Final Report of the Committee for the Review of Proposals to the 2009 Engineering and Physical Science Research and Commercialization Program of the Ohio Third Frontier Program

Committee for the Review of Proposals to the
2009 Engineering and Physical Science Research and Commercialization Program
of the Ohio Third Frontier Program

Aeronautics and Space Engineering Board
Division on Engineering and Physical Sciences
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April 17, 2009

Mark Barbash
Interim Director
Ohio Department of Development
77 S. High Street
Columbus, OH 43215-6130

Dear Mr. Barbash:

This letter details the work and transmits the final report of the Committee for the Review of Proposals to the 2009 Engineering and Physical Science Research and Commercialization Program of the Ohio Third Frontier Program (TFP). This activity was supported by a contract of the Ohio Department of Development (ODOD) with the National Academy of Sciences and was performed under the auspices of the National Research Council's Aeronautics and Space Engineering Board (ASEB).

The goal of the Research and Commercialization Program (RCP) is to make Ohio a national leader in creating new jobs and business opportunities by commercializing technology-based products. Proposals selected for funding under the RCP should lead to an integrated program of a substantial scale and consistent high quality that will move Ohio toward a position of national leadership in the selected focus area.

Commercialization of new technologies involves multiple phases from imagining new commercial opportunities to market entry and, ultimately, growth and sustainability to generate financial returns. The RCP is focused on two phases of commercialization: the incubating phase (to define the ability to commercialize a new technology) and the demonstration phase (to demonstrate new products and processes in a commercial context). Projects are expected to commercialize new products during the 3-year period when active work funded by the RCP grants will take place. Projects are also expected to demonstrate the potential for on-going commercialization after the grants expire.

Applicants were told that their proposals would be evaluated against multiple criteria, including the following: technical merit and plan, commercial potential, leadership and management quality, and budget and cost share.

The Request for Proposals (RFP) welcomed proposals in two broad areas: (1) engineering and physical science (EPS) and (2) biosciences. This letter assesses proposals in the first area. Another National Research Council committee assessed bioscience proposals, and the results of that assessment are reported separately.

The RCP RFP describes four focus areas relevant to engineering and the physical sciences: advanced/alternative energy; instruments, controls, and electronics; advanced materials; and advanced propulsion. Before submitting a proposal, applicants were required to submit a letter of intent. Based on those letters of intent, each proposal was assigned to either the EPS committee or to the biosciences committee for evaluation. A total of 39 proposals were ultimately determined to fall within the scope of the EPS area. Seven of the 39 EPS RCP proposals were eliminated during an administrative review by ODOD. The other 32 proposals were forwarded to the committee for evaluation. These proposals encompassed all four EPS focus areas.

At the request of ODOD, the National Research Council convened the Committee for the Review of Proposals to the 2009 Engineering and Physical Science Research and Commercialization Program

of the Ohio Third Frontier Program to assess the EPS RCP proposals. The committee of 18 included one member of the National Academy of Science and seven members of the National Academy of Engineering. Committee members were chosen to provide necessary expertise based on the subject areas of the 32 EPS RCP proposals to be evaluated by the committee. In addition, the committee included members with expertise and experience in business practices, technology transfer, and economic development. The committee was chaired by Lyle H. Schwartz, director (retired) of the Air Force Office of Scientific Research and member of the National Academy of Engineering. The committee roster appears in Appendix C, and biographies of the committee members can be found in Appendix D.

The process used by the committee to review the proposals was as follows: Based on criteria and proposal requirements specified in the RFP, ASEB staff developed an evaluation worksheet (see Appendix B) and numerical measure to help guide the initial evaluation of the proposals. After the committee was formed, each of the 32 proposals was read by a committee member acting as the primary reviewer and by one or two other members acting as secondary reviewers. Each reviewer completed a worksheet for each proposal they evaluated.

The committee held its first meeting in Washington, D.C., on February 19-20, 2009. At that meeting, the primary and secondary reviewers used the worksheets they completed to lead the rest of the committee in a discussion of the strengths and weaknesses of each of the 32 proposals. Because of their subjective nature, the numerical scores were only used to guide discussions. Based on those discussions, the committee selected 10 proposals by consensus for further examination at the committee's second and final meeting. The committee also developed a list of follow-up questions to address areas of concern for each of the 10 proposals. These questions were sent to ODOD staff, who forwarded them to the lead applicants prior to the second meeting.

On March 12-13, 2009, 10 members of the committee traveled to Columbus, Ohio, to meet with groups representing the 10 best proposals. Each group was given 25 minutes to address the committee's follow-up questions, followed by 20 minutes of additional discussions led by the committee. The committee subsequently reached consensus on which proposals to recommend as most qualified.

The committee recommends that the Third Frontier Commission consider for funding five proposals that make a strong case that they would achieve the goals and purpose of the RCP. In terms of the evaluation criteria presented in the RFP, the strengths of these proposals far outweigh whatever weaknesses may be present. A brief description of the goals and strengths of these 5 proposals follow; more detailed reviews of all 32 proposals appear in Appendix A. The committee has rank-ordered the proposals based on their assessment of the degree to which the proposals met the standards set forth in the RFP.

1. EPS RCP 09-056: Microchannel Hydroprocessing for Upgrading Synthetic Biofuels, Petroleum Feedstock, and Chemical Intermediates. This applicant team, led by Velocys, Inc., proposes to apply its microchannel process technology to hydroprocessing, with a specific focus on hydrocracking to upgrade Fischer-Tropsch (FT) fuels and heavy petroleum feedstock. Successful extension of the microchannel technology platform would result in modular, less capital-intensive hydrocracking units that achieve favorable economics at the scale of individual biomass-to-liquid facilities and small-scale units for incremental capacity increases in petroleum refineries to treat increasingly heavier crude oil feedstock as well as non-conventional sources, such as tar sands and wax from FT liquid fuel production. The technical merit of this proposal is outstanding, and it has impressive commercial potential.

2. EPS RCP 09-040: Electronically Changeable Color Skins for Consumer Electronics. This applicant team, led by Kent Displays, Inc. (KDI), proposes to use KDI's commercially successful Reflex™ (bistable color reflective liquid crystal) technology to create a multi-layer reflective skin capable of changing the color of cell phones, laptop computers, MP3 players and other consumer electronic products. The new electronic skin product line (to be known as "eGo") would leverage technology controlled by KDI and the collaborators to develop a new technology and create as many as 100 new jobs

in Ohio. The committee views the proposed technology to be commercially viable, and it has a very large potential market. The proposed work is quite innovative and fits well in the goals and requirements of the ERCP grant program.

3. EPS RCP 09-003: Advanced Composites: The New Generation of Materials Powered by Nanotechnology. This applicant team, led by Zyvex Performance Materials, proposes to further develop Zyvex's proprietary technology, called Kentera™. This technology, which has already been demonstrated, appears not to damage or compromise the functional attributes of carbon nanotubes, but rather opens the door for optimizing functionalization in different matrices. The difficulty of processing and manipulating promising nanomaterials such as carbon nanotubes is a major limitation in expanding this technology's applications to large-scale industrial and structural components. The diverse commercialization team and supply chains proposed for undertaking the research and development across three product applications has the potential to help accelerate nano-applications of carbon nanotubes and broaden product lines. This is likely to create high-value jobs in Ohio. The diverse array of applications is likely to lead to several entry points to early marketing, supporting continued growth of other business areas with a proven revenue stream. The proposal benefits strongly from earlier investments made by ODOD at many of the participating organizations.

4. EPS RCP 09-014: Magnesium Diboride for Next Generation MRI. This applicant team, led by HyperTech Research, will develop commercial, full body MRI Systems utilizing HyperTech's magnesium diboride (MgB2) superconducting wire. The proposal has a sound technical footing and firm support from Siemens, a major producer of MRI systems. Success of the project will enable a large reduction in the amount of liquid helium required for MRI operation. Even if the proposal's price projections for liquid helium do not bear out, helium is an exhaustible resource with limited future supplies. Additionally, there is a strong need for more robust, lighter MRI technologies and improved superconducting wires for MRI and other superconducting applications.

5. EPS RCP 09-018: Development and Commercialization of Next Generation Composite Tooling Solutions. This applicant team, led by GrafTech International, proposes to develop lightweight carbon as a tooling material for making composites and replace the existing, expensive tools and dies that made from steel, composites, or Invar®. Due to the generally high friability (surface dusting) of graphite, the proposed work would use foams sealed with polymers and coatings that would expand the temperature range of the tooling. The specific value of one of the research components (use of polyaniline nanograss) of the proposal was not completely clear to the committee, but the rest of the research proposed is clearly linked to the final products. The potential for job creation from this proposal is particularly high.

The RFP specifies that the budget for each RCP proposal should include approximately $2 million to $5 million in state funds. The five proposals above ask for a total of $24.1 million in state funds.

All of the remaining 27 proposals scored substantially lower than the 5 proposals listed above, when ranked *against the criteria and requirements specified in the RCP's Request For Proposals*, and they are not recommended for consideration under the current RCP. This does not necessarily mean that the proposals lack merit or should not be funded as part of some other program sponsored by the TFP, the state of Ohio, or the federal government. For example, EPS RCP 09-067, Scalable and Integrated Waste to Energy System, was a very strong technology demonstration or public education project, but the committee determined that the proposal's commercialization strategy was too ill-defined to be a good fit for the RCP. However, it may warrant funding under a program focused more on the development of green technology or education projects in its field as opposed to the commercialization of a new product. The specific strengths and weaknesses of all the EPS RCP proposals are included in Appendix A.

The committee wishes to thank the state of Ohio for the opportunity to review these proposals and to provide its recommendations as to which of the proposals best meet the requirements set forth in the RCP's RFP.

Sincerely,

Lyle H. Schwartz
Chair

cc: Richard Rowberg

Appendixes

A Individual Summary Evaluations
B Evaluation Worksheet
C Committee Roster
D Biographical Sketches of Committee Members and Staff
E Reviewer Acknowledgment

Appendix A
Individual Summary Evaluations

EPS RCP 09-002
Development and Commercialization of a Reconfigurable Resilient Prognostic System for High Performance Manufacturing

TechSolve, Inc.

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$2,911,240	$4,055,697
Capital Funds	$240,000	$150,000
Subtotal	$3,151,240	$4,205,697
TOTAL	$$7,356,937	

The work proposed by TechSolve, Inc., relates to research and commercialization efforts to develop a system for predicting machine tool health and part quality. The primary focus area is the integration of various algorithms into an adaptive model that can predict whether the health of a machine tool is acceptable to complete a given production task to specification.

The proposal includes two collaborators: the University of Cincinnati and Frontier Technology. The proposed work would build from the research of Jay Lee's group at the University of Cincinnati over the last decade and benefit the machine tool industry by minimizing machine down time and scrap parts.

Detailed Review

- **Technical Merit and Plan**

While the technical complexity of the task is significant, the level of scientific merit of the proposal is intermediate from the perspective of the RFP expectations. Only incremental improvements are anticipated to emerge from the large amount of investment that is requested. The proposal does not meet the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

The impact on the machining industry is questionable because the market penetration potential and market size are rather small. Further, design packages can provide critical cost savings in principle, but the time-lines and cost for developing and validating a package over a vast range of machine tool and product configurations may limit widespread use in Ohio's machining industry, which is struggling with near-term survival because of competition with cheaper foreign manufacturing. The arguments in favor of minimizing machine down time and part scrap rate notwithstanding, the potential for successfully transforming the Ohio manufacturing landscape to compete globally from the proposed work is low. The proposal does not meet the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

The industrial collaboration assembled for the proposed work covers project management, algorithm development and integration, technology demonstration design packages, and new business development. The proposal does not identify a technical director or a commercialization director, as required in the RFP. However, the leadership team for the specific technical tasks and the overall management is very strong. The proposal meets the requirements of the RFP on Leadership and Management.

- **Budget and Cost Share**

The budget from the development and management tasks seem generally reasonable. The proposal meets the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

The proposed technology builds from research expertise developed at the University of Cincinnati over the last decade, and the team has demonstrated good project management skills. However, the proposal does not include a credible process for widespread implementation of the proposed model in Ohio's varied and struggling machining industry, resulting in unacceptably low commercialization potential.

The committee does not recommend that this proposal be considered for the limited Third Frontier Programs funds.

EPS RCP 09-003
Advanced Composites: The New Generation of Materials Powered by Nanotechnology

Zyvex Performance Materials, LLC

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$ 4,038,609	$5,058,754
Capital Funds	$958,000	$637,000
Subtotal	$4,996,609	$5,695,754
TOTAL	$10,692,363	

Zyvex Performance Materials, LLC, has organized a large team of composite suppliers, end users, universities, and technology transfer organizations in Ohio to pursue the further development of a proprietary technology, called Kentera™. This technology, which has already been demonstrated, appears not to damage or compromise the functional attributes of carbon nanotubes, but rather opens the door for optimizing functionalization in different matrices. Through two thrusts, Zyvex proposes to develop and commercialize applications to advanced composites, elastomer products, and specialty resin products. A framework for sharing intellectual property among the members of the proposal team is in place. The difficulty of processing and manipulating promising nanomaterials such as carbon nanotubes is a major limitation in expanding this technology's applications to large-scale industrial and structural components. Collaborators include PolyOne Corporation, the University of Akron, Shawnee State University, the University of Dayton Research Institute, the National Composite Center, the Center for Multifunctional Polymer Nanomaterials and Devices, Renegade Materials Corporation, Hexion, PolymerOhio, Lockheed Martin, Owens Corning, and Hexcel.

Detailed Review

- **Technical Merit and Plan**

The proposed project could allow Zyvex to enter markets where advanced composites and structures are critical, including the marine, sporting goods, aerospace, and high-end automotive industries. The technology is an innovative platform and could have significant impact if the project is successful. Kentera™ is a versatile and non-damaging chemistry platform that uses rigid conjugated polymers. The rigid rod backbone of Kentera™ is designed to adhere to the surface of the carbon nanotube while the side chains are designed for enhanced compatibility, adhesion to the host matrix, and creation of a steric-barrier that prevents aggregation (i.e., clumping) of the nanotubes. The technology uses the less expensive multi-wall carbon nanotubes, rather than the very costly single-wall carbon nanotubes. The proposal lists a high number of Level C attributes, which indicates that several significant technology risks have been addressed. Additionally, the proposal provides a comprehensive discussion of A, B, C level metrics with credible partners. It appears that there is significant process- and product-oriented research, which will reduce costs and enable new applications. The proposal exceeds the requirements of the RFP on Scientific and Technical Merit and Plan.

- **Commercial Potential**

The proposed work would expand the application of carbon nanotube composites for the sporting goods, defense, aerospace, automotive, marine, energy, and industrial markets. Thus, this work is an excellent fit for Ohio's economy. The proposal has a good balance of technology push and market pull in place with its commercialization strategy for new products in thermoset nano-composites, new adhesives, and thermoplastics. This three-pronged approach is a potential advantage for accelerating the industry,

and it appears that Kentera™ technology can be tailored for many applications. The proposal is strengthened over last year's by the addition of Lockheed Martin as an equity partner in Zyvex Performance Materials, and by the cash and technology investment in Zyvex made by a supplier of multi-wall carbon nanotubes (Arkema, Inc.). The proposal exceeds the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

The proposal team and its track record are very strong, and they are strengthened further by the presence and endorsement of Lockheed Martin as a "technology pull" end-user and equity partner. Zyvex has a strong prior track record as an innovator in nanomaterials and nanotechnology tools, and it is well-suited to manage this project. The industrialization team is also well composed with a good balance of support from suppliers and academia. The proposal exceeds the requirements of the RFP on Leadership and Management Quality.

- **Budget and Cost Share**

The proposal's budget and cost share include significant industry matches, and the project leverages previous investments by ODOD particularly well. Arkema intends to set up a plant for carbon nanotubes in Ohio after overcoming some critical technology and manufacturing scale-up issues. Even though the total cost share in Budget Table 1 does not match the total shown on the cover of the proposal, the proposal exceeds the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

The diverse commercialization team and supply chains proposed for undertaking research and development across three product applications has the potential to help accelerate nano-applications of carbon nanotubes and broaden product lines, which is likely to create high-value jobs in Ohio. The diverse array of applications is likely to lead to several entry points into early marketing, thereby supporting continued growth of other business areas with a proven revenue stream. The proposal benefits strongly from earlier investments made by ODOD at many of the participating organizations.

The committee recommends that this proposal be considered for the limited Third Frontier Programs funds.

EPS RCP 09-004
Development and Commercialization of Nano Graphene Platelets:
A New Class of Carbon Nano Materials

Angstron Materials, LLC

Proposal Summary

Angstron Materials, LLC, seeks to develop and commercialize a new, inexpensive method for synthesis of nanographene platelets (NGPs) and polymer mixtures. The targeted markets focus on polymer nanocomposites for both functional and load-bearing applications.

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$2,888,793	$2,119,311
Capital Funds	$295,302	$1,145,000
Subtotal	$3,184,095	$3,264,311
TOTAL	$6,448,406	

Detailed Review

- **Technical Merit and Plan**

Low-cost exfoliation capabilities and concepts could dramatically redefine the rules of the game for advanced composites and nanocomposites. However, few enhancements in polymer mixtures that take advantage of these possibilities for specific applications were demonstrated. The proposal would have been stronger if it had demonstrated the superiority of the proposed new materials over currently available alternatives. Further, unique dispersion methodologies to minimize agglomeration in the matrix and in-line quality control methods should have been more effectively addressed. The committee believes that these issues are the main technical challenges that the proposed work must overcome. The proposal does not meet the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

There is a potentially huge market for nanographene-based composites. However, a clear pathway for bringing the results of the proposed work to market was not demonstrated convincingly. The proposal does not meet the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

The lead applicant has strong scientific leadership, but it could benefit from further development of complementary partnerships with others who have experience in translating new technology ideas into viable businesses. The proposal meets the requirements of the RFP on Leadership and Management.

- **Budget and Cost Share**

Although K2 Energy Solutions is listed as a collaborator in the collaborator information section of the proposal, it is not included on Budget Form 4, nor does it have a Budget Form 3. Nanotek Instruments, Inc., is not listed as a collaborator, even though it is listed on Budget Form 4, and a Budget Form 3 is included. Otherwise, the proposal meets the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

The committee recognizes the huge potential for nanographene-based materials and the significance of the exfoliation capability demonstrated by the lead applicant. However, the proposal team did not sufficiently demonstrate the performance advantages of the polymer nanocomposites over competing materials for specific applications. The presence of committed end users with a stated desire to procure these materials in large quantities would have strengthened the proposal. The technological challenges and commercialization plans need to be better addressed before market penetration is possible.

The committee does not recommend that this proposal be considered for the limited Third Frontier Programs funds.

