National Science Foundation

Directorate for Engineering

Awards Impact & Assessment Task Group Report – Part 2 APPENDIX

Final

21 June 2005

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APPENDIX

Support Documentation Follows

A1. Nugget Quad-Chart from George Hazelrigg, DMII

NSF Grant Number: DMI- 0342088

Principal Investigator: Richard Y. Chiou **Institution:** Drexel University

Title: Investigation of Embedded Heat Pipes in Cutting Tools for Dry Machining

Research Objectives:

- Explore embedded heat pipes in cutting tools for eliminating the use of fluids.
- Minimize adverse impact of cutting fluid on the environment.
- Reduce thermal damage to the cutting tools.

Approach

- Optimize the design of the embedded heat pipes in a cutting tool to achieve the best performance of environmentally safe machining system.
- Design and build the heat pipe with the best pattern to achieve the most desirable temperature distribution.
- Machining Experiments with an installed heat pipe are carried out to verify the analytical models.

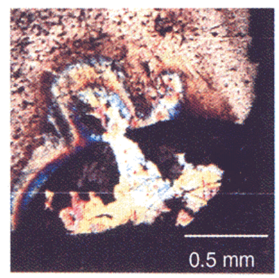
Broader Impact:

- Embedded heat pipes for heat transfer in cutting tool design.
- Modeling of the heat transfer behavior due to the embedded heat pipes.
- Optimization of heat transfer in cutting tools.
- Elimination of the use of cutting fluids.

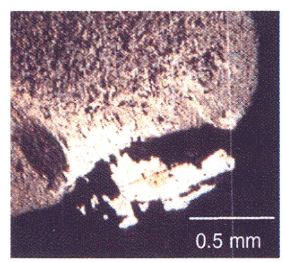
Significant Results:

- The installed heat pipe in a cutting tool has a significant effect on temperature drop at tool-chip interface, tool wear reduction, and tool life prolongation in machining.
- Machining experiments with heat pipe cooling agree with simulation results.

Graphic:



(a)



(b)

Figures:

(a) Carbide insert without heat pipe cooling,

(b) Carbide insert with heat pipe cooling at the cutting condition:

Doc: 1 mm,

Feed: 0.1mm/rev,

Cutting speed: 32.57m/min, and

Cutting Time: 5 min.

(Photo-micrographs, × 50)

