

APPENDICES

Appendix A: IMPLAN Background and Methodology

Appendix B: Science, Technology, Engineering, and Math Education Programs at NASA Ames

Appendix C: "IMPLAN Analysis Assumptions"





Appendix A:

Overview of IMPLAN Input-Output Model

IMPLAN Input-Output Model

Regional and national input-output models have been used for years by economists as a tool to understand the extremely complex interactions among the various parts of an economy. There are two basic types of models available to assess the economic impacts of an activity including regional input-output models and customized dynamic econometric models. The economic model used in this analysis, IMPLAN (“IMpact analysis for PLANning”), is a PC-based computer software package that automates the process of developing input-output models for regions within the United States. The IMPLAN model is well respected as the industry standard for projecting economic impacts resulting from existing economic activities or future “events.” In this study, the projected construction budget and operating employment make up the “events” in the IMPLAN model.

What is IMPLAN?

In 1976, the USDA Forest Service in conjunction with the University of Minnesota developed the IMPLAN model in response to the National Forest Management Act, which required the USDA Forest Service to create five-year management plans that estimated the local socio-economic impacts associated with various land use alternatives. In 1988, the University of Minnesota began offering the use of the IMPLAN model to non-Forest Service users. Finally, in 1993, through a technology transfer agreement, the Minnesota IMPLAN Group, a private enterprise, was formed with the purpose of maintaining and distributing the IMPLAN software and databases.

At the heart of the model is a national input-output dollar flow table called the Social Accounting Matrix (SAM). Unlike other static input-output models, which just measure the purchasing relationships between industry and household sectors, SAM also measures the economic relationships between government, industry, and household sectors, allowing IMPLAN to model transfer payments such as unemployment insurance. Thus, for the specified region, the input-output table accounts for all of the dollar flows between the different sectors within the economy.



National Industry Data

The model uses national production functions for 440 industries, including government and households, to determine how an industry spends its operating receipts to produce its commodities. Using construction as an example, IMPLAN uses a production function based on the average national construction firm to determine how a firm in the construction industry¹ spends “each dollar of outlay on goods and services to produce a dollar of output.”² The model also uses a national matrix to determine the byproducts³ that each industry generates. IMPLAN couples the national production functions with a variety of county-level economic data to determine the impacts of the economic “event.”

County-Level Economic Data

To estimate the county-level impacts, IMPLAN combines national industry production functions with county-level economic data. IMPLAN collects data from a variety of economic data sources to generate average output, employment, and productivity for each of the industries in a given county. It also collects data on average prices for all of the goods sold in the local economy. In the case of a county and a regional model, IMPLAN uses average county data to estimate the impacts to the county, and averages all of the economic data across the region’s counties to estimate the impacts to the region. In addition, IMPLAN gathers data on the types and amount of output that each industry generates within the county. This allows the model to determine how much of each production input (i.e. wood, steel, labor, etc. for the construction industry) the firm can buy locally, within the county, or within the region. In the case of labor, the model accounts for county and regional commute patterns, so as not to overestimate the impacts from labor spending its income in the local economy. Finally, the IMPLAN model uses county-level data on the prices of goods and household expenditures to determine the consumption functions of county households and local government, taking into account the availability of each commodity within the specified geography.



Multipliers

IMPLAN combines this data to generate a series of multipliers for the local economy. The multiplier measures the amount of total economic activity that results from an industry (or household) spending an additional dollar in the local economy. IMPLAN uses the national and county-level data to generate type-SAM multipliers, which include the direct, indirect, and induced impacts to the local economy.