EPS RCP 09-008
Renewable, Bio-based Plasticizer Solutions for the Poly(vinylchloride) Industry

PolyOne Corporation

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$4,984,698	$4,984,699
Capital Funds	$0	$0
Subtotal	$4,984,698	$4,984,699
TOTAL	$9,969,397	

The PolyOne Corporation proposal is predicated on the assumption that bio-based plasticizers are desired for polyvinyl chloride (PVC) to replace conventional plasticizers because of health and toxicity concerns (primarily of phthalates; specifically DOP [dioctyl phthalate]) and raw material costs, especially rising petroleum costs.

This proposal considers cost and use of renewable raw materials in the production of PVC, where petroleum-based raw materials continue to enjoy an economic advantage that will likely erode over time. The proposal notes that many attempts to replace conventional petroleum-based plasticizers with renewable raw materials have failed, in part due to economic concerns. The approach of this proposal is to use epoxidation and esterification to utilize derivatives of vegetable oils (soybean oils) as plasticizers to provide both compatibility and a modest thermal stabilization improvement. Epoxidized soybean oil has been employed as a secondary plasticizer and a secondary thermal stabilizer for decades and is an inherent component of many plasticized PVC applications. Improved compatibility is desired for the vegetable oil products to replace primary plasticizers. There should be a market for such products to replace DOP where regulations and consumer pressure require a change. The key hurdle is to find vegetable-oil-based plasticizers that offer price and performance profiles that are an improvement over existing non-phthalate plasticizers.

This project includes seven collaborators: Archer Daniel Midland, RJF International, Canadian General Tower, Avery Dennison, The Ohio Soybean Council, Ohio BioProducts Innovation Center, and Omnova Solutions.

Detailed Review

- **Technical Merit and Plan**

The approach of epoxidation and esterification of unsaturated vegetable oils to improve the compatibility with PVC appears viable. As significant work has already been conducted in this area over a number of years, achieving cost/performance equal to or better than DOP appears questionable. The toxicity concerns of DOP will continue and while this may not be a real concern, it is at least a perceived concern and "perception is reality." Thus, attacks on DOP will probably continue and regulations will probably cause other plasticizers to be used in specific applications such as children's toys, food contact films and packaging, and blood bags. DOP has been used in these applications for over 50 years without any proven adverse effects but continues to be under attack now in Europe and is likely to eventually be removed from the U.S. market.

As a significant amount of work has already been done on bio-based plasticizers, it would appear that the proposed research is straightforward, and evaluation of the variants should also be straightforward, leading to a rapid commercial evaluation. It would have been informative to see a property comparison between the most promising bio-based plasticizer from the earlier PolyOne study and the industry standard (DOP). Bio-based does not necessarily mean that toxicity concerns will be absent. Plasticizers need to be taken through extensive toxicity profile determinations. Some epoxidized compounds have

been found to be quite toxic, so the proposed epoxidized varients may also present concerns. The proposal does not meet the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

With technical success in achieving an efficient bio-based plasticizer, the economics versus other choices (adipates, citrates, oligomeric aliphatic polyesters) will determine commercial viability. There is some question as to how cost and performance effective the soybean-based plasticizers would be versus the established non-DOP plasticizers. The impact on cost and performance appears to be modest, but could yield a viable, sustainable business with good growth for a company the size of PolyOne. Non-DOP plasticizer PVC products are now appearing in the market for medical use, specifically targeted to replace DOP. Other plasticizers, such as low-molecular-weight aliphatic polyesters and adipates could potentially replace DOP in these applications and may be the primary competitors for the products of this proposal and not DOP. However, the willingness of consumers to pay for a "green" plasticizer is noted but not properly documented.

As a supplier of plasticizers, PolyOne is in an excellent position to evaluate plasticizers and to market a successful product. They have an alliance with ADM that should be helpful. PolyOne notes that they have defined and evaluated several potential structures but failed to commercialize those, based on economic viability. One problem is that when petroleum prices go up (over a five year span), soybean prices also increase. The committee notes that the impact of the proposed project on the soybean production in Ohio would be quite small. The committee believes that the proposal does not meet the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

This is the strongest part of the proposal. PolyOne has put in place an alliance with ADM to commercialize bio-based plasticizers. PolyOne is in a position to commercialize technical and economic successes from this work. The proposal meets the requirements of the RFP on Leadership and Management Quality.

- **Budget and Cost Share**

The support of the state of Ohio should be limited to the research phase of this proposal to develop improved bio-based plasticizers. The requested dollar amount appears to be somewhat high relative to the research requirement and the impact of the proposal. The proposal does not meet the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

The use of modified vegetable oils (such as soybean oil) as a primary plasticizer replacement for conventional PVC plasticizers has been a reasonably well-researched area for decades without success. The primary applicant acknowledges a similar conclusion in their prior work. Replacement of DOP will ultimately occur in specific applications for which the available non-DOP plasticizers would appear to suffice. Any research successes could be easily evaluated, scaled, and commercialized by PolyOne/ADM partnership.

The committee does not recommend that this proposal be considered for the limited Third Frontier Programs funds.

EPS RCP 09-009
Unducted Low-Noise Fans for Extremely Fuel Efficient Engines

The Ohio State University Research Foundation

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$5,000,000	$5,000,000
Capital Funds	0	0
Subtotal	$5,000,000	$5,000,000
TOTAL	$10,000,000	

The proposal team is led by the Ohio State University Research Foundation and includes two collaborators: NASA Glenn Research Center, and GE Aviation. The proposed work would investigate the noise characteristics of four different unducted fan designs. GE Aircraft Engines would design the fans, NASA Glenn would noise test the fans, and Ohio State University would modify existing numerical codes based on the observed data.

Detailed Review

- **Technical Merit and Plan**

The proposed program is based on a balanced technical approach consisting of analytical and empirical activities to provide detailed understanding of the parameters impacting the noise and operating efficiency of unducted fans and generate tools for future propulsion systems designs. The proposal contains original and innovative approaches for the design of high-speed rotating aerodynamic components and methods development and validation. The proposed work, if successful, would generate a more detailed understanding of the noise generation phenomenon and the interaction with propulsion efficiency. However, it seems highly unlikely that a Reynolds-averaged turbulent model would accurately predict the unsteady pressure levels that produce noise. Otherwise, the proposal meets the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

The proposal notes the significant strength of the aerospace power and propulsion community in Ohio, and the commercial potential of an unducted fan engine is large. However, realizing this potential requires overcoming barriers to that go beyond the ability of the proposed computer model to address, and the commercial value of the computer model itself seems to be very limited. The proposal does not meet the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

The proposal would have been stronger if the industry collaborator had been the lead applicant. Also, the proposal does not identify a technical director or a commercialization director, as required in the RFP. Otherwise, the proposal meets the requirements of the RFP on Leadership and Management.

- **Budget and Cost Share**

The budget is adequate, although all of the cost share is in kind, with no cash contribution. The proposal meets the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

While this effort shows good coordination between Ohio State University, NASA Glenn Research Center, and GE Aviation, the primary activity to be supported by this proposal is of questionable technical merit. In addition, the activity itself has little or no commercial value and the proposal does not convincingly demonstrate that it is enabling to the unducted fan engine.

The committee does not recommend that this proposal be considered for the limited Third Frontier Programs funds.

EPS RCP 09-011
Nano-Reinforced Polymer Foams for Insulation and Structural Markets

The Ohio State University Research Foundation

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$4,072,681	$5,000,000
Capital Funds	$927,319	$0
Subtotal	$5,000,000	$5,000,000
TOTAL	$10,000,000	

Polymer foams (i.e., polymer-gas composites) are widely used in construction and other industries for insulation and as structural materials. A wide range of foamed plastics is available, and in principle, their properties can be tailored to specific applications through tuning of material parameters such as matrix, foam density, and cell size. This Ohio State University Research Foundation proposal seeks to improve current polymer foam technology with a number of innovative advances and to provide materials with greater price-performance trade-offs. Innovations include the commercialization of new foaming technologies, the addition of nanomaterials for improved physical properties, and an emphasis on recycling waste materials as a raw material stream. The proposal team includes a large number of Ohio-based companies, including some that are already major producers of cellular plastic materials. In particular, the collaborators are A.R.E., Applied Sciences, Inc., Commercial Vehicle Group, Living Space Sunrooms, Nanomaterial Innovation, Ltd., Ovation Polymers, Owens Corning Science and Technology Center, PolymerOhio, Inc., Rain Drop Products, LLC, The Ohio State University Center for Multifuntional Polymer Nanomaterials and Devices, and Zyvex Performance Materials.

Detailed Review

- **Technical Merit and Plan**

The proposal provides innovative concepts in a several areas involving polymer foam technology:

—*Blowing Agents.* The uses of chloro/fluorohydrocarbon derivatives will be prohibited relatively soon, and alternative blowing agent systems are urgently needed. The most probable replacement candidate is CO_2. There are technical problems associated with the use of CO_2, both thermodynamic (having to do with gas solubility in the matrix) and kinetic (having to do with gas diffusion rates). This proposal seeks to solve these problems by incorporating an appropriate quantity of a second polymer/polymer blend. This approach needs to be carefully monitored with regard to possible negative outcomes arising from polymer-to-polymer compatibility issues.

—*Material Stream.* The proposal places special emphasis on using large quantities of scrap expanded polystyrene foam that is currently consigned to landfills. This is laudable from several points of view, but it is not obvious that a balance between recyclable material availability and consumption in new foam products can be achieved, especially if demand for the proposed advanced property foams is high. Virgin resins may eventually be required.

—*Nanomaterial Additives.* A main feature of the proposal is the production of plastic foams that are improved by incorporating one or more nanomaterials. Such additives will, in principle, strengthen cell walls. In addition, and perhaps more importantly, these additives could be used to modify overall cell morphology and foam density, resulting in foam materials with improved physical properties. In principle, it should be possible to produce cellular plastics with properties approaching those of the corresponding bulk materials, but with lower density, lower cost, and more versatile production

processes. Nonetheless, the use of large amounts of nanomaterials will add significantly to the overall product cost.

The committee is concerned that the proposed work may require considerably more resources to complete than what can be provided by the ERCP grant, thus pushing the proposal outside of the timeframe of interest to the program. As such, the proposal does not meet the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

Plastic foams are very widely used in many industries. Therefore, a foam with significantly improved properties and low cost is very likely to be highly successful commercially. It is significant that Owens Corning, a major producer of plastic foams located in Ohio, is committed to this project. A large number of consumer-oriented Ohio companies are similarly identified as key collaborators. The committee is concerned that the new products promised by the proposal may not achieve market entry within the timeframe set forth by the RFP. Nevertheless, the proposal meets the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

A comprehensive multi-level management scheme is proposed to lead this rather complex project. Success will depend on the ability of management to coordinate the roles of a lengthy list of proposed collaborators. The proposal does not identify a commercialization director or a technical director, as required by the RFP. Otherwise, the proposal meets the requirements of the RFP on Leadership and Management Quality.

- **Budget and Cost Share**

The numbers presented and the distributions of funds appear to be well conceived and plausible. However, even though the collaboration information section lists 11 collaborators, only three have a Budget Form 3, and only those three are listed on Budget Form 4. Otherwise, the proposal meets the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

The proposal identifies several innovative approaches to the development of improved foams, but technical and commercial problems remain and require further attention.

The committee does not recommend that this proposal be considered for the limited Third Frontier Programs funds.

EPS RCP 09-012
Development of an Intelligent System to Optimally Grind Exotic Materials

TechSolve, Inc.

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$3,189,102	$2,513,496
Capital Funds	$0	$708,000
Subtotal	$3,189,102	$3,221,496
TOTAL	$6,410,598	

The TechSolve, Inc., proposed work relates to research and commercialization efforts associated with a knowledge-based system development for grinding difficult to process materials for aerospace and other applications. The proposed work would build from the research of faculty at Ohio State University and Wright State University to benefit the grinding industry and their customers. Collaborators include University of Toledo, Wright State University, Scientific Forming Technologies Corporation, and Ohio State University.

Detailed Review

- **Technical Merit and Plan**

Grinding process analysis and modeling are technically challenging, and the ability to fine tune process parameters for specific advanced alloys and ceramics can be beneficial to the field. Incremental improvements are anticipated to emerge from the large amount of investment that is requested. However, the scientific merit of the proposal is low to intermediate from the perspective of the RFP expectations. The proposal does not meet the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

The potential impact on the machining industry is questionable, since the market penetration potential and market size are rather small. Furthermore, advisory systems can provide critical cost savings in principle, but the timelines and cost of developing and validating the package over a vast range of materials and product configurations can limit widespread use in an industry struggling with near-term survival in Ohio. The proposal does not meet the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

The industrial collaboration assembled for the proposed work covers project management, knowledge-based advisor system development, and demonstration. The leadership team for the specific technical tasks and the overall management are strong. The proposal meets the requirements of the RFP on Leadership and Management Quality.

- **Budget and Cost Share**

The budget from the development and management tasks seems generally reasonable. As discussed earlier, relative to the requested funds in the budget, the return on investment is expected to be low. The proposal meets the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

The proposed technology builds from research expertise developed at Ohio universities, and the team has demonstrated good project management skills. However, the potential impact on the Ohio economy from advanced technology development leading to new jobs appears to be very limited, and the proposal does not provide any discussion regarding the value of the technology to existing firms. The industry is currently struggling to compete with cheaper overseas manufacturing and it is unlikely that the proposed work will adequately impact these trends. Long-term benefits for Ohio to compete globally are minimal, given the market situation and the ability of the technology to address it.

The committee does not recommend that this proposal be considered for the limited Third Frontier Programs funds.

EPS RCP 09-014
Magnesium Diboride for Next Generation MRI

HyperTech Research Inc.

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	4,395,000.00	5,339,298.00
Capital Funds	605,000.00	0
Subtotal	5,000,000.00	5,339,298.00
TOTAL	10,339298	

Niobium-titanium (NbTi) superconductors have been the workhorse for MRI background magnets—and they have also been the technology that has enabled improvements in MRI image quality. All current 1.5 and 3.0 tesla MRI systems use NbTi superconductors that are maintained at 4 K by liquid helium. Liquid helium increased in price by 60% in 2007 and price increases are likely to continue when the global economy resumes growth. Also, future helium supplies are uncertain over the long term. Superconductors that operate at higher temperatures, such as magnesium diboride (MgB_2) superconductors, do not require the use of liquid helium bath cooling, which would greatly reduce or eliminate the need for liquid helium, producing secondary benefits in the design of MRIs and MRI-user facilities.

The work proposed by HyperTech Research Inc., builds on HyperTech's high-field and high-temperature superconductor wire technology. HyperTech's MgB_2 superconductor wire is entering the large-scale, high-volume MRI system demonstration phase of the ERCP commercialization framework. The intent of this proposal is to bridge the gap between HyperTech's current MgB_2 superconductor wire properties and those specified by potential customers who are preparing to conduct prototype MRI demonstration systems using the MgB_2 superconducting wire. This project would enable HyperTech to demonstrate the price and performance for MgB_2 superconductor wire for commercial full body MRI systems, and to have HyperTech's MgB_2 wire demonstrated in a commercial-size next-generation MRI system by an MRI system producer. This project would also demonstrate the commercialization potential for the market entry phase, which will enable HyperTech to penetrate the several-hundred-million-dollar world market for MRI superconductor wire and expand its manufacturing of the wire in Ohio.

Detailed Review

- **Technical Merit and Plan**

The proposal's discussion of goals is scientifically well founded and accurate. Specific details on how to improve wire performance are in place. For example, the proposal clearly describes how the team intends to increase the superconductor fraction in the wire from approximately 15 to 18 percent up to 25 to 30 percent in long lengths, to double the superconducting current density at operating temperature, and to improve persistent joints at temperatures of 4 K to 25 K. In particular, this project would investigate approaches for improving the understanding of dual nano-technology dopants to enhance flux pinning and the understanding of superconductor connectivity to greatly enhance superconductor properties, in practical, long-length superconductor wires. This knowledge is applicable to MgB_2 for MRIs and for other applications, such as fault current limiters, motors, generators, and high-energy physics. The proposal exceeds the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

The proposal's primary objective is to satisfy Siemens' MRI wire needs, because Seimens is providing the majority of the cost share. The proposed work would also address the MRI wire needs of Philips and GE (because they are very similar to the needs of Seimens). HyperTech has nondisclosure agreements with GE and Philips and has been working with them for over 3 years. Both GE and Philips have internal MgB_2 programs with HyperTech, and while this RCP proposal is partnered with Siemens, so far nothing in their relationship with Siemens or in the proposed work would restrict HyperTech from providing improved MgB_2 wire to GE or Philips. If helium prices soften considerably in reaction to the global economic downturn, it is possible that penetration of the MRI market by the new technology could occur more slowly than currently is projected. Nevertheless, the proposal exceeds the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

The proposal includes a detailed description of team member's responsibilities, strengths, and weaknesses. Capabilities and demonstrated leadership are documented. Siemens has a proven capability to apply fundamental R&D to the design of successful and innovative products. The proposal exceeds the requirements of the RFP on Leadership and Management.

- **Budget and Cost Share**

Siemens is providing substantial funds for experimental wire, plus a cost share of at least $3 million for internal MRI magnet and system development using the MgB_2 wire. The budget is well justified and adequate to meet the proposal's goals. The proposal exceeds the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

The proposal has a sound technical footing and firm support from Siemens. Collaboration with other customers (e.g., Philips and GE), although outside of the scope of this proposal, is likely. Although the proposal's price projections for liquid helium may not be borne out, helium is an exhaustible resource with limited future supplies. In addition, there is a strong need for more robust, lighter MRI technologies and improved superconducting wires for MRI and other superconducting applications.

The committee recommends that this proposal be considered for the limited Third Frontier Programs funds.

EPS RCP 09-016
Commercialization of Zinc Oxide Growth for Solid State Lighting Applications (OhioGrowZ)

Sawyer Technical Materials

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	2,830,000	600,194
Capital Funds	420,000	2,660,000
Subtotal	3,250,000	3,260,194
TOTAL	6,510,194	

The purpose of Sawyer Technical Materials's proposed OhioGrowZ is to create an Ohio-based source of single-crystal, hydrothermally-grown, bulk zinc oxide (ZnO) for lighting and electronic applications. Currently the only sources for this advanced material are a company in Japan and another in Russia. ZnO has been used in a variety of commercial applications for years, but it has only recently been identified as a material that could be used by the solid-state-lighting industry for light-emitting diodes (LEDs) and, possibly, as a compound semiconductor.

Detailed Review

- **Technical Merit and Plan**

ZnO crystals of the appropriate size, shape, and quality for fabrication into LED substrates do not readily occur in nature; they must be produced synthetically to be commercially viable. Synthetic growth of crystals such as silicon and quartz for electronics applications is common, but a commercially viable method of growing ZnO crystals has not been demonstrated.

