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MARSHALL SPACE FLIGHT CENTER
THE UNIVERSITY OF ALABAMA

TECHNOLOGY TRANSFER EXTERNAL METRICS, RESEARCH, SUCCESS STORIES, AND PARTICIPATION ON EVALUATION TEAM FOR THE REUSABLE LAUNCH VEHICLE (RLV)

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INTRODUCTION

This research report is divided into four sections. The first section is related to participation on the team that evaluated the proposals for the X - 33 project and the Reusable Launch Vehicle (RLV) during mid-May; prior to beginning the 1996 Summer Faculty Fellowship. The second section discusses the various meetings attended related to the technology evaluation process. The third section is related to various research and evaluation activities engaged in by this researcher. The final section discusses several success stories this researcher aided in preparing.

Despite the fact that this researcher is not an engineer or science faculty, invaluable knowledge and experience have been gained at MSFC. Although related to the previous summer's research, the research has been new, varied, and challenging. This researcher was fortunate to have had maximum interaction with NASA colleague, David Cockrell. It would be a privilege and honor to continue a relationship with the Technology Transfer Office. In addition, we will attempt to aid in the establishment of a continuous formalized relationship between MSFC and Jacksonville State University. Dr. David Watts, Vice President for Academic Affairs, J.S.U., is interested in having the Technology Division cooperating with MSFC in sharing information and working tech transfer inquiries.

The principal benefits gained by this researcher include the opportunity to conduct research in a non-academic, real world environment. In addition, the opportunity to be involved in aiding with the decision process for the choice of the next generation of space transportation system was a once in a lifetime experience. This researcher has gained enhanced respect and understanding of MSFC/NASA staff and facilities.

EVALUATION OF RLV

Prior to the beginning of the 1996 NASA/ASEE Summer Faculty Fellowship this researcher participated on the team evaluating the three proposals for the X-33 project and the Reusable Launch Vehicle (RLV) during mid-May. This researcher was primarily responsible for aiding in the evaluation of the industry business plans submitted by Lockheed Martin, Rockwell, and McDonnell-Douglas.

TECHNOLOGY TRANSFER MEETINGS

This researcher participated in an all-day meeting with representatives from the National Association of Public Administrators (NAPA) on June 19, 1996 related to how tech transfer is conducted at MSFC. The following day a follow-up meeting was held to review, with David Cockrell, William Fieselman and the Auburn University team, the results of the NAPA meeting. Further research and activities were discussed during this meeting; including the analysis of SBIR data and the relationship of the economy's production frontier to job opportunities.

Working with Jeff Cornelius, Fred Schramm and David Cockrell, this researcher helped with proposing a plant visitation with a major appliance manufacturer in Tennessee. Although the technology assistance provided by MSFC was of a sensitive nature, there remains an opportunity to forge a continuing relationship with the research and development department of this appliance manufacturer.

TECHNOLOGY TRANSFER RESEARCH

This researcher prepared a brief analysis and review of an article entitled, "Will Metrics Really Measure Up," by Randy Barrett. The article refers to the problem of gaining a consensus on whether jobs creation is a good measure of technology transfer's success. The author specifically questions the MSFC technology transfer study for extrapolating the gains reported by survey respondents to the total of the participating industrial partners. However, with response rates of between 30 and 50 percent there can be no question that these responses are representative of the entire group of industrial partners. Moreover, non-participants were contacted by phone whenever possible to gain insight into the non-response bias. For instance, gaining further information from those businesses that did not respond answers critics claim that the sample of respondents is not representative.

In addition, a brief analysis was performed comparing the RIMS II approach and Computable General Equilibrium (CGE) model. The working paper entitled, 'The Use of Mulipliers: An Assessment of RIMS II," by Henry Thompson and Clint LeNoir was reviewed. This paper was written in response to a Working Paper, entitled "Measuring the Economic Benefits of Technology Transfer From A National Laboratory: A Primer", by R. B. Archibald, et.al. of the College of William & Mary. The authors of the William & Mary paper advocate the use of the CGE model instead of the RIMS II approach to measuring the impact of technology transfer. Listed briefly below are three major reasons related to the advantages of RIMS II over the CGE model.

