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"TECHNOLOGY TRANSFER METRICS: MEASUREMENT AND VERIFICATION OF DATA/REUSABLE LAUNCH VEHICLE BUSINESS ANALYSIS"

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Introduction

Congress and the Executive Branch have mandated that all branches of the Federal Government exert a concentrated effort to transfer appropriate government and government contractor-developed technology to the industrial use in the U.S. economy. For many years, NASA has had a formal technology transfer program to transmit information about new technologies developed for space applications into the industrial or commercial sector. Marshall Space Flight Center (MSFC) has been in the forefront of the development of U.S. industrial assistance programs using technologies developed at the Center.

During 1992-93, MSFC initiated a technology transfer metrics study. The MSFC study was the first of its kind among the various NASA centers. The metrics study is a continuing process, with periodic updates that reflect on-going technology transfer activities.

Body

This researcher, working with NASA colleagues, David Cockrell and Timothy Tyson, has been engaged in a series of projects aimed at both measurement and verification of technology transfer metrics. One of the major tasks in which this research has been involved with is the development of metrics for the Small Business Innovation Research Program (SBIR).

Annually, NASA invites eligible small businesses to submit proposals for its SBIR program. The SBIR program objectives include stimulating technological innovation in the private sector, strengthening the role of small business concerns in meeting Federal (NASA) research and development needs, and increasing the commercial application of federally supported research results.

This researcher was involved in verifying SBIR recipients of MSFC for the years 1989-92 in order to develop a list to be surveyed. A questionnaire was developed in cooperation with Tech-Masters, Inc. (William Fieselman), David Cockrell, and Auburn University (Clint LeNoir, Jr.). The questionnaire is designed to elicit responses from past recipients of SBIR grants regarding the commercial and economic benefits of the research and development activities resulting from the SBIR's. The completed questionnaire was mailed on July 14th (see attached copy).

In developing the SBIR questionnaire, this researcher was part of a team that traveled to Auburn University to meet with Clint LeNoir and his team at the Auburn Technical

Assistance Center on June 13-14, 1995. From a detailed and complicated four-page questionnaire, the teams were able to reduce it to a single page with a cover letter in a very brief period of time.

This researcher also aided in developing an approach to measure the economic benefits of investments made by businesses utilizing NASA/MSFC technology. The original technology transfer metrics did not include benefits that accrued to businesses as a result of investments made. An accepted internal financial management practice generally includes depreciation on investments as part of cash flows (e.g., net income + depreciation). Therefore, once a firm has deducted depreciation from its sales revenue to derive Earning Before Taxes, the firm is able to determine its net income by deducting taxes.

Since depreciation expense can be thought of as a tax savings, managerial finance adds depreciation savings back in to the firm's net income to derive net cash flows from operations. We proposed that using an average allowable depreciation charge, which was determined by polling leading accounting firms regarding the average depreciation taken by its industrial-type clients. The average depreciation charge can then be used to adjust the total investment for business respondents to the NASA survey as follows:

[Total Investment by Firms] [Average Depreciation Percent] = Adjusted Cash Flow.

Suppose the average depreciation taken by industrial firms is 80 percent during the first two years of an investment. If the total investment is $100 million, the following result occurs:

[$100 Million Investment] [.80] = $80 Million Adjusted Cash Flow.

By restating and recalculating the existing collected data in the above manner, it is possible to add many additional "jobs added or jobs saved" to those already calculated as a result of NASA/MSFC technology transfer.

This researcher writes a weekly column entitled "Your Investing" that is distributed by the New York Times regional newspapers wire desk. In addition, the column is internationally syndicated by United Press International. As a result of working with the Technology Transfer Office, a column has been written to appear on September 3, 1993, entitled, "NASA's Technology Transfer Program: Opportunities for Investment" (see attached). Each column will be coordinated with the Technology Transfer Office, MSFC.

In addition to working with external metrics, this researcher also aided in reviewing and suggesting changes to the MSFC Internal Metrics Project. The purpose of the MSFC Internal Metric Project is to develop a set of integrated metrics, which provide

quantifiable measures of MSFC's overall performance with respect to the five strategic goals detailed in the Center's Strategic Plan. The five strategic goals are related to space transportation and propulsion systems, scientific research/payload development, payload integration/operations, research technology and advanced development, and human and physical resources.

