Final Project Report

Staff Exchange with Spokane Intercollegiate Research and Technology Institute (SIRTI)

G. M. Alexander

December 1994

Prepared for
U.S. Department of Energy
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Pacific Northwest Laboratory
Richland, Washington 99352

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Transfer of PNL Strategic Planning and Defense Expertise to Spokane Intercollegiate Research and Technology Institute Initiative to Develop Strategic Plans for SIRTl's Defense Grant

Staff exchanges, such as the one described in this report, are intended to facilitate communication and collaboration among scientists and engineers at Department of Energy (DOE) laboratories, in U.S. industry, and academia. Funding support for these exchanges is provided by the DOE, Office of Energy Research, Laboratory Technology Transfer Program. Funding levels for each exchange typically range from \$20,000 to \$40,000. The exchanges offer the opportunity for the laboratories to transfer technology and expertise to industry, gain a perspective on industry's problems, and develop the basis for further cooperative efforts through Cooperative Research and Development Agreements (CRADAs) or other mechanisms.

Purpose/Objective

The objective of this staff exchange was to participate in the development and organization of the Spokane Intercollegiate Research and Technology Institute (SIRTl) and its programs. The specific objectives were as follows:

- develop strategic plans for SIRTl to organize into three centers: a manufacturing technology center, an environmental quality center, and a biomedical center
- develop a program and a proposal acceptable to the Department of Defense's Advanced Research Projects Agency (ARPA) that will result in the \$15 million Defense Grant already earmarked for SIRTl being implemented
- establish under SIRTl an Export Product Modification Center
- develop research projects to assist industry under SIRTl that will serve SIRTl's needs and be of interest to ARPA.

Pacific Northwest Laboratory's (PNL's) extensive expertise in strategic planning and operations research filled voids in SIRTl's capabilities. PNL's understanding of DoD requirements and experience in working with DoD was a major assist to the successful establishment of SIRTl as a viable force in the economy of the Pacific Northwest.

Summary of Activities Performed

The Staff Exchange Program between PNL and SIRTl began in October 1993. It was a follow-on effort to previous support provided by PNL to SIRTl. It involved assisting SIRTl with organizing their program to meet the requirements of ARPA.

The staff exchange of George M. Alexander, with assistance from Patricia Godoy-Kain, both of PNL to SIRTl occurred during six weeks from mid-October 1993 through 13 December 1993. During the program, Mr. Alexander met with SIRTl personnel, experts in manufacturing technology centers, biomedical researchers, and environmental specialists. Mr. Alexander worked with SIRTl to develop a strategic plan, an implementation plan, and a proposal to ARPA over the six weeks. These were submitted to ARPA on 13 December 1993. In addition, Ms. Godoy-Kain met with officials from the International Trade Administration regarding the establishment of an Export Product Modification Center.

As part of the staff exchange Mr. Alexander met with officials at the University of Maryland to gather lessons learned from their manufacturing technology center. They have been in operation since 1982. Appendix A includes a description of their manufacturing technology extension service, their technology advancement program, and their technology initiatives program. These programs offer the kind of services that SIRTl would like to offer under their Northwest Manufacturing Technology Center concept.

Significant Accomplishments

The staff exchange of Mr. Alexander of PNL to SIRTl promoted significant interaction among SIRTl, PNL, ARPA, and local industry.

The first objective of developing strategic plans for SIRTl's three centers is tied to the second objective of creating the program and proposal for ARPA. The plans became a part of the proposal. In developing the strategic plan for the manufacturing center, PNL developed a manufacturing study. Appendix B includes a copy of the report PNL prepared for SIRTl to assist in creation of their manufacturing technology center. PNL also developed a SIRTl Implementation Plan, as a part of the ARPA proposal, which can be found in Appendix C. The proposal to ARPA was the central piece of work with which Mr. Alexander assisted. The executive summary of the proposal is attached as Appendix D. The items in these three appendixes met the first two objectives.

Most important of all was the successful conclusion of PNL's support to SIRTl with the announcement by ARPA of the awarding of a \$15 million grant to SIRTl to move forward with its work. A copy of that announcement can be found in Appendix E.

Work also progressed on the establishment of an Export Product Modification Center. Ms. Godoy-Kain attended meetings in Richland and Seattle, Washington, with representatives of the International Trade Administration of the Department of Commerce. While work continues on establishment of an Export Product Modification Center, the objective was met.

Finally, the last objective calls for significant research projects to be developed for SIRTl. Several ideas have been advanced. Mr. Alexander developed a SIRTl Project Management Plan for Radiology Artificial Neural Network (RADANN) in substantial detail. The plan can be found in Appendix F. RADANN is moving forward as a project under SIRTl's Center for Biomedical Technology. The

Department of Defense is particularly interested (Army and Air Force), as is ARPA. This is a dual use technology project. It is based on a PNL system developed for main battle tanks and is now being modified for civilian medical applications.

Significant Problems

No problems occurred during the staff exchange. PNL and SIRTl freely exchanged information. In the future, however, SIRTl would like PNL personnel to sign "Non-Disclosure Agreements" if we do work with them.

Industry Benefits Realized

Although no direct industry benefits were realized during the exchange, it is believed that the relationship between SIRTl and PNL developed through the exchange offers substantial potential to assist industry in the future. SIRTl now has significant funding, and linkages with PNL will enable in-depth technical expertise to be used to assist small and medium-sized manufacturers in the Pacific Northwest. PNL will also be able to assist in the environmental and biomedical centers.

Recommended Follow-On Work

The most important recommendation for follow-on work resulting from the staff exchange is that a memorandum of understanding should be put in place between SIRTl and PNL. This should address how PNL and SIRTl will work with the member colleges and universities and how PNL will price its services for SIRTl. It will also address SIRTl's role as a go-between with manufacturers and a funding source for projects. Finally, it will address linkages with SIRTl that will be used to identify opportunities for CRADAs and other joint projects between PNL and small and medium-sized manufacturers in the Pacific Northwest.

Potential Benefits from Follow-On Work

SIRTl has an important role to play in helping the economy of the Pacific Northwest region. SIRTl can be instrumental in harnessing the inventive energy of the public and private sectors to make sustainable economic development part of the Pacific Northwest's agenda. Pacific Northwest Laboratory can provide strong technical assistance to help SIRTl play its roles successfully.

Appendix A

**University of Maryland
Engineering Research Center**

UNIVERSITY OF MARYLAND

ENGINEERING RESEARCH CENTER

*Forging New Links Between Industry
and the University*

AN INVITATION TO INDUSTRY

The Engineering Research Center extends an invitation to industry to join with the University of Maryland in advancing toward new levels of excellence in engineering and science. Industry is encouraged to draw on the expertise of the faculty and staff, to utilize the capabilities of unique advanced research and

measurement laboratories and to share in a wealth of knowledge available in the classroom and other instructional programs. Through collaborative efforts we can do more to meet industry needs, contribute to economic development and growth in the state and the nation and strengthen the University as a vital and contributing institution.

Industrial relationships have always been important to the growth and quality of scientific and technical programs at the University of Maryland. The Engineering Research Center, through its programs, provides a variety of options for mutually beneficial ties between the business community and the University. Industry-university collaboration is even more important now, as industry faces ever increasing competitive challenges and universities seek to provide quality education and to conduct state-of-the-art research to keep our industry competitive.

The programs described in this brochure address this need with activities ranging from research partnerships to technical and business assistance for start-up companies. We invite industry to participate in these programs, and we welcome inquiries and proposals for working together.

Herbert Rabin
Director, Engineering Research Center

TECHNOLOGY FOR INDUSTRIAL COMPETITIVENESS

The Engineering Research Center (ERC) was established in 1984 to promote interaction in engineering and science between the University of Maryland and the business and industrial community. The ERC addresses the needs of technology-oriented companies in Maryland and forms relationships with industry on a national and international level as well.

Industry and the University benefit from this association. The ERC draws on the resources of the University of Maryland System's eleven campuses and helps industry gain access to the expertise within the many departments, institutes and centers. Collaborative projects with industry give students and faculty direct experience solving industry's problems. These interactions help the University to strengthen its educational programs and research capabilities to meet the present and future needs of industry.

ERC programs include technical assistance, support for technically oriented start-up firms, research consortia, seminars in technical fields of current interest to industry and other activities to promote the transfer of technology to industry.

Programs

The Engineering Research Center conducts four principal programs of industry/University cooperation:

TES **Technology Extension Service (TES)**—provides on-site technical assistance to companies throughout Maryland.

TAP **Technology Advancement Program (TAP)**—provides business and technical support for start-up firms.

TIP **Technology Initiatives Program (TIP)**—promotes development of research capabilities within the University in technical areas of importance to industry.

MIPS **Maryland Industrial Partnerships (MIPS)**—establishes cooperative research projects between industry and the University.

The ERC also sponsors a student employment program: the **Summer Undergraduate Employment Program (SUEP)**, which provides Maryland employers with a pool of talented students seeking summer employment in technical fields.

TECHNOLOGY EXTENSION SERVICE

Technical Assistance for Maryland Firms

The Engineering Research Center's principal program for extending the University's expertise directly to Maryland industry is the Technology Extension Service (TES). Operating from five regional offices throughout the State, TES's staff of experienced engineers offers free on-site technical assistance to Maryland companies. They arrange for the participation of University faculty and staff as required by the needs of the companies.

The TES role in working with individual companies is to disseminate information, to help identify and solve critical short-term problems, to provide guidance and orientation in developing solutions to long-term problems and to serve as a point of contact with other ERC programs and the University faculty and staff. TES sponsors industrial forums and other educational activities that draw on University resources.

TES also provides connections to Federal laboratory technologies of benefit to business and industry.