A2. ENG Program Evaluations and Studies - - 1993-2004

ENG Program Evaluations and Studies 1993 - 2004

Title	Initiator; Yr Completed	Purpose	Use of Results
EEC Studies			
The Impact on Industry of Interaction with Engineering Research Centers http://www.sri.com/policy/stp/erc/ Conducted by SRI International	ERC Program 1997	Identify the types of results and value to industry of interaction between ERCs and their industrial sponsors; determine which types of interaction are most useful to industry, estimate the frequency of occurrence of the most useful types in different settings, and examine the process by which firms make use of results of ERC research.	Results presented at ERC Annual meeting; Initiated training visits to Industrial Liaison Officers (ILOs) at new ERCs by experienced ERC ILOs to jumpstart development of strong industrial partnerships; Provided each center with center-specific results and study briefing materials to enhance impact of industry partnerships.
Job Performance of Graduate Engineers who Participated in the NSF ERC Program Results in http://www.nsf.gov/pubs/1998/nsf9840/nsf9840.htm Conducted by Abt Associates.	ERC Program 1996	Complementary study of former graduate students at the first 14 ERCs to evaluate the impact of the ERC research and education experience on the effectiveness of masters and doctoral graduates working in industry, academia, and other sectors relative to contemporaries.	Results presented at ERC Annual Meeting; initiated Student Leadership Councils at all ERCs to provide center identity and cohesion to students involved in ERCs; initiated Student Retreat day at the ERC Annual Meetings; provided each center with center-level results and study briefing materials to help ERCs enhance the impact on students of ERC involvement.
Documenting Center Graduation Paths Two annual reports in Word. Conducted by SRI International	ERC Program 1999, 2000	Evaluate the extent to which centers that graduate retain the characteristics that made them ERCs, e.g., engineering systems approach to research, interdisciplinarity, industrial collaboration, testbeds, team-based research, and involvement of graduate and undergraduate students in ERC activities.	Results presented at ERC Annual Meeting and provided to centers to use with their industrial partners; caused introduction of required graduation plan in 6th year renewal proposals; focused attention on importance of university support in retention of ERC education an outreach activities after graduation.
Progress of the Engineering Education Coalitions Program http://www.nsf.gov/pubsys/ods/getpub.cfm?nsf00116 Conduted by SRI International	Engineering Education Program 2000	Examine the results of the program within the participating universities and more broadly after first five years of operation and identify areas in which improvements could be made.	Study took place after decision to make no more awards was made. Study results used to focus final years of the Coalition awards on identifying the best curricular products, evaluating them, implementing them beyond the originating institution, and dissemination of them beyond the originating Coalition.
Outcomes and Impacts of the State/Industry-University Cooperative Research Centers (S/IUCRC) http://www.nsf.gov/pubs/2001/nsf01110/nsf01110.html Conducted by SRI International	S/IUCRC Program 2001	Compares the S/IUCRC program's outcomes impacts with those of the I/UCRC program to determine whether the unique features of the S/IUCRC program brought about outcomes and impacts that differed from those produced by the I/UCRC program.	The study began after the S/IUCRC Program stopped making new awards. Results provided important information for any future joint program involving collaboration with state governments. Since the study included the I/UCRC Program,

Title	Initiator; Yr Completed	Purpose	Use of Results
CRCD pilot test Conducted by Abt Associates	EEC Education Program 2000	Examine how successful awards in the first three award years, FY 1992-94, had been in developing and implementing courses and curriculum that improve and make more relevant the content of engineering courses and serve as a means to engage and retain students in engineering degree programs.	Curricular materials developed by early awardees were provided for evaluation to an expert panel convened by the contractor. Not all awardees had materials to provide, so the project shifted to be a pilot test of the methodology, since there had been no previous study conducted in this fashion with EEC-funded engineering education curricular materials.
Graduate Engineering Education (GEE) Traineeship Program Conducted by Abt Associates	EEC Human Resources Program 2000	The goal was to learn what institutional collaborations brought about increased production of doctorates to women and underrepresented minorities.	This study was conducted after GEE was discontinued due to the creation of the NSF-wide IGERT program. However, the final report was very useful to program officers in EHR's HRD division who were beginning to fund similar collaborations to increase the production of doctorates to underrepresented groups and wanted understand what worked and what didn't work as well with collaborations funded by GEE in terms of achieving the goal of increasing doctorates to underrepresented groups.
The Impact on Institutions of Hosting and ERC Report in Word. Conducted by SRI International	ERC Program 2001	Examine the extent to which the ERC awards were change agents in the awardee engineering schools, particularly through the emphasis on interdisciplinarity, undergraduate research, and long-term collaborations with industry.	The results pointed to the engineering education impacts as being often the most profound. This was important in light of results of the ERC Graduation studies that pointed to ERC education programs being the most vulnerable when centers moved to self-sufficiency. The centers have been made aware of the need to prepare for the education programs to be self-sufficient, not just the research.
The Impact on Industry of Interaction with ERCs, Repeat Study Report in Word. Conducted by SRI International. Addendum to report in progress	ERC Program Base work: 2004	Examine how member firms in mature second-generation ERCs benefit from ERC collaboration and underlying dynamics that affect if/how firms are positioned to take advantage of ERC research, students, emerging technology, engineered systems, etc.	A comparison of results from this study and the original study of first-generation ERCs is in progress. The results will be provided at the 2004 ERC annual meeting and the base study results were provided at the 2003 meeting at the invitation of the ERC Industrial Liaisons, who use them to assist in positioning their centers to attract more firms and to inform their Industrial Advisory Boards about program-level impacts on industry.
Research Experiences for Teachers Conducted by SRI International	EEC Human Resources Program in progress	Study the first three years of the RET Site and Supplement mechanisms to determine what the teachers did and circumstances that correlate with clear impact of the RET experience on the content and methods of teaching.	n/a - study in progress