The proposal adequately describes the technical issues that must be overcome to grow ZnO crystals for electronics applications. The main difficulty identified by the committee is the significant amount of time that is proposed to be devoted to literature searches on the various technical issues that should have been carried out already. The need for such a large amount of time for literature searches indicates that the project is likely too nascent for the RCP. The proposal does not meet the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

The degree of customer readiness is weak. The proposals states that, "At a minimum, we expect that once crystals have been generated, whether successfully p-doped or not, commercial sales to [Company X] of at least developmental or pre-production quantities will occur." As detailed in a "confidential" letter of support, Company X is a U.S. start-up company that is eager to work with Sawyer to develop commercial ZnO crystals for the market, and the proposal anticipates that commercial sales to Company X might be achieved by the end of the project period. However, Company X is still in the demonstration phase and is not currently producing any products, and the actual name of Company X is identified as a trade secret in the proposal. The proposal does not meet the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

The proposal claims that (1) "Sawyer's experience in the quartz industry positions it uniquely to deal with the challenges—both technical and commercial—associated with bringing a new material such as ZnO to successful implementation in designs and applications," (2) "the Semiconductor Research Center

(SRC) at Wright State University (WSU) has been one of the world's leaders in the development and characterization of bulk, single-crystal ZnO for over 10 years," and (3) "the main role of WSU in the present collaboration will be to establish the quality of the ZnO material as it is developed at Sawyer and to suggest ways to improve it." However, the budget indicates that WSU's participation in this project would be minimal (less than 10 percent). Also, the proposal does not provide substantive information that is required by the RFP on how the project would be managed. The proposal does not meet the requirements of the RFP on Leadership and Management.

- **Budget and Cost Share**

The budget includes more than $65,000 for travel, which seems high and is not well justified. Otherwise, the proposal meets the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

This proposal would have been much stronger if literature searches had already been completed and the information gleaned from such an effort incorporated into the technology plan. The budget for the university collaborator seems rather low in view of the important role that this partner seems to have in the characterization of the proposed materials.

The committee does not recommend that this proposal be considered for the limited Third Frontier Programs funds.

EPS RCP 09-018
Development and Commercialization of Next Generation Composite Tooling Solutions

GrafTech International Holdings, Inc.

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$3,732,702	$3,844,512
Capital Funds	$412,310	$300,500
Subtotal	$4,145,012	$4,145,012
TOTAL	$8,290,024	

The GrafTech International Holdings, Inc., proposal would develop lightweight carbon as a tooling material for making composites and replace the existing, expensive tools and dies that are made from steel, composites, or Invar®. Due to the generally high friability (surface dusting) of graphite, the proposed work would use foams sealed with polymers and coatings that would expand the temperature range of the tooling. The collaborators on this proposal are Case Western Reserve University, University of Dayton Research Institute, Smithers-Oasis, Renegade, Maverick, Ohio State University, Nanomaterial Innovation Ltd., and the Ohio Aerospace Institute.

Detailed Review

- **Technical Merit and Plan**

The technical content of this proposal is very good. It addresses several important issues associated with graphite, including water uptake, durability, improved mechanical properties, and sealants to enhance the operating temperature for use of these tools. The use of nanomaterials coupled with the intelligent choice of materials could lead to a continuing series of product improvements. However, the research component on the use of functionalized polyaniline nanograss to create superhydrophobic surfaces appears to be out of place and does not directly support product commercialization. Despite this seeming disconnect, the proposal meets the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

This project has excellent commercial opportunities, especially in the automotive, aerospace, and marine markets. The potential for multiple markets enhances the value of the proposed work and increases the likelihood of job creation. If successful, this project will create a large number of jobs for Ohio. The proposal exceeds the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

The experience of the proposal team in developing products with various foam cell sizes is clearly beneficial. The involvement of the Ohio Aerospace Institute would definitely expand the scope and application of the proposed work. The proposal exceeds the requirements of the RFP on Leadership and Management.

- **Budget and Cost Share**

The proposed budget and cost share seem adequate. The proposal meets the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

This proposal describes a very focused approach for the use of graphite foam and polymers in building tooling for composite formation, which would be especially useful for large components in a variety of applications. The plan for continuous improvement using other nanotechnologies is also advantageous, but it needs to be better defined in the overall context of product development. The potential for job creation from this proposal is particularly high.

The committee recommends that this proposal be considered for the limited Third Frontier Programs funds.

EPS RCP 09-020
Aerostat Emergency Communication System

Western DataCom Company, Inc.

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$3,978,336	$4,942,136
Capital Funds	$963,000	$0
Subtotal	$4,941,336	$4,942,136
TOTAL	$9,883,472	

The Western DataCom Company, Inc. (WDC), proposal establishes collaboration between WDC and the University of Cincinnati to develop an electronics suite and platform for protecting the public at large-scale events, providing security for key facilities, and enabling oversight of critical transportation hubs, as well as providing a situation-awareness tool to be used following major disaster declarations. The proposed platform is a tethered aerostat that would provide mobility and low-cost deployment. The proposal team claims growth in this market is likely to create high-tech jobs within applicable business clusters.

Detailed Review

- **Technical Merit and Plan**

The technical risk of this project appears to be very low and the research potential could be better described. The development of the requirements and architecture for the mission payload for this proposal is not clear. It is also not clear whether the use of a tethered airframe in the airspace that will make this an easy capability for first responders to quickly deploy will require certification or flight approvals.. The airspace in a disaster area is precious as a means of command and control, critical asset entry, and search and rescue or medical extraction; the proposal does not address the varied and competing needs of the airspace and possible costs of alternatives.

The proposal's abstract discusses endurance tests of possibly weeks in length, while the test plan in the proposal suggests endurance tests of only several days. Aerostat technology has been used since World War II, but a number of alternatives have replaced this requirement for the military. The shortcomings of using the technology as a border device have been publicized, but these are not discussed in the proposal. More discussion on the position location and gimbaled imagery and ground distance determination would be helpful in determining the precision of the image location as viewed from altitude. The proposal lacks sufficient detail and does not meet the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

The market for this application should be better researched than what appears in the proposal. The apparent high unit cost of the equipment seems to be much higher than terrestrial options that are available to first responders now. For some of the less-populated states, grant funds from the Department of Homeland Security (DHS) may not exceed $3 million for the entire grant funding year. One included letter of support serves as evidence of some state-level DHS interest, but it would be more compelling with recognition of the potential cost of the unit, use of DHS grant funds to purchase when available, and expectations of peers' willingness to fund. The proposal does not meet the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

The leadership and management team for this proposal are adequate. Specific expertise and participation of Dr. Beck would be informative on selection as a co-investigator. The proposal meets the requirements of the RFP on Leadership and Management Quality.

- **Budget and Cost Share**

The budget is satisfactory for this proposal. The proposal meets the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

Overall, this proposal was fair. Demonstration to emerging markets could be improved with a more thorough review of possible DHS customers and possible alternatives to an aerostat as a deployment platform. The alternatives and competitors should be better explained to improve understanding of competition, potential for success, and the value provided from this capability. This proposal is low risk with much diversity in possible applications. There is a high likelihood of some success in creating some business and jobs if funded. If successful, this project is likely not a significant high-tech job creator.

The committee does not recommend that this proposal be considered for the limited Third Frontier Program funds. However, the committee encourages the proposal team to take into account the suggestions and recommendations made and consider resubmission in the future.

EPS RCP 09-022
Enabling Technologies for Advanced Natural Fiber Composites

Ohio State University Research Foundation

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$2,125,000	$2,577,500
Capital Funds	$425,000	0
Subtotal	$2,550,000	$2,577,500
TOTAL	$5,127,500	

This Ohio State University Research Foundation proposal is concerned with the use of products that use natural fibers as reinforcing agents for synthetic polymers such as polypropylene. The principal innovation in this proposal is the use of microfibrillated fibers developed by an Ohio-based organization, the Natural Fiber Composite Corporation (NFCC), which would contribute technical expertise, raw materials, and, in some cases, serve as a customer for developed products. The Ohio BioProducts Innovation Center at Ohio State University (OSU) would direct the project. Collaborators on this proposal are NFCC, Engineering Mechanics Corporation, VinylTech, Michelman, Proctor & Gamble, PolymerOhio, Inc., OMNOVA Solutions Inc., and International Paper.

Detailed Review

- **Technical Merit and Plan**

The mechanical properties of synthetic polymers are typically modified by the introduction of a second component dispersed in the polymer matrix to form a composite. A wide variety of materials can be used as the dispersed agent, which are typically categorized as reinforcing or non-reinforcing (filler) additives. Reinforcing agents are fibrous in nature; examples include glass, carbon, or synthetic polymer fibers. This technology is well established and the choice of materials used is based on price and performance.

The use of natural fibers (i.e., those derived from agricultural products such as flax, jute, or other cellulosics) as an alternative to the examples given above is not particularly new. Thermoplastic or thermosetting matrices reinforced with natural fibers are extensively used in the European automotive industry. Problems include, but are not limited to, consistency of fiber product, moisture uptake, processing problems associated with high temperature exposure, and long-term degradation of material properties. The proposed work seeks to address these shortcomings through the use of newly developed fibrillated fibers. It is claimed that such fibers, which have a smaller cross-sectional area and higher aspect ratio compared to natural fibers currently in use, will enhance the performance of the resulting products. However, impact strength of composites made with fibrillated fibers is at present too low for wide application. This is a major deficiency in the technical outlook of this project. The proposal discusses this issue, but seemingly as a relatively minor aspect of the overall development of fibrillated fibers. The proposal indicates that the major technical problem to which much of the development costs would be devoted lies in the fibrillation project itself. In fact, both problems need to be addressed as major issues.

Several other technical problems are mentioned in a minor way or not at all, including (a) processing temperature issues (natural fibers as proposed here are susceptible to degradation at the high temperatures needed to process, e.g., polypropylene); (b) dimensional stability in high-humidity conditions (a particular concern for construction materials); (c) reproducibility of the properties with fibrillated fibers (a common problem with materials derived from agricultural products); and (d) the cost in comparison with conventional glass-reinforced plastics or non-reinforcing filler-based composites.

This proposal does not significantly improve upon the OSU's 2008 EPS RCP proposal on this topic, and it does not meet the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

A composite plastic material using natural fiber reinforcement with appropriate properties no doubt has significant commercial potential, as has been demonstrated in the European market. Viability will depend on successful solutions to several key technical and cost issues. Although not noted in the proposal, other markets for improved cellulosic fiber exist. Because this proposal focused on niche markets and did not sufficiently address other practical applications, this proposal does not meet the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

The proposal offers a good leadership and management plan, but it appears to be unduly focused on one of the technical problems at the expense of other equally important issues. This proposal meets the requirements of the RFP on Leadership and Management Quality.

- **Budget and Cost Share**

The budget and cost share seem adequate, and the proposal meets the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

The key objective of this proposal is the development of an improved polymer composite using fibrillated fibers and a newly developed process. However some properties of test articles made with these fibers are as yet inadequate. The proposal development program should address this issue in a more forceful and direct manner.

The committee does not recommend that this proposal be considered for the limited Third Frontier Program funds.

EPS RCP 09-024
Low Cost Energy Efficient Manufacturing Process for Hypoid Geared Systems

American Axle and Manufacturing, Inc.

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$3,965,503	$4,487,721
Capital Funds	$994,111	$514,111
Subtotal	$4,959,614	$5,001,832
TOTAL	$9,961,446	

The American Axle and Manufacturing, Inc., proposal intends to combine a number of product design and manufacturing technologies to develop a total manufacturing process aimed at converting a bar of steel into a finished hypoid gearset for use in automotive driveline applications. The technologies to be used include near net forging the gears from a low-alloy steel, induction harden, induction temper, and precision grinding, followed by application of an advanced welding process for gear system subassembly. While each of these technologies have been explored and validated individually, they have never been combined in the intended fashion. Furthermore, the near net forging process had very limited deployment and continues to present challenges in achieving implementation on a large scale.

The collaborators in this project include Colfor Manufacturing, Ajax Tocco Magnethermic, Scientific Forming Technologies Corporation, the Ohio State University (OSU) Gear and Power Transmission Research Laboratory, the Ohio State University Center for Precision Forming, and Republic Engineered Products.

Detailed Review

- **Technical Merit and Plan**

The committee likes that fact that a large and well-known automotive supplier is leading the effort and has embraced lean manufacturing principles, while aiming to reduce waste and cost so as to remain competitive against lower cost suppliers. However, this proposal has some fundamental flaws from a metallurgy standpoint which render it infeasible. Alloying elements were expensive 30 years ago and are still expensive today. The hardenability of boron steels for this specific hypoid gear application has always been an unpredictable issue because the concentration of boron cannot be distributed uniformly from feedstock to feedstock. Hence their ability to develop hardening uniformly is unpredictable for this specific application on hypoid gears. Boron, like nitrogen, also has embrittlement issues—especially in hardened steels. Differential cooling, use of quenchants, and coefficient of thermal expansion changes are all major issues in induction hardening, and manufacturing productivity will suffer immensely. The process is not as simple as carburizing. Induction hardening does not work because there is no gradual transition zone, which is important. The residual stresses and the gradation of stresses keep carburizing way ahead of any form of induction hardening in fatigue properties, where even under conditions of overloading, carburizing is superior to all other methods of case hardening. Fatigue studies have not been planned or proposed by team, but should have been included, as this is the most important property in all gears. This proposal does not meet the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

The commercial potential of this technology is good, but since the concept is flawed, there is little relevance to this category of evaluation. Nevertheless, the applicant team has provided well-researched

and compelling data on the potential economic impact accruing from a higher-efficiency process for manufacturing quality components. This proposal meets the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

The team is well managed but initially seems to be more of a research project with a significant emphasis on work from OSU. This proposal meets the requirements of the RFP on Leadership and Management Quality.

- **Budget and Cost Share**

A reasonable budget has been provided and the cost share follows the guidelines for this program. The proposal meets the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

This is a technically flawed proposal, as distribution of boron in steels cannot be controlled to provide reproducible hardenability, which is very important in hypoid gears. Induction hardening cannot match the transition in stresses and the superior fatigue strengths observed in carburizing and nitriding processes. The residual stresses in induction-hardened gears cannot be controlled, and a gradual transition between the core and the surface is not feasible.

In view of all of the above technical reasons, this proposal is infeasible for hypoid gear applications. The committee does not recommend that this proposal be considered for the limited Third Frontier Program funds.

EPS RCP 09-030
Distributed Energy Grid Connected Inverter

Edison Materials Technology Center

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$5,000,000	$5,000,000
Capital Funds	$0	$0
Subtotal	$5,000,000	$5,000,000
TOTAL	$10,000,000	

The project proposed by Edison Materials Technology Center is focused on the design, development, and manufacture of an advanced Utility Interactive Uninterruptible Power Supply (UI-UPS) to provide distributed generation to critical electrical equipment and grid applications, principally for information technology systems in data centers. The goal is to develop a UI-UPS with a capacity of 2 MVA with improved operational efficiency (96%), lower cost, and the same footprint as a currently available 1 MVA unit. The proposed work would evaluate the proof of concept and build a prototype to make an initial market assessment. Collaborators are Emerson Leibert Corporation and the Ohio State University.

Detailed Review

- **Technical Merit and Plan**

This proposal describes concept models, including accompanying mathematics, and provides schedules and details of technical activities. Proposed activities seem to focus largely on product engineering efforts to be conducted by Emerson Liebert with a small amount of university-based research and technology development. The relationship between the two activities and the transition from research to product development are not well defined. The proposal meets the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

This project is focused on a market sector (data centers) that is poised for growth in capacity and is focused on a technology that can take advantage of the growing UPS market. The proposal team seems to be familiar with product requirements and key market drivers, and it has a successful track record in developing and commercializing similar systems with a well-defined channel to market. The proposal demonstrates a good understanding of the resource requirements and process for commercialization. The proposal reflects a good understanding of competing products, and it justifies the market need for an advanced, lower-cost 2 KVA UPS system. The proposal meets the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

The lead applicant and collaborators have demonstrated commitment and leadership through all of the critical phases of the program. The proposal defines a clear line of responsibility for the project participants, with well-qualified individuals playing key roles. The proposal would be much stronger if the lead applicant were a for-profit corporation. The proposal meets the requirements of the RFP on Leadership and Management.

- **Budget and Cost Share**

The program budget appears to be sufficient to support the proposed activity. The supporting letter from Emerson Liebert says that its cost share is in the form of "industrial cash," but the Budget Form 4 identifies the cost share as in-kind. Otherwise, the proposal meets the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

The proposal addresses an important market sector, and it is well organized and well written. The proposal team is committed, but the proposal does not sufficiently demonstrate the linkage and transition from early-stage university-based research to late-stage product development activities. The proposal would be stronger if a for-profit company was the lead applicant. The proposal would be further strengthened if at least some of the cost share were in the form of cash.

The committee does not recommend that this proposal be considered for the limited Third Frontier Programs funds.

EPS RCP 09-034
Integration of Advanced Fuel Cell–Energy Storage Systems into the Distribution Grid of the Future

The Ohio State University Research Foundation

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$3,314,423	$3,434,423
Capital Funds	$120,000	$0
Subtotal	$3,434,423	$3,434,423
TOTAL	$6,868,846	

The focus of this Ohio State University Research Foundation project is to provide the basis for design and implementation of battery storage and an electric power grid interface with the Rolls Royce Fuel Cell Systems' solid oxide fuel cell (SOFC). The Ohio State University (OSU) is the lead applicant, with Rolls Royce, American Electric Power (AEP), and Sandia National Laboratories (SNL) as collaborators. Rolls Royce is working to commercialize a megawatt (MW)-scale stationary SOFC power system. AEP has a strategy for distributed energy resources that makes use of the SOFC system in conjunction with energy storage. By minimizing or eliminating transmission and distribution losses while "shaving" peaks and "filling" valleys in demand the intent is to create savings by reducing the need for peaking central power plants and increasing utilization of existing transmission and distribution infrastructure. OSU would leverage its expertise in power systems, power electronics, materials science, and controls to address the challenges of putting the Rolls Royce MW-scale SOFC system "on the grid" while simultaneously developing technologies that benefit the distributed resource field. This product addresses markets for stationary power, distributed generation, and central station power.

Detailed Review

- **Technical Merit and Plan**

This proposal addresses several important activities that are central to successfully integrating a MW-scale SOFC with the electric grid. Key activities include the installing a MW-scale Rolls Royce SOFC system into AEP's Walnut Test Facility, validating intelligent grid capabilities, reducing the cost and increasing the durability of MW-scale power electronics circuits, and completing a case study concerning integration of the SOFC with batteries. These activities appear to be very important to the successful commercialization of this technology and could provide valuable interface technology for other distributed energy resource devices. The proposal claims that the only significant barriers to extensive markets for stationary power generation are optimization of power electronics, development and use of smart control strategies, and evaluation of the durability of fuel cell stacks and components as a system. The committee believes that other factors such as high-volume manufacturing and market acceptance of a new, disruptive technology also represent significant barriers, and the proposal would have been stronger if it had discussed these issues. The proposal meets the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

The technologies being developed as part of this project address a growing market for distributed energy resources. The proposers have assembled an experienced and well-qualified team that has a successful track record in developing and commercializing similar systems with defined channels to market. The proposal demonstrates a solid understanding of the commercialization process and the

resource requirements for commercialization. However, the market projections seem optimistic and the proposal does not articulate a clear value proposition for the end user to substantiate the market estimates. Moreover, it is not clear how the "smart grid" technology would yield economic benefits for Ohio taxpayers through its broader adoption, except insofar as it catalyzes broader adoption of the SOFC. Nor does the Rolls Royce letter of commitment clearly and unambiguously state that production of the SOFC technology would occur in Ohio. The proposal does not meet the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

The proposal demonstrates the commitment of the lead applicant and industrial collaborator, with leadership demonstrated through all of the critical phases of the project. The proposal defines a clear line of responsibility for project participants with well-qualified individuals playing key roles. The proposal would have been be stronger if the industry collaborator had been the lead applicant. The proposal meets the requirements of the RFP on Leadership and Management.