- ▶ **Direct Impacts.** Direct impacts refer to the dollar value of economic activity available to circulate through the economy. The direct impacts may equal the operating budget (or revenues) of an industry, or less, depending on several factors. First, the direct impacts do not include payments to capital, inventory, federal taxes, or state and local taxes, as payments of these types do not circulate through the economy.
- ▶ **Indirect Impacts.** The indirect impacts refer to the “inter-industry impacts of the input-output analysis.”⁴ In the construction example this would include payments for construction inputs such as wood, steel, office supplies, and any other non-labor payments that the construction firm would pay in the building process. Indirect impacts vary between the county and region models based on the availability of goods within the two geographies. For example, if the construction firm buys some inputs from a firm in a different county within the region, those expenditures would be represented in the regional model, but not in the county model. As such, the indirect impacts will always be larger for the larger geography (region) that includes the smaller geography (county).
- ▶ **Induced Impacts.** The induced impacts refer to the impacts of household expenditures in the model.⁵ When households earn income, they spend part of that income on goods and services. The model treats households as an “industry” in determining their local expenditure patterns in the model, based on the availability of goods and services within the geography. In the construction example, the induced impacts include the expenditures of construction laborers’ incomes, as well as the expenditures of the incomes of persons who work in industries represented in the indirect impacts. First, the model accounts for local commute patterns in the geography. If 20 percent of construction workers who work in the county live outside of the county, the model will allocate 80 percent of labor’s disposable income into the model to generate induced impacts. In addition, as with industries, the model excludes payments to federal and state taxes and savings based on the geography’s average local tax and savings rates. Thus, only the disposable incomes from local workers’ households are included in the model.



Summarizing the Impacts

Once the model is applied, IMPLAN generates a series of output tables to show the direct, indirect, and induced impacts within each of the model's 440 sectors. IMPLAN generates these tables for two types of impacts: output and employment, defined as follows:

- ▶ Output refers to the total economic value of the project in the local economy.

- ▶ Employment shows the number of employees needed to support the economic activity in the local economy. It should be noted that for annual impacts of ongoing operations, the employment figure shown represents the amount of employment needed to support that activity for a year. Thus, IMPLAN reports the total number of workers required to support the economic activity over the course of a year. In the case of a construction project, IMPLAN reports the number of workers needed to support the economic activity over the life of the project and, thus, it is necessary to divide the total number of employees who would be required to support the project by the estimated duration in years that the project would last. Furthermore, IMPLAN reports the number of jobs based on average output per employee for a given industry within the geography. This is not the same as the number of full-time positions.

¹ An industry consists of businesses that produce goods and services. The goods and services are known as commodities. IMPLAN Pro User's Guide, 2000.

² IMPLAN Pro User's Guide, 2000.

³ The byproducts refer to any secondary commodities that the industry creates.

⁴ IMPLAN Pro User's Guide, 2000.

⁵ Ibid.



Appendix B:

NASA Ames STEM Education Programs

Primary and Secondary Education

NASA Ames operates the following programs focused on primary and secondary STEM education:

Educator Resource Center (ERC).

The ERC allows educators to access a wide variety of NASA resources to develop their own educational programs. The facilities and staff at the center will assist educators in gathering ideas, doing research, and duplicating selections from an outstanding collection of audiovisual and printed materials.

ERC materials reflect NASA research and technology development in such curriculum areas as: Life Science, Physical Science, Astronomy, Energy, Earth Resources, Environment, Mathematics, Geography, and careers in aerospace. Educators in disciplines other than science and mathematics are also encouraged to visit the ERC and explore ways in which aerospace materials may be incorporated into their lessons. The Ames ERC serves educators in the western states: Alaska, Northern California, Hawaii, Idaho, Montana, Nevada, Oregon, Utah, Washington, and Wyoming.

Ames Exploration Encounter.



This NASA Ames-sponsored program offers an interactive science field program to students in the 4th, 5th, and 6th grades. Ames Exploration Encounter provides hands-on education in aeronautics, space science, and space exploration, with an emphasis on role playing in the space station and mission control section. The presentation of basic physics, flight, aircraft design, and wind tunnel testing is designed to stimulate enthusiasm for science, technology, engineering, and math in visiting students and their teachers. This program inspires students to learn more about STEM and intrigues them about the possibility of working for NASA. It has hosted more than 100,000 over the last 17 years.