Title	Initiator; Yr Completed	Purpose	Use of Results
Other ENG Studies			
The Role of NSF's Support of Engineering in Enabling Technological Innovation Report 1: MRI, Reaction Injection Molding, Summary report: http://www.nsf.gov/pubs/1997/nsf9756/nsf9756.htm; Full report: http://www.sri.com/policy/stp/techin/ Conducted by SRI International	O/AD 1997	Document NSF's involvement in bringing about the innovations; evaluate the significance of NSF's role in the broader context of the innovations' development to understand better the roles that ENG's activities and funding played in the emergence of specific engineering-based innovations in preparation for GPRA reporting. Innovations studied: *Magnetic resonance imaging, High-performance polymer matrix composites, the Internet.*	ENG, OLPA, and O/D have used the results from these two reports in a variety of ways, e.g., in speeches by NSF senior management, presentations to ENG AD COM, and numerous other NSF and non-NSF audiences, GPRA documents.
The Role of NSF's Support of Engineering in Enabling Technological Innovation Report 2: Summary second year report: http://www.nsf.gov/pubs/1999/nsf98154/nsf98154.htm Full report: http://www.sri.com/policy/stp/techin2/	O/AD 1998	Document NSF's involvement in bringing about the innovations and evaluate the significance of NSF's role in the the innovations' development to understand better the roles that ENG's activities and funding played in the emergence of specific engineering-based innovations in preparation for GPRA reporting. Innovations studied: *Cellular Phone, CAD, and Optical Fibre .*	ENG, OLPA, and O/D have used the results from these two reports in a variety of ways, e.g., in speeches by NSF senior management, presentations to ENG AD COM, and numerous other NSF and non-NSF audiences, GPRA documents.
The National Science Foundation's Small Business Innovation Research (SBIR) Awards: Enabling Developments and Societal Impact Report in Word Conducted by Abt Associates	SBIR Program 1999	Study the use of NSF-funded research in NSF SBIR awards and fundamental knowledge developed by NSF SBIR Phase II instrumentation-based awardees to respond to Congressional questions.	Unknown
A Retrospective Assessment: NSF's Design and Manufacturing Research Programs Report in Word Conducted by Abt Associates	O/D and DMII 1998	Funded by O/D as a GPRA pilot project testing the methodology for utility in GPRA reporting. This study examined award-level outcomes and impacts of DMII research programs' FY 1984-1986 after 10 years.	Initiated by one division director, Bruce Kramer, and completed for another, Louie Martin-Vega, study results were used in a variety of documents needing examples of results from individual research program awards, including COVs.
A Retrospective Assessment: NSF's Design and Manufacturing Research Programs Report in Word. Conducted by SRI International	DMII	Examine results after 10 years from the DMII research programs' FY 1989-1993 awards, comparing results from awards made in three DMII initiatives during those years with those not addressing the initiative topics. This was to have been the first of a formal sequence of studies of these programs' awards.	Louie Martin-Vega institutionalize the project so that new case studies for a sample of awards made 10 years previously to DMII research programs would be produced annually. His interest was the differential outcomes from initiative awards he had made as a program officer and unsolicited awards. Results showed that unsolicited were generally more productive. Kesh Narayan became division director before the second year's case studies were completed and initiated preparation of a report summarizing across all case studies information for program management and improvement. Both reports were used for COVs.