(1) National versus Regional Approach - The RIMS II approach, with its emphasis upon the regional impact of effects from technology improvements, is more applicable to essentially smaller enterprises that receive SBIR grants and technology assistance.

(2) CGE Model's Assumptions and Simplifications Reduce Reliability - As with the RIMS II approach, the CGE model is based upon assumptions and simplifications. But, since the CGE model attempts to derive estimates of the impact of economic changes upon the entire economy, it is necessary to make many more assumptions and simplifications leading to gross aggregations of data. The RIMS II approach, on the other hand, being a direct input type approach that considers primarily regional effects, does not need the added complexities of a greatly aggregated model in treating economic improvements.

(3) Adapting CGE Model Expensive/Difficult - It may be possible to adapt the CGE model for the specific purpose of measuring the impact of technology improvements. However, in order to keep the costs of applying the CGE model down, numerous assumptions and simplifications would be necessary. Indeed, the

model would probably have to utilize the estimates of the production function of the RIMS II approach.

Another research project involved describing a simple economic model of the impact on the economy of technological advances by shifting outward the economy's production frontier (see Figure 1). Figure 1 shows a flow chart of a simple model of the economy's production frontier (Yo) in Panel A. The production frontier shows the ability of an economy to produce goods (Go) and services (So) with existing capital (Ko), labor (Lo), and technology (To). The classical economic model assumes both capital and labor are fixed at any given time; and that technology is imbedded in the existing stock of capital and labor. Under these constraints, if the economy wants more goods is must give up some services (see graphic, Panel A). The only way to shift the production frontier outward is to increase capital and labor.

However, we now recognize that technological improvements and innovation need not be imbedded in capital (see Panel B, Figure 1). For instance, the development of a computer program to, say, increase the production flow in a plant, or the order flow, or improve shipping or billing. All of these improvements increase the productivity of existing capital and labor. Therefore, technological improvements are capable of shifting the production frontier outward with existing capital and labor, as well as allowing the production of improved capital.

Panel C, Figure 1 shows the economy with an outward shift in the proauction frontier as a result of, say, technological innovation. Now, with the higher level of the production frontier (Y1), the economy is able to produce more goods (G1) and services (S1). The outward shift in the production frontier increases job opportunities.

MSFC Technology Transfers are contributing to the outward shift of the economy's production frontier. A great preponderance of evidence gathered both by surveying participants in MSFC technology transfer assistance and the SBIR program supports the contention that technology transfer helps industry to improve innovation. This, in turn, enables industry to increase productivity, which allows an increase in the nation's production frontier. Outward shifts in the production frontier increase job opportunities for the Southeast region and the entire economy.

This researcher was also involved in attempting to determine the source of the often quoted ratio of $7 for every $1 spent on R & D. Upon reviewing all available studies, it was determined that there are several studies that are the likely source of the above ratio. The most likely source are two studies by the Midwest Research Institute (MRI) that analyzed the macroeconomics effects of the U.S. space program on technological progress. The study concluded that each dollar spent on NASA R&D resulted in returns of an average of seven dollars in GNP over an eighteen year period following the expenditure (MRI, 1971, 1988).

Upon reviewing the above studies, H.R. Hertzfeld, in his book Measuring Returns to Space Research & Development (1992), questions two major assumptions made in these studies. The first assumption was that NASA R&D was not separated from other R&D in the economy. MRI calculated returns for total R&D (Federal and private), and assumed that space R&D was the same as all other R&D. One could argue the space R&D carries much larger benefits to the economy due to the often "break-through" nature of the research. A second assumption of the MRI study was that R&D has an 18-year lifetime from outlay to terminal value. After 18 years had elapsed in the study, no further returns were measured. Many NASA technologies take a longer period before they reach full commercial potential and impact on the economy. The above assumptions appear to be too conservative, which implies that the ratio for NASA technology transfer may be higher. But, lacking further hard evidence, specific numbers should be avoided.