- **Budget and Cost Share**

The budget appears to be justified based on the tasks proposed. In general, cost share letters are provided and sufficiently detailed. However, there is no Budget Form 3 for American Electric Power, and the Budget Form 3 for SNL is incomplete—it does not describe how SNL would use $400,000 in state funds, and it includes no cost share from SNL, even though the Budget Form 4 specifies a $400,000 cost share from SNL. Also, the commitment letter from SNL does not actually make any commitment whatsoever, either to provide a cost share or even to participate in the project at all. Instead, the letter states that SNL services "may be acquired by the Ohio State University under [a] work for others agreement [with] Sandia post award." In other words, if this proposal is funded, SNL will then discuss with OSU the possibility that OSU may procure the services of SNL, although any agreement would be subject to "DOE review and approval," which has not yet been obtained. Without the cost share from SNL, the total amount of the cost share included in the proposal is not enough to meet the requirements of the RFP. The proposal does not meet the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

The proposal was organized and well written, addressing critical technical elements in an emerging product area. Collaborator Rolls Royce has made a large cash commitment to the project, but the SNL cost share is unsubstantiated. The market projections seem optimistic, however, the proposal does not articulate a clear value proposition for the end user that substantiates the market estimates. While the proposal assembled an impressive team of researchers and appropriate development organizations, the proposal would have been strengthened if a for-profit company served as the lead organization.

The committee does not recommend that this proposal be considered for the limited Third Frontier Programs funds.

EPS RCP 09-039
Development of Surface Characteristics and Application Opportunities for the Production and Use of Engineered High-Strength and Advanced High-Strength Steels

New Steel International

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$3,642,116	$3,464,177
Capital Funds	$110,000	$288,000
Subtotal	$3,752,116	$3,752,177
TOTAL	$7,504,293	

New Steel International (NSI) proposes to supply the U.S. manufacturing industry with new grades of high-strength steel (HSS) and advanced-high-strength steels (AHSS) by building an integrated steel mini-mill in Ohio, with plans to generate 1,200 new jobs. The proposed new grades of steel would be lighter, stronger, and longer-lasting. Lighter steel will help reduce vehicle and structure weight, stronger steel will better absorb energy during a crash and increase maximum payload, and longer-lasting steel will improve reliability and ecological sustainability. NSI, a consulting company begun in 1999 (per corporate website), relies on the technical skills of researchers at the Case Center for Surface Engineering at Case Western Reserve University (CWRU) to develop, validate, and transfer the technologies needed to produce these new grades of steel for diverse end users. NSI has teamed up with CWRU, Edison Welding Institute, GSI Technology, Inc., and U.S. Bridge. Other collaborators include ASTI; Bricmont/Inductotherm; IEHK-RWTH, Germany; Andritz AG, Austria; and Topocrom Systems AG, Switzerland.

Detailed Review

- **Technical Merit and Plan**

The proposal's discussion of technical merits and commercial potential was comprehensive, and the discussions of objectives, activities, and technology areas were clear. In an ideal economy, the project has high potential to impact the primary and secondary AHSS steel supply chains and the North American automotive industry, especially. The proposal did not include discussion of the intellectual property (IP) portfolio or strengths/differentiators NSI has versus other competitors that would make it a strong partner for Ohio. There is a lack of credible technical information on weldability of AHSS. The proposal would have benefited from a brief discussion on what technology is being leveraged with AISI/ISI and the Auto/Steel Partnership (or the U.S. Department of Energy) as well as other third-generation steel-development initiatives in progress at National Science Foundation-sponsored programs with other U.S. institutions. This proposal does not meet the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

The committee likes the discussion on multiple U.S./Ohio-based end users and beneficiaries, but also feels that the current economic downturn is a major impediment to realizing the successful commercial viability of the NSI plan to establish a fully functional mini steel mill within the timeframe of interest to the ERCP. By its own admission, NSI is already having great difficulty raising the $2 billion in Phase 1 capital to set up the first mini-mill for producing AHSS and other niche steels. Therefore, the committee is concerned about the need to set up a new capital-intensive facility in a down market, where customers (especially automotive) are weak and market demand for new vehicles has dropped off drastically; thus, there is a questionable impact on return on investment. The committee questions the near-term and long-

term job creation potential (page 14 indicates 40,000 new jobs, assuming a multiplier effect), even if the CWRU development program were funded by Ohio. Markets for improved HSS and AHSS include rail, marine, and container transportation; construction; architecture; and infrastructure. This proposal does not meet the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

The committee feels that NSI has assembled a generally strong and meritorious team. However, it is unclear what North American collaborator options were explored before settling on foreign technology (IP) sources such as Andritz, IEHK, and Topocrom. The role of U.S. Bridge was not addressed in much detail. This proposal does not meet the requirements of the RFP on Leadership and Management Quality.

- **Budget and Cost Share**

The vast majority of cost share for this proposal is in kind; otherwise, the budget is appropriate. This proposal meets the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

It is unclear how these proposed partnerships would integrate together and how they would be managed effectively to develop the objectives of the proposal. Since little mention is made of IP-related issues, and there was no differentiator between this group and others that are similar, the overall benefits of bringing this technology to Ohio are not clear. Overall the request is for developing the infrastructure and doing some routine testing with minimal innovation. Although this technology and plant may be a step to commercialization of AHSS, their importance to Ohio and their case for supporting the industrial base is not very convincing in the current economic context. It is also unclear what metrics were used to arrive at the potential to create 40,000 jobs in Ohio.

The committee does not recommend that this proposal be considered for the limited Third Frontier Program funds.

EPS RCP 09-040
Electronically Changeable Color Skins for Consumer Products

Kent Displays, Inc.

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$4,787,310	$5,950,487
Capital Funds	$180,000	$0
Subtotal	$4,967,310	$5,950,487
TOTAL	$10,917,797	

The Kent Displays, Inc.(KDI), project proposes to use KDI's commercially successful Reflex™ (bistable color reflective liquid crystal) technology to create a multi-layer reflective skin capable of changing the color of cell phones, laptop computers, MP3 players, and other consumer electronic products. KDI has enlisted the support of several very capable collaborators including Kent State University (for technology development), the University of Akron (for application development), DuPont Teijin Films (for multiwall film production technology development), Solomon Systech Ltd. (for electronic chip design), and the University of Akron (for polymer nanomaterials development). The new electronic skin product line (to be known as "eGo") would leverage technology controlled by KDI and the collaborators to develop a new technology and create as many as 100 new jobs in Ohio.

Detailed Review

- **Technical Merit and Plan**

The lead applicant has successfully developed and commercialized bistable color reflective liquid crystal technology, and it has a demonstrated capability to successfully translate and then gain access to capital for commercialization of new technologies. A prototype electronic skin cell phone was demonstrated to the committee, and the display is not unduly sensitive to the spectrum of the incident light. This technology seems like an excellent candidate for commercialization, and the proposal exceeds the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

The proposed technology is viable and has tremendous growth potential in new applications. Although it may be difficult to achieve proposed milestones in the time-frame outlined in the proposal, success in this endeavor could prove enormously valuable considering the sizeable market demand for technological accessories. This proposal exceeds the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

The leadership and management quality for this proposal are excellent, given the experience of the lead applicant and collaborators. This proposal exceeds the requirements of the RFP on Leadership and Management Quality.

- **Budget and Cost Share**

The budget and cost share are appropriate. This proposal meets the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

The committee views the proposed technology to be commercially viable, and it has a very large potential market. The proposed work is quite innovative and fits quite well in the goals and requirements of the ERCP grant program.

The committee recommends that this proposal be considered for the limited Third Frontier Program funds.

EPS RCP 09-043
Exhaust Jet Control for Noise Mitigation of Subsonic and Supersonic Commercial and Military Aircraft

The Ohio State University Research Foundation

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$3,257,124	$3,368,748
Capital Funds	$261,527	$322,996
Subtotal	$3,518,651	$3,691,744
TOTAL	$7,210,395	

This work proposed by the Ohio State University Research Foundation would use technology based on an Ohio State University (OSU) patent of a plasma actuator to actively mitigate jet noise by controlling pressure variations in the exhaust stream of a gas turbine. The system would be operated when noise is critical (e.g., during takeoff), but not during cruise. The proposal work plan is for OSU to perform laboratory demonstrations of an advanced plasma actuator, and NASA Glenn Research Center would then conduct wind tunnel testing of the device. GE Aviation would provide general consulting support and help the team assess interface and integration issues. All of this work would be supported by simulations conducted by the University of Toledo, Wright State University, and the Air Force Research Laboratory (AFRL).

Detailed Review

- **Technical Merit and Plan**

Active noise control of gas turbine noise is a important topic. OSU intellectual property could provide a unique approach to this problem. The proposal indicates, however, that the invention is at a very early stage, because the first step of the proposed work is to demonstrate that the invention works. In addition, the problems associated with incorporation of a plasma-based system into the exhaust area of a gas turbine are very large. Therefore, the proposal does not meet the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

If this invention works and could be incorporated into the gas turbine exhaust environment, it would have great commercial potential. However, GE Aviation's letter of support indicates that it will wait to see if the proposed work by OSU and NASA Glenn are successful before committing itself to participate in commercial development. Given GE Aviation's minimal commitment to participate in the project, the proposal does not meet the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

The proposal does not identify a technical director or a commercialization director, as required in the RFP, nor does it provide other substantive information listed in the RFP on how the project will be managed. The proposal would have been improved if the industry collaborator has served as the lead applicant. The proposal does not meet the requirements of the RFP on Leadership and Management Quality.

- **Budget and Cost Share**

A Budget Form 3 was not included in the proposal for GE Aviation, even though the proposal states "Obviously, participation of GE is crucial to successful execution of the proposed work." A Budget Form 3 was also not included for the AFRL. In addition, neither of these collaborators is contributing any cost share, even though the RFP states that "Collaborators should be committed to the long-term commercialization of the technology and play a role in accomplishing that goal. A contribution of Cost Share resources by a Collaborator is evidence of that commitment." The proposal does not meet the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

Plasma actuators for mitigation of jet engine noise are at a very early stage of development. They must be demonstrated at a laboratory scale and in wind tunnels, followed by successful integration into a gas turbine exhaust environment. Because this technology is at such an early stage, the leadership and management team is dominated by researchers, and the industrial partner is not yet ready to commit to commercial development.

The committee does not recommend that this proposal be considered for the limited Third Frontier Programs funds.

EPS RCP 09-044
Quickstep Composite Structures Manufacturing Technology Development and Commercialization for Aircraft Structural Components

Vector Composites, Inc.

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$3,010,951	$4,380,661
Capital Funds	$350,000	$375,000
Subtotal	$3,360,951	$4,755,661
TOTAL	$8,116,612	

A joint venture between Vector Composites, Inc., and Quickstep Technologies would develop new processes and materials to bring to commercial application a replacement for high-cost autoclave process technology for high-performance composites. Standard test methodologies would be applied to verify that the Quickstep process using liquid heating and low pressures produces final material properties equal to or superior to the industry autoclave standards. Strong intellectual property position, excellent partnerships with Ohio-based materials producers, and support from significant local end users in aerospace suggest a reasonable path to market. Market potential is huge if capital expenditure on equipment can be justified.

Vector Composites is also collaborating with NanoSperse LLC, National Composite Center (NCC), the University of Dayton Research Institute, and Renegade Materials Corporation.

Detailed Review

- **Technical Merit and Plan**

Quickstep is a patented out-of-autoclave replacement process developed in Australia and marketed in several countries in the world. One-sided tooling, coupled with low pressure and rapid heating liquid heat transfer media, promise a lower cost product. Preliminary data suggests that the Quickstep process produces equal or better properties when applied to some high performance composites. The proposal notes that previous non-autoclave processes have required the development of new composite resins demanding new data, certification, design allowables, and so on. They claim this would not be required for Quickstep; however, a significant portion of this proposal is focused on developing new materials optimized for the Quickstep process (including nano-particle reinforced) in collaboration with Renegade and NanoSperse. UDRI would participate in new prepreg design. The technical discussion of these materials, and especially the exfoliation aspects of the graphitic nano-materials, is less than revealing and needs clarification. Without the new materials development, the proposal involves routine materials testing of an already patented, commercially available machine. This proposal does not meet the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

The proposal documents a strong market potential for even a modest number of parts, as composites take over an increasingly large share of the structural materials market in aerospace and new wind/energy technology. The Quickstep process seems limited at first to relatively simple, low-curvature parts, but these could act as a strong entry point into a complex market. On the other hand, while the joint venture would be based in Ohio, Quickstep Technologies has already sold equipment in six countries, suggesting a strong incentive on their part to license the new intellectual property to others. This may impact on the

leadership role promised for Ohio and certainly on the jobs and revenue promised. This proposal meets the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

This proposal is led by a newly constituted joint venture of Quickstep Technologies with Vector Composites, a for-profit spin-off of the Ohio-based NCC. While there is a history of excellent leadership and management on the part of both entities, there is always some question about how a joint venture will operate. The lack of specifics regarding the new materials development work by some of the partners raises serious questions about the potential for integration of the elements of management. Additionally, the leadership does not seem focused on a broad market strategy for their product, but are looking to enter a niche market, which might not be an appropriate outlet. This proposal does not meet the requirements of the RFP on Leadership and Management Quality.

- **Budget and Cost Share**

Adequate cost sharing seems to be present, with significant cash coming from the joint venture and mostly in-kind from other collaborators. There are some questions raised by the identification of Navy and Air Force Small Business Innovation Research (SBIR) as the source for significant portions of this cash. If this program were to be funded, it would be necessary to ensure that the money and work are not being "double-counted" by these principal investigators. It is significant that there is no cost-sharing from any of the end users and that their letters of support focus on providing specifications that must be met by the joint venture as targets during demonstration. This proposal meets the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

The project would lead to further synergism among strong Ohio-based entities that have received previous funding from both federal and Ohio government agencies, NCC, Vector, Renegade, UDRI and NanoSperse. Alternatives to autoclaving are highly desired, and if proven, could lead to significant business opportunities. A likely first-to-market position would give the joint venture a strong leadership position in manufacture of several parts under study. Likely end users, GE, ITT, and Sikorsky, have provided component designs and requirements. There remains the question of how intellectual property will be licensed to other Quickstep customers and what impact that will have on the eventual jobs/revenue in Ohio. The question of SBIR as a source of matching funds would also need to be clarified.

The proposal is significantly flawed in technical justification. The narrative begins by emphasizing that many other out-of-autoclave process have failed because they required development of new, specialty-polymer composite resins that demand extensive and costly certification. The proposal proceeds to describe a research plan aimed at the development of a series of new materials optimized for the Quickstep process. If this research will lead only to more unqualified materials, then it is not justified. If the proposed research plan is stripped from the proposal, what remains is some rather conventional testing of specialty parts in an already marketed product, the Quickstep Technology.

The committee does not recommend that this proposal be considered for the limited Third Frontier Program funds.

EPS RCP 09-045
High Efficiency Hybrid Solar Collector and System

reXorce Thermionics, Inc.

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$3,238,500	$3,039,500
Capital Funds	$961,500	$1,160,500
Subtotal	$4,200,000	$4,200,000
TOTAL	$8,400,000	

The primary goal of this reXorce Thermionics, Inc., project is to grow Ohio's leadership in photovoltaics (PV) technology R&D and manufacturing through the development and commercialization of a hybrid concentrator solar receiver (HCSR), integrating PV with solar thermal improved technologies. This is a *disruptive technology* aimed at overall efficiencies greater than 60-70%. The concentrating solar technologies are receiving increased attention for intermediate and utility-scale applications. This approach is innovative in the thermal management of the system to utilize both "PV" and thermal components of the solar spectrum. The proposed advantages of this system are a lower levelized cost of electricity than competing technologies and a better space utilization (kW/area).

The collaboration is led by reXorce Thermionics, Inc., which manufactures next-generation thermal engines that recover waste heat energy from a wide variety of solar thermal to industrial waste heat sources, transforming this energy into useable electricity, cooling, and heating. GrafTech International Holdings, Inc., is one of the world's largest manufacturers and providers of high-quality synthetic and natural graphite- and carbon-based products and technical/R&D services. GreenField was formed to establish a market for concentrating solar PV technology—primarily based on a unique solar cell design called "PhotoVolt." Babcock & Wilcox specializes in manufacturing and service capabilities. Ohio University (and Dr. Alam) provides the development of materials with a focus on thermal management—as well as a focus on carbon and graphite-based composite R&D. Ohio State University (OSU; Professor Yi) provides expertise in manufacturing R&D and tool development. The University of Akron covers a broad spectrum of mechanical engineering, including dynamics, mechanics, and contols to assist in the thermal and fluid dynamics and manufacturing portions of this program. Finally, Oregon State University provides (in conjunction with Pacific Northwest National Laboratory) research information and expertise on solar-selective absorbers, including those with low emissivity critical to this project.

Detailed Review

- **Technical Merit and Plan**

This is a *high-risk* but potentially *high-payoff* venture. This proposal is directed at the fabrication and commercialization of innovative solar PV devices that more fully utilize the solar spectrum (for PV and solar thermal) to attain very high efficiencies. This area of thermal management is one that is receiving increased attention and increased importance for the concentrating PV (CPV) technologies because they leverage use of the waste heat into a useful form of electricity (or other thermal use). The proposal does formulate a very good match and use of the partners in this development. The central "focus" is the receiver (Hybrid Concentrated Solar Receiver—HCSR) that is really the innovation and the key part of the development. This approach complements other recent ones for this application using thermoelectrics and thermophotovoltaics. It does offer some benefits of cost and flexibility. This proposal meets the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

The concentrating solar power (CSP) technology and industry is growing currently—primarily in solar thermal to electricity, but there is also significant development in CPV technologies. The areas of using both the PV and the solar thermal outputs have largely been neglected—with the CPV systems mainly "dumping" the heat from heat exchanges in contact with the cells (which are under 300-1000 concentration). This proposal comes at a time that is commensurate with the growth of this technology—and may well be the "added factor" that makes CPV even more cost competitive for the large-MW, and perhaps utility-scale, markets. The proposers have certainly recognized this potential. This proposal meets the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

The management plan is adequate and the technical staff are very qualified. The inclusion of Greenfield, a company that has good experience in solar concentrators, in this proposal is noteworthy. It is possible that the proposal is developing a competitor for their technology (the worst case for them) or more likely, a technology that enhances their systems. The quality of the technical expertise of the leadership team is excellent overall. This proposal meets the requirements of the RFP on Leadership and Management Quality.