NASA Digital Learning Network

This program provides interactive educational experiences to students and teachers using state-of-the-art teleconferencing equipment to

- ▶ Foster the effective use of interactive instructional technologies through the delivery of NASA educational content for the benefit of its students and educators;
- ▶ Promote collaborative activities among its member sites in order to optimize learning experiences for its students and educators;
- ▶ Encourage open communication among its member sites so that expectations, limitations, strengths, and weaknesses can be objectively addressed for mutual improvement and positive development;
- ▶ Provide timely responses to internal and external inquiries about technical issues, content development and delivery, and event scheduling;
- ▶ Encourage innovation and experimentation by its member sites with the expectation that instructional integrity is maintained and NASA educational goals and standards are upheld;
- ▶ Strive to reach targeted populations associated with the NASA Explorer Schools Program and other NASA distance learning initiatives that target underserved populations while providing access to appropriately equipped members of the general education community;
- ▶ Participate in the development of an agency-wide infrastructure that makes use of existing and emerging interactive instructional technologies; and contribute to the professional development of internal and external educators through the delivery of face-to-face and distance learning-based events.

NASA INSPIRE.

The Interdisciplinary National Science Project Incorporating Research and Education Experience (INSPIRE) is a multi-tiered, year-round program designed for students in ninth- to 12th -grade who are interested in science, technology, engineering, and mathematics, or STEM, education and careers.

The Online Community (OLC) is INSPIRE's centerpiece that provides a place for INSPIRE students to interact with their peers, NASA experts and education specialists. Through grade-level-appropriate educational activities, chats and the discussion board, students and their families will be exposed to the many careers and opportunities at NASA. The OLC also provides parents resources designed to help them champion their student's education and career goals. To ensure all students have an opportunity to participate in the OLC, those who qualify for the National School Lunch Program are eligible to receive a free laptop. Once accepted into the OLC, students and their parents remain participants of the community through the students' freshmen year of college as long as they stay active participants.

Members of the INSPIRE OLC are given the opportunity to compete for a grade-appropriate summer STEM experience. The summer STEM experience is designed to provide hands-on experiences to investigate education and careers in STEM at a NASA facility or university. All summer experiences, except the collegiate experience, take place at NASA Ames.



Explorer Experience:

INSPIRE OLC participants in the ninth-grade can compete for this summer experience. Students selected receive an expense paid trip for them and an accompanying parent or legal guardian to NASA Ames for a VIP tour and workshop. The visit occurs the summer between their ninth and 10th-grade.

Collegiate Experience:

INSPIRE OLC participants in the 10th-grade can compete for this summer experience. Students participate in a two-week on-campus collegiate experience at a university and are chaperoned by the host institution. This exposure to college life is designed to improve study skills and encourage the pursuit of higher education and careers in STEM areas. The collegiate experience occurs the summer between the students' 10th and 11th-grade.

Residential Internship:

INSPIRE OLC participants in the 11th-grade can compete for this summer experience. Students participate in a paid eight-week apprentice experience with a NASA mentor at NASA Ames.

Collegiate Internship:

INSPIRE OLC participants in the 12th-grade who have been accepted to attend a college or university to pursue a STEM degree can compete for this summer experience. Students participate in a paid eight-week intern experience with a NASA mentor at NASA Ames.

Student Space and Biology Research Program.

This program provides an opportunity for high school seniors to be placed in a research environment at NASA Ames. NASA Ames does not accept applications directly, but solicits nominations of one candidate per school from the local high schools in Santa Clara, San Mateo, Alameda and Contra Costa Counties. This is a volunteer program, and students attend lectures and work six to eight hours per week.

NASA Educator Resource Center Network.

The Educator Resource Center is an initiative that assists educators in the western U.S. in developing their own educational programs through the use of NASA resources. The center provides educators with NASA-related instructional materials suitable for use in the classroom. Resources include: curriculum materials, classroom activities, Internet access, lesson plans, computer programs, videos, 35mm slides and publications. This service helps teachers explore new ideas for curriculum development in areas such as life science, physical science, astronomy, mathematics and the environment. The Educator Resource Center also provides aerospace-related materials that can be incorporated into classroom lesson plans.