To obtain TES assistance for your business, contact the State Director or your regional office.

TES STATE OFFICE

Director, Technology Extension Service
Engineering Research Center
University of Maryland
Stadium Drive Building #092
College Park, Maryland 20742
Phone: (301) 405-3883
Toll Free: 1-800-245-5810

TES FEDERAL TECHNOLOGY TRANSFER OFFICE

Mid-Atlantic Technology Applications Center
Liaison
College Park, Maryland
Phone: (301) 405-3814

NORTHERN REGIONAL OFFICE

Baltimore, Maryland
Phone: (410) 706-3233
Serves: Baltimore City Cecil County
Baltimore County Harford County

CENTRAL REGIONAL OFFICE

Rockville, Maryland
Phone: (301) 738-6028
Serves: Carroll County Howard County
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Phone: (410) 476-5476 or (410) 651-6472
Serves: Caroline County Somerset County
Dorchester County Talbot County
Kent County Wicomico County
Queen Anne's County Worcester County

TECHNOLOGY ADVANCEMENT PROGRAM

An Incubator for Technology Based Start-up Companies

The Technology Advancement Program (TAP) is a small business "incubator" facility offering shared services, space and assistance to start-up companies engaged in the development of technology-oriented products or services.

TAP's technical and business support services reduce overhead and other start-up obligations for a company, allowing concentration of its limited resources on developing and commercializing new products and services. TAP participating firms enjoy the additional advantages of the stimulating intellectual environment that comes with a university affiliation. TAP's network of motivated entrepreneurs learn from each other and develop mutually beneficial business arrangements.

The program provides low cost furnished operating space, shared secretarial-reception services and use of conference rooms. TAP services include a small business reference library; use of copiers, computers, telefax and other office equipment; and access to the University's extensive libraries, computer resources, state-of-the-art laboratories and machine shops.

TECHNOLOGY INITIATIVES PROGRAM

Resources for Industry Oriented Research

TAP participants benefit from the availability of faculty and staff expertise in engineering, science and business. Undergraduate and graduate students provide an excellent source of part-time talent to supplement these companies' employees.

TAP works closely with the College of Business and Management and its Dingman Center for Entrepreneurship. Through the University of Maryland Law School's Entrepreneurship Law Program, affordable legal representation may be provided to TAP Companies by major full-service law firms.

For more information about TAP, contact:

Technology Advancement Program
Engineering Research Center-Bldg. 335
University of Maryland
College Park, Maryland 20742
Phone: (301) 314-7803

The Technology Initiatives Program (TIP) supports laboratories and facilities, centers of excellence and research projects of importance to industry. These activities supplement the University's existing research and educational programs in advanced engineering.

Technical Disciplines

The Technology Initiatives Program staff consists of technical specialists who help guide the development of advanced University research capabilities and state-of-the-art facilities. TIP managers actively maintain contact with industry in their fields. They represent the following programs:

- Computer-Aided Design
- Biotechnology
- Electronics
- Composite Materials Technology
- Manufacturing Technology
- Computer Engineering
- Reliability Engineering
- Computer Aided Life Cycle Engineering

The ERC supports additional programs, facilities and research in various disciplines, including the following:

- Computer Software
- Very Large Scale Integrated Circuit Design
- Laser Technology
- Combustion Engineering
- Energy Engineering

The Engineering Research Center is continuously expanding its support of emerging technologies. For information about other specific areas of interest, please contact us.

The following laboratories and programs have received special support:

Computer-Aided Design **CAD**

In cooperation with the Departments of Mechanical, Civil and Aerospace Engineering, the Engineering Research Center established a CAD Laboratory to promote research, development and education in computer-aided design, a field of growing importance in today's technological and economic environment.

Computer-aided design has a profound influence on the productivity, quality and competitive position of business and industry. The CAD Laboratory provides a vehicle for further advances in revolutionizing the design process.

In addition to research, another key element of the CAD Laboratory involves hands-on workshops and pilot projects aimed at helping the industrial community to use CAD technologies.

Bioprocess Scale-up Facility **BSF**

To serve the needs of both the University and the growing number of biotechnology companies in the region, the Engineering Research Center, in cooperation with the Department of Chemical Engineering, established the Bioprocess Scale-up Facility (BSF). Use of the facility focuses on developing and evaluating technologies for process scale-up and for separation and purification of bioproducts.

The capital investment in equipment and support systems of the biotechnology industry can be very costly. Many companies working with small volumes of raw materials are limited in the amount of product they can generate for analysis, functional testing and pre-clinical trials. With the BSF, companies can bring bioproducts up to mass production quantities, refining the process for industrial applications. This program allows University and

industry researchers to assess the feasibility and economics of alternative bioprocess strategies with state-of-the-art equipment and software.

Communications and Signal Processing **CSPL**

The Communications and Signal Processing Laboratory (CSPL) provides the experimental vehicle for studying the design and performance of complex communications problems with dedicated facilities for real-time data acquisition, data compression and

image and speech processing. The CSPL, established as a joint undertaking between the Engineering Research Center and the Department of Electrical Engineering, has broad experimental capabilities for studies of digital signal processing, simulation and algorithm development. By collaborating with the micro-electronics program and using a satellite earth station, the lab can undertake complete end-to-end analyses and studies. The lab also offers educational seminars and workshops to the industrial community on communications, signal processing and related subjects.

Manufacturing Technology

The Engineering Research Center's Manufacturing Technology program promotes research and education in areas of industrial production, design and manufacturing techniques incorporating the most up-to-date concepts in computer integrated manufacturing and design. Key areas of study within the program include smart production processes, automation of assembly and manufacturing processes, development of knowledge-based expert systems for the integration of design and manufacturing, product and process design and redesign, and the analysis and review of designs. These activities are conducted jointly with the Department of Mechanical Engineering.

Composites Research (CORE)

New composite materials, having unique characteristics of high strength, rigidity and low weight,

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Composites Research (CORE)

New composite materials, having unique characteristics of high strength, rigidity and low weight,

are finding applications in a wide variety of products and industries. Aircraft components and other structural components are designed, fabricated and analyzed using equipment in the Composites Research Laboratory. This laboratory, a joint endeavor of the Department of Aerospace Engineering and the Engineering Research Center, benefits industry by serving as a resource for conducting research projects and by enhancing the educational curriculum at the University. State-of-the-art facilities are available for fabrication, machining, testing, inspection, conditioning and analysis of composites.

CALCE Electronic Packaging Research Center

The Computer Aided Life Cycle Engineering (CALCE) research effort focuses on the design of reliable electronic products and complex systems. A well-designed product must simultaneously satisfy performance requirements, reliability, availability, maintainability, supportability, producibility and cost criteria. To be effective, this unified life cycle engineering approach to design must provide: efficient interaction among design disciplines, optimization among competing design goals, state-of-the-art design and analysis tools and decision support for the design engineer.

Emphasis is on the establishment of a software environment that integrates all aspects of the design process. Specific design issues, including electrical, thermal and mechanical effects which determine product reliability, are treated as parts of a coherent whole. The CALCE Center includes electrical, mechanical, chemical and reliability engineers and computer scientists who form an interdisciplinary team of experts devoted to the integration of life cycle engineering criteria into an effective, efficient design process.

For information on these technology initiatives, call (301) 405-3906.

MARYLAND INDUSTRIAL PARTNERSHIPS

Matching Grants for University-based Research

The Maryland Industrial Partnerships (MIPS) program provides matching funds for joint industry/University research and development projects that have potential to stimulate the growth of industry in Maryland.

MIPS matching funds are awarded on a competitive basis to companies with operations in Maryland. Projects are carried out by faculty members at any of the eleven University of Maryland System campuses.

The participating company makes a matching contribution of cash and in-kind services, with the matching percentage varying for start-up, small and large firms.

All types of manufacturing and service firms are invited to participate in the program. Eligible research areas are engineering, computer technology, physical sciences and life sciences.

Projects involving the development of a technical education or training program, proposed by a business or other organization in conjunction with a University faculty member, are also eligible for MIPS matching grants.

Technical experts on staff at the Engineering Research Center help match companies with faculty researchers. The company and faculty member jointly submit their proposal.

Projects are selected for funding on the basis of economic benefit potential and technical soundness.

MIPS accepts applications twice a year. For more information about MIPS, write or call:

Maryland Industrial Partnerships
Engineering Research Center
University of Maryland
Stadium Drive Building #092
College Park, Maryland 20742-3415
Phone: (301) 405-3891

The Engineering Research Center makes referrals for additional services and sources of assistance within the University and in other organizations both private and public.

Inquiries from the business and industrial community are welcome. For more information about the Center, its programs and its network of resources, contact:

Engineering Research Center
University of Maryland
College Park, Maryland 20742
(301) 405-3906

ENGINEERING RESEARCH CENTER

College of Engineering
University of Maryland
College Park, Maryland 20742
(301) 405-3906

Appendix B

Copy of Pacific Northwest Laboratory Report to SIRT

**PRELIMINARY
PLAN TO SUPPORT AREA MANUFACTURING COMPETITIVENESS**

developed for

**Spokane Intercollegiate
Research & Technology Institute
(SIRTI)
Spokane, Washington**

prepared by

**Pacific Northwest Laboratory
Richland, Washington**

November 30, 1993

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1.0 Background / Introduction

The Spokane Intercollegiate Research and Technology Institute (SIRTI) is a consortium of five Inland Northwest institutions of higher learning fostering cooperative efforts with industry in applied research, technology transfer, and education. The five member institutions are:

- Washington State University
- Eastern Washington University
- Gonzaga University
- Whitworth College
- Community Colleges of Spokane.