Title	Initiator; Yr Completed	Purpose	Use of Results
NEHRP; Phase 1-- history of NSF's role in NEHRP -- completed. Phase 2 -- outcomes and impacts study -- never funded Conducted by SRI International	CMS	Examine the outcomes and impacts from ENG's long-term investment in the Earthquake Hazard Mitigation Program in the context of multi-agency National Earthquake Hazards Research Program, especially the outcomes and impacts of the investments.	This project was commissioned by one program officer, who rotated out and the replacement wanted to change the second phase of the project, but never did so. However, a request from OMB led to the NEES program director to initiate a different follow-on project to assemble a website with detailed technical world-wide information about instrumentation and facilities related to NEES. The website is a public document.
The Emergence of Tissue Engineering as a Research Field Report will be on NSF website shortly	O/AD 2004	Learn from the history of the emergence of tissue engineering as a research field points at which NSF was involved, where there was no involvement but it would have been useful, and conclusions help ENG spot early and support emerging fields and technologies with substantial potential.	The interagency tissue engineering group and OMB found the report to be excellent, leading to rapid NSF clearance being received several weeks ago and the URL for the report is to be provided to the public in the near future.
Other Directorates			
Outcomes and Impacts of the National Science Foundation's Minority Postdoctoral Research Fellowship Program Report in Word. Conducted by SRI International	BIO 2004	Examine the extent to which this BIO and SBE program has met the program's objectives by documenting the career tragectories of awardees to date and determine the program's impact on their careers. The study was initiated by the program directors for their own use and for the BIO Advisory Committee.	BIO Advisory Committee received several presentations as the project was in progress. When the final report was presented to the Advisory Committee, members discussed the possibility of expanding the program based on the study results showing a distinct role of the program's fellowships in light of other funding opportunities for young minority researchers in the covered fields.
Evaluation of the National Science Foundation's Japan Programs Report in Word. Conducted by Westat	INT 2002	Document the activities, experiences, and accomplishments of during fellowship of former participants and impact of participation on subsequent career in relation to the programs' goals.	

National Science Foundation - ENG Awards Impact and Assessment Task Group

A3. Engineering Research Centers - Performance Review Criteria

NSF Directorate for Engineering | Division of Engineering Education and Centers

Engineering Research Centers - Performance Review Criteria - Years 1 to 10/11

	High Quality Effort	Low Quality Effort
Systems Vision & Value Added (Years 1-3)	Strong systems vision motivates the ERC, early systems requirements understood	Little understanding of engineered systems
	Vision has potential to transform or significantly impact industry/practitioners, the workforce, and society	Losing sight of the promise of the vision and its potential impact
	Vision positions the ERC to lead in the field	ERC lags the state of the art or is already eclipsed by competitors
	Research output is high quality, some deriving from interdisciplinary collaboration, publications based on ERC research in process	Research output is low quality; or if high quality, it resembles the output of a collection of single investigator projects
	Some research advances may be moving into use, most likely to be useful in a few years	Low probability of impact of the research on industry and practice
	Course and curriculum impacts derived from the ERC's research are planned or underway	Little or no impact on courses and curricular impact underway or planned
Strategic Research Plan (Years 1-3)	Systems concepts and technology goals drive and integrate all levels of research	The strategic plan is not motivated by systems concepts and technology goals
	Strategic plan focuses on significant barriers and challenges that position the research to lead the field and advance the state of the art	Barriers and challenges are not significant and will not result in contributions that will lead the field
	Research effectively organized into well integrated thrusts designed to achieve the vision	Thrusts have little relationship to each other or the vision
	The team is appropriately cross-disciplinary	The team is not appropriately cross-disciplinary, needed disciplines are missing
	College-level outreach faculty and students becoming effectively involved in collaborative research that contributes to the vision	College-level outreach faculty and students are not effectively connected to the ERC's research
	Test beds provide a significant opportunity to integrate the research to explore and prove enabling and systems level technologies	No evidence of test beds in plans or test beds appear to be demonstrations, isolated from research or the strategic plan
Research Program (Thrust level) (Years 1-3)	Thrust and its projects designed to contribute to the goals and vision of the ERC	Thrust has little relevance to the goals and vision of the ERC
	Projects are appropriately cross-disciplinary and becoming integrated, growing interdependence of projects within the thrust, appropriate interdependence among thrusts beginning	Thrust resembles a collection of single investigator projects working in isolation
	Significant research barriers/challenges being addressed through high quality research methods	Research barriers/challenges are not significant and research methods are not advancing the state of the art
	Effective research management tools starting up to team doctoral students so their individual Ph.D. dissertation research is integrated to achieve thrust and ERC deliverables	ERC is not impacting the traditional Ph.D. culture, drilling down reveals a collection of individual dissertations, with little integration or synergy in place or planned
	Positioned to or beginning to deliver results that are unique in the field, high quality publications in process, some interdisciplinary	Results do not appear to be unique in the field, could have been achieved by a collection of individual projects
	Results beginning to impact industry/practitioners	Little interest on the part of industry/ practitioners in the outcome of the research
	Thrust team is becoming cohesive; opportunities for cross-institutional collaboration being pursued	Faculty not cohesive and/or opportunities for cross-institutional collaboration not pursued
	Appropriate allocation of funds at the project level to fulfill thrust and center goals	Thrust and/or a significant proportion of its individual projects are under funded