SOFIA's Education Program.

The Stratospheric Observatory for Infrared Astronomy (SOFIA) education program includes activities for a wide range of participants, including K-12 students and teachers, textbook authors and curriculum developers, faculty and students in schools of education, and professional societies in science and education. A unique and important element of the SOFIA education program is the teacher flight program. Approximately 200 educators per year have the opportunity to fly aboard SOFIA, NASA's next-generation airborne observatory and interact with working astronomers and see first-hand the process of scientific research.

Industry Initiatives for Science and Math Education.

This program provides opportunities for teachers to gain firsthand experience in industry and research environments by working with professionals in math- and science-related fields in the summer. The program also provides resources and support for teachers to translate their experiences into specific mechanisms for enhancing classroom instruction, career counseling for students and ongoing professional development during the academic year.

Spaceward Bound.

Spaceward Bound trains the next generation of space explorers by having students and teachers explore scientifically interesting -- but remote and extreme -- environments on Earth as analogs for human exploration of the moon and Mars.

Exploration Center.

This is a unique educational program designed to inspire positive attitudes about science, math and technology for all students in the 4th through 6th grade (ages 8-14 for summer months.). Located in a renovated supersonic wind tunnel building at NASA Ames, the Ames Exploration Encounter makes math and science curriculum come alive. Students experience science in action and come to realize its connection to their lives.



Post-Secondary Education

NASA Ames offers an impressive variety of programs targeted to both undergraduate and graduate-level STEM education and research. In addition, NASA Ames has partnered with a number of colleges and universities to provide on-site STEM education and research programs as part of its NASA Research Park initiative.

Education Associates Program.

The Education Associates Program is administered through a cooperative agreement and provides work/study opportunities for university students (enrolled in B.S., M.S., or Ph.D. programs), post-doctoral students, and faculty from any accredited four-year university in the U.S. The program's main objective is to link students and faculty with projects at NASA Ames. The project runs the gambit of NASA's missions—from Space Shuttle to exploring the solar systems, exploring extreme environments on earth, and research aircraft.

Science Teacher and Researcher (STAR) Project.

STAR summer research internship program, establishes a dual professional pathway for secondary school science and mathematics teachers to participate in paid, state-of-the-art research beginning during their pre-service preparation, continuing as part of their initial five years of teaching, and on an ongoing basis thereafter. Participants are engaged in the excitement of scientific research through active experimentation and inquiry and bring this orientation to learning, teaching, and participating in real science into their own classroom.

ARC implements this project in partnership with the California State University (CSU) system.

NASA Academy at Ames for Space Exploration.

The goal of the Academy is to inspire gifted students to become leaders in the aerospace program. Its primary objectives are to:

- ▶ Provide upper level undergraduate/first year graduate students cutting-edge research opportunities with NASA scientists, engineers, and educators,
- ▶ Provide opportunities for leadership development, teamwork, and relationship building,
- ▶ Connect to communities at different places in the educational pipeline through special projects and outreach efforts, especially to under represented student populations, and
- ▶ Link Academy alumni to future hiring opportunities within NASA and throughout the space program.

The NASA Academy program is committed to providing a strong technical foundation through which leadership potential can develop among an academically strong and diverse student population. Upon graduation, students immediately find themselves within a latticed network of support from the NASA Academy Alumni Association (NAAA). This structure helps place the students in positions of employment within NASA and in related industries.



NASA Robotics Academy.

The Robotics Academy is a NASA multi-Center, 10-week residential internship during the summer for undergraduate students specifically interested in robotics. Participants are assigned to a team project developed by NASA, local industry or an academic institution.

Foothill-DeAnza Community College District Internship and Training Programs.

The Foothill-De Anza Internship Program is conducted as a cooperative effort between NASA Ames and the Foothill-De Anza Community College District. These internship positions provide paid work experience for students planning to transfer to four year universities, students new to or preparing for the job market, and students making a career change or reentering the labor force. Students continue to take courses at the college while working 20 hours per week at their NASA Ames job site. During the summer, students work 40 hours per week. Internship positions are available in a wide range of settings, and correspond to almost every college major. Student interns work directly with multimedia specialists, scientists, accountants, psychologists, engineers, administrators, programmers and other professionals as they carry out or support research related to information technology, aviation operation systems, and astrobiology.