In addition, partnerships with the International Environmental Institute (IEI) for the Westinghouse Hanford Company and with the Battelle Pacific Northwest Laboratories, both of the Tri-Cities, Washington area, extends SIRTI's activities in environmental and manufacturing technologies.

The overall role of SIRTI is to link the resources of higher education members and other partners with the needs of business and industry. The specific objective is to enhance the industrial base and economic vitality of the Spokane area and Inland Northwest region, and to improve their competitiveness in an emerging global economy.

The Inland Northwest area has over 1.6 million in population and is an area of about 80,000 square miles which includes Eastern Washington, Northern Idaho, Northern Oregon, and Western Montana. It is estimated, using 1990 data, that this region has approximately 9,000 retail establishments and more than 2,500 manufacturing companies. About 13% of the labor force is estimated to be in manufacturing. [NOTE: This information was extracted from SIRTI's proposal to NIST for a Northwest Manufacturing Technology Center, dated April 10, 1992.]

SIRTI programs and support activities are emphasizing three primary thrusts:

- manufacturing
- the environment
- biotechnology.

This specific plan, however, is limited to the manufacturing thrust. The next section of this preliminary plan outlines its purpose and other related issues.

2.0 Purpose of Plan

The purpose of this plan is to provide a **preliminary** roadmap on the basic steps and critical actions needed to leverage SIRT's resources and partnerships into an effective support function for the area's manufacturing base, meeting SIRT's overall objectives on economic growth of the area served.

Although the major steps and pertinent points suggested in this plan cover the needed action, additional sub-tasks as well as the degree of alternatives to be explored are likely to require refinements to this plan.

This plan also does not specifically itemize the costs and support budget necessary for the plan's implementation, but it is assumed that this plan will allow that refinement in its early implementation, or can be used as the basis for estimates.

3.0 SIRTI Role and Mission for Manufacturing Thrust

As alluded to in Section 1.0, SIRTI's role and mission is to conduct, facilitate, and coordinate applied research, technology transfer, and education programs to enhance the economic development of the region through:

- education and training to develop a skilled, adaptable and motivated workforce
- applied research, product development, technology deployment and diffusion to enhance the competitive edge of businesses and industries
- technical and business assistance to establish and support an entrepreneurial climate
- networking of systems to optimize the availability and use of information resources.

The role and mission of SIRTI for its manufacturing thrust, then, is to conduct, facilitate, and coordinate applied research, technology transfer, and education programs that improve competitiveness of manufacturers and "like-manufacturers" located in the Spokane area, the Inland Northwest region, and eventually the entire Northwestern U.S. such that the overall economic growth of the geographic areas served can be supported and sustained.

"Like-manufacturers" are companies that are traditionally not classified as a manufacturer but indeed add value to a process that produces some kind of tangible product. A software developer that provides a completed product (diskettes, manual, package) is an example. Value-added retailers who re-configure equipment and add unique combinations of options or software would also be "like-manufacturers." And distributors who kit various combinations of offerings dependent on the customer orders can also be categorized as "like-manufacturers."

Categories of services for the manufacturing / like-manufacturing thrust include:

- Education / Training Programs
- Simulation Capabilities
- Demonstration Capabilities
- Field Support
- Information Support.

Brief descriptions of these categories are in the paragraphs that follow.

3.0 SIRTI Role and Mission for Manufacturing Thrust, cont.

Education / Training Programs

This category includes seminars, workshops, and most importantly, hands-on training activities.

Simulation Capabilities

Tools and services for electronic mockups of products and computer simulations of production processes would be included in this category.

Demonstration Capabilities

Utilizing physical demonstration "laboratory" facilities, properly equipped, physical prototyping of new products, new or specially upgraded equipment, or customized configurations of standard equipment could be demonstrated and evaluated. Incubation cubicles for new businesses could also be included.

Field Support

Assessments by experienced professionals to help manufacturers determine where they are, where they need to be, and assistance in identifying and implementing the ways to get there are examples of the field support services. Unbiased, professional advice can accelerate results and avoid costly errors when applied properly.

Information Support

Access to information networks and other databases to assist manufacturers in finding and evaluating information on, for example,

- capabilities and comparisons on commercially available equipment
- functionality and comparisons on commercially available manufacturing application software
- profiles on potential new suppliers
- market / customer profiles
- new technologies and their potential application.

The underlying emphasis in all these services is to assist manufacturers and qualifying like-manufacturers in identifying and implementing existing technology and methodology (rather than developing new technology and methodology) that will improve their competitive position and favorably impact the overall economic growth of the region.

All services, of course, need to be tailored to the needs of the manufacturing base in the regions served. Those needs are outlined in the next section.

4.0 General Needs of Manufacturers in Region

Based on research previously completed by the SIRTl staff [Same reference as noted on page 1], the Inland Northwest is a major transportation and inland distribution center for Northwest U.S. and is located on the main transcontinental line of Burlington Northern and Union Pacific Railways as well as AMTRAK. Key estimates and other data about the region include:

- 1.6 million population
- 80,000 sq. miles (Eastern Washington, Northern Idaho, Northern Oregon, Western Montana)
- 9,000 retail establishments
- 2,500 manufacturing firms
- 13% of employment in manufacturing
- 27% of employment in trade-related activities.

The overall manufacturing base (2,500 firms) in the Inland Northwest is comprised of the following:

		<u>% with < 100 employees</u>
● 30% - Food & related products	(SIC 20)	85%
● 26% - Plastics	(SIC 28, 30)	94%
● 11% - Wood and related products	(SIC 24, 26, 27)	80%
● 4% - Metals, equipt. & machinery	(SIC 33-38)	88%
● 29% - all others.		

Industries in the area which have matured and are facing major restructuring needs include:

- lumber and wood products
- primary metals
- transportation equipment.

The limited resources of **very small** manufacturers (less than 100 employees) and **small** manufacturers (100 - 500 employees) typically creates a burden in responding to the ever-changing, intensely competitive, global marketplace. The challenge for SIRTl is to meet the area and regional needs with services that indeed can be leveraged into enhanced competitiveness earmarked for the very small and small manufacturer but also useful for the rest of the manufacturing base, resulting then in economic growth for that area.

In 1989, Eastern Washington University conducted a survey of business and industry in the Spokane area to help SIRTl focus its intended services. Four categories were surveyed. The categories and the top four choices for each are itemized on the next page.

4.0 General Needs of Manufacturers in Region, cont.

Results of 1989 needs survey:

- Business Resource
 1. Provide access to new equipment, technology, and applications
 2. Provide technical consultation
 3. Develop a mentor program and/or network advisory service to emerging entrepreneurs, inventors, researchers, and small business
 4. Recruit research and development units to locate in Spokane.

- Education and Training
 1. Offer continuing education programs with timely topics for variety of disciplines geared toward practical application
 2. Offer seminars in APICS concepts, MRPII principles, AME concepts, and Operations Analysis
 3. Offer continuing education program in Statistical Process Control
 - (tie) 4. Offer M.S. degrees in Engineering
(Chemical, Civil, Electrical, Mechanical, and Management)
 - (tie) 4. Offer M.S. degrees in Computer Science and related technologies.

- Information and Networking
 1. Facilitate ideas exchange between researchers and entrepreneurs
 2. Provide computer interface to various databases such as U of I Patent Services Library, Medlars, Hanford, Information Services Corp. and other electronic libraries
 3. Provide a database on state of the art technologies
 4. Provide a network to include global information on applied research.

- Research and Product Development
 1. Provide "think tank" for business development and scientific research
 2. Protect proprietary information
 3. Assist in getting new products to market, from development to production
 4. Identify new products and needs through research.

4.0 General Needs of Manufacturers in Region, cont.

This list, except perhaps for "protecting proprietary information" and providing M.S. degrees, does correspond reasonably well to the five services listed on page 3 and described on page 4. In other words, the services listed should meet area needs when the particulars are adequately tailored to the specific industries being served.

One service, **field support**, is an excellent candidate for implementation with quick, tangible results and several existing successful extension service models to learn from. For example, from page 178 of the comprehensive 1990 study by the Office of Technology Assessment (OTA) entitled Making Things Better: Competing in Manufacturing it was stated that:

What small manufacturers need more than the newest technologies fresh out of the laboratory is off-the-shelf hardware and software and individual help in choosing and managing them. They need advice on these choices from an independent source with no financial stake in the selection. And they need to understand how much training is involved in adopting new equipment and where to get it. These conclusions are drawn from the experience of people involved in technology extension, both the agents providing the services and the firms receiving them.

The OTA visited and interviewed five State industrial extension programs (Georgia, Maryland, Michigan, and 2 in Pennsylvania) and found that the programs were serving genuine needs that were not otherwise being met and that demand for the services was high. So high for Georgia and Maryland, for example, that they did not advertise for fear of being swamped with requests for assistance. For the year reviewed, an average of about 450 companies were served for each program with a low of 40 and a high of 960.

With effective selection of technical consultants and training specialists from the member institutions and the affiliated partner organizations, field support services should be able to be provided early in the implementation of this plan and help promote expansion of overall services with the manufacturing and like-manufacturing base.

Furthermore, the particular services to be offered by SIRTl are applicable to U.S. manufacturing needs in general. Five such general needs are described in the next paragraphs and were originally defined by the Department of Defense Manufacturing Technology (ManTech) Advisory Group in 1993 as 5 of their 7 major thrusts.

4.0 General Needs of Manufacturers in Region, cont.

DoD ManTech Major Thrusts applicable to industry:

Concurrent Engineering (CE)

CE refers to the concurrent design of a product, manufacturing facilities, production processes and tooling, used to produce that design, including the support processes to be employed once the product is in full production. Functions included are production management approaches, support processes, product design/analysis techniques, the supplier chain as partners in the design and manufacturing activities, the manufacturing engineering, tooling and quality functions appropriate to all stages in the product design process, rapid technology insertion, and the information systems supporting the entire process. Benefits include more rapid product introductions at lower cost.