- **Budget and Cost Share**

The budget and cost share level conform to the requirements to carry out this work. The committee feels there are still some questions, including some uncertainty about how OSU is being funded as part of this proposal. Since OSU's input and information seems key, it would seem that their work should be compensated. This proposal meets the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

The committee is impressed by portions of this proposal, but has questions about other parts.

The central focus of this project is the HCSR. Its design is innovative and the development makes excellent use of the research/technology partners for the most part. This project builds technology in the thermal management area that is very important for CPV. The proposal team has an excellent understanding of thermal properties and concentrating PV—and this is key to the success of this project. They also understand the benefits of better utilizing the wasted thermal energy in these solar systems. The inclusion of an existing CPV partner in this proposal is foundational to its ability to move into the technology and into the markets.

However, the committee feels strongly that the proposal was not adequately prepared. It lacks sufficient details on materials utilization and design, in comparison to other EPS RCP proposals submitted. Although the proposal is not cohesive, although it does a good job representing the HCSR. The proposal has an excellent idea, but appears hastily composed.

- The proposal would be strengthened by comparing this approach to the others under consideration for thermal management (e.g., thermoelectrics, thermophotovoltaics, and passive cooling).
- There is not a clear understanding of the incorporation of the cell technology (triple junction monolithic cell like the Spectrolab or the vertical Si junction), who has responsibility for this (how the cells will be acquired or fabricated), and what are the concentrations that are being considered (1000x or low concentration).

- The proposal gives the impression that the science and engineering aspects received more attention than the commercialization efforts.
- There is no proof of concept yet, and the time from proof of concept to working model is very fast (about 18 months). The committee would prefer to see a working prototype that shows the approach to be viable beyond design.
- It is unclear whether this work is being leveraged from any other funded sources (e.g., Department of Energy or Department of Defense).
- Addressing reliability concerns would strengthen the proposal.
- The committee is confused about the job creation elements. Though not a serious deficit here, addressing job creation would be nice in the future. The proposal underestimates the effects of the success of this project.
- Is there any concern about the carbon dioxide escaping? This was not addressed (although it is obviously a closed-cycle system).
- The provided letter of partnering from OSU seemed to be only a superficial effort, given OSU's apparent importance in the project. It would be better to have a more strong commitment from OSU.
- Independent evaluation of results (efficiency, operating stability) should be included to provide some validation of the technology. This is especially true since the efficiencies combine two separate energy sources. Some standards may need to be developed for this new technology.
- The committee would like to see collaboration in ongoing accelerated lifetime testing development programs just started in the U.S. programs for CPV.

The committee does not recommend that this proposal be considered for the limited Third Frontier Program funds. However, the committee recommends that the proposal team better integrate the elements and concepts in their proposal, and they strongly advise future resubmission.

EPS RCP 09-048
A Process for the Recovery of the Petroleum Content of Waste Polymers

Polyflow Corporation

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$4,694,000	$3,885,247
Capital Funds	$306,000	$6,447,666
Subtotal	$5,000,000	$10,332,913
TOTAL	$15,332,913	

The Polyflow Corporation proposal is focused on the use of a patented pyrolysis process to convert mixed polymer waste (including tires) to light hydrocarbons such as gasoline and feedstock chemicals used by the plastics industry. The specific goal is to build a full size production processor and demonstrate its performance. The proposal team includes seven collaborators: SABIC-Innovative Plastics, Chemstress Construction Company, the University of Akron, Waste Management, Grossman Environmental Recycling, PolymerOhio, and Value Recovery Group (which is misidentified as Global Recovery Group in the Collaborator Information section of the proposal).

Detailed Review

- **Technical Merit and Plan**

The proposal discusses the viability of processing tire and automotive polymeric scrap to produce useful chemicals (including fuel), processes for economic collection of a myriad of waste streams, comparison with other approaches, and a discussion of why this proposal will succeed where alternative processes have failed. Even so, more information is needed to understand how the proposed process would realize technical and economic advantages of the proposed process (compared to the many other pyrolysis processes that exist). For example, the recovery of value-added chemicals using this process is considered a primary advantage. However, the extraction of pure products (such as monomers) from the heterogeneous stream using distillation or extraction processes is a monumentally difficult task. This is not adequately addressed in the proposal. Unless the proposal team has a highly efficient distillation and extraction process, the useful product from this approach will most likely be fuel. Of course purer waste streams (such as polyethylene terephthalate bottles) could be used to deliver purer chemical/monomer outputs; but as the proposal notes, this approach is of limited interest because of the difficulty of segregating monolithic waste streams. The proposal does not meet the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

If successful, this project could have a large environmental and economic impact. The collection, sorting, and processing of waste materials could create a large number of jobs over a broad skill base. The design, fabrication, and licensing of the process equipment could likewise have a large impact, assuming the process described is significantly better than alternative processes (which are not clearly delineated in the proposal). If Waste Management is committed to the commercialization of successful process development, the project has a real chance for success; if not, the potential is limited. Less than 1 percent of the budget is set aside for Waste Management, meaning it would not play a large role in this effort. In fact, Waste Management's efforts are entirely self-funded (through its own in-kind cost share), but the letter from Waste Management in the proposal makes no commitment to participate in the project, it

offers no cost share, and it is unsigned. The proposal does not meet the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

Without expertise in the collection and disposal of waste materials, this proposal would not be considered viable.One of the key elements of the proposal is the involvement of Waste Management. However, as noted above, Waste Management's involvement is likely to be minimal, at best. Additionally, the proposal does not identify a technical director or a commercialization director, as required in the RFP, nor does it provide substantive information listed in the RFP on how the project would be managed. The proposal does not meet the requirements of the RFP on Leadership and Management Quality.

- **Budget and Cost Share**

The budget appears to be proper relative to the potential. The cost share is more than reasonable. The proposal meets the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

This proposal has many desired attributes, but it leaves important questions unanswered. The ability to transform plastic waste (including tires) to useful raw materials (including fuel and higher value chemicals such as styrene and aromatics) would be of great value. A unique advantage of the proposed pyrolysis process would be the ability to create products with an aromatic content that exceeds the aromatic content of the raw material stream. The elimination of post-consumer waste products from landfills would be an important and valuable benefit if this process were commercialized and widely adopted. This process could also reduce the amount of polymeric components from the large scrap automotive stream. However, technical uncertainties remain. Distillation and extraction processes are limited in their ability to separate specific components (such as monomers) in pure form from highly heterogeneous waste streams. While this is feasible when using monolithic waste streams, it is at least an order of magnitude, more difficult with mixed polymer waste streams. In addition, many other pyrolysis processes have reached the developmental stage, and several are being commercialized. However, the proposal does not demonstrate that the Polyflow process is clearly superior to these other process.

The committee does not recommend that this proposal be considered for the limited Third Frontier Programs funds.

EPS RCP 09-056
Microchannel Hydroprocessing for Upgrading Biofuels, Petroleum Feedstock and Chemical Intermediates

Velocys, Inc.

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$5,000,000	$6,038,031
Capital Funds	$0	$174,500
Subtotal	$5,000,000	$6,212,531
TOTAL	11,212,531	

The Velocys, Inc., team proposes to apply its microchannel process technology to hydroprocessing, with a specific focus on hydrocracking to upgrade Fischer-Tropsch (FT) fuels and heavy petroleum feedstock. Successful extension of this microchannel technology platform would result in modular, less capital-intensive hydrocracking units that achieve favorable economics for individual biomass-to-liquid facilities and small-scale units for incremental capacity increases in petroleum refineries to treat increasingly heavier crude oil feedstock as well as non-conventional fuel sources, such as tar sands and wax from FT liquid fuel production. Other opportunities for hydroprocessing are in the processing of edible oils, specialty and fine chemicals, and conversion of natural oils and fats to transportation fuels.

The team includes collaboration from NetJets, Inc., Albemarle Catalysts Company BV, BP-Husky LLC Toledo Refinery, the Ohio Bioproducts Innovation Center (OBIC) at the Ohio State University, and Archer Daniels Midland Company.

Detailed Review

- **Technical Merit and Plan**

- The proposed microchannel hydroprocessing technology platform appears to be well suited for a variety of chemical conversions, including upgrading bio-based feedstocks to transportation fuels or conversion of a variety of feedstocks to chemical or food materials. This novel microchannel reactor and catalyst system appears to offer significant potential for application of hydroprocessing to a family of economically valuable reactions that includes hydrogenation, hydrocracking, and hydrotreating. The common characteristic of these reactions is the addition of hydrogen to liquid hydrocarbons in the presence of a catalyst. Although hydroprocessing techniques have been in common use for years, the technology is far from optimized. The proposed microchannel process technology offers a solution to the core technical hydroprocessing challenges of obtaining good three-phase contact between the gaseous hydrogen, the solid catalyst, and the liquid product and maintaining temperature control inside the reactor.

The key technical outcomes of this project are scaling-up the hydrocracking process, bringing the equipment to the laboratory-pilot level, and constructing a field-demonstration unit. The Velocys team has completed this same process in their application of the microchannel process technology to the FT process and would apply this experience to these new applications.

- Pilot tests on FT waxes from multiple sources, including the Third Frontier funded FT demonstration at Wright Patterson Air Force Base (WPAFB), would provide the valuable engineering information needed to build a larger scale hydrocracker demonstration unit.
- Product from the hydrocracker test would be evaluated by industrial collaborators and in WPAFB laboratories.

- The pilot-scale reactor would also be used to evaluate other hydroprocessing applications, including hydrogenation of edible oils and upgrading heavy petroleum feedstock.

Velocys has clearly identified key technical challenges and proposed approaches to address them. This proposal exceeds the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

If successful, this technology offers a great improvement in the economies of scale for hydroprocessing in important industries. The commercialization objectives are to develop industrial partnerships and secure the resources required to progress microchannel hydrocracking and other hydroprocessing applications toward market entry. High-priority items include identifying and securing demonstration sites for the hydrocracking skid and funding development efforts for other high-value hydroprocessing applications.

The technology remains in early development and the company appears to understand the difficulties in commercialization. The company's record at acquiring funding from both private and public sources is impressive and demonstrates good commercialization connections. The partnership with end users in the project design is critical, although the absence of strong scale-up and manufacturing partners is a concern. The path to market includes a strong reliance on licensing, which potentially reduces the impact for Ohio. Potential Ohio-based supply-chain partners were identified, but no commitments have been made. Ultimately, the potential for commercial success is very high, including worldwide markets. This proposal exceeds the requirements of the RFP for Commercial Potential.

- **Leadership and Management Quality**

The proposed project partners include industry (BP-Husky, Albemarle, ADM, and Net Jets) and academia (OBIC at Ohio State University). These are strong partners and the roles and responsibilities of the team members are well defined. Velocys provides a strong project management plan and team. Their new parent company, Oxford Catalysts, has a good commercial track record, and strong relationships have been formed with customer groups. The proposal meets the requirements of the RFP for Leadership and Management Quality.

- **Budget and Cost Share**

The budget appears appropriate to the proposed plan. Indeed, external funding relevant to the project has been raised since original submission of the proposal. The cost share is virtually all in-kind, with little cash, which is mostly from Velocys. This proposal meets the requirements of the RFP for Budget and Cost Share.

Summary of Review and Recommendation

The committee views this project as having great potential, both for the partners and for Ohio. The technical merit of this proposal is outstanding, and it has impressive commercial potential.

The committee recommends that this proposal be considered for the limited Third Frontier Programs funds.

EPS RCP 09-060
Developing High Performance Insulated Wallboard for Refrigerated Trucking Applications

Doubleday Acquisitions/AccuTemp

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	2,406,000	2,058,587
Capital Funds	600,000	950,000
Subtotal	3,006,000	3,006,587
TOTAL	6,012,587	

AccuTemp, the lead firm on this proposal and a subsidiary of Doubleday Acquisitions, has developed a high-performance insulation (HPI) technology that is currently applied in demanding applications in pharmaceuticals and biomedical technologies. The current HPI technology is well suited to applications for which performance is critical and cost is secondary. AccuTemp seeks RCP funding to develop HPI technologies for applications in refrigerated truck trailers. The project involves a search for (unspecified) substitute materials that will be lower-cost and robust to the demanding operating environment of refrigerated truck trailers.

AccuTemp and Doubleday have enlisted Wright State University, the National Composites Center, Fiber-Tech, and Compsite Advantage as collaborators in this R&D project. Major prospective users of the technology also have committed to participate. Wabash National (a leading truck trailer producer), Morgan Corporation, and Stoops Freightliner would test and evaluate prototypes of the new technology.

Detailed Review

- **Technical Merit and Plan**

The proposal outlines a program of extending the applications of an existing technology by substituting lower-cost, more rugged materials for the higher-cost insulation in its current technology. Therefore, the R&D is exploratory but incremental in nature. The proposal's discussion of the R&D program is severely weakened by the absence of any detailed discussion of the materials chosen for exploration and the likely success of its search for materials that will support the broader applications of the HPI technology within the 3-year timeframe of the project. This proposal does not meet the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

The proposal provides little or no information to support an assessment of the feasibility and performance of its technological and commercial goals. It seems obvious that the construction applications of the HPI technology discussed in the proposal are far more distant and uncertain than indicated in the proposal. The proposal also notes that the refrigerated trailer applications for which near-term applications are significant may require certification (health and food-safety regulations) for success in the market. The proposal states, however, that the research team lacks any information on these requirements, and the lack of such information suggests the need for greater due diligence by the research team to investigate customer and regulatory obstacles (if any) to broad application of the technology. The refrigerated-tractor-trailer market is a large one, and successful penetration of this market with HPI technology could yield considerable commercial and economic benefits for Ohio. But the proposal needs to more clearly address certification issues, as well as the presence of alternative insulation-related technologies now under development that could pose a competitive threat to the AccuTemp HPI

application (should it be developed) in this market. Because of an overall lack of specificity, this proposal does not meet the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

The research team and management structure for the proposal appear to be adequate. The engagement of prospective users as collaborators is a noteworthy strength of the proposal. However, the committee is somewhat concerned about the level of commitment of the collaborators to the project, given the lack of details concerning their cost share contributions (see below). Despite this concern, the proposal meets the requirements of the RFP on Leadership and Management Quality.

- **Budget and Cost Share**

The total budget appears to be appropriate. However, only AccuTemp is contributing any cash to its share of the total project budget. All other collaborators are offering only in-kind contributions. Moreover, with the exception of Wright State University and the National Composites Center, none of the collaborators offering in-kind contributions provide any basis for evaluating the nature of their estimated in-kind contributions. Due to this lack of information the proposal does not meet the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

This proposal is difficult to evaluate because of the lack of information on its underlying technical details. The feasibility of AccuTemp's search for alternative materials to support extension of its HPI to a promising commercial application is subject to great doubt, inasmuch as the proposal provides no detail on the types of materials and acknowledges considerable uncertainty about the characteristics, and therefore the likely performance of alternatives in refrigerated truck trailers. Any future revision of this proposal should devote more attention to the array and feasibility of technical alternatives that can support the extension of AccuTemp's HPI technology into refrigerated truck trailers. The proposal's analysis of the commercial prospects for the HPI technology in refrigerated truck trailers must be developed in more detail, both in terms of regulatory or certification requirements and the prospective availability of alternative novel technologies in refrigerated trailers. In addition, the possibilities for applications of the new technology in construction applications should be presented more clearly as highly uncertain and distant possibilities.

The composition of the project's research team, especially the enlistment of users as collaborators, is an important strength of this proposal. But the modest financial commitment of the collaborators other than AccuTemp, as well as the lack of detail regarding the in-kind contributions for many of these collaborators, are additional causes for concern and skepticism. As a result of these concerns, the committee does not recommend that this proposal be considered for the limited Third Frontier Program funds.

EPS RCP 09-067
Selectable and Integrated Waste to Energy System

Univenture, Inc.

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$3,814,159	$2,003,707
Capital Funds	$1,154,000	$2,964,452
Subtotal	$4,968,159	$4,968,159
TOTAL	$9,936,318	

The proposed Univenture, Inc., effort would demonstrate the commercial viability of an integrated, small-scale, closed-loop waste-to-energy system. The project would take food, manure, and other organic wastes from the Columbus Zoo and food waste from Honda of America Manufacturing as feedstock for an anaerobic digester that would produce biogas that could be used on site as fuel for either heating or generating electricity. In addition, an onsite algae farm would convert the remaining output from the digester into (1) oil for energy and (2) biomass for use as animal feed or as input for the anaerobic digester. The proposed self-sustaining system would generate heat for the zoo's wildlife conservation and display infrastructure, and it would generate heat for greenhouses that could produce agricultural food products for local markets. Successful completion of this project could lead to installations at other zoos and in other industrial and agricultural settings.

The proposal team includes nine collaborators: Rockwell Automation, Makel Engineering, Inc., the Ohio State University Ohio Agricultural Research and Development Center (OARDC), the Columbus Zoo and Aquarium, EISC, Inc.'s Center for Innovative Food Technology (CIFT), Resource 100 LTD, George J. Igel & Co., Inc., Ohio Grocers Association, and Honda of America Manufacturing, Inc.

Detailed Review

- **Technical Merit and Plan**

The proposal team aims to (1) transform animal and food wastes into valuable feedstock, (2) develop an anaerobic digester that can produce biogas for electricity and fluid feed for an algae farm, (3) establish an algae farm that produces oil for generating electricity, with leftover biomass be fed to the anaerobic digester, (4) produce electricity from biogas using a generator driven by a homogeneous-charge compression-ignition (HCCI) engine, (5) develop system interfaces and controls for an integrated system, and (6) demonstrate the operation of the proposed system at the Columbus Zoo. This proposal meets the requirements of the RFP for Technical Merit and Plan.

- **Commercial Potential**

The partnership includes several experts in five different Ohio-based organizations: Univenture, Inc. (expertise in algae farming), OSU-OARDC (expertise in anaerobic digestion), Rockwell Automation (expertise in controls), Makel Engineering (expertise in HCCI engines), and the Columbus Zoo (lead applicant, supplier of animal waste, and primary customer for animal feed). It was initially assumed that the broad partnership would increase the project's commercial potential.

The proposal's economic analysis (page 40) highlights benefits of the proposed system. Zoo trash costs of $47,660/year (Fig. 7-7) and animal waste disposal costs at about $20,000/year (Fig. 7-8) could be avoided, with trash and animal wastes being converted into energy of algae feed. The prospective capital market, business model, and the economic impact of the proposed waste-to-energy system shows the importance of the proposed work. Also, the committee appreciates the zoo's requirements for large

volumes of feed for the zoo animals, which are relatively expensive and must be transported sometimes at great distance to the zoo.

However, it was not clear to the committee how the team would maintain intellectual property control of their system and be commercially successful. The job creation of this project was also not apparent. As such, this proposal does not meet the requirements of the RFP for Commercial Potential.