Working with a team composed of Larry E. Lechner, Don Whirley, Gene A. Olsen, and Tony Sharpe (Tech-Masters, Inc.), we developed a structure of sub-categories for objectives to measure the effectiveness of NASA/MSFC in meeting goal #1 in space transportation and propulsion systems. Specifically, four overall sets of metrics are set forth to measure safety, reliability, performance, and cost effectiveness for space shuttle main engine, solid rocket motor, solid rocket booster, external tank, and expendable launch vehicle. The overriding focus of this set of metrics is to provide sufficient information to determine both the overall efficiency of MSFC in meeting goal #1 and to provide management with a tool for tracking safety, reliability, performance, schedule, and cost-effectiveness.

This researcher was involved in analyzing and critiquing a draft Working Paper, "Measuring the Economic Benefits of Technology Transfer from a National Laboratory: A Primer," by R. B. Archibald, D. H. Finifter, and N. R. Smith, The College of William and Mary, July, 1995. The fatal flaw in their analysis is the classical assumption of "...technology know-how imbedded in machinery and the minds of the workers are held constant..." (pp. 2-3). This means that technology is frozen in their approach. The whole point of technology transfer is to actively advance technological commercialization so as to impact economic development positively.

The authors of this Working Paper agree that there are two basic outcomes of technology transfer, "...(1) a change in total output produced, and (2) a change in the mix of goods and services produced." (pp. 7-8). Yet, they totally ignore the first to concentrate their analysis on the second. Their conclusions fall directly out of their original assumption of fixed technology and concentrates only on changes in the mix of goods and services. Thus, their conclusion that "...on average technological progress increases the quality of jobs in the economy, not the quantity..." is totally false.

The authors defend their national approach to measurement of economic effects over a regional one, stating the "...defining a region is an arbitrary process..." (p. 16). This may be so, but once one defines a region, it is entirely feasible to develop metrics to measure economic factors within a specific region. Indeed, the U. S. Department of Commerce does this with virtually all of the economic data, including the RIMS II Regional Input-Output Modeling System, which sets forth regional economic multipliers based upon industry SIC codes. ("Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II)," 2nd edition, U. S. Department of Commerce, Bureau of Economic Analysis, Washington, D. C., May, 1994).

various missions of NASA/MSFC has become apparent. In addition, a tremendous respect for the industriousness and dedication of the MSFC fellow staff has been gained.

Based upon limited exposure and experience in the Technology Transfer Office, several observations and/or suggestions are offered:

1. Having reviewed the technology transfer metrics measurement process, it is the view of this researcher that the adoption of the RIMS II economic multiplier used by the U.S. Department of Commerce to be both reasonable and widely accepted. Moreover, use of the RIMS II multipliers allows for easy comparison; thus should be adopted by the other NASA Centers similarly engaged in measurement of the benefits of technology transfer.

2. Regarding the actual application of the multipliers, the suggestion made is to include the value of depreciation in calculating the benefits of investments to both the business enterprise and the economy (see discussion above).

3. Regarding internal metrics, it appears that under the five categories of goals set forth in the overall strategic plan, there are too many strategic objectives specified. Moreover, there are difficulties in adequately measuring and/or generating data to determine if the objectives are being met. For instance, under goal 4, a strategic objective is to be the "agency lead" in promoting the timely introduction/application of scientific research and technology developments. This invites comparison with other Centers and government agencies without providing any means of measurement or comparison. Perhaps this goal could be reworded to read, "Be a leading Agency."

4. In addition, under goal 5, the overall goal is stated to be, "enhancement and sustaining of a highly skilled and motivated work force... supported by first-class facilities, equipment, and services." Who is to determine what is "first-class?" Perhaps this wording could be changed to "...supported by excellent state-of-the-art facilities...." Moreover, what measures are appropriate in determining if the Center has achieved the

reduce jobs but increase output, productivity or efficiency, this is still a benefit. However, as currently counted, it tends to understate the "job creation" measure for the particular business. Suppose a firm installs a new process as a result of technology transfer from MSFC that increases output or productivity by $1 million; but it results in the use of five fewer employees. Using the approach suggested by the RIMS II Regional Multipliers User Handbook, we can derive the following. Suppose each additional $1 million of output from one firm results in the total (all industries) final demand multiplier for employment of 22 new jobs. Therefore, the net effect on all industry employment from one firm's job-reducing innovation is still a net increase of 17 jobs (+22 - 5 = 17).