Student Career Experience/ Cooperative Education Program (SCEP/COOP).

The SCEP/COOP Program provides paid work experiences for undergraduate and graduate students who attend accredited universities. There are both full-time and part-time SCEP/COOP programs available to meet individual student needs. Students are U.S. citizens at the sophomore, junior, senior levels as well as Masters and PhD students and are studying life sciences, electrical, mechanical, or aerospace engineering; computer science; physics; math; or business administration.

NASA Cooperative Education Program.

The Cooperative Education Program is open to doctoral, graduate and undergraduate students. As co-ops, students alternate semesters at school with semesters at NASA centers. Students work in paid positions directly related to their field of study.

Motivating Undergraduates in Science and Technology (MUST).

MUST awards scholarships and internships to undergraduates pursuing degrees in science, technology, engineering and mathematics, or STEM, fields.



Undergraduate Student Research Program (USRP).

USRP is an on-site mentored research experience. Open to full-time rising undergraduate juniors or seniors, USRP provides challenging 10- to 15-week internships at all NASA centers. Only individuals enrolled in U.S. colleges or universities, who are majoring in engineering, physical/life sciences, mathematics or computer science, with at least a 3.0 grade point average, may apply.

Graduate Student Researchers Program.

The Graduate Student Researchers Program offers competitive fellowships to U.S. citizens who are pursuing graduate degrees at the masters and doctoral levels, at U.S.-accredited colleges and universities in areas of science and engineering that support the NASA research and development mission. The fellowship is renewable annually up to three years, based on satisfactory academic progress. Competitive stipends are provided.

The Harriet G. Jenkins Pre-Doctoral Fellowship Program (JPFP).

JPFP provides financial support for full-time underrepresented graduate students at accredited U.S. colleges and universities in science-, technology-, and education-related disciplines. The program provides financial support for research-based education leading to a doctoral degree in a NASA-related discipline. Each three-year fellowship includes an annual, hands-on research experience.

NASA Postdoctoral Program (NPP).

This program provides talented postdoctoral scientists and engineers with valuable opportunities to engage in ongoing NASA research programs and serves as a source of talent to ensure the continued quality of the NASA research workforce. These one- to three-year Fellowship appointments are competitive and are designed to advance NASA's missions in space science, earth science, aeronautics, space operations, exploration systems, and astrobiology.

University Affiliated Research Center (UARC).

The University Affiliated Research Center (UARC) is a performance-based task order research contract between NASA Ames and the University of California that is managed by the Santa Cruz campus. NASA Ames awarded this contract, reasoning that the UARC, with access to expertise at UC campuses, would do a better job contracting research to UC than by NASA doing so itself. An additional objective in creating the UARC was to foster scientific collaboration between UC faculty and students with NASA Ames scientists.

In 2007, the UARC piloted the Small Spacecraft Summer Project, or S4P. The UARC solicited proposals from University of California scientists to develop a low-cost scientific mission in collaboration with the NASA Ames Small Spacecraft Center—a mission that is relevant to the NASA strategic plan. A national recruitment yielded six talented graduate students, each with unique expertise, who came together for an intensive concept design study led by NASA scientists and engineers.



Systems Teaching Institute (STI).

San Jose State University and University of California, Santa Cruz are partners in the development of the UARC's Systems Teaching Institute (STI). As NASA builds its future workforce, it needs professionally educated scientists and engineers with on-the-job experience akin to what a medical doctor receives in medical school. STI will serve science, technology, engineering and mathematics students as a teaching hospital serves medical students. Students will learn through direct experience on research projects where they examine realistic problems and data. STI will create accomplished new researchers by bringing together curriculum and practice.