- **Leadership and Management Quality**

The proposal includes an effective group of managers and leaders from the applicant team. The organizational capabilities and the experience of the principal investigators involved are clearly shown in the biographical sketches, which cover eight of the 10 organizations in the proposal team. However, the proposal did not provide substantive information listed in the RFP on how the project would be managed. Also, neither the Columbus Zoo nor Univenture are well suited to lead the proposed work, as the zoo has had almost no previous experience in business development and commercialization of products and Univenture has no commercialization experience in this field. This proposal does not meet the requirements of the RFP on Leadership and Management Quality.

- **Budget and Cost Share**

The budget and cost share for this proposal are fitting. The budget indicates that, in terms of project execution, the key players are the lead applicant (Univenture) and three collaborators (Rockwell, Makel, and OSU); the budget allocates 90% of total operating funds to these four organizations. The other six collaborators share the remaining 10 percent of operating funds. The proposal meets the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

Overall, this is a relatively good low risk proposal. However, there are numerous algae research, municipal waste-to-energy, and animal waste- and agricultural waste-to-biofuels/biomaterials projects being conducted throughout the country (and around the globe, for that matter). It is unclear what specific competitive advantage this team will have over these other projects. The team could also not clearly address what precisely they would commercialize or how. The business plans and the scalability of this contained-system project were not defined. The committee was very enthusiastic about the ideas behind the project, but did not see how it fit into the ERCP.

The committee does not recommend that this proposal be considered for the limited Third Frontier Program funds.

EPS RCP 09-071
Commercialization of Novel Electromagnetic Imaging Modalities

Traycer Diagnostic Systems, Inc.

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$4,625,000	$4,603,353
Capital Funds	$375,000	$675,000
Subtotal	$5,000,000	$5,278,353
TOTAL	$10,278,353	

The Traycer Diagnostic Systems, Inc., proposal collects the technology from three companies (Traycer, Photon-X, and TeraView together form the Electromagnetic Imaging Commercialization Partnership, EICP) with support from Ohio State University, Miami University of Ohio, and the Air Force Research Laboratory to address terahertz (THz) products. Usage of the THz part of the spectrum, which is roughly centered about 300 GHz (1000 μm), has evolved slowly because of the lack of suitable sources. Availability of THz products has progressed from radiation sources from hot elements, to far infrared lasers, to microwave frequency multiplier chains, and finally to laser-activated Austin switches. These developments have permitted new applications which are addressed by this group.

Detailed Review

- **Technical Merit and Plan**

Traycer has developed THz/millimeter wave focal plane arrays (FPA) for imaging using conventional electronic methods. TeraView uses the Austin switch to make time-domain-pulsed diagnostic products. Photon-X utilizes conventional visible cameras and algorithms to perform "stand-off" high-resolution sensing of object features using a novel spatial-phase-imaging technique. University support of new-materials-based devices is described.

The proposed activity features an amalgamation of the technologies from these three companies to address markets in:

- Stand-off inspection in the visible and THz spectrum for portal security;
- Non-destructive evaluation (NDE) for integrated circuits, production line quality control, and fault detection on the surface of structures;
- Bio-medical imaging to detect cancerous tissue; and
- Some opportunities for original equipment manufacturer sales of existing and new devices.

It can generally be stated that the uniqueness of the THz spectral region makes the competitive product analysis one of comparing the new technique with some existing techniques currently available. This combination of companies appears to have no comparable competition in the THz applications area for this range of technologies.

Each company has fine technology and can probably be regarded as best in class. The plan addresses products which range from easy to very difficult for the intended markets. For example, the spatial imaging technique for portal inspection and security historically requires meeting exacting practical requirements; thus most technological innovations never make it into actual usage. The proposed plan does not address in detail how these practical constraints (set-up configuration, subject diversity, data processing, false alarm or error rate, and so on) impact the achievement of product goals except by stating

that the statistical performance variations will be studied. On the other hand, detection of corrosion or other flaws underneath paint has been demonstrated, so there is more assurance of meeting this goal. This proposal meets the requirements of the RFP for Technical Merit and Plan.

- **Commercial Potential**

EICP has a seasoned team with good commercial experience, which the committee appreciates. At issue is the length of the time given for product development, improvement, and deployment to generate jobs and sales. These are, for the most part, game-changing products that will compete with existing products.

One promising product is the biomedical THz imaging for cancerous tissue. This might be a great product for in vivo surgery to delineate the extremes of cancerous tissue for real time surgical assistance, but this use will probably require clinical trials for certification. For this reason, the market potential is high and the time frame is very long. The risk of development of this product is moderate since the basic prototype demonstrates excellent results.

Again, the seasoned team and the game-changing nature of technology with great long-term potential should bode well for attracting capital and investment. The business model is ideal in the sense that each member of this consortium has individual existing markets for stability, and by joining together, they create new products. Cooperation also optimizes other factors; for example, TeraView (in the U.K.) would locate a plant in Ohio with the assistance of the other members.

This proposal exceeds the requirements of the RFP for Commercial Potential.

- **Leadership and Management Quality**

The proposal aptly demonstrates the great strength of the EICP consortium and letters attest to the technical merit of the academic and professional community. Citations of initiatives from the investment community are also noteworthy. This proposal meets the requirements of the RFP on Leadership and Management Quality.

- **Budget and Cost Share**

All budget issues appear to be resolved in this section. It should be noted, however, that no major security or semiconductor firm in major market segments have sent letters agreeing to substantial cost shares. The proposal would be strengthened by such a commitment, but even without it, this proposal meets the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

This proposal offers significant potential and received high marks by the committee. However, the committee is ultimately not convinced of the effectiveness of the team to address the diverse commercial applications and the integral role of the proposed university research.

The committee does not recommend that this proposal be considered for the limited Third Frontier Program funds.

EPS RCP 09-079
Electical Dual Mode Vehicle Development Project

MonoMobile Corporation

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$2,789,222	$2,817,792
Capital Funds	$0	$0
Subtotal	$2,789,222	$2,817,792
TOTAL	$5,607,014	

The MonoMobile Corporation proposal is for is an electric car that drives to local destinations as an automobile and for long-distance travel connects to an elevated rail at speeds of up to 30 MPH and travels to its destination at speeds up to 100 MPH.

MonoMobile is the lead applicant with the Air Force Institute of Technology, Wright State University, National Composite Center, and Henry Wood Company as collaborators.

Detailed Review

- **Technical Merit and Plan**

The proposal is long on generalities and short on technical specifics. Huge problems are identified with little discussion to indicate that the fundamentals are understood or how they would be addressed. For example: “Can we switch vehicles moving 100 MPH?” “Can we connect a vehicle to a rail at 30 MPH?” Can we “prove the technology safe and reliable? Public transportation officials, large corporations that we hope to partner with, and the general public will be very skeptical of a new technology that has the potential to seriously injure or kill.”

Although there is mention of a “small” proof of concept vehicle that was built, there is no discussion of what was learned in the process. It is not clear if a section of track was included.

With many technical aspects lacking in this proposal, it does not meet the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

The success of this project depends on “partnering with the automotive companies” to produce or modify vehicles to be compatible with the system that is designed to couple the vehicle to a fast moving rail carrier, but there is no indication that any automotive company has expressed an interest in the project, and certainly no commitment of time or dollars on their part.

Success also depends on building the rail system and addressing significant safety issues, which would require that a local, state, or federal government provide land, right of way, approvals, and so on. The proposal does not indicate that there have been any discussions with any government agency that has shown any interest in taking on these challenges. Even if there were, the time required involved would likely fall outside of the requirements of the RFP.

In addition, success depends on attracting investors to commit huge investments (probably well into the billions of dollars) to commercialize the system, including the building of the track system. The report states that “venture capital funding is not a good match because it takes too long until profitability.” The proposal does not suggest where the money will come from if it does not fit into the profit requirements of venture capitalists.

For these reasons, the proposal does not meet the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

The proposal states that "the main responsibility for . . . the lead applicant will be to assure that the different groups work together and that there is a constant flow of information between every participant . . . [and] to participate in almost every meeting."

Neither the lead applicant nor any of the collaborators seem to have experience in commercializing a high-volume product or managing a complex production-oriented project. No entity is identified that would have the responsibility for driving or guiding the project to commercialization. Hence, the proposal does not meet the requirements of the RFP on Leadership and Management Quality.

- **Budget and Cost Share**

It appears that the contributions approximate the state funds requested, but only a small fraction of it is in cash. This proposal does not meet the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

There are significant technical, governmental, and managerial issues that make the proposal generally infeasible.

The committee does not recommend that this proposal be considered for the limited Third Frontier Program funds.

EPS RCP 09-080
Developing Load Matching Technology to Improve HVAC and Domestic Hot Water System Efficiency

R.W. Beckett Corporation

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$2,088,872	$2,117,865
Capital Funds	$30,000	$270,000
Subtotal	$2,118,872	$2,387,865
TOTAL	$4,506,737	

The R.W. Beckett Corporation project proposes to develop a new line of HVAC controls that utilize state-of-the-art load matching microsensor and microprocessor technologies. Smart sensors and smart control algorithms would be developed to monitor outdoor and indoor conditions and optimize boiler or furnace operations to save as much as 20% of the fuel used. Furthermore, the lead applicant and the collaborators would develop a fuel-tank-monitoring system that will provide information to fuel suppliers for more efficient oil/LP gas delivery routing.

R.W. Beckett Corp. is collaborating with the University of Akron (heat sensing and disturbance models development), Essential Research, Inc. (microfabrication development and production), Sensiics, Inc. (integrated circuits), and Lorrain County Community College (fabrication laboratory).

Detailed Review

- **Technical Merit and Plan**

The project goals for reducing fuel consumption by optimizing boiler and furnace operations and simultaneous reduction of improved carbon footprint are laudable but there is precious little new technology that is being brought forth that can provide a lasting technological edge to Beckett and to Ohio. The proposed development of "AquaSmart" multifunction sensor is seen as neither stressing the known technology nor providing a unique intellectual leap in sensor technology that will afford a lasting advantage to Ohio. The overall ideas behind optimization of HVAC operation are hardly new. They are already being practiced in large-scale operations and the trickle down to smaller operations will happen even without this project. Finally, the proposal lacks a serious research effort, which is crucial for committee approval. This proposal does not meet the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

The proposed project may have a moderate impact on the commercial growth in Ohio, although there is a high likelihood of having a measurable local impact. The absence of any clearly identifiable intellectual property, either being brought to the table or being developed during the course of the project, will stand in the way of wide-scale deployment by the Ohio-based companies. This proposal does not meet the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

The committee sees the technical leadership as being marginal. The management and business leadership is also seen as being weak, because they did not recognize that the generation of intellectual property that would permit Ohio to retain the "ownership" of the improvements was missing from the proposal. This proposal does not meet the requirements of the RFP on Leadership and Management Quality.

- **Budget and Cost Share**

Budget and cost share appear to be on the borderline. The proposal does not meet the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

In view of the significant lack of scientific and technical innovation and of a comprehensive research effort, the committee does not recommend that this proposal be considered for the limited Third Frontier Program funds.

EPS RCP 09-082
Manufacturing Technology for SOFC Cells and Stacks

NexTech Materials, Ltd.

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$4,005,100	$2,596,603
Capital Funds	$994,900	$4,726,000
Subtotal	$5,000,000	$7,322,603
TOTAL	$12,322,603	

NexTech Materials, Ltd., with its collaborators, Mound Laser and Photonics Center, Rimer Enterprises, the Ohio State University, and Hocking College, would work to eliminate engineering and cost barriers to market introduction of two patent-pending technologies—FlexCell and FlexStack—to enable low-cost manufacture of solid oxide fuel cells (SOFCs) with performance and durability attributes that exceed market competition. NexTech, working with a committed end user (POSCO Power, Seoul, South Korea), would design and construct a manufacturing plant for production of fuel cells at a scale of 10-MW per year to be located in Lewis Center, Ohio. Completion of this project would position NexTech for intermediate-volume manufacturing to meet the needs of the global market for advanced energy systems.

The intended markets for NexTech's products include large, stationary power systems for commercial and residential housing and small combined heat and power systems for single family homes. NexTech would also work with Battelle and other industrial partners to develop power products for military uses, including auxiliary power units and portable generators.

Experience gained on the project would create unique capabilities in Ohio's technical colleges and universities, position manufacturers to participate in the supply chain, and ready Ohio manufacturers for expansion into high-volume production of fuel cells.

Detailed Review

- **Technical Merit and Plan**

This project is focused on the continued development and commercialization of NexTech's SOFC technology, which includes improved materials, multilayer ceramic fuel cell architectures, and fuel-cell stacks for high-temperature fuel-cell systems. The proposal focuses on manufacturing large-area planar SOFCs and testing SOFC stacks manufactured from the planar cells. During the project,

— NexTech proposes to procure and install required equipment for an SOFC-manufacturing facility designed for production of 10-MW capacity of low-cost, high-quality ceramic fuel cells, using funding from POSCO.

- Large-area fuel cells would be manufactured and supplied to POSCO for production of 100+ kW stacks and integration into stationary power systems.
- Using RCP funding, capabilities would be created for small-area cells to be integrated into NexTech's 1-10 kW fuel-cell stacks for supply to integrators in the military, small stationary, and transportation markets.

— The Mound Laser and Photonics Center would adapt its high-speed laser-welding technology for the fabrication of metallic interconnects.

— Rimer Enterprises would investigate an investment-casting method for fabricating stack manifolds.

— Ohio State would use its stack-modeling expertise to improve mechanical robustness and thermal cycling capability.

— An SOFC stack-testing facility would be established at the Hocking College Energy Institute to support long-term testing of SOFC stacks.

Key manufacturability, durability, and cost issues and risks have been identified and detailed plans proposed for mitigation. The proposal meets the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

NexTech anticipates finalizing a $7 million contract with POSCO Power in 2009 to build a manufacturing facility in Ohio (10 MW/year) for large-area cells designed for 100+ kW scale SOFC power systems. RCP funding would be used to extend the business opportunities derived from this Ohio facility. Key goals for the use of project funds include the following:

— Expand production capacity for multiple product opportunities, to include the ability to produce 1-10 kW value-added stacks.

— Adapt technology to meet market needs in multiple military and commercial markets.

— Build commercial partnerships between Ohio companies, including Ohio-based suppliers of critical stack components (Rimer Enterprises and the Mound Laser and Photonics Center).

— Establish unique capabilities at Ohio universities by leveraging and enhancing thermal/mechanical stack modeling capability at Ohio State University and developing fuel cell stack testing capabilities at Hocking College's Energy Institute, as well as education and training capacity to support employer requirements.

For NexTech's stack manufacturing business, successful project outcomes include capturing military SOFC demonstration projects, establishing stack supply agreements with fuel cell system integrators in Ohio (e.g., Battelle and Lockheed Martin), across the U.S., or globally.

With resolution of the challenges identified in the technical plan, the project's result is expected to be a viable cost-effective solution for the target markets. If successful, this project would position NexTech and it partners to compete effectively in the global market for SOFCs. The relationship and commitment of POSCO is important to the success of the project, NexTech, and the longer-term economic impact on Ohio.

Assuming the POSCO agreement is successfully concluded, the proposal exceeds the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

By bringing key supplies and a partner/customer to the table, NexTech has focused on assembling a team that understands the value chain. This team should be able to handle the difficult challenge of commercial scale-up. The committee is interested in better understanding the team's relationship and long-term plans with POSCO. Managing relationships with large and foreign companies are a significant challenge for small companies. The proposal meets the requirements of the RFP on Leadership and Management Quality.

- **Budget and Cost Share**

The budget appears reasonable for the proposed tasks; however, this proposal is unusual in that virtually the entire cost share is provided by a committed end user, POSCO Power (a foreign corporation with no presence in Ohio)—not the lead applicant or the collaborators. In particular, the lead applicant

and four collaborators together are contributing less than 5 percent of the cost share ($322,000), an amount that pales in comparison to the state funding requested. The RFP states that "Collaborators should be committed to the long-term commercialization of the technology and play a role in accomplishing that goal. A contribution of Cost Share resources by a Collaborator is evidence of that commitment." Although POSCO Power appears to be committed to the program, this arrangement raises questions about the commitment of the lead applicant and the collaborators.

Moreover, "NexTech is***anticipating*** a $7 million contract from POSCO Power (in June 2009) that will provide formal cost sharing to this project" [emphasis added]. Therefore, given the limited local cost share and the lack of evidence that the POSCO agreement is committed, the committee must conclude that the proposal does not meet the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

This is an excellent proposal. The technical plan is well developed and the risks and challenges are clearly addressed. However, the commercialization plans depend heavily on POSCO's commitment. The committee ranked this proposal very high on technical merit and commercial potential, but, in the absence of firm budget match and a solid commitment from POSCO, the committee does not recommend that this proposal be considered for the limited Third Frontier Program funds.

EPS RCP 09-086
Agile Manufacturing of Sheet, Tube, and Extruded Metals via Electromagnetic Forming

American Trim, LLC

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$5,000,000	$4,942,797
Capital Funds	$0	$83,000
Subtotal	$5,000,000	$5,025,797
TOTAL	$10,025,797	

The American Trim, LLC, proposal is aimed at addressing the agile manufacturing needs of various niche markets for sheet metal products, by accelerating developments in electromagnetic (EM) forming. The team intends to apply these advances in EM forming and demonstrate agile manufacturing on selected steel and aluminum components used in automotive, aerospace and appliance manufacturing applications, eventually creating 731 jobs in Ohio.

American Trim leads a team consisting of Honda of America, Whirlpool, Motoman, Cutting Dynamics, Ohio Northern University, Ohio Energy & Advanced Manufacturing Center, and Ohio State University, with management by the Edison Materials Technology Center.

Detailed Review

- **Technical Merit and Plan**

The committee likes the proposal team's emphasis on demonstrating agile manufacturing applications of EM forming simultaneously in three different sectors. However, the proposal does not clearly state what is the real enabling innovation in EM forming that is required; EM forming has been investigated by automakers for well over a decade, yet no suitable manufacturing application has been convincingly demonstrated from all aspects of technology readiness. The applicant, by its own admission, indicates that significant barriers remain that impede the EM forming applications.

The committee feels that polymer dies do not have the strength and adequate life to meet even low-volume applications. Energy consumption in EM forming is very high, and the proposal does not address the secondary impact on energy costs to the supplier. Also not addressed are concerns about worker safety that would arise. EM forming offers a panacea for Ohio's greatly weakened tool- and die-manufacturing industry, but this change may be too disruptive. For a balanced assessment of the claim of "10X" in savings using EM forming, the committee would prefer to see what proportion of fully accounted costs in the conventional sheet forming process the springback correction step is responsible for, besides the "quick change tooling" benefits EM promises, as stated in the proposal. The committee would prefer to see clear evidence of the simulation and modeling basis/tools that can expedite design and application of EM forming (e.g., for actuator and coil design and forming process modeling), since EM forming induces tri-axial stresses in sheet metal by inducing momentarily high temperatures. This proposal does not meet the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

The committee feels that given the current economic recession and unpredictability of market demand for products, technologies enabling low-volume applications should proliferate, and EM forming has the potential to fill that niche at low investment. However, given the extended downturn in U.S. manufacturing, the committee is not satisfied that the proposal has adequately addressed the capital investment and workforce training issues in order to achieve successful commercialization of EM

forming. Examples of commercial interest in EM forming cited in the proposal are mainly with equipment suppliers (e.g., Pulsar and Poynting). Furthermore, the proposal did not include Honda's allocation of key personnel, their role, and specific contributions to the collaboration, evaluation, and commercialization of EM forming developments (other than in letter). As a result, this proposal does not meet the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

The committee believes the credentials of the lead applicant and collaborators (including academic organizations) are very good. The leadership of American Trim and leverage of capabilities at Motoman and Cutting Dynamics along with key committed end users is commendable. The inclusion of a bona-fide sheet-metal tool and die manufacturer would have further strengthened the proposal. This proposal meets the requirements of the RFP on Leadership and Management Quality.