	High Quality Effort	Low Quality Effort
Education and Educational Outreach (Years 1-3)	Cross-disciplinary, cross-institutional education culture is developing, where undergraduate and graduate students are starting to work in teams; significant commitment to involvement of undergraduates in research (ratio of graduate to undergraduate students of approaching 2:1)	Little or no cross-disciplinary, cross-institutional, and/or team-based interaction on the part of faculty and students, minimal involvement of undergraduates in research
	ERC is beginning to produce high quality educational output based on its research and some is impacting the curriculum (impact on courses is required, new degree programs/options are optional) for undergraduate and graduate students and practitioners	Few if any research results are being integrated into courses for students and practitioners, little or no activity related to any proposed degree programs/options
	Strong plans in place to implement, evaluate and disseminate education programs and curricular materials	Evaluation/assessment plans poor or they do not exist, personnel involved lack appropriate background for the task
	Students beginning to have formal training in systems integration with industry/practitioners involved in the training (New in 04)	Students have little or no awareness of systems issues, no formal training in place (New in 04)
	Students have ample opportunities to work with industry/practitioners	Few if any students work with practitioners at the ERC or on site in industry
	Student Leadership Council (SLC) in place, starting to effectively lead student programs, SWOT (Strengths, Weaknesses, Opportunities, Threats) process starting to work, ERC leaders receptive to the SLC's recommendations for improvement, SLC has adequate resources to achieve its goals	Student Leadership Council is not effective or ERC leadership ignores their input
	College level outreach programs are beginning to increase diversity through connectivity with institutions serving underrepresented groups, an NSF-sponsored Louis Stokes Alliances for Minority Participation (LSAMP), and one or more of the NSF-sponsored awardees focused on diversity such as the Alliances for Graduate Education and the Professoriate (AGEP), NSF Tribal Colleges and Universities Program (TCUP), etc. (New in 04)	Students involved in the ERC at all levels are not diverse and there has been no effort to include female or minority serving institutions as core partners or outreach institutions or to involve students affiliated with the NSF-sponsored LSAMPs, AGEPs, or TCUPs; outreach connectivity proposed has not materialized (New in 04)C45
	Precollege outreach starting to effectively involve K-12 students and teachers in the ERC's research and education programs, with an emphasis on increasing diversity	Precollege outreach programs are nonexistent, inappropriate or disconnected from the ERC's research and education programs, or no emphasis on diversity
	In a multi-university ERC, a partnership in education among the lead and core partner institutions will impact all	Education activities in multi-institutional ERCs are not coordinated and are not likely to impact all the core partner institutions
Industrial / Practitioner Collaboration and Technology Transfer (Years 1-3)	Growing or stable group of members across sectors appropriate for the ERC's vision (manufacturing, suppliers, other end users, etc.), key players have joined by the third year or are in the process of joining	Membership promise of proposal not fulfilled, many of those committed or promising to commit did not sign up, large numbers of firms are leaving, and/or major sectors are missing
	Members are beginning to impact the ERC's planning, research, technology transfer, and education programs; Industrial Advisory Board (IAB) active and effective; SWOT process starting to coalesce the IAB and yield cogent advice to the ERC	Little involvement of industry in the programs of the ERC, IAB rarely meets, SWOT process not in place or outcome ignored
	Center-wide membership agreement structures the industry collaboration program with clear statements of fees, benefits, and intellectual property policies	Industry involved only on a project-by-project basis, no collective, collaborative partnership
	In a multi-university ERC, membership agreements and intellectual property policies yield an ERC-level partnership with members, as opposed to a collection of partnerships with each core partner university	Industrial collaboration amounts to an independent collection of partnerships with each core university involved.
	Membership fees provide sound level of cash for generic support of the ERC, commensurate with typical investments in academic R&D for the sectors represented by the firms involved	Low level of membership cash support for generic research, most goes to sponsored projects
	Knowledge and technology transfer is beginning to impact industry/practitioners	Little knowledge or technology transfer has occurred, the center has had little impact on industry/practitioners

