to accomplish its purposes? The purposes of this step is to identify success criteria for the VT CRC based on its objectives and its interaction with its stakeholders. The flow in the data flow diagram is used to identify actions that the center and its stakeholders need to take for the center to accomplish its objectives.

Strongly disagree Disagree Agree Strongly agree

21. What other success criteria do you think should be identified which the proposed methodology has failed to identify? More to the point ... how would you decide the extent to which the VT CRC (or any university-related research park) is successful?

Appendix C

Answers and Implications for Question 21 in the Questionnaire

Question 21: What other success criteria do you think should be identified which the proposed methodology has failed to identify? More to the point ... how would you decide the extent to which the VT CRC (or any university-related research park) is successful?

Before providing answers for this question, it should be noted that these answers may be classified or stated in terms of one or more success criteria which have already been identified by the methodology. Furthermore, based on a definition of success criteria used in this study, most answers are performance indicators for one or more of thirteen success criteria.

The question is designed to provide an opportunity for selected members to suggest and communicate their thought on the VT CRC operation. Nevertheless, there are two implications for this study. The first implication is that this question helps the study accomplish its objectives. One of the study's objectives is to communicate with selected members. The second implication is that this question would help overcome one of the methodology's roadblocks. This roadblock is the inability to clearly state that the methodology identifies all success criteria for the VT CRC. If the VT CRC president and/or director approves

some of the answers for this question, they may be used as additional success criteria for the VT CRC. The following are all answers provided by selected members of the VT CRC stakeholders.

- Spouse and student employment provided.
- Impact on economic development of the region (payroll, jobs, purchasing in local community).
- Attraction of companies and federal labs or centers that provide jobs with salaries above community norms.
- Ability of the park to generate economic growth within the broader community.
- Knowledge and awareness in community.
- Number of spin offs.
- Favorable impact on university's image (both academic and political).
- Contribution to the core missions of the university while adding to the economic and cultural life of the community.
- Additional research opportunities for faculty and graduate students.
- Amount of $ in research growth.
- Amount of sponsored research funded at the university.
- Tenant relation: proactive view on tenant relation, focusing on space/expansion needs for tenants, improved contact with tenant organizational leaders, asking and implementing suggestions on improved service, forming a tenant steering committee to obtain suggestion on directions for the VT CRC, and promoting networking among tenants.
- Degree of existing tenants' satisfaction.

- Growth and expansion of existing tenants.
- A good working atmosphere: reasonable rent and "a window and a view of my window."
- Good service: clean bathrooms, consistent heat, a secure building, room for expansion, good parking and a friendly landlord.
- How well the VT CRC "clear objectives" are communicated to the university community.
- How well the VT CRC can support itself as a for profit enity or how well the VT CRC can obtain additional long-term financing to support its objectives.
- Financial success (self-supporting) or financial return to univeristy.
- Degree of profitability.
- Occupancy of existing facilities.
- Rate of expansion of these facilities.
- % of research activities which are successfully commercialized.

Comments:

- Success should be measured in terms of private business endeavors with the support from the university.
- The extension and research missions of the university should be broad enough to allow for future objectives that are somewhat creative which may be applied at the VT CRC.
- It is important that the VT CRC objectives and criteria not be constricted through the sole use of today's success benchmarks. Furthermore, the VT CRC should be strong, flexible, visible, and competitive center of research which has reasonably direct importance to the Commonwealth, and, in the normal course of events, to U.S. stature in the international world of technology and gross national product.

Appendix D

Important Definitions and Processes in the Research

Important Definitions:

I. University-related research park: It is an entity, operating as an affiliate under assumptions of the framework of the university, to help the university accomplish its missions by partnership and cooperation with both the public and private sector.

II. Stakeholder: It is a person, persons, a group of persons who has a stake (responsibility, obligation, cooperation, and interaction) in the organization's operation.

III. Methodology: It is an overall worldview, meaning and action system governing research activities in fields of inquiring in order to establish a global perspective. (Acar)

IV. Research: It is the way of looking at accumulated facts so that these data become meaningful in the total process of discovering new insights into unsolved problems and revealing new meanings. (Leedy)

V. Validity: It is the degree to which available evidence supports inferences made from scores on selection measure. (Gatewood& Feild)

VI. Success: It is a measure of extent the VT CRC meets its objectives.

VII. Success Criteria: They are measurement criteria for the VT CRC to assess its progress toward its objectives.

VIII. "Communicate:" It is a process of sending selected members of the VT CRC stakeholders the questionnaire and then asking them to respond whether outputs from the methodology should be success criteria for the VT CRC and whether each step in the methodology helps the methodology accomplish its purpose.

IX. Potential tenants: They are those that the VT CRC president and/or director are, at the moment, hoping to bring to the center.

X. Existing tenants: They are those now located in the center.

XI. Research faculty: They are of the larger university, and probably in areas of agriculture, engineering, and science.

Important Processes:

I. Technology Transfer:

- Conduct basic research.
- Conduct applied research.
- Design, develop, and enhance the application of research.
- Conduct testing/evaluation.
- Commercialize research results.

II. Economic Development:

- Acquire and upgrade land.
- Make plots available for building sites or building available for space renting.
- Add services and supporting operation of incubator.
- Attract tenants and develop a critical mass.
- Expand tax base, generate employment and career opportunity. by spinning off new business or expanding existing business.

VITA

Kongkiti Peter Phusavat

Current status:

Graduate student in the Management Systems Engineering program of the Industrial and Systems Engineering Department at Virginia Polytechnic Institute and State University.

Teaching assistant in ISE 5015: Management of Change and Performance in Organizational Systems.

Personal:

Born: July 19, 1968.

Place: Bangkok, Thailand.

Education:

- June 1973- March 1984

  Chulalongkorn University Demonstration School.

  Bangkok, Thailand.

- August 1984- June 1986

  Foothill High School.

  Bakersfield, California, USA.

- September 1986- May 1989

  Bachelor of Science in Industrial Engineering.

  Texas Tech University.

  Lubbock, Texas, USA.

- January 1990- December 1991

  Master of Science in Industrial and Systems Engineering.

  Virginia Polytechnic Institute and State University.

  Blacksburg, Virginia, USA.

Honors:

- Alpha Pi Mu, Industrial Engineering Honor Society, September 1988.
- Tau Beta Phi, Engineering Honor Society, January 1988
- Phi Eta Sigma, Freshman Honor Society, January 1987.
- Dean's List, Fall 1986, Fall 1987, and Spring 1988.

Professional experience:

- August 1989- December 1989

  Esso Standard Thailand Limited, Bangkok, Thailand.

  Purchasing engineer.

Training:

- May 1989- August 1989

  Office of the Eastern Seaboard Development Committee under

  Office of the National Economic and Social Development Board,

  Office of the Prime Minister, Bangkok, Thailand.

Specialization and interest areas:

Measurement for performance improvement, quality and productivity improvement, modeling of management systems, and the system engineering process.

Hobbies:

Tennis, Squash, Racquet Ball, Swimming, Field Hockey, and Soccer.