- **Budget and Cost Share**

The proposal has requested the maximum funds from the Ohio RCP program. The committee is concerned (per Honda's letter) that Honda, as an end user, is expecting to draw up to $1 million from the State proceeds for direct project-related expenses; this does not indicate Honda's confidence in the proposal team's ability to deliver the benefits of EM forming. Perhaps some additional work is needed to truly integrate Honda as a team player. Some mistakes were found in American Trim's Budget Sheet (Budget Form 2 shows American Trim is requesting $5 million in State funds, whereas the total RCP budget is $5 million). This proposal does not meet the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

The committee feels that the risk, resources, and activation energy needed to develop and implement new applications of EM forming across three industry sectors are far higher than estimated by the applicant. While the theoretical benefits of EM forming appear promising, the committee feels that many technical challenges lie in scale-up, manufacturing science, modeling, and production systems development; these concerns make this proposal weaker relative to other, less risky proposals the committee has reviewed. The proposal gives the impression that the major tasks lie in systems integration, which is no mean feat to achieve.

The committee does not recommend that this proposal be considered for the limited Third Frontier Program funds.

EPS RCP 09-088
Recovery and Purification of BioIsoprene™

Goodyear Tire & Rubber Company

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$4,937,000	$12,820,000
Capital Funds	$0	$0
Subtotal	$4,937,000	$12,820,000
TOTAL	$17,757,000	

This is a collaborative project between the Goodyear Tire & Rubber Company in Ohio and Genencore in Palo Alto, California.

The principal synthetic (oil-based) rubber in current use is based on a styrene-butadiene copolymer (SBR). The proposed project is to produce a bio-based synthetic rubber based on "polymer grade" microbially derived isoprene. This monomer (with a trade mark of BioIsoprene™) would be a substitute for isoprene derived by molecular rearrangement of hydrocarbons.

Genencore would use its bio-processing and fermentation knowledge and Goodyear would use its polymer synthesis and manufacturing expertise. Goodyear would also collaborate with Burns & McDonnell and NUCON International, which has additional polymer expertise.

Detailed Review

- **Technical Merit and Plan**

It is implied that the major problem associated with recovery and purification of BioIsoprene™ is the removal of impurities that inhibit the polymerization of the monomer to polyisoprene. Therefore the main goal of this project is to develop new separation technologies for recovery and purification of this valuable bio-based material at Genencore fermentation facilities for eventual commercialization.

The aims of the project are therefore to (1) develop a cost-effective fermentation process to produce BioIsoprene™; (2) develop an efficient and effective means to remove impurities; (3) develop an efficient polymerization of BioIsoprene™ and assurance of its quality, as compared to currently available petroleum-based isoprene; (4) find markets other than tires for BioIsoprene™; (5) identify Ohio-produced agricultural feedstock that could be used economically for production of BioIsoprene™; and (6) test cellulosic biomass as future use of feedstock for production of BioIsoprene™.

To attain the very large demands for BioIsoprene™ as postulated in this proposal, a very high isomeric purity polymer will have to be manufactured. It is by no means clear that BioIsoprene™ can improve the final product in comparison to oil-derived isoprene. The argument that BioIsoprene™-based polyisoprene is "green" is hardly relevant, given that natural rubber is also "green" and, moreover, as an agricultural product is available in virtually unlimited amounts from relatively politically stable sources (unlike petroleum). This proposal does not meet the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

The commercial potential of BioIsoprene™ is certainly present to some extent; the product is under development by Genencore, with not much impact in Ohio. However, the market for polyisoprene, as presently manufactured, is quite small, the principal reason being that it is inferior in many technical respects to its chief competitor, natural rubber. This has been known for decades, as has the reason: insufficient purity of the cis isomer in the commercial-petroleum-derived polymers. This proposal claims there is a huge potential market (8×10^5 tons) for BioIsoprene™. This would be true only if the resulting polymer is technically and economically competitive with natural rubber.

Isoprene is also used as a feedstock for other polymer products such as in styrene-isoprene-styrene triblock rubbers and in adhesives. But the demand is relatively small and, as this proposal itself points out, there is much idle monomer capacity available in Russia where the less useful synthetic polyisoprene has now been supplanted by natural rubber. This proposal does not meet the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

The proposal does not identify a commercialization director as required by the RFP. Thus, this proposal does not meet the requirements of the RFP on Leadership and Management Quality.

- **Budget and Cost Share**

The cost share of the proposed work is almost three times the requested funds ($4.9 million to $12.8 million). This proposal meets the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

The authors of this proposal have chosen not to address the key issue of the isomeric content of the polymer based on BioIsoprene™, which dominates the issue of its technical and economic viability. The committee also had other questions about the fermentation process; for example, regarding the yield and disposal of by-products. The principal rationale for converting the isoprene industry to a fermentation-derived feedstock industry is a worthy one, but not necessarily a sufficient one.

The committee does not recommend that this proposal be considered for the limited Third Frontier Program funds.

EPS RCP 09-094
Plastic Friendly Advanced Energy Devices

MetaMateria Partners, LLC

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$1,675,000	$2,000,000
Capital Funds	$325,000	$0
Subtotal	$2,000,000	$2,000,000
TOTAL	$4,000,000	

The primary goal of the MetaMateria Partners, LLC, project is to grow Ohio's leadership in renewable energy technology R&D and manufacturing by establishing a technology start-up effort in the area of organic photovoltaics (OPV). This is a disruptive technology (many classify it at the beginning of the third generation approaches compared to second generation thin films such as CdTe, a-Si:H, and CIGS) that builds on the intellectual property base and expertise of the proposing group. OPV is in its infancy and still requires substantial demonstration of performance (pathways toward and beyond 10% efficiencies, for example) and reasonable reliability (commensurate with the U.S. goals of 20-30 year lifetimes). Recent accomplishments by members of the proposal team in novel transparent conducing films designed for OPV and their work on nanostructured organic semiconductors brings some innovation to this technology development investment. The collaborators in this project include Ohio State University (OSU) (with the Wright Center for Photovoltaic Innovation and Commercialization [PVIC]), Edison Welding Institute, NanoDynamics, and Epik Energy Solutions.

Detailed Review

- **Technical Merit and Plan**

This proposal is directed at the fabrication and commercialization of photovoltaic (PV) devices based on conjugated polymer nanocomposites containing nanoparticles, which allow for heterojunctions to enhance the exciton charge separation and direct the holes and electrons to the appropriate electrodes for electrical current production. This is an area that has received a significant amount of research activity worldwide, with the goal of producing lower-cost solar energy modules than is possible with current technologies (silicon and other thin films).The technical and economic risk is very high, but this technology has potentially high payoffs. OPV is among the lowest-cost approaches (in terms of materials and manufacturing) to solar energy electricity. Benefits include excellent materials availability and environmentally friendly components.

MetaMateria brings the ability to synthesize nanoparticles of the desired inorganics for the device harvesting (collecting) layer in combination with an appropriate conjugated polymer. This expertise and ability is key to a successful PV device and appears to be capable of being accomplished by MetaMateria technology. Even if reasonable efficiencies (>5%) can be achieved, the major problem confronting these systems (compared to the established silicon technology) is their lifetime. Assuming the device can be shielded from oxygen and water (which should be quite possible with glass, but is far from being solved for flexible panels), the lifetime of such systems is rarely reported in the technical literature, but rather only initial results are noted. It is well known in the LED device field that the hole injection layer (required for device performance) has a limited lifetime (for blue). LED lifetime requirements are much less than PV requirements for long-term use. This proposal exceeds the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

The commercial potential of OPV depends on whether the proposal can achieve technical and economic goals, particularly with regard to lifetime issues, and thereby compete favorably with silicon and thin-film technologies. Some markets will exist with lifetimes of a year or more—but lifetimes of even a year may be difficult with the current state of the art. It is not apparent that the members involved in this proposal have the ability to adequately scale-up commercial entry into the market, although they could scale-up products for niche markets while obtaining partners for much larger-scale (silicon and thin film) markets.

The one significant short-coming of this proposal is that the pathway to commercialization is not clearly presented. The proposal appears to be focused on developing and demonstrating a OPV prototype meeting the market requirements, with scale-up to commercialization being less clear. This proposal does not meet the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

The management plan is adequate and the technical staff for this proposal are very good. MetaMateria has recent experience in establishing capabilities to produce a variety of nanostructured materials for various applications—with support from the Third Frontier Program. The involvement of the Wright PVIC is key—PVIC has already established itself as a key resource in the U.S. for solar energy research and information. The links that PVIC has with other Ohio institutions is very important. OSU brings resources (characterization, processing, and materials) that are key. However, the leadership and management plan has not properly considered plans for commercial scale-up if technical success is achieved. Therefore, this proposal does not meet the requirements of the RFP on Leadership and Management Quality.

- **Budget and Cost Share**

The budget is relatively low for this rather aggressive and R&D-intensive project. The committee suggestes that the proposal team examine whether this budget is adequate to match the work plan. The proposal does not meet the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

MetaMateria brings the ability to synthesize nanoparticles of the desired inorganics for the device harvesting (collecting) layer, in combination with the appropriate conjugated polymer. This expertise and ability are key to a successful PV device and appear to be capable of being accomplished by MetaMateria technology. However, there are significant technical and commercial concerns about this project. The detailed technical write-up appears quite good, but some items require more consideration. Even if OPV devices with reasonable efficiencies (>5%) can be achieved, the major problem confronting these systems (compared to established technology) is lifetime (stability). Assuming the device can be shielded from water and oxygen (which is difficult with flexible panels), the lifetime of such systems is rarely reported in the technical literature. Instead, only initial results are noted. The one area the committee believed was deficient in the proposal planning and discussion was in the commercialization plan if technical success were to be achieved. The proposal also appears to be somewhat early in the development cycle to meet the criteria of funding under the directives of this review process.

The committee does not recommend that this proposal be considered for the limited Third Frontier Program funds.

EPS RCP 09-104
Electrofluidic Displays: Advanced Materials and Flexible Electronics That Expand Ohio's International Leadership in Displays from Niche to Mass Market

Sun Chemical Corporation

Proposal Summary

Proposed Budget		
	State Funds	Cost Share
Operating Funds	$1,992,043	$2,098,676
Capital Funds	$116,000	$36,738
Subtotal	$2,108,043	$2,135,414
TOTAL	$4,243,457	

The Sun Chemical Corporation project proposes to further develop and commercialize the technology of electrofluidic displays that has already been demonstrated by the University of Cincinnati to exhibit brightness and world-record white reflectance of greater than 85 percent. The proposal team has two collaborators: the University of Cincinnati and Kent State University.

Detailed Review

- **Technical Merit and Plan**

Building on the University of Cincinnati's technology of electrofluidic displays with a demonstrated brightness of 85 percent, this project's plan to include carbon-black pigment in the fluidic dispersion will result in a contrast ratio ranging from 15:1 to 18:1. Inclusion of other pigments in the fluid can lead to multicolored electronic paper that could rival printed material on white paper. The lead applicant has the knowledge to formulate fluids with a variety of dyes. Electrofluidic displays have already demonstrated 350 million switching cycles. Technological challenges that must still be overcome include increasing the size of the display from the current 1 inch square to about 4 inch square, increasing the number of switching cycles to support at least one year of continuous operation at 100 Hz (greater than 500 million cycles), and enabling continuous manufacturing of the final product. The proposal addresses all these issues to an excellent degree and the technical risk seems minimal.

The University of Cincinnati would manage the intellectual property generated by this activity; however, the committee is concerned that Sun Chemical is owned by a Japanese company, Dainippon Ink and Chemicals, Inc. To safeguard the long-term economic viability of the commercial activity resulting form this proposal for Ohio, there needs to be an assurance that the intellectual property generated by this project will not leak back to Dainippon and prevent the long-term growth of jobs in Ohio.

The proposal meets the requirements of the RFP on Technical Merit and Plan.

- **Commercial Potential**

Successful development and commercialization of this technology could lead to substantial business opportunities in electronic paper, displays, electronic skins for consumer appliances, and electronically alterable camouflage, perhaps on the order of several hundred million dollars of revenue over a 5-year time frame. The proposal meets the requirements of the RFP on Commercial Potential.

- **Leadership and Management Quality**

The technical leadership described in the proposal is excellent. However, the management and business leadership is quite weak, because no viable existing commercial organization has been identified for the eventual commercialization of the developed technology. For example, commercialization of

color-changing laminates would be led by the Ohio startup company γ-Dynamics, which will not begin operations until 2010, and the funds for this proposal would be used to create a business plan for γ-Dynamics. In addition, the proposal does not identify a technical director or a commercialization director, as required in the RFP. The proposal does not meet the requirements of the RFP on Leadership and Management Quality.

- **Budget and Cost Share**

Budget and cost share appear to be reasonable. The proposal meets the requirements of the RFP on Budget and Cost Share.

Summary of Review and Recommendation

The proposal does not include a manufacturing company as either the lead applicant or a collaborator. This is a major flaw, and the committee does not recommend that this proposal be considered for the limited Third Frontier Programs funds.

Appendix B
Evaluation Worksheet

Evaluation Criteria	ERCP 09- Score 0-5*
A. Technical Merit and Plan [all from RFP section 5.3.6]	
1. Understanding the Program Intent. Proposal is responsive to the long-term purposes of the OTF.	
2. Problem Statement. a. Technical and commercial challenges described. Why are they important? b. Description of eventual customer needs and performance requirements.	
3. Project Goals and Objectives. a. Objectives described in terms of Level A, Level B, and Level C Metrics (See RFP section 2.2) b. How will goals and objectives carry technology forward into each phase of the Technology Commercialization Framework.	
4. Technical Approach and Work Plan. a. How will goals and objectives be met? Compare research techniques, methods, and facilities, and equipment to alternatives b. Tasks described in terms of objectives, approaches, resources, and outcomes. How will progress will be made and measured?	
5. Scientific and Technical Merit a. Scientific objectives are original and innovative; novel concepts, approaches or methods are employed b. Project has potential for new discoveries and understanding; advances beyond previous studies can be expected c. Scientific and technical feasibility; conceptual framework, design, methods, and analyses adequately developed	
6. Schedule and Deliverables described with tangible milestones for commercialization and technical progress	
B. Commercial Potential [all from RFP section 5.3.7]	
1. Value Proposition. Define benefits of the proposed approach and explain why the market values these benefits.	
2. Management of Intellectual Property. How will new Intellectual Property be managed to benefit Ohio-based companies?	
3. Potential for Products. a. Identify focused commercialization opportunity for new products with significant market size and growth within 3 years b. Proof of Principle already demonstrated c. Technologies or products have competitive advantage over existing and alternative technologies	
4. Size of Opportunity. Proposal accurately assesses market and has realistic assumption about market share that could be captured	
5. Degree of Customer Readiness. Customer input, especially from collaborators who may be eventual customers	
6. Investment and Time to Market. How much money and time is needed to bring the product to market	
7. Receptive Capital Markets. Provide evidence that various sources of capital are interested in the project	

8. Potential for Leverage. Define goals and plans for leveraging OTF grant funds with other non-state funds	
9. Ability to Compete Globally. Demonstrate an understanding of the global marketplace and trends, including barriers to market entry that favor large firms. How well the Lead Applicant be able to compete for international business opportunities.	
10. Degree of Sustainable Competitive Advantage. Demonstrate that the proposed Project fits within, or can create, an environment which enables Ohio to maintain a leading, competitive advantage.	
11. Type of Business Model. Team strengths and weaknesses with respect to implementing the proposed business model.	
12. Roles and Responsibilities. Roles and responsibilities of the Lead Applicant and Collaborators in the commercialization process	
C. Leadership and Management Quality	
1. Proposal demonstrates commitment of the Lead Applicant and Collaborator(s) to building a sustainable partnership [3.2]	
2. Teams are "very strongly encouraged" to have a for-profit firm as the Lead Applicant [3.3.2]	
3. Leadership is demonstrated in all critical phases, including research, IP protection, regulatory compliance, product development, leveraging of additional funding, and commercialization [5.3.11]	
4. Team has relevant organizational experience to perform technical and commercialization work involved [5.3.11]	
5. Proposal is founded on research and development programs that are already well-established [3.3.1]	
6. Collaborators committed to the long-term commercialization of the technology (e.g., as evidenced by a cost-share contribution), play a role in accomplishing that goal, and submit a letter that defines the commitment being made [3.3.3]	
7. Lead applicant and Collaborators demonstrate potential to secure additional funds to accomplish the next phases of commercialization [3.2]	
D. Budget and cost share	
1. Budget justified and adequate to meet proposal goals; no more than 20% for either indirect costs or for capital costs [5.3.12]	
2. Cost share is necessary and reasonable; > state funds, and is preferably in the form of unrestricted cash [3.5.1 and 3.5.2]	
3. Commitment letters are provided and are sufficiently detailed [5.3.13]	

* A score of 0 should be used to indicate that the applicant either did not address the requirement or that the applicant completely failed to meet the requirement. A score of 5 should be used to indicate that the applicant meets the requirement exceptionally well.

Appendix C
Committee Roster

Lyle H. Schwartz, Chair
Director (retired)
Air Force Office of Scientific Research

Sundar V. Atre
Associate Professor and Director
Manpower Technologies Group
Oregon Nanoscience and Microtechnologies Institute
Oregon State University

John A. Betti
Undersecretary of Defense (retired)
Department of Defense

David (Ed) Crow
Professor of Mechanical Engineering
University of Connecticut

J. Eric Dietz
Associate Professor
Computer and Information Technology Department
Purdue University

Thomas S. Hartwick
Independent Consultant

Frank E. Karasz
Silvio O. Conte Distinguished Professor
Department of Polymer Science and Engineering
University of Massachusetts

Lawrence L. Kazmerski
Director
National Center for Photovoltaics
National Renewable Energy Laboratory

R.A. Lukaszew
VMEC Associate Professor
Applied Science and Physics Departments
College of William and Mary

Manish Mehta
Director
Collaboration Programs
National Center for Manufacturing Services

Trent M. Molter
Research Scientist and Business Development Officer
Connecticut Global Fuel Cell Center

David C. Mowery
Professor of New Enterprise Development
Walter A. Haas School of Business
University of California, Berkeley

C. Kumar N. Patel
Chairman
Pranalytica, Inc.

Arthur L. Patterson
Chief Executive Officer
Elona Bio-technologies

Lloyd M. Robeson
Principal Research Associate (retired)
Air Products and Chemicals, Inc.