This researcher recommends that no aggregate figures be quoted, but instead focus on specific examples of successful transfers of NASA technology to the private sector. All that can be said of all the studies reviewed is that the economic benefits far exceed the costs of transferring the technology to the private sector.

A final research activity involved preparation of a description of the statistical techniques used by the U.S. Bureau of Labor Statistics (BLS), Division of Labor Force Statistics in measuring employment in the economy. Based on a brief summary it is determined that the BLS relies on two major surveys to determine the level of employment in the economy. These surveys are the (1) Current Population Survey (Households), and (2) Current Employment Survey (Establishments). These surveys differ in emphasis, i.e. household employment versus establishment employment, measurement techniques, and inclusiveness. Each one provides a monthly estimate of total employment in the economy. By tracking employment over time, these surveys provide a good measure of the general employment trends, especially on a revised quarterly basis.

TECH TRANSFER SUCCESS STORIES

This researcher worked closely with TecMasters, Inc. (William Fieselman) and Louis Galipeau to scan responses received from companies that received MSFC technical assistance for potential success stories. Several firms were contacted to determine the extent of help provided by MSFC, and their willingness to allow us to develop success stories.

Currently, this researcher is working with Bob Lessels to investigate several potential success stories. Listed below are some of these success stories.

(1) Specialty Plastics, Inc., Baton Rouge, LA - MSFC assisting them in developing innovative joining and fitting technologies for advanced composite piping systems for the U.S. offshore oil and gas drilling industry. This story is currently in coordination with the company.

(2) A steel fabricating manufacturer in Alabama - MSFC assisting in solving serious welding problems in the manufacture of stainless steel sheets and trim for major appliances. This story is waiting for further development and verification of the new technology.

The above are on going activities, with results still pending. However, they appear well enough along to indicate successful outcomes. The managers were contacted by this researcher and they appear willing to cooperate with MSFC/Tech Transfer Office in telling their stories.

In addition, this researcher developed a positive success story related to the Tethered Satellite System flight. The story emphasizes the many significant discoveries accomplished by the exploratory experiment. Several suggestions are offered for handling so-called failures as an introduction to the story.

Finally, this researcher developed a success story about the new Pratt & Whitney engine for the Boeing 777. MSFC, in partnership with Pratt & Whitney, helped them to develop a clocking system for the turbine airfoils on the new engine. This improvement in design allows an increase in engine efficiency of a full half-percent. This, in turn, saves fuel making the U.S. less dependent upon imported oil

CONCLUSIONS AND RECOMMENDATIONS:

On the whole all of the activities of the Technology Transfer Office that this researcher has been involved with are carefully planned and efficiently implemented. This Office is serving as a leader in targeted marketing of MSFC capabilities. In addition, this Office is literally breaking new ground in surveying technical assistance partners; and evaluating and analyzing data gathered from the returned questionnaires. Moreover, this Office is taking the lead in surveying and analyzing responses from SBIR's. As with any pioneering effort there are critics and set-backs, but the results will surely satisfy the impartial reviewer. Summarized below are several observations and suggestions for the continued effort.

(1) Continue developing the data base for the SBIR surveys. The Auburn "team," working in conjunction with this Office and TecMasters, Inc. is a good approach.

(2) Continue collecting and refining data collected from the tech-assistance surveys. The data collection process is sound; the use of the RIMS II regional multipliers is appropriate for the task; and the reporting process is conservative but realistic.

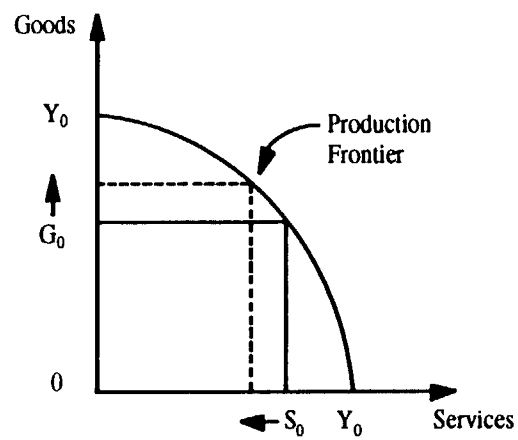
(3) Continue to develop success stories in cooperation with business partners who have been helped by MSFC/NASA technology transfer. Based on this researcher's experience and discussions with Cathy Funston, David Cockrell and William Feiselman, a suggested outline of an approach for identifying and developing success stories is offered (see Table 1).