	High Quality Effort	Low Quality Effort
Infrastructure (Years 1-3)	Appropriate institutional configuration among lead, core partner, and outreach institutions, partnership beginning	Individual center institutions operating mostly independently of each other
	Effective Center Director and Deputy Director, able to implement vision and provide leadership.	Center Director and/or Deputy Director have not translated vision into operation, leadership skills of one or both are not up to the task
	Other members of the leadership team (research thrusts, education, industrial collaboration, SLC, and administration) are becoming cohesive and effective in planning and implementing the research, education, industrial collaboration, and administrative aspects of the ERC	Some or all of these leaders are not effective and there are no plans to replace them
	Effective management systems that include outside input on planning, project review, and assessment	Management systems weak, planning and project review are conducted mostly or exclusively within the ERC and minimal outside input is included in other center activities
	High quality research team with appropriate mix of expertise beginning to share the vision	Research team is not strong or does not have the appropriate mix of expertise, operating independently
	Diversity strategy in place and team of leaders, faculty and students is becoming more diverse in gender, race, and ethnicity, approaching or exceeding national averages for engineering (New in 04)	Little or no commitment to diversity at some or all levels
	High quality experimental and enabling equipment/facilities; test beds under development	Experimental and/or enabling equipment/facilities lack critical components, are not state-of-the-art, or test bed development is not evident
	Headquarters and communications network facilitate interaction among students, faculty, and industry/users and participating institutions	Headquarters and communications network are effectively non-existent
	Effective partnership with university administration facilitates the success of the Center through policies that encourage its cross-disciplinary configuration, its diversity, and its partnership with industry	University administration does not facilitate the cross-disciplinary configuration, diversity, or industrial partnership of the Center
	Investment made by industry/users, university, and other non-NSF investors commensurate with their ability to contribute and benefit	Most or all sectors are below what would be expected
	Effective use of financial resources to achieve the ERC's goals, thrust and institution level budgets are appropriate for their roles in the ERC, timely allocation of funds, any annual residuals are below 20% of NSF support	Allocation of resources not commensurate with achieving the ERC's goals, long delays in allocation of funds, any annual residuals are significantly greater than 20% of NSF support
Systems Vision & Value Added (Years 4-6)	Strong systems vision is fully operational as a motivator for the ERC, systems requirements understood, focus is evolving	Systems vision does not motivate the ERC or it has been fulfilled already
	Vision is producing output that is transforming or significantly impacting industry/practitioners, the workforce, and society	Losing sight of the promise of the vision and its potential impact
	Center is recognized as one of the leaders in the field because of its cross-disciplinary, systems level vision and significant output	Center is behind leaders in the field and center contributions are rarely recognized by the field as significant
	Research output is high quality and largely derived from interdisciplinary collaboration, extensive interdisciplinary publications in important journals	Research output is low quality; or if high quality, it resembles the output of a collection of single investigator projects
	ERC is producing broad-based and unique impact on technology (inventions, licenses, technology in use in industry or other arenas)	ERC has largely failed to impact technology and practice
	Significant course and curriculum impacts derived from the ERC's research	Curricular impact is minimal or could have been achieved without the ERC
Strategic Research Plan (Years 4-6)	Systems concepts and technology goals drive and integrate all levels of research	The strategic plan is not motivated by systems concepts and technology goals
	Strategic plan focuses on significant barriers and challenges, research leads the field and advances the state of the art	Barriers and challenges are not significant, research is lagging the field
	Research effectively organized into well integrated thrusts that contribute to the vision, results being used within and across thrusts	Thrusts have little relationship to each other and the vision
	The team is appropriately cross-disciplinary, starting to pursue new opportunities afforded by their interdependence	Team is not sufficiently cross disciplinary, missing interdisciplinary opportunities
	College-level outreach faculty and students are effectively involved in collaborative research that contributes to the vision	College-level outreach faculty and students are not effectively connected to the ERC's research
	Test beds provide a significant opportunity to integrate the research to explore and prove enabling and systems level technologies	No test beds underway or they are demonstrations, isolated from research or the strategic plan