Enterprise Integration

This need refers to the technical and non-technical activities and capabilities that will enable the extended business entity to perform its functions more efficiently. Extended business entity includes its horizontal and vertical partners, and its customers. The activities and capabilities will impact business and technical process understanding and simplification, straightforward integration of information systems from multiple vendors, and the information systems capabilities which enable them.

Manufacturing Management Systems

This refers to actions which streamline, automate, and integrate a company's manufacturing management. Aspects of manufacturing engineering, quality assurance, design engineering, information management, facilities management, personnel management, and accounting and finance as well as production management are addressed. In comparison to enterprise integration, manufacturing management systems focuses on manufacturing operations within an enterprise, while enterprise integration focuses on relationships between businesses.

Customer - Supplier Relationships (C-SR)

This refers to all activities between a customer and its supplier chain. For product development, pertinent information such as market analysis, design evaluation, technological assessment, and producibility analyses should be shared among customers and their suppliers. In actual production, C-SR includes sharing of production and manufacturing information, coordinated inventory and raw material delivery policies, coordinated quality management and quality control practices, and coordinated planning and control activities.

4.0 General Needs of Manufacturers in Region, cont.

Quality Management (QM)

QM refers to all management and technical activities and processes of the company which affect product quality. It includes all quality-related activities at all stages of product design, development, and manufacturing. It also includes such activities as management philosophies, interfacing with shop floor processes, data archiving, product design involvement (as in CE) and supplier relationships.

The above five needs were categorized to help improve the competitive aspects of the industries that are part of the defense prime contractors, 2nd tier and 3rd tier supplier network. It has, of course, application to all U.S. industry.

* * *

Based on the author's personal experiences, U.S. manufacturing has made great strides in the last several years. However, the marketplace, global in scope, remains very competitive. Today's customers are also expecting diversity in product selection and a level of availability and service that is not being accommodated by U.S. manufacturers as well as it should. In addition, there is a growing need to become more environmentally compatible in their production methods, an area which has long been neglected or deprioritized. Some industries also face the reality that the cost of labor, the cost of benefits, such as health care, or the cost of processing the paper "glut" are rising faster than productivity improvements.

The general needs, then, to acquire and sustain a competitive position are not difficult to identify and categorize, but do require leadership and focused efforts to satisfy them fully. The categories are **quality**, **delivery**, **flexibility**, and **cost**.

Quality is the degree that a product meets and exceeds the customers' expectations. It will continue to be an absolute necessity for a manufacturer to at least meet the customers' expectations to stay in most markets. If not competitive in this area, the company faces a crisis situation or will face eventual departure from the industry.

Delivery is the capability of the organization to deliver products or services dependably and quickly. If the manufacturer indicates a product will ship in two weeks, it indeed ships in two weeks. In addition, the overall time it takes to deliver a product or service is also a critical performance criteria in today's market. Dependability implies credibility in support systems, whereas the overall delivery speed implies waste-free process functionality. Significant emphasis in reducing the overall time of the delivery cycle is critical action for the enlightened manufacturer. The shorter it is, the easier it is to also provide dependability.

4.0 General Needs of Manufacturers in Region, cont.

Flexibility is the ability of a company to rapidly respond, cost-effectively, to:

- product mix changes
- total volume changes
- new product / service introductions
- new technology deployment
- world-market opportunities

and is, although broad in scope, the key area of emphasis in the 1990s for most enlightened manufacturers. Encompassing a much more comprehensive solution than an FMS (Flexible Manufacturing System) or an FMC (Flexible Machining Center) it has also been referred to as Agile manufacturing. And because of its presumed criticality for all manufacturing, should take a major role in SIRTII's services being offered.

Cost, of course, can not be ignored in the competitive arena. Systems to simply capture costs may be grossly misaligned or even non-existent in the smaller firm. It is the kind of thing, however, that most firms, once told what to do and how to do it should address themselves. From a different perspective, a company's lowered cost of product and reduced operating costs are distinct by-products of effective implementation of programs in the other three categories with the benefits justifying the effort. However, the initial cost of some of the programs, could prohibit the smaller companies from implementing the needed actions. Financial assistance in the form of low-interest or deferred-interest loans, subsidized services, or special membership privileges should also be part of the SIRTII program for qualified companies in targeted industries.

In addition to the above four categories of need, which in many ways reflects areas of performance improvement, a thorough understanding of **how to effectively align production processes to overall business strategy** is also a prevalent need in most small and medium-sized companies. Even the business strategy itself may require realignment for industries facing significant restructuring, including extensive retraining of the workforce. With the rich mix of university and college faculty as well as experienced practitioners from SIRTII's partnerships, effective programs on this need of practical manufacturing strategy should be able to be easily met.

* * *

The three sets of needs reviewed in this section, although derived and stated differently, have distinct overlap. As the plan to serve the region manufacturers becomes more refined, specific categories should be agreed to and confirmed.

5.0 General Approach for SIRTI's Manufacturing Thrust

The approach that is reflected in the balance of this plan to support area / region manufacturing competitiveness follow a set of general guidelines. They serve as the basic framework and underlying philosophy of the implementation plan and are itemized below:

- deploy existing technology and methodology rather than develop new technology and methodology
- focus on area and regional manufacturing and like-manufacturing rather than general manufacturing
- utilize practical solutions rather than theoretical ideas
- emphasize "pilot" introduction of solutions, rather than "across-the-board" implementations
- learn from other extension service programs rather than implement from scratch
- encourage cost-sharing rather than subsidized services
- respond to changing needs rather than follow static programs
- measure results in quantitative terms as well as qualitative ones.

The specific steps in the approach are described in detail in the subsequent sections of this plan and are listed here and on the next page:

The Start-Up Phase

1. Crystallize objectives and approach (finalize this preliminary plan)
2. Collect and apply lessons learned from similar services in the U.S.
3. Update / confirm area manufacturing demographics
4. Reconfirm manufacturing needs of "key" industries
5. Reassess and categorize SIRTI member and partner capabilities

5.0 General Approach for SIRTIP's Manufacturing Thrust, cont.

The Start-Up Phase, cont.

6. Prioritize specialized services
7. Refine implementation plans for prioritized services
8. Obtain funding and initiate services
9. Conduct "pilot" tests of services; modify as needed
10. Formalize offerings; advertise services
11. Repeat steps for new services and periodically for all services.

On-Going Operations Phase

1. Utilizing a "Manufacturing Advisory Board"
2. Selection criteria for recipient of services
3. Tracking of results
4. Probable staffing requirements.

These two phases comprise the basic steps in developing and providing the services that will support manufacturing competitiveness in the area and the region such that overall economic growth can occur. Each is discussed and more completely described in the subsequent sections of this plan.

6.0 Start-Up Phase for SIRTII's Manufacturing Thrust

The steps for the Start-Up Phase for the manufacturing thrust are described in the next eleven sections.

6.1 Crystallize Objectives and Approach (Finalize this Preliminary Plan)

Due to the very nature of this report being a preliminary plan, the first step in the Start-Up Phase will be to review this plan thoroughly, modifying it as needed, and finalizing the objectives of the manufacturing thrust and the underlying guidelines of the general approach. Qualifying definitions of "like-manufacturers" will also be needed. Anticipated deviations in the specific Start-Up Phase and On-Going Operations steps should also be noted.

Agreement / concurrence also needs to be obtained on what geographic areas the plan should address. The Spokane area and the Inland Northwest is presumed to be the starting place, although the entire Northwestern U.S. is a logical extension.

6.2 Collect and Apply Lessons Learned From Similar Services in U.S.

Fortunately, there are several state and federally supported services which have excellent reputations in assisting their manufacturing clientele in improving operations and competitiveness. This step is intended to learn from those successful operations and apply them to SIRTII's manufacturing thrust. The process would involve letters, phone calls, and a few site visits. Examples of potential candidate services to be contacted include:

Georgia Institute of Technology Industrial Extension Regional Offices (GTRI)
c/o Georgia Tech in Atlanta, Georgia

Maryland Technology Extension Service based at the University of Maryland

Michigan Modernization Service, a state sponsored program affiliated with Michigan's Industrial Technology Institute

Pennsylvania Technical Assistance Program (PENNTAP), a joint program of Penn State University and Pennsylvania Department of Commerce

Pennsylvania Technology Management Group, a nonprofit corporation sponsored by the state of Pennsylvania

6.2 Collect and Apply Lessons Learned From Similar Services in U.S., cont.

Examples of potential candidate services to be contacted, continued:

Cleveland Advanced Manufacturing Program (CAMP) is a not-for-profit economic development initiative funded by the State of Ohio and NIST (National Institute of Standards and Technology) and has five separate manufacturing support centers:

- Great Lakes Manufacturing Technology Center (GLMTC) in Cleveland
- Advanced Manufacturing Center (AMC) at Cleveland State University
- Center for Automation and Intelligent Systems Research (CAISR) at Case Western Reserve University
- Edison Sensor Technology Center (ESTC) also at Case Western
- Unified Technologies Center (UTC) at Cuyahoga Community College recently opening a Manufacturing Resource Facility.

Contacting representatives and making site visits from this list (or a list like it), to gather lessons learned on providing services which really accomodate the competitive position of the clients served and enhance the overall economic growth of the region, is the intent of this step.

Some typical review questions include:

- How were the services being offered decided upon?
- How are the services advertised? What's most effective?
- How do clientele get qualified? How is size and other conditional criteria confirmed?
- What special financing or discounting is provided to clientele?
- What are the staffing needs? Operating budget levels?
- Are outside consultants and specialists used? How are their qualifications matched to needed services?