Mariam B. Sticklen
Professor
Department of Crop and Soil Sciences
Michigan State University

T.S. Sudarshan
President and CEO
Materials Modification, Inc.

J.W. (Jim) Wheeler
Director
Economic Competitiveness Policy and Research
Thomas P. Miller and Associates

Staff

Richard Rowberg, Interim Director, Aeronautics and Space Engineering Board
Marcia S. Smith, Director, Aeronautics and Space Engineering Board (through February 2009)
Paul Jackson, Associate Program Officer
Alan Angleman, Senior Program Officer
Andrea Rebholz, Program Associate
Lewis Groswald, Research Assistant

Appendix D
Biographical Sketches of Committee Members

LYLE H. SCHWARTZ, NAE, (retired) was Director of the Air Force Office of Scientific Research, guided the management of the entire basic research investment for the U.S. Air Force. As former Director of the Materials Science and Engineering Laboratory at the National Institute of Standards and Technology (NIST), he managed the NIST nuclear research reactor, and is responsible for the development of the Presidential Initiative on Advanced Materials and Processing. He is widely known for his contributions in the areas of phase transitions in iron alloys, applications of mossbauer spectroscopy, x-ray and neutron diffraction, characterization of catalysts, and policy issues related to materials science and engineering. Dr. Schwartz has received many awards, including the Presidential Meritorious Executive Rank Award and the Department of Commerce Gold Medal. He has been elected to membership in the National Academy of Engineering, the Federation of Materials Societies, and ASM International—the Materials Information Society. Dr. Schwartz received his B.S. in Science Engineering, and his Ph.D. in Materials Science from Northwestern University. He is currently serving on the NRC Committee on Research Opportunities in Corrosion Science and Engineering, and previously served on 13 other NRC committees throughout his career, three of which as the Chair. In addition, he is currently Vice Chair of the NRC's National Materials Advisory Board.

SUNDAR V. ATRE is an Associate Professor in the Industrial and Manufacturing Engineering Department at Oregon State University. Dr. Atre's association with the Industrial and Manufacturing Engineering Department involves the integration of nanomaterial synthesis techniques and silicon and non-silicon microfabrication techniques. His research interests include advanced materials and manufacturing techniques for multiscale architectures, with applications in transport, energy, medical, communications and consumer sectors. Dr. Atre previously served on an NRC committee that reviewed proposals for the state of Ohio. Dr. Atre obtained his B.S. in chemical engineering from Indian Institute of Technology in India and his Ph.D. in materials science and engineering from Pennsylvania State University.

JOHN A. BETTI, NAE, is a retired Undersecretary of Defense for the Department of Defense (DOD). In that position he had oversight responsibility for the Defense Research and Development and Acquisition process involving over $140 billion and 500,000 people. Prior to his position with the DOD, Mr. Betti was the Executive Vice President of Diversified Products Operation at the Ford Motor Company. He was responsible for twelve of Ford's businesses with total revenue of $13 billion, 95,000 people, with manufacturing plants in the United States, Canada, Mexico, Brazil and six countries in Europe and joint ventures in Japan, Korea and the United States. Six of the businesses engineered and manufactured electronic, electrical-mechanical, heating and air-conditioning, plastic, aluminum and iron castings and glass components for the automotive industry. Mr. Betti also served as Executive Vice President of Technical And Operating Staffs and was responsible for eight corporate staffs, including the Alpha Project, which was responsible for developing innovative manufacturing, engineering, product and business processes to ensure the company's competitiveness for products, quality and cost into the 21st century. Mr. Betti has been a Member-National Academy of Engineering since 1989, and is currently a member of NRC Committee on Optimizing U.S. Air Force and Department of Defense Review of Air Force Acquisition Programs.

DAVID CROW, NAE, joined the faculty of the University of Connecticut as a Distinguished Professor-in-Residence in the Mechanical Engineering Department after a career in industry. Dr. Crow's background is in propulsion engineering, thermodynamics, aerodynamics, systems engineering and rocket propulsion engineering. Dr. Crow joined Pratt & Whitney in 1966, rising to the position of Senior Vice

President of Pratt & Whitney's Engineering organization in May 1997, where he was responsible for the design, development, validation and certification of all Pratt & Whitney large commercial engines, military engines and rocket products. He also led the research and development of advanced technologies systems to meet future aircraft requirements. He is a past Secretary of the Society of Automotive Engineers, and a Member of both the American Society of Mechanical Engineers and the American Institute of Aeronautics and Astronautics. Dr. Crow is currently serving on the NRC's Board on Manufacturing and Engineering Design and the NRC's Panel on Air and Ground Vehicle Technology. Prior to his current NRC duties, he served on eight committees. Dr. Crow received his M.S. in Mechanical Engineering from Rensselear Polytechnic Institute, and his B.S. and Ph.D. in Mechanical Engineering from the University of Missouri, Rolla.

J. ERIC DIETZ is the Director of the Purdue Homeland Security Institute, Associate Director of the e-Enterprise Center and Associate Professor in the Computer and Information Technology Department at Purdue University. On loan from Purdue to the State from 2005-2008, Dr. Dietz was the founding Executive Director for the Indiana Department of Homeland Security, a new cabinet-level department in Indiana that included over 300 public safety employees. Prior to serving as Executive Director, Indiana Department of Homeland Security, he was responsible for the catalysis of Purdue's homeland security research, increasing the impact of Purdue research on society, and organizing Super Projects in Purdue's Discovery Park. Retiring as a Lieutenant Colonel from the U.S. Army in 2004, he led Army research and acquisition programs including chemical weapons detectors, command and control software and army power systems and was in the initial cadre of Uniformed Army Scientists and Engineers. Dr. Dietz has no prior NRC experience.

THOMAS S. HARTWICK is retired from general management in the aerospace industry. He has more than 45 years of research and development, technology transfer/insertion, and mainstream business experience supporting all segments of the U.S. government. Dr. Hartwick previously worked at Hughes Aircraft Company, Aerospace Corporation and TRW. His areas of published research include sensors and imaging, optical communications, magnetic materials, microwave devices, molecular lasers, far-infrared lasers and their applications, and laser heterodyne radiometry. Since leaving the aerospace industry in 1995, Dr. Hartwick has served on a number of academic, government, and industrial boards in a technical management role. He is Chairman (Emeritus) of the Advisory Group on Electron Devices for Office of the Secretary of Defense, Chair of NRC committees on Aviation Security R&D, active with the Defense Science Board and GAO, and active for two decades with the National Technology Transfer Center. Dr. Hartwick is currently Vice Chair on the NRC Board on Manufacturing and Engineering Design. He has previously served on eight other NRC committees or panels.

FRANK E. KARASZ, NAE, is currently the Silvio O. Conte Distinguished Professor Emeritus at the University of Massachusetts. His research activities are concentrated in a number of areas in polymer physics and chemistry: polymer-polymer interactions in binary amorphous and amorphous crystalline blend systems: effects of copolymerization and microstructure; computer simulations of polymer-polymer miscibility; and quasi-elastic light scattering from macromolecular solutions. He has more than 570 publications and is the recipient of several national and international awards. Dr. Karasz is a past member of the National Materials Advisory Board and served on the National Material Advisory Board's Panel on Functional Organic and Hybrid Materials for the Committee on Materials Research for Defense-After-Next. His most recent service was on the NRC Committee on Assessing Corrosion Education. Dr. Karasz received his B.S. in Chemistry and D.Sc. in Macromolecular Science from the University of London, and his Ph.D. in Physical Chemistry from the University of Washington.

LAWRENCE L. KAZMERSKI, NAE, is Director of the National Center for Photovoltaics, located at the National Renewable Energy Laboratory (NREL). He was the first staff member in photovoltaics at NREL's predecessor, the Solar Energy Research Institute (SERI). NREL is the U.S. Department of

Energy's primary national laboratory for renewable energy and energy efficiency research and development. Dr. Kazmerski has published over 260 journal/proceedings papers and book chapters in the areas of solar cells, thin films, semiconductor materials and devices, surface and interface analysis, nanoscale technology, and high-temperature superconductivity. Dr. Kazmerski is currently serving on the NRC's Electric Power/Energy Systems Engineering Peer Committee. He received his B.S., M.S., and Ph.D. in Electrical Engineering from the University of Notre Dame.

R.A. LUKASZEW is the Virginia MicroElectronics Consortium (VMEC) Associate Professor in the Applied Science and Physics Departments at the College of William and Mary. Prior to working at William and Mary, Lukaszew taught in the Physics and Astronomy Department at the University of Toledo, and was a Research Scientist at the Mass Spectrometry Laboratory of the National Atomic Energy Commission in Buenos Aires, Argentina. Her research deals with fundamental studies on thin films (epitaxial, magnetic, etc.) and highly anisotropic nano-magnets; the correlation between structure, surface morphology and physical properties in thin films; and magneto-optical applications of magnetic nano-particles and magneto-optical sensors. Dr. Lukaszew has no prior NRC experience. She received her B.S. in Physical-Chemistry from the University of Buenos Aires, Argentina, and her Ph.D. in Physics from Wayne State University in Detroit.

MANISH MEHTA is Executive Director of Industry Forums at the National Center for Manufacturing Sciences (NCMS) since 2001, and also the Executive Director of Technologies Research Corporation (TRC), a subsidiary of NCMS, established to provide professional technology management services. His responsibilities include assessing emerging manufacturing-related technology needs in the national interest, and developing collaborative research and development projects with NCMS' government, industrial and academic partners. These collaborations include multi-partner projects in fuel cell components manufacturing, lightweight materials, and nanomanufacturing technologies. From 1991-2000, he was Director of Consortium Programs at the Environmental Research Institute of Michigan (ERIM) responsible for commercialization of ERIM's remote sensing and imaging technology innovations, as well as organized and managed several NIST-ATP and DARPA-sponsored Joint Venture projects in advanced materials and processes for aerospace and automotive end-users. As the Director of the Aluminum Metal Matrix Composites Consortium (a supplier group hosted by NCMS), he co-authored a technology roadmap for discontinuously reinforced MMCs. He also convened an alliance of steel-making, forging, heat treating, powder metal suppliers with automotive manufacturers and national laboratories to promote cross-industry leverage through standardization of test methods and process simulations. He was the Peer Review Agency Director of the 2008 Michigan 21st Century Jobs Fund Business Plan Competition. He obtained his BS (Mechanical Engineering) from Bangalore University, India, and MS and Ph.D. from University of Cincinnati, and is also a graduate of the Executive Program at the University of Michigan's Ross Business School. Dr. Mehta previously served on NRC committees that studied lightweight materials for 21st Century Army Trucks and that reviewed proposals for the state of Ohio 2008 Third Frontier Program; he also served on the NRC's Board on Manufacturing and Engineering Design.

TRENT M. MOLTER is a Research Scientist and Business Development Officer for the Connecticut Global Fuel Cell Center, whose mission is to be a world leader in fuel cell research, development, and education. The Connecticut Global Fuel Cell Center was awarded nearly $2 million from the U.S. Department of Energy to research the effects of impurities on fuel cell performance and durability. Dr. Molter leads this team, and is focused on improving the performance and durability of proton exchange membrane (PEM) fuel cells when challenged with various fuel-borne hydrocarbon impurities. In addition, Dr. Molter serves as President and CEO for Sustainable Innovations, LLC, a small company dedicated to the development of products for human sustainability. The Company's current focus is on the development of systems for hydrogen compression, energy storage, and renewable fuels production. Dr. Molter previously co-founded Proton Energy Systems, a company that develops and manufactures

hydrogen generation equipment. There he played an integral role in the Company's development leading technology and business development efforts, and culminating in a successful IPO in 2000. Dr. Molter previously served on an NRC committee that reviewed proposals for the state of Ohio. He received a B.S. in Chemical Engineering from Clarkson University, M.S. in Metallurgy from Rensselaer Polytechnic Institute, and a Ph.D. in materials science and engineering from The University of Connecticut.

DAVID C. MOWERY is the William A. and Betty H. Hasler Professor of New Enterprise Development at the Walter A. Haas School of Business at the University of California, Berkeley, and a Research Associate of the National Bureau of Economic Research. Dr. Mowery previously taught at Carnegie-Mellon University, and served in the Office of the United States Trade Representative as a Council on Foreign Relations International Affairs Fellow. His research deals with the economics of technological innovation and with the effects of public policies on innovation; he has testified before Congressional committees and served as an adviser for the Organization for Economic Cooperation and Development, various federal agencies and industrial firms. He has been a member of a number of National Research Council panels, and served as the Study Director for the Panel on Technology and Employment of the National Academy of Sciences. Dr. Mowery is currently serving on the NRC Committee on Understanding the Impact of Selling the Helium Reserve, and the Committee on Competitiveness and Workforce Needs of United States Industry. He has served on 19 other committees or panels throughout his career. He received his B.A. and Ph.D. in Economics from Stanford University.

C. KUMAR N. PATEL, NAS/NAE, is CEO of Pranalytica, a company that develops trace gas detection instrumentation. He was previously a professor of physics, chemistry, and electrical engineering at the University of California, Los Angeles (UCLA). He served as Vice Chancellor for Research at UCLA from 1993-1999. Prior to joining UCLA in March 1993, he was the Executive Director of the Research, Materials Science, Engineering and Academic Affairs Division at AT&T Bell Laboratories, Murray Hill, New Jersey. He joined Bell Laboratories in 1961 where he began his career by carrying out research in the field of gas lasers. Dr. Patel has a B.E. in Telecommunications from the College of Engineering in Poona, India, and received his M.S. and Ph.D. in Electrical Engineering from Stanford University in 1959 and 1961, respectively. In 1988, he was awarded an honorary Doctor of Science degree from the New Jersey Institute of Technology. In 1996, Dr. Patel was awarded the National Medal of Science by the President of the United States of America. Dr. Patel has served on numerous NRC Committees and is a current member of the Air Force Studies Board.

ARTHUR L. PATTERSON is the CEO of ELONA Biotechnologies. Patterson previously held positions with General Electric Company, Ethyl Corporation, Albemarle Corporation and TETRA Technologies. Prior to working for ELONA, he was the executive director for Flagship Enterprise Center (FEC) in Anderson, Indiana, whose mission is "To be a premier technological Business incubator creating new jobs and contributing to the long-term economic development of the communities of Anderson, Madison County and the state of Indiana." Mr. Patterson has also been responsible for establishment of the FEC's client-specific Client Support Program which identifies each client's strengths and weaknesses by overarching objectives of helping each client to develop a plan, build a competent management team, gain access to capital and achieve cash flow. He obtained his B.A. in Economics and Management Services from Duke University and his MBA in Marketing Finance from Northwestern University. Mr. Patterson previously served on an NRC committee that reviewed proposals for the state of Ohio.

LLOYD M. ROBESON, NAE, has been a Principal Research Associate in Corporate Research at Air Products and Chemicals, Inc. since 1986 and spent almost twenty years in polymer research at Union Carbide Corporation. Dr. Robeson's research areas include polymer blends, structure/property relationships, reactive extrusion compatibilization, engineering polymers, composites, biomedical polymers, dynamic mechanical analysis, emulsion polymer characterization, adhesion, polymer permeability, membrane separation, polymer utility in electrical/electronic/optoelectronic applications and

water soluble polymers. He has received numerous awards, including the Applied Polymer Science Award of the American Chemical Society in 2003. Dr. Robeson has also served on NRC committees that reviewed proposals for the state of Ohio. His most recent NRC committee service was with the Panel on Building and Fire Research, 2008.

MARIAM B. STICKLEN is a Professor in the Department of Crop and Soil Sciences at Michigan State University. Since 1987, she has supervised and advised over 160 scientists. Dr. Sticklen has participated in several advisory roles at the National Academies. She is developing systems to eliminate or minimize human and environmental risks posed by transgenic crops. Her expertise includes production of biofuels-related industrial enzymes, polymers, and pharmaceuticals in transgenic plants. Her research activities also center on improvement of agricultural crops of developing countries (Africa, India, Indonesia, Pakistan, Iran, and Turkey), development of crops that are tolerant to extreme abiotic factors (such as drought, high salinity, and low temperature), and reductions of pests and applications of hazardous pesticides through gene discovery, cloning, and genetic engineering. Dr. Sticklen previously served on an NRC committee that reviewed proposals for the state of Ohio. She is nominated for this committee because of her work with biofuels and environmental science.

T.S. SUDARSHAN is President and CEO of Materials Modification, Inc. He has been responsible for the management and technical development of innovative materials, processes, and techniques and the development of new technologies related to surface engineering and nanotechnology. Dr. Sudarshan has been the recipient of numerous awards and honors, including the Design News Award and R&D 100 for the microwave plasma technique Nanogen and for the Plasma Pressure Compaction technique. He has served on numerous committees of the National Science Foundation, the National Institutes of Health, U.S. Army and Michigan Economic Development Council and ASM International - the Materials Information Society. He has served on the technical advisory boards of numerous companies over the last two decades. Dr Sudarshan is the Editor of "Materials and Manufacturing Processes" and "Surface Engineering" journals. He is a Fellow of ASM International and the International Federation for Heat Treatment and Surface Engineering. He previously served on an NRC committee that reviewed proposals for the state of Ohio, and on numerous other NRC panels on Corrosion, National Nanotechnology Initiative and two terms on the NRC National Materials Advisory Board. Dr. Sudarshan received his B.S. in Metallurgy from the Indian Institute of Technology in Madras, India, and his M.S. and Ph.D. in Materials Engineering Science from Virginia Tech.

J.W. (JIM) WHEELER joined Thomas P. Miller and Associates (TPMA) in July 2005 to head up Economic Competitiveness, Policy and Research. He has served as the lead consultant for the Strategic Economic Development Plan for Indiana, helped to create various regional economic and workforce strategies, developed Base Realignment and Closure workforce and economic impact analyses for Fort Knox, six sites across Indiana and the San Antonio region, as well as leading multiple energy and energy industry projects. Jim came to TPMA from Electricore (a consortium of companies and universities focused on advanced technology development) where he served as the Director of Midwest operations. He was primarily focused on capturing federal R&D funding for energy technology commercialization. As Executive Vice President for TechPoint - a merger between Indiana Technology Partnership (ITP) and Indiana Information Technology Association (INITA) -- and President of ITP, Dr. Wheeler served as a leader for the statewide technology community's public policy and economic development initiatives (2002-2004), as well as managed special programs for information technology. He has previously served on NRC committees that reviewed proposals for the state of Ohio.

Appendix E
Reviewer Acknowledgment

This report has been reviewed in draft form by Alexander Flax, consultant, in accordance with procedures approved by the Report Review Committee of the National Research Council (NRC). The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process.

Although Dr. Flax provided many constructive comments and suggestions, he was not asked to endorse the conclusions or recommendations, nor did he see the final draft of the report before its release. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.