Federated Intelligent Product Environment (FIPER)

Technical Proposal

Prepared for

National Institute of Standards and Technology
Advanced Technology Program
Quince Orchard and Clopper Roads
Gaithersburg, MD 20899-0001

In response to

Competition 99-01
Technology Area MO200

Submitted by

Ohio Aerospace Institute
General Electric Company
BFGoodrich
Parker Hannifin
Engineous Software
Ohio University
Stanford University

FIPER Team

April 14, 1999

Proprietary Information

99PRO011

3. Executive Summary

The Federated Intelligent Product EnviRonment (FIPER) will drastically reduce design cycle time, and time-to-market, with potential to reduce the cost of product creation by $2.2B annually for the U.S. manufacturing sector. This four-year, $21.5M program will reduce cycle time by intelligently automating elements of the design process in a linked associative environment, thereby providing true concurrency between design and manufacturing. This will enable distributed design of robust and optimized products within an advanced integrated web-based environment

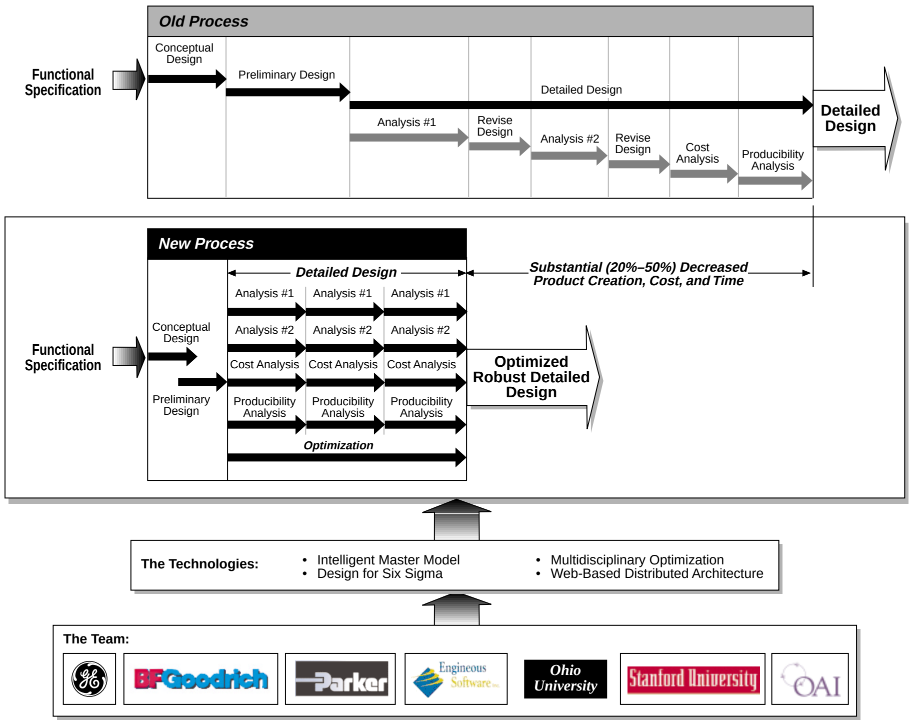

Figure 1. By providing breakthrough product design technology, FIPER will significantly reduce product creation costs and time to market by 20-50%, while improving design robustness.

3.A Scientific and Technological Merit

3.A.1 Innovation in Technologies

Improvements in the design process, and the technologies that enable them, have led to significant reductions in time-to-market and improvements in product functionality and quality, mainly through automation. However, speeding up elements of what is essentially a serial process has physical limits. The need for further improvements in these areas, and the increasing need to reduce product *life cycle costs*, require significant further improvements in product design technology. We believe that incremental improvements will not suffice, and so we propose the development of FIPER. This system, based on the concept of the Intelligent Master Model (IMM), will provide an environment that will permit true concurrent engineering, thus permitting the different elements of design to proceed with a level of concurrency not achievable in the manual serial process. Specific innovations include:

- Preliminary 3D solid geometry will be automatically generated and analysis codes invoked from product requirements.
- Knowledge Based Systems (KBS) will automatically revise component geometry in response to analysis outputs. Geometry changes or analytical results for a component will be reflected in geometries of associated components through “intelligent,” nonlinear scaling.
- The FIPER environment will support electronic experimentation for robust designs and MultiDisciplinary Optimization (MDO)
- A “zooming” capability will provide increasing fidelity of analysis, automatically selecting methods of analysis appropriate to increasing detail of geometry and assembly information.
- Cost and producibility will be integrated into the knowledge base
- Design processes distributed across platforms and locations will be enabled by an open, web-based environment

in which existing proprietary CAD and analytical packages are integrated through Java-based wrappers.