Answers should be obtained from the professionals and staff involved in the work at the centers. In addition, several customers or clients receiving the service, with the center's sanction of course, should be contacted to determine what they like and hope to see in the future.

A summary report to capture the lessons learned from the centers reviewed and the applicable impact for SIRTl should be used to help tailor the subsequent steps in the plan.

6.3 Update / Confirm Area Manufacturing Demographics

For the service area / region decided upon in Step 6.1, updated information about the manufacturers and like-manufacturers in that service area and region should be collected and analyzed, making sure the database used can be accessed for specific company name, size, company officers' names, addresses, and phone numbers.

In addition, 4-digit SIC numbers should be retained on each company in the region or area to be serviced and accessed in the database. The additional detail will allow much better understanding of the particular scope of manufacturing in the selected service region.

If financial information on revenue is available, it too should be retained. Economic growth will imply an increase in revenue for the manufacturers in the service region if the programs are to be effective.

6.4 Reconfirm Manufacturing Needs of "Key" Industries

Because the 1989 needs survey covered only Spokane and was broader in scope than just manufacturing needs, a new determination of the manufacturing and like-manufacturing needs of the geographical area to be serviced should be determined. From the economic and demographic information about the service area collected in Step 6.3, specific industrial areas can be chosen for concentrated study. If, for example, food related products and plastics still account for over half the manufacturers in the area, and say, at least 10% of the labor force, then they are "key" industries and a refined, focused survey on their particular needs should be attempted for the approximately 1400 companies (.56 x 2,500 from the Inland Northwest data shown on page 5 of this report). The specific steps for the "key" industry focused needs assessment are:

- Contact trade associations for applicable portions of food industry (for example) to identify competitiveness issues of that industry
- Interview authorities in the industry on current trends and difficulties
- Design and circulate short, focused, surveys for the high concentration, "key" industries (e.g. food related and plastics industries)
- Tabulate results, synthesis needs of "key" industries
- Confirm needs with on-site visits to representative companies in service area that are part of "key" industries

6.4 Reconfirm Manufacturing Needs of "Key" Industries, cont.

"Key" industry focused needs assessment, continued:

- Determine how needs have been satisfied in "key" industry elsewhere or in similar industry
- Review technologies and methodologies used as possible additions to SIRTl services for "key" industry
- Survey balance of area to be serviced for confirmation that selected services, as modified by "key" industry needs, still have application
- Modify, adapt services, if significant need is revealed.

The results of this step should be a detailed list of services that, in addition to the five categories of service listed on page 3 and described on page 4 (Education/Training; Simulation Capabilities; Demonstration Capabilities; Field Support; Information Support), will also provide very specific examples of each, based on the refined needs from this step.

For example, the food related "key" industry may need special seminars on legal requirements for generic ingredients in food labels as an educational service, or special templates on simulation software to synchronize the flow of batches into packaging lines, or third-party demonstrations and evaluations on new packaging equipment before acquiring it from a vendor, or field assessments of capital expenditures in their batching operations, or information requests that provide literature and patent searches for alternative cost-reduced substitutes for ingredients in their recipes.

For SIRTl to be most effective, it must satisfy the needs of the area it is servicing. Knowing what those needs are and how they translate into specific service tasks is the point of this step. Skills of the staff, access of resources, types of specialized support systems, initial databases in the information network are all examples why this focus is so important. The needs and specific tasks will change and will naturally expand. Initially, however, for economic growth to occur in the region being serviced, focus is essential.

6.5 Reassess and Categorize SIRTl Member and Partner Capabilities

There is an immense array of talent and existing services within the member institutions and partner organizations that SIRTl can call upon in meeting the specific needs of the "key" industries as well as other companies. They may not, however, necessarily be poised nor available to assist the potential client on demand.

6.5 Reassess and Categorize SIRTl Member and Partner Capabilities, cont.

In fact, new combinations of skills may need to be assembled, as support teams, in order to provide unique services. For example, if access to information about a new production technique is available only in Japanese literature, translation skills will be needed, interpretation skills of the information after translation will be needed, and skills on accessing the trade journals in the first place will also be needed. These skills are not typically found in a single person and not typically found in anyone working on a staff such as that at SIRTl. SIRTl needs to be in a position to be able to find the needed resources to field such teams. This means categorizing the capabilities of the SIRTl members and partners.

However, to start, rather than categorizing every person and service likely to be accessed from the members and partners, a better approach will be to identify member and partner capabilities that match those detailed services selected by the "key" industries. This implies not only skill capability, but also product and industry knowledge. It is presumed that some gaps, needed skills and industry background not found or not readily available, will be uncovered. These areas will signal a development shortfall for SIRTl to work with its members and partners to fill and for SIRTl to provide from other sources in the interim.

6.6 Prioritize Specialized Services

Based on the results of the prior steps, very specific, industry-focused services will have been identified to meet "key" industry needs and still have general applicability to other manufacturers. But in order to allow the initial service offerings help refine subsequent specific service offerings, **field support** and **education and training** services should be prioritized. In fact, the generic priority sequence to develop the programs to provide the very specific services would be:

- #1 - education / training programs in "key" industries topics - high survey results
- #2 - field support programs for "key" industries for crisis or critical needs
- #3 - education / training programs for other topics with high survey results
- #4 - field support programs in "key" industries for other than critical needs
- #5 - simulation capability program for "key" industries
- #6 - information support program for "key" industries
- #7 - field support program for other manufacturers
- #8 - demonstration program for "key" industries
- #9 - simulation capability program for other manufacturers
- #10 - information support program for other manufacturers
- #11 - demonstration program for other manufacturers.

6.6 Prioritize Specialized Services, cont.

Announcements about the service offerings for the first four priorities listed can all be handled through mass mailings to the names already in the "key" industry database as well as other databases for interested parties that the member institutions may have in promoting existing seminars and workshops. All such existing as well as future education and training activities will provide an opportunity for promotional material on field service offerings and other services to be circulated widely.

Similarly, field support services allows low-cost and possibly no-cost (to client) physical contact with companies needing help, and will be the best way to capture early SIRT field support service case studies for use in subsequent promotions.

Although subject to modification, this priority scheme will allow a starting point for the development of services to be offered, with "key" industries prioritized heavily.

6.7 Refine Implementation Plans for Prioritized Services

For each of the prioritized services itemized in Step 6.6, specific implementation plans will need to be developed. Developing demonstration capabilities, for example, in a food related industry is more process or semi-process oriented than the very product oriented plastics industry. Rapid prototyping of new products would take on entirely different spectrums of equipment for these two industry types.

The point here is that, depending on the specific direction at this point (identification of "key" industry, specific high priority needs, specific services to match needs) a detailed implementation plan, including equipment acquisition and testing, needs to be developed. It would be unwise to spend several hundred thousand dollars on stereolithography equipment if the industry most suited for it (plastics, machining, instrumentation) did not have a need for extensive acceleration of prototyping new products. Or if the industry needing rapid prototyping was a food processor that could not benefit from discrete parts analysis.

6.8 Obtain Funding and Initiate Services

Following the steps in this preliminary plan should allow the creation of a very focused attack on improving competitiveness in the target geographical area. At this point, specific costs can be refined due to the fact that specific direction has been clarified. However, effort and funds will need to have been expended for Steps 6.1 through 6.7 in order to be specific enough on operating budgets and equipment capitalization.

6.9 Conduct "Pilot" Tests of Services; Modify as Needed

As part of the underlying guidelines, even with full funding, the services to be offered should be "pilot" tested with good feedback before being offered on a wide scale. During the field contacts made in Step 6.4 when confirming the industry and company needs, specific company representatives can be asked to help test the new services when available. If services are not to be provided at no-cost to the client, then the amount he is likely to pay plus estimates of the company's staff time should be provided to the prospective test site.

The objective of the "pilot" test will be to:

- confirm SIRTI work methodology as effective
- identify strengths of service being offered
- pinpoint service areas needing modification or refinement
- establish ways to develop quantitative measurements at client site from implementing service.

And with the emphasis on **field support** and **education / training** as the prioritized services the initial "pilot" test for these are discussed in more detail. For a new education or training program on a highly needed topic for a "key" industry, explicit evaluation for that first "pilot" offering should be conducted, for example:

- number and % of companies from target industry
- contacts made if numbers low
- special feedback forms for attendees
- some telephone follow-up to attendees may be needed
- action plan for next offering.

For a "pilot" field support visit, the user of the services as well as the professionals on-site at the client location representing SIRTI are important sources of input. For example, the user of services could provide:

- service expectations / anticipated benefits
- service rating in regard to expectations
- service strengths
- service areas needing improvement.

And the professionals assigned by SIRTI to provide the field support could provide:

- sufficiency of pre-visit information
- clarity of scope of project
- value of pre-developed checklists (if any used).

6.10 Formalize Offerings; Advertise Services

After effective "pilot" testing is completed and any needed modifications to the service have been incorporated, the formal offerings and advertisements can be conducted. This is the point where the formal literature and brochures as well as more wide-spread mailings and publicity programs can be implemented. Use of member institution capabilities seems to be an excellent leverage point. Also, because clear industry focus has been targeted, trade journals for that focus industry will be obvious places to place ads and articles. Speaking engagements by SIRTl staff, members on former site visits, and appropriate partner representatives will aid the effort with minimal cost.

6.11 Repeat Steps for New Services and Periodically for All Services

The previous ten steps in the Start-Up Phase, essentially are to be repeated every time a new service is considered, or a major modification to an existing service has been suggested. It should allow a refinement process to the services being offered to be responsive to manufacturer's pressing needs.

A comprehensive version of all ten steps should be done at least every three years to make sure the direction of the services is still valid.