(4) This researcher will continue to write about tech transfer success stories as they relate to investment opportunities in the weekly column, "Your Investing". Currently, a story on the Lockheed Martin X-33 and RLV is being developed.

Figure 1. FLOW CHART - TECHNOLOGY & PRODUCTION FUNCTION

A

Ability of economy to produce Goods (G) and Services (S) with existing Capital (K), Labor (L), and Technology (T)



If economy wants more G, must give up some S.

Assumes: (Classical Model)
1. **Capital (K), Labor (L) are fixed;**
2. **Technology is inbedded in K and L**
3. **Only way to shift production outward (increase) is to increase K or L.**

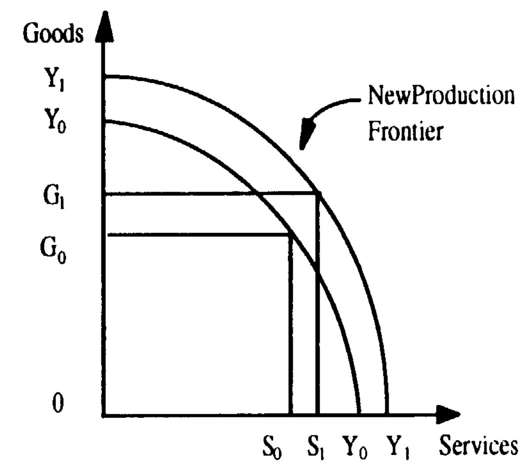
B

Now recognize that technological improvement and innovation need not be inbedded in capital.

For instance:
1. **Development of a computer program to:**
   a. **Increase production flow;**
   b. **Order flow;**
   c. **Billing/shipping**
2. **Technological innovation is capable of:**
   a. **Improving productivity of existing capital and labor, and:**
   b. **Allowing production of improved capital.**
3. **All of these can shift the production frontier outward.**

C

Technical Innovation able to shift the production frontier outward.



1. **Economy can now produce more G and S by increasing the productivity of K and L.**
2. **Outward shift in production frontier increases job opportunities.**
3. **MSFC Technology Transfer is contributing to the outward shift in this production frontier for the Southeast region and the economy.**

Table 1. Suggested Outline of Approach for Identifying and Developing Success Stories

Listed below is a suggested outline for an approach for identifying and developing new technology transfer success stories.

A. Periodic review by TecMasters, Inc. of all returned questionnaires from enterprises receiving technical assistance from MSFC/NASA in the Southeast region to:

1. Identify potential success stories.
2. Identify respondents with unusually large employment or revenues numbers.

B. There is a need to create a position of Success Story Coordinator, who would be responsible for the following.

1. Screening all possible success stories from all sources by verifying:
    a. The nature of the problem worked ,
    b. The extent of MSFC/NASA help in solving the problem,
2. Maintain a time-sensitive matrix of all potential success stories to determine progress, need for further technical assistance, or possible release of the story.
3. Schedule a Quarterly Review Luncheon to be held with Lab POC's to discuss actual or potential success stories.
4. Check to see if there are human interest stories, such as medical developments or environmental benefits.

C. Upon closure of Space Act Agreements and Cooperative Agreements, a summary of potential success stories should be provided by the responsible parties to the Success Story Coordinator.

1. The State Representatives should alert the TAB Board of any potential success stories.
2. The TAB Board should verify and pass along possible success stories to the Success Story Coordinator.
3. Success Story Coordinator should participate in TAB Board meetings.

D. The person devoted to writing success stories should be responsible for:

1. Verifying all information on success stories with success story Success Story Coordinator, the LA Office, the Lab chief, and the customer with appropriate signatures.
2. Writing and publishing the final success stories
3. Publishing success stories in Tech-Tracs.
4. The assistant should be responsible for maintaining a spread sheet record of all success stories submitted for publication by State, SIC code, and topic for easy reference.