Demonstrations of incremental technology developments by the industry members of the FIPER team consistent with planned milestones will prove the feasibility of the approaches adopted. In addition they will provide data to support the anticipated productivity improvements of the breakthrough technology in support of the design of highly engineered products through automation of design and analysis tasks and web-based integration of incompatible platforms. The distributed functionality of FIPER will be validated with a demonstration of the integration of the design of a nacelle, engine, and fuel nozzle using IMM's built in Unigraphics, CATIA and ProEngineer.

3.A.2 High Technical Risk and Feasibility

This project includes three primary technology development thrusts:

- Development of the IMM technology that links analysis to geometry, and enables automation of design tasks in a linked associative environment.
- Development of a web-based environment that enables distributed design employing geographically dispersed and incompatible proprietary platforms.
- Scale-up and practical application of multi-disciplinary optimization algorithms and robust design methodologies.

Risk elements include the ability to fully integrate incompatible proprietary tools, including the three leading CAD platforms, Unigraphics, CATIA, and ProEngineer, which along with analytical tools will interact in support of distributed design through Java-based wrappers. Another risk element is the implementation of KBS to achieve the required functionality.

The FIPER Team includes General Electric (GE), BFGoodrich (BFG), Parker Hannifin (PH), Engineous Software Inc. (ESI), Ohio University (OU), Stanford University (SU), and the Ohio Aerospace Institute (OAI). The three manufacturers have extensive capabilities in advanced design technologies for highly engineered products. ESI has existing complementary software products, and will provide software development and commercialization outside this project. The universities have been leading research efforts in the area of this project. OAI has demonstrated skills in the management of similar projects. The research, development, and application experience of the FIPER Team provides the ability to manage this significant technical risk.

3.A.3 Quality of R&D Plan

The FIPER team has developed a high-quality plan to ensure that risks associated with meeting the objectives of the proposed work are mitigated to the extent possible. In particular, the team itself is comprised of a synergistic group of large, medium, and small companies, including a software company, and two universities, permitting the right resources to be applied to the appropriate task. These tasks include developing, disseminating, and demonstrating the technology. Significant core competency and experience in the requisite technologies exist among the team members, which will ensure that FIPER is successfully developed and deployed.

The plan calls for developing, and initially demonstrating, FIPER among team members' companies. Early evaluators outside the team will be the NASA Glenn Research Center and Allied Signal, who have been identified to further test, validate, and provide feedback on improvements to the technology. A prime software commercializer, ESI, plans to commercialize the technology within one year after meeting key milestones within the proposed work. The industrial team members will also work with their respective CAD and KBE suppliers to encourage teaming with ESI on the commercialization of the software.

3.B Potential for Broad-Based Economic Benefits

3.B.1 Economic Benefits

The industry members of the FIPER anticipate benefits totaling $2.2B annually for the U.S. manufacturing sector, based on reduction of product creation costs and timing, increased sales due to earlier product availability, and superior functionality and quality. Engineous Software projects the market potential for the software that they will commercialize based on this technology to be $714M. Similar revenues are anticipated for other software vendors who will gain an opportunity to expand their product lines to provide complementary capabilities.

3.B.2 Need for ATP Funding

The broad vision and risk of FIPER prohibits any single company from undertaking the proposed pervasive solution. ATP funding will drive a general solution versus the typical point solutions that result from scarceness of resources and lack of need to provide an industry-general solution. Without ATP funding, even if partial solutions were forthcoming within a few companies, the potential for the sharing, transitioning, and commercializing required to achieve timely and pervasive benefits is minimal.

3.B.3 Pathway to Economic Benefit

Benefits are anticipated for the major manufacturers on the FIPER team. They are committing substantial resources to support development of what they believe to be strategic technology. Additional benefits are anticipated by ESI. They are committed to commercializing the FIPER technology in a series of products that will be developed outside this project, but with initial offerings anticipated within 2 years of initiation of ATP supported work. Venture funding is also anticipated for this commercialization phase, once risk has been reduced to appropriate levels. Further benefits are anticipated for CAD and analytical tool vendors, once the planned demonstrations illustrate compelling benefits and market pull.