7.0 On-Going Operations for SIRTl's Manufacturing Thrust

The On-Going Operations Phase for SIRTl's manufacturing thrust reflects the kinds of policies and procedures that need to be developed to operate effectively, rather than a sequence of steps developed for the Start-Up Phase. Although they are listed in somewhat of a priority sequence, they all need to be in place, if confirmed as needed, before the Start-Up Phase is completed. The four points are:

- Utilizing a "Manufacturing Advisory Board" (for effective review of manufacturing thrust activities)
- Selection criteria for recipient of services (for clear definition of who can be served, at what price or discounted price, for what obligation from manufacturer)
- Tracking of results (to measure SIRTl's objectives of economic growth in region being served)
- Probable staffing requirements (for early field support emphasis).

Each of these points is discussed in more detail in the subsequent sections of this plan.

7.1 Utilizing a "Manufacturing Advisory Board"

A "Manufacturing Advisory Board" is a group of people made up of representatives from the client (or potential client base), from the member institutions, and from the partner organizations who are authorities in the areas that the manufacturing thrust is trying to accomodate. Their role would be to meet periodically and advise SIRTl on its overall direction, policies, and program offerings to better serve the manufacturing sector targeted. The term on the group would be limited, say 3 years, and would rotate such that half the group would be on the committe more than a year and the other half less than a year. This of course would not be the case for the first such group with all new participants.

The point is to keep SIRTl current and fresh with open feedback from authorities in the service area. Approximately 10 to 12 people should be large enough to account for absences but small enough to provide effective advice.

7.2 Selection Criteria for Recipient of Services

Already discussed, early definition on which "like-manufacturers" qualify for SIRTl services is part of the selection criteria. Also, however, is the question of how much subsidy will be applied to fees charged to clientele and what scale, if any, is to be used for size. That is, does a small manufacturer pay less than a medium-sized one?

Another issue involves financial services. Will state and government funds be permitted for low-interest, no-interest, deferred-interest loans? Much insight on these issues will be determined from the review of existing services in the U.S. already discussed in Step 6.2, but, three points should be noted:

- Getting something for nothing does not inspire "ownership" in the solution of the problem or the effectiveness of the service.
- Credibility of offered services must be established if small companies are expected to pay. (Especially true for front-end diagnostic reviews.)
- Dependence on federal or state funding to sustain SIRTl's survival is not a solid foundation for long-term operations.

Therefore different types of charges are recommended:

No cost to client services which are diagnostic in nature, are limited in scope (one day plant review by two professionals, for example), and are for qualifying companies (to be decided by SIRTl but could be those in geographic region, small in size, in "key" industry, or a targeted growth industry). This free service will help establish the credibility such that reasonable fees can be rendered a few years in the future.

Subsidized cost to client services which are only offered to qualifying companies. These qualifications will need to be pre-defined by SIRTl but could be, for example, the same criteria itemized above. To keep SIRTl solvent, of course, the net revenue (price less subsidy) should not be lower than SIRTl's actual cost unless a budget has been established which can be tracked and measured in subsequent accounting periods.

Commercial cost to client services which are offered to anyone willing to pay the commercial rate. Information network fees come to mind as a good example. Regular fees for seminars is another. The revenue from this portion of SIRTl business will need to show enough growth to eventually, as a minimum, off-set the free services in the "no cost to client" category.

7.2 Selection Criteria for Recipient of Services, cont.

As far as financial services are concerned, if SIRTII's funding sources permit it, very small companies (less than 100 employees or other such restrictions) should be eligible for lower than commercial rate loans. The project underway at the manufacturer will need to be qualified by the field support service staff experienced in the area, and the prospective loan recipient will need to do the leg work in establishing the loan source. But it is a service that should benefit the smaller, capital-strapped manufacturer. Upper limits on the amount of subsidy (2% for example) may also be pertinent.

Easier to implement and possibly just as useful would be facilitation services to match companies needing financing with investors and institutions willing to invest. Initially this could be a simple referral service without endorsements, evolving into a true financial service.

7.3 Tracking of Results

Most criticism from manufacturers about government deployment programs is that the results are not worth the costs. Ways to calculate real results in the client base and in the economic growth categories will need to be determined. Below are some typical results which are easy to develop:

- number of clients served for each service category
- number and size (total hours) of projects completed
- number of inquiries supplied
- size of various databases used.

The more difficult results are for tracking the objectives of SIRTII:

- increased revenues of served clients due to manufacturing thrust
- total economic growth of area served due to manufacturing performance
- internal competitive improvements for clients in quality, delivery, flexibility, and cost.

For the first two, economic data about the region being served can provide baseline information as the starting point. For the last, surveys and post-implementation visits can be used to collect key performance improvements from client companies, much harder to verify.

It is suggested, that if not readily available, current economic data be collected and analyzed as part of Step 6.3 to serve as the baseline just mentioned.

7.4 Probable Staffing Requirements

This is a very difficult area to detail. It will depend heavily on the specific focus and direction the SIRTI manufacturing thrust does indeed take. However, some particulars appear needed in any event, especially if the **field support** services are adopted with as much importance as implied in this plan.

At least three field support teams appear needed within one year after start-up. Each team would be made up of a team leader and one other specialist depending on the scope of the project:

Team Leader - senior member with manufacturing experience in industry served and could have background in engineering or other fields

Design Engineer - with project experience and educational credentials in discipline required (electrical, mechanical, chemical, etc.)

Industrial / Systems Engineer - with process improvement experience in areas being served

Training Specialist - in appropriate field for the development of special orientations of client staff.

If it is estimated that at least 150 companies should receive field support visits in the first year, and that at least two people per visit will take a calendar week to provide that service, then there will be a need for three 2-person teams underway 50 weeks of that year.

Permanent staffing could be initially limited to 3 senior team members, phased in one at a time until service requests increased appropriately. The rest of the team members could be provided by the member institutions and partner organizations from the matching of skills developed in Step 6.5 discussed earlier.

For each primary service, as phased in, an experienced professional may be needed. The first team leader hired could serve as the overall **field support** service manager and perhaps coordinate the development of the **demonstration** capabilities, but other professional specialists in **simulation** and **information networking** would likely be needed for development of those services. It is assumed that SIRTI already has adequate staffing for the **education / training** services.

The point here is to phase in the staffing along with the services, using member and partner personnel or even third-party personnel until full-time employees are justified.

8.0 Possible Concerns

As with all partially government-sponsored services, although in the best interests of the overall economic growth for the area, there is the possibility that the services offered will interfere and directly compete with already established firms providing such services for profit. This is certainly true for any no cost to client field support services, even if only diagnostic in nature. Many consulting services provide similar services for a fee. However, there seems to be a strong precedent of existing extension services providing no cost diagnostic services without criticism from the competition, especially if some of those specialized requests are directed to local consulting firms who get paid for their work even if the client pays nothing.

A more serious potential issue is with the services provided through simulation capabilities and demonstration capabilities. Those services, once fully developed, could have software and hardware capability that would rival any company providing such services for simulation and prototype development. Although widespread availability of these services do not appear evident in the potential geographical areas to be served, it is still a point worth considering during the implementation steps where actual equipment or major software products may be acquired.

If some of these capital-intensive, heavy-investment services are being offered in the area being served, one way to eliminate the negative economic impact on that sector of the economy is to coordinate the use of their services through SIRTII. Presumably this would permit some reduction of fees to SIRTII's clients due to larger volume of business anticipated by the service provider. This approach would be more economically viable than merely subsidizing the difference, since the service could prosper and expand with all users eventually reaping the benefit.

Whatever the final solution, it is pertinent to note the possible concerns and explore the area for service providers who would be negatively affected from SIRTII's manufacturing thrust and initiate appropriate action to avert such an outcome.

9.0 Next Action Steps

This preliminary plan needs to be studied thoroughly. It is expected that modifications will be needed before the Start-Up Phase is fully initiated. However, if there are steps that could be implemented as a way to accelerate the clarification of the rest of the plan they are Steps 6.1 and 6.2 and needed decisions discussed in Sections 7.0 and 8.0, in particular:

- Crystallize objectives and approach (6.1)
 - finalize objectives of manufacturing thrust
 - concur / modify general approach guidelines
 - define "like-manufacturers" and agree to include or not
 - decide on geographical areas to be served first year, second year, and beyond
- Collect and apply lessons learned from similar services in U.S. (6.2)
 - pick sites
 - make contacts (letter, phone)
 - conduct visits (at least 3)
 - synthesize lessons learned
- Confirm direction for on-going operations (7.0)
 - decide on "Manufacturing Advisory Board" and initiate if so agreed
 - finalize selection criteria and fee structure for SIRTl clientele
 - determine extent of financial services to be provided
 - establish results tracking indicators.

It is presumed that current funding would permit the above actions to take place very quickly and such action is highly recommended. In fact, it is almost a prerequisite to ensure effectiveness in finalizing this preliminary plan.