This researcher will take back to the Jacksonville State University campus many experiences to share with fellow faculty, administrators, and students. As part of the Business Finance Course, numerous examples are given to students from the business world, now NASA/MSFC, examples will be presented ranging from measuring technology transfer to determining the projected cash flows from a future RLV. For instance, whenever capital budgeting for long-term investment by private industry is discussed in Business Finance, this researcher will provide a simplified procedure for estimating the cash flows from a proposed Reusable Launch Vehicle.

Commercial Benefits of the Small Business Innovative Research Program

Company Name: Contact Person:
Address: Phone Number:

SBIR Project Name and Phase:

1. Number of employees in firm: _____ 2. Standard Industrial Classification (SIC) Code |__|__|__|__|

Please answer the following questions about the above listed SBIR project. Your participation in this survey is very important and greatly appreciated.

A. About this SBIR project: (Answer all questions that are appropriate to your firm)

1. Which of the following outcomes resulted from this SBIR project: (Check all that apply)___ a. New product;
_____b. Improved product; ___ c. New process; __ d. Improved process; __ e. New or Improved service _____f. Other

2. What is the direct impact to your firm from this SBIR project (above the value of the SBIR funding provided)?

   a. Revenue or sales: $ _____

   b. Cost savings: $ _____

   c. Number of jobs: # New jobs _____ ; # Saved jobs _____ .

   d. Investment in the firm's operations: $ _____

3. Did this SBIR result in your firm acquiring any of the following? (Check all that apply)
__ a. Patent(s); __ b. Copyright(s); __ c. Licensing agreement(s)

4. Did this SBIR result in your firm "spinning off" another company or division? Yes ____ No ____

5. Would this project have been undertaken without the SBIR program? Yes ____ No ____

B. Indirect effects:

1. Beyond the above direct benefits of this SBIR project, did your firm experience any indirect benefits as a result of this SBIR?
Yes ___, No _____ What kind of indirect benefits? (Check all that apply)
____ a. Investment in new or improved instruments, equipment, or software
____ b. Improved staff training or utilization
____ c. Related product / service development
____ d. Related R & D
____ e. Other (please specify): _____

2. Please estimate the value of the total indirect benefits to your firm resulting from the performance of the SBIR: $_____

3. In addition to your company did the outcomes from this SBIR project result in:
   a. a technology advancement within your industry? Yes ____ No ___
   b. a technology advancement in other industries? Yes ____ No ___

C. Summary:

1. Indicate the amount and source of any additional funding received for this project above the amount of the contract:
Internal Company Funding $_____; External Funding $_____

2. Rate your overall experience with the SBIR program on the following scale:
____ Excellent; ____ Good;_____ Fair; _____Poor.

3. The above company information is considered proprietary and confidential under the B4 exception to the Freedom of Information Act, and therefore cannot be released without permission of the originator. Yes____ Initial _____

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$$$[September 3, 1995][''NASA's Technology Transfer Program: Opportunities for Investment''][Local]

This past summer, this writer had the opportunity to conduct research at NASA/Marshall Space Flight Center, Huntsville, AL. As part of the 1995 NASA Summer Faculty Fellowship Program jointly sponsored by NASA and the University of Alabama, this writer worked on several fascinating projects, including technology transfer.

Technology transfer is the process of moving new technology from government research and development to the private sector to benefit Americans generally, and U.S. businesses specifically. NASA has been actively engaged in technology transfer, virtually from its beginning back in the 1960's. Most people are well aware of numerous technological break-throughs as a direct result of NASA research and development related to the U.S. space program. Such things as miniaturization of computers, Teflon, Velcro, Corning-ware, that we use in our everyday lives, are commercial developments resulting from NASA research.

One of the