STI offers a 10-12 week summer research program for graduate students in fields relevant to NASA Ames research. Selected students will gain hands-on experience working with cutting-edge research and development teams, an increased understanding of the NASA mission, and mentoring in research management skills. Besides working closely with Ames scientists and engineers, students will have the opportunity to attend seminars tailored to their level of expertise, career development workshops, and an end-of-summer symposium where they can share their results with other student interns.

The STI will develop and provide student resources and programs in support of research task orders assigned by NASA Ames Research Center to the UARC. In addition, the STI will provide for educational interaction among university faculty, students and Ames researchers, and work to develop future human resources in technology and science in those areas of particular importance to the NASA Ames mission.

Tribal Colleges and University Project -- Native American Internships (TCU).

This 10-week, summer project provides qualified students with internship opportunities to gain hands-on experience in their NASA-related field of study.

Education Associates Program (EAP).

The Cooperative Space Grant Education Program, sponsored by NASA Ames and developed by the University of California Extension, Santa Cruz links students and faculty with projects at NASA Ames Research Center. Students and faculty members, from undergraduate to post doctoral level, at any accredited U.S. university, may participate as Education Associates (EAs). EAs must be either U.S. citizens or permanent resident aliens. The most relevant backgrounds are in the fields of engineering, information systems and communications, space science, physical sciences, life sciences, behavioral sciences, and mathematics.

National Administrator's Fellowship Program.

NASA Administrator's Fellowship Program is designed to enhance the professional development of faculty at minority institutions, who teach in the fields of Science, Technology, Engineering, and Mathematics (STEM).

Pre-Service Teacher Institute.

This program is designed to increase PreService teachers' skills in teaching mathematics and science while incorporating technology and NASA content to the curriculum.



Appendix C:

IMPLAN Analysis Assumptions



Table III-2. NRP Construction Costs, FY 2009 to FY 2024

Land Use	Square Feet	Cost/Sq. Ft.	Total Cost
Commercial:			
Office/R & D	1,755,000	\$ 432	\$ 758,160,000
Retail	112,800	\$ 400	\$ 45,120,000
Mixed Commercial on McCord	43,400	\$ 400	\$ 17,360,000
Educational and Research Facilities	614,700	\$ 500	\$ 307,350,000
Technical	125,000	\$ 432	\$ 54,000,000
Conference and Training Center	250,000	\$ 390	\$ 97,500,000
Museum	440,000	\$ 300	\$ 132,000,000
Total Commercial	3,340,900		\$1,411,490,000
Residential	1,843,000	\$ 266	\$ 490,238,000
Infrastructure			\$ 139,000,000
Grand Totals	5,183,900		\$2,040,728,000

Note: Costs shown in 2008 dollars.

Source: BAE, 2009.



Table III-4. NRP Employment at Full Operation

Employment Density (Sq. Ft./worker) (a)			
Office	250		
R&D	250		
Education	132		
Retail	500		
Hotel (workers/room) (b)	0.75		
Museum (c)	3,826		
Use	NRP Employment	IMPLAN Sector	
Office	1,090	371	(d)
R&D	3,046	376	(e)
Education	1,956	392	(f)
Retail	312	330	(g)
Hotel	188	411	(h)
Planetary Ventures (office)	4,820	350	(i)
Museum	115	406	(j)
Total	11,527		

- Notes:
- (a) Employment density figures from AECOM.
 - (b) Hotel employment density figure from BKF.
 - (c) Museum employment density figure from Lord Associates.
 - (d) Custom computer programming services. Corresponds to NAICS sector 541511.
 - (e) Scientific research and development services. Corresponds to NAICS sector 5417.
 - (f) Junior colleges, colleges, universities, and professional schools. Corresponds to NAICS sectors 6112-3.
 - (g) Miscellaneous retail.
 - (h) Hotels and motels. Corresponds to NAICS sectors 72111-2.
 - (i) Data processing, hosting, ISP, and web search portals. Corresponds to NAICS sector 518112, which includes web search portals.
 - (j) Museums, historical sites, zoos, and parks. Corresponds to NAICS sector 712.

Sources: IMPLAN; NAICS 2007; AECOM; BAE, 2009.