Appendix C
Implementation Plan

SIRTI IMPLEMENTATION PLAN

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
				ACTUAL						PROJECTIONS		
STARTUP PHASE												
INDUSTRY LEADERS (MOMENTUM) INITIATE/SUPPORTS SIRTI	△											
STATE LEGISLATION ESTABLISHES SIRTI, ANNUAL FUNDING		△										
JCHE BOARD ESTABLISHED, OVERSIGHT CONTINUES					△							
EXECUTIVE DIRECTOR & INITIAL SUPPORT STAFF HIRED						△	△	△				
INITIAL OPERATIONS PHASE												
SIRTI FACILITY CONSTRUCTION						△	△	△				
WESTINGHOUSE/BATTELLE PARTNERSHIPS							△	△				
INITIAL PROJECTS				△					△			
OPERATIONS STAFF ADDITIONS							△					
DOD GRANT FUNDING						△						
LEGISLATIVE APPROPRIATION							△					
ARPA NAMED SPONSOR							△					
DOD/ARPA FUNDING IN PLACE								△				
ORGANIZATION & PLANNING PHASE							△					
ORGANIZATION, POLICIES & PROCEDURES DEVELOPMENT							△					
3 CENTER PROGRAM PLANNING						△	△	△				
PLANNING PHASE PROJECT SCREENING & SELECTION						△	△	△				
PHASE PROJECT CONTRACTUAL AGREEMENTS								△				

SIRTI IMPLEMENTATION PLAN

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
				ACTUAL								
								PROJECTIONS				
KEY OPERATIONS STAFF ADDITIONS								△				
INSTALL COST CONTROL/ PROJECT MANAGEMENT SYSTEMS							△	△				
FACILITY LAYOUT/EQUIPMENT INSTALLATION							△	△				
PERIODIC DOD/ARPA REVIEWS								△	△	△	△	△
FULL SCALE OPERATIONS PHASE 3 CENTERS PHASED TO FULL OPERATION								△				
BUSINESS INCUBATOR OPERATIONS								△	△			
NEW PROJECT SOLICITATION, SCREENING, REVIEW							△					
CENTER/PROGRAM/PROJECT PERFORMANCE REVIEWS								△	△	△	△	△
CORPORATE SPONSOR/GRANT APPLICATIONS							△					
ADDITIONAL INDUSTRY PARTNERSHIPS								△				
ADDITIONAL UNIVERSITY PARTNERSHIPS								△				

C.2

Appendix D

Executive Summary of Proposal

SPOKANE INTERCOLLEGIATE RESEARCH & TECHNOLOGY INSTITUTE

EXECUTIVE SUMMARY

Proposal to the US Department of Defense Advanced Research Projects Agency

The Spokane Intercollegiate Research and Technology Institute (SIRTI) represents a strategic technology alliance involving business and industry, education, and government designed to advance economic growth in the Pacific Northwest. SIRTI's programs are designed to enhance manufacturing, to increase new business development, and to assist researchers to apply innovative technology to important regional problems. This grant is for program startup and initial operation of the Department of Defense-related initiatives planned within SIRTI.

Created by the legislature in 1988, SIRTI is supported by the State of Washington with facilities, and \$2.3 million in operating funds (1988-1993). A \$12 million SIRTI research development/laboratory facility is under construction and will be completed for occupancy in the summer of 1994.

Along with resources and programs of our member institutions (Eastern Washington University, Gonzaga University, Washington State University, Whitworth College and Community Colleges of Spokane), SIRTI's technical capabilities have been enhanced by private industry/technology partnerships with the Westinghouse Hanford Company's International Environmental Institute and Battelle Pacific Northwest Laboratories. In these partnerships and others, SIRTI will function as an adaptable, flexible, and responsive catalyst to meet the needs of government and industry. Private/public linkages and collaborations will be leveraged to increase resources for programs, projects, and services.

SIRTI's initial strategic plan and future planning is based on an awareness of the global marketplace; knowledge and support of the federal defense, economic, and technology agendas; national and regional industrial needs. Programmatic planning reflects attention to national and regional needs, and emphasizes industrial modernization, defense conversion objectives, and dual-use technology development and deployment. Four key directions will be emphasized:

- Applied research and technology development, demonstration and deployment;
- National and regional needs which are consistent with major Department of Defense (DOD) and other federal initiatives;
- Capitalize on existing technology resources by forging entrepreneurial partnerships with federal laboratories and other major Research and Development institutions throughout the nation;
- Utilize the resources of SIRTI institutions and strengthen these resources through cooperative industry/government technology initiatives.

This approach will support the technology transfer mandates of the federal government, and the State of Washington.

January, 1994

Programs and Services

SIRTI's products and services will remain industry-driven through its positioning and continual communication with customers, problem holders, and technology providers. SIRTI products and services include: *research and product development* to stimulate commercialization of new products; *education and training* aimed at building a highly skilled work force ready to meet the challenges of new regulations and industrial requirements; *technical and business assistance* to help advance competitiveness, particularly in the global market; and *information and system networking* aimed at linking business, researchers, and developers with the emerging information highways.

SIRTI's programs and expertise will be focused around three centers of excellence. The **Northwest Manufacturing Technology Center** will be established with programmatic emphases in environmentally sound manufacturing, quality management, and product/process innovation and improvement. Major facilities will include the Manufacturing Prototype Demonstration Laboratory featuring large-scale computer modeling and simulation capability.

A second center, the **Center for Environmental Quality** will demonstrate and deploy innovative environmental technologies and will provide assistance with environmental changes, training and education. Additional program elements will address small to medium-sized business needs emanating from the explosion of environmental concerns and regulations. Training programs which bring industry skills, safety information and compliance techniques are an important component of these efforts.

Capitalizing on the resource base emerging from a rapidly expanding regional health care industry, SIRTI will assist in the creation of biomedical technology and pharmaceutical product industries through its **Biomedical Technology Center**. It will develop and deploy health care technologies based on computer and information systems such as health care information systems and networks. This emphasis will strengthen SIRTI's linkages to the software industry and hospitals within the region. SIRTI initiatives will offer important cost-savings potential for the government and the health care industry.

Summary

Through its resource base and partnership approach to service delivery, SIRTI is well-positioned to address the priorities of the DOD and the federal government for industrial modernization, defense conversion, and dual-use technologies. By capitalizing on existing expertise and focusing on urgent industrial needs, the DOD investment in SIRTI will significantly advance programs of major importance to the Department of Defense and strengthen the national and Pacific Northwest economies.

January, 1994

Appendix E
Announcement

SIRTI

13 April 1994

Dear Friend :

Good news! Our proposal to the Advanced Research Projects Agency (ARPA) of the U.S. Department of Defense has been approved, releasing funds appropriated to SIRTI in the Department of Defense Appropriations Act, 1993.

We wanted you to be among the first to know that the review process has concluded. Although it will be a few weeks until funds are received, the award confirms the value of our initiatives. This means regional business and industry will be able to participate fully in new defense, technology and economic agendas of the federal government. It also opens doors for our regional colleges and universities to become involved in government and industry projects.

The formal announcement is being made this morning at the regular meeting of the Joint Center for Higher Education Board of Directors. I have included for you a copy of the executive summary of the proposal, and am looking forward to a time in the very near future when we can discuss details.

Until then, thank you for your continued support of SIRTI as we embark on a new phase of growth and program implementation. I hope you will join us in celebrating this hanner day for the Institute.

Sincerely,

Hugh D. Sullivan, Ph.D.
Executive Director

Attachment

Appendix F
Project Management Plan

SIRTI PROJECT MANAGEMENT PLAN

Project Name: Radiology Artificial Neural Networks (RADANN)
Project Number: BMT-019412-4
Client: Madigan Army Medical Center, Sacred Heart Medical Center
Center: Biomedical Technology Center
Program Manager: TBN, SIRTI
Industry Lead: George M. Alexander, Battelle
University Lead: Eastern Washington University
Westinghouse/Battelle: George M. Alexander
Outside Consultants: N/A
Start Date: ARPA funds receipt date (assumed 2/1/94)

Completion Dates:	Phase I (Heart)	September, 1994
	Phase II (Chest)	December, 1994
	Phase III (CT Scan)	February, 1995
	Phase IV (Bone Cancer)	March, 1995
	Phase V (Breast Cancer)	May, 1995
	Phase VI (Colon Cancer)	August, 1995

Impact Levels: RADANN is a series of high-technology projects that will take a technology originally designed for M1A2 main battle tanks and put it to use in the medical field. It will be designed to benefit both the military and civilian medical communities. RADANN will enable radiologists to reduce costs in the diagnoses of several major diseases. At the same time RADANN offers the possibility for early detection of heart disease and several cancers while they are more curable.

**Project Funding Level
for Covered Period:** TBD

This plan is intended to serve for the life of the project. Changes in scope, schedule, or funding require that a revision be prepared and approved.

Project Manager: _____ **Date:** _____

Participant Approvals: _____ **Date:** _____

_____ **Date:** _____

1.0 INTRODUCTION

One of the most powerful and useful characteristics of an artificial neural network is its ability to identify patterns. The objective of the RADANN project is to use artificial neural networks, along with image processing and expert systems, to identify patterns from digitally-stored medical imagery data. This will facilitate the analysis of images, providing physicians a useful tool to aid them in their diagnoses.

2.0 PROJECT DESCRIPTION

The work in this project will be a joint effort of SIRTI; Madigan Army Medical Center (MAMC), Fort Lewis, WA; Eastern Washington University (EWU); Sacred Heart Medical Center (SHMC), Spokane, WA; and Battelle Pacific Northwest Laboratory (PNL). Madigan has one of the most advanced and extensive digital medical image archives in existence. PNL, a U.S. Department of Energy National Multiprogram Laboratory, has experience and active research programs in the areas of image analysis, artificial neural networks and expert systems. The Computer Sciences Department of EWU has a medical image analysis laboratory and experience in neural network projects. SHMC, a private medical center, is renowned for heart and cancer specialties. The proposed work builds upon recent Army-sponsored PNL research in which neural networks were used to diagnose turbine engine failures. Participants on that project included PNL and EWU personnel who will be part of the proposed work.

The primary object of this research will be to enhance the operations at Madigan and at Sacred Heart. The medical staff want to take advantage of their unique digital databases, in particular through the use of automated methods for the detection of clinically-significant anomalies in the digitized images. The projected outcomes of the application of automated methods will be improved quality of medical care, more accurate and timely diagnosis, and a reduction in the rate of false negative diagnoses. Because Madigan and Sacred Heart are teaching hospitals, the staff is also interested in using automated methods to assist in peer review and the detection and analysis of human error. Finally, automated tools will facilitate the analysis of historical data for research purposes.

The RADANN project will investigate various forms of digitized data to develop automated methods to assist in identifying coronary artery disease, lung cancer and other chest anomalies, bone cancer, breast cancer, and colon cancer. For each of the above conditions, it is hoped that a combination of digital imaging techniques, neural networks, and expert systems, or some combination of these, can be designed to aid in identification of the condition. If such an automated method is designed, it will be thoroughly tested with independent data to judge the validity of the method. A human computer interface will be designed to aid in transferring the results of the method to the user, if the method is deemed valid and useful. The package will then be marketed and deployed.

2.1 Scope

The work outlined in this proposal will be divided into five major tasks.

Project Management. SIRTI will manage the series of RADANN projects as a program under its Biomedical Technology Center. SIRTI has already assembled the team of Madigan Army Medical Center, Sacred Heart Medical Center, Battelle Pacific Northwest Laboratories, and Eastern Washington University and completed initial planning. The SIRTI RADANN team has begun data acquisition and data analysis work on the prototype for RADANN. The SIRTI project manager will control all phases of the projects working directly for the center manager.

Data Acquisition. Digitized imagery tiles stored on Madigan computers will be transferred to a new image database that merges diagnostic and patient information (currently maintained separately). File formats will be compatible with the Sun workstations and 486DX-based PCs that will be used for neural network, image analysis and user interface developments. This work will be performed by PNL, EWU, Sacred Heart and Madigan staff.

Data Analysis. PNL and EWU staff will investigate several conventional neural network paradigms in developing methods for detecting anomalous features of the imagery data. Diagnostic information from the patients' medical history records will be combined with related imagery data in training the networks to recognize diagnostic categories. Rule-based, i.e., expert system methods may be used to enhance network performance during this stage of analysis.

User Interfaces. The software applications that will be developed to assist medical personnel will be designed to facilitate use by medical personnel who have a wide range of computer skills. Graphical user interfaces and advanced visualization techniques will be employed as appropriate. PNL human-factors specialists will work closely with the medical staffs and application developers to assure that user requirements are identified and met. Application development will proceed through an iterative rapid prototyping process, during which medical staffs will have ample opportunities to influence the design of the emerging product.

Diagnostic Validation. Neural networks will be trained and tested with independent sets of data. In addition, the performance of the resulting network(s) may be compared to the performance of groups of medical personnel, if that is practical at the Madigan location. The overall usability and utility of the application will be evaluated through survey questionnaires and interviews with the Madigan and Sacred Heart staffs.

2.2 Task Summary

Tasks defined for this project are highlighted below:

Phase O - Project Management

- Task 1: Initial Planning

- Task 2: Evaluate ANN tools
 - Compare different "off the shelf" packages
- Task 3: ANN Feasibility

Phase I - Heart

- Task 1: Data Acquisition
 - Link digitally-stored image to appropriate diagnosis of the condition
 - Transfer digitally-stored data to project development team
- Task 2: Data Analysis
 - Use image analysis to identify features in the data
- Task 3: Develop ANN
 - Develop artificial neural network to identify the patterns in the data
 - Develop expert system to provide output to user from the network results
- Task 4: Diagnostic Validation
 - Test automated system with independent sets of data
 - Compare the system's output with the physician's diagnosis
 - Statistically evaluate the performance of the system
- Task 5: User Interface (UI) Design and Prototyping
 - Identify requirements for a UI
 - Develop UI with rapid prototyping
- Task 6: User Interface Development
 - Develop UI
 - Evaluate UI
- Task 7: System Integration and Testing
 - Fully integrate ANN, expert system and user interface
 - Test automated system
- Task 8: Documentation and Delivery
 - Users' Manual
 - Executable system packaged
 - Lessons learned documented
 - Deliver to Madigan Army Medical Center

- Task 9: Deployment to Private Sector
 - Intellectual Property
 - Royalty Stream

Phase II - Chest and Lungs

- Task 1: Data Acquisition
 - Link digitally-stored image to appropriate diagnosis of the condition
 - Transfer digitally-stored data to project development team
- Task 2: Data Analysis
 - Use image analysis to identify features in the data
- Task 3: Develop ANN
 - Develop artificial neural network to identify the patterns in the data
 - Develop expert system to provide output to user from the networks results
- Task 4: Diagnostic Validation
 - Test automated system with independent sets of data
 - Compare the system's output with the physician's diagnosis
 - Statistically evaluate the performance of the system
- Task 5: User Interface Design and Prototyping
 - Identify requirements for a UI
 - Develop UI with rapid prototyping
- Task 6: User Interface Development
 - Develop UI
 - Evaluate UI
- Task 7: System Integration and Testing
 - Fully integrate ANN, expert system and user interface
 - Test automated system
- Task 8: Documentation and Delivery
 - Users' Manual
 - Executable system packaged
 - Lessons learned documented
 - Deliver to Madigan Army Medical Center

- Task 9: Deployment to Private Sector
 - Intellectual Property
 - Royalty Stream

Phase III. Computed Tomography (CT) Scan

- Task 1: Data Acquisition
 - Link digitally-stored image to appropriate diagnosis of the condition
 - Transfer digitally-stored data to project development team
- Task 2: Data Analysis
 - Use image analysis to identify features in the data
- Task 3: Develop ANN
 - Develop artificial neural network to identify the patterns in the data
 - Develop expert system to provide output to user from the networks results
- Task 4: Diagnostic Validation
 - Test automated system with independent sets of data
 - Compare the system's output with the physician's diagnosis
 - Statistically evaluate the performance of the system
- Task 5: User Interface Design and Prototyping
 - Identify requirements for a UI
 - Develop UI with rapid prototyping
- Task 6: User Interface Development
 - Develop UI
 - Evaluate UI
- Task 7: System Integration and Testing
 - Fully integrate ANN, expert system and user interface
 - Test automated system
- Task 8: Documentation and Delivery
 - Users' Manual
 - Executable system packaged
 - Lessons learned documented
 - Deliver to Madigan Army Medical Center
- Task 9: Deployment to Private Sector
 - Intellectual Property
 - Royalty Stream

Phase IV. Bone Cancer

- Task 1: Data Acquisition
 - Link digitally-stored image to appropriate diagnosis of the condition
 - Transfer digitally-stored data to project development team
- Task 2: Data Analysis
 - Use image analysis to identify features in the data
- Task 3: Develop ANN
 - Develop artificial neural network to identify the patterns in the data
 - Develop expert system to provide output to user from the networks results
- Task 4: Diagnostic Validation
 - Test automated system with independent sets of data
 - Compare the system's output with the physician's diagnosis
 - Statistically evaluate the performance of the system
- Task 5: User Interface Design and Prototyping
 - Identify requirements for a UI
 - Develop UI with rapid prototyping
- Task 6: User Interface Development
 - Develop UI
 - Evaluate UI
- Task 7: System Integration and Testing
 - Fully integrate ANN, expert system and user interface
 - Test automated system
- Task 8: Documentation and Delivery
 - Users' Manual
 - Executable system packaged
 - Lessons learned documented
 - Deliver to Madigan Army Medical Center
- Task 9: Deployment to Private Sector
 - Intellectual Property
 - Royalty Stream

Phase V. Breast Cancer

- Task 1: Data Acquisition
 - Link digitally-stored image to appropriate diagnosis of the condition
 - Transfer digitally-stored data to project development team
- Task 2: Data Analysis
 - Use image analysis to identify features in the data
- Task 3: Develop ANN
 - Develop artificial neural network to identify the patterns in the data
 - Develop expert system to provide output to user from the networks results
- Task 4: Diagnostic Validation
 - Test automated system with independent sets of data
 - Compare the system's output with the physician's diagnosis
 - Statistically evaluate the performance of the system
- Task 5: User Interface Design and Prototyping
 - Identify requirements for a UI
 - Develop UI with rapid prototyping
- Task 6: User Interface Development
 - Develop UI
 - Evaluate UI
- Task 7: System Integration and Testing
 - Fully integrate ANN, expert system and user interface
 - Test automated system
- Task 8: Documentation and Delivery
 - Users' Manual
 - Executable system packaged
 - Lessons learned documented
 - Deliver to Madigan Army Medical Center
- Task 9: Deployment to Private Sector
 - Intellectual Property
 - Royalty Stream

Phase VI. Colon Cancer

- Task 1: Data Acquisition
 - Link digitally-stored image to appropriate diagnosis of the condition
 - Transfer digitally-stored data to project development team
- Task 2: Data Analysis
 - Use image analysis to identify features in the data
- Task 3: Develop ANN
 - Develop artificial neural network to identify the patterns in the data
 - Develop expert system to provide output to user from the networks results
- Task 4: Diagnostic Validation
 - Test automated system with independent sets of data
 - Compare the system's output with the physician's diagnosis
 - Statistically evaluate the performance of the system
- Task 5: User Interface Design and Prototyping
 - Identify requirements for a UI
 - Develop UI with rapid prototyping
- Task 6: User Interface Development
 - Develop UI
 - Evaluate UI
- Task 7: System Integration and Testing
 - Fully integrate ANN, expert system and user interface
 - Test automated system
- Task 8: Documentation and Delivery
 - Users' Manual
 - Executable system packaged
 - Lessons learned documented
 - Deliver to Madigan Army Medical Center
- Task 9: Deployment to Private Sector
 - Intellectual Property
 - Royalty Stream

3.0 SCHEDULE

Major tasks and key milestones are shown on the attached Preliminary Project Schedule Gantt Chart.

a:SIRTIPMP.RAD

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