	High Quality Effort	Low Quality Effort
Research Program (Thrust level) **(Years 4-6)**	Thrust and its projects contribute significantly to the goals and vision of the ERC	Thrust has little relevance to the goals and vision of the ERC
	Projects are appropriately cross-disciplinary and integrated, interdependence of projects within the thrust, robust interdependence among thrusts	Thrust resembles a collection of single investigator projects, most or all projects are isolated from one another, thrust is isolated from the others
	Significant research barriers/challenges being addressed through high quality research methods	Research barriers/challenges are not significant and research methods are not advancing the state of the art
	Effective research management tools in place to team doctoral students so their individual Ph.D. dissertation research is integrated to achieve thrust/ERC deliverables	ERC is not impacting the traditional Ph.D. culture, drilling down reveals a collection of individual dissertations with little or no integration or synergy
	Delivering results that are unique in the field, high quality publications in journals important for the field, many are interdisciplinary	Results do not appear to be unique in the field, could have been achieved by a collection of individual projects, minimal interdisciplinary publication
	Results significantly impacting industry/practitioners (patents, licenses, technology transferred to industry and practice)	Little interest on the part of industry/practitioners in using the output of the research to advance technology/processes/ procedures
	Thrust team is cohesive, opportunities for cross-institutional collaboration effectively pursued	Faculty not cohesive and/or opportunities for cross-institutional collaboration not pursued
	Appropriate allocation of funds at the project level to fulfill thrust and center goals	Thrust and/or a significant proportion of its individual projects are under funded
Education / Educational Outreach **(Years 4-6)**	Cross-disciplinary, cross-institutional education culture in place, where undergraduate and graduate students work in teams; significant commitment to involvement of undergraduates in research (ratio of graduate to undergraduate students is approaching 2:1)	Little or no cross-disciplinary, cross-institutional, and/or team-based interaction on the part of faculty and students, minimal involvement of undergraduates in research
	ERC is producing high quality educational output based on its research with a significant impact on the curriculum (impact on courses is required, new degree programs/options are optional) for under-graduate and graduate students and practitioners	Few if any research results have been integrated into courses for students and practitioners, little or no activity related to any proposed degree programs/options
	Strong program in place to implement, evaluate and disseminate education programs and curricular materials, including formative and summative evaluations.	Evaluation/assessment plans poor or they do not exist, personnel involved lack appropriate background for the task
	Students have ample opportunities to work with industry/practitioners, many have assisted with technology development through internships or sponsored projects, many have been hired by member firms	Few if any students work with practitioners at the ERC or on site in industry
	Students beginning to have formal training in systems integration with industry/practitioners involved in the training (New in 04)	Students have little or no awareness of systems issues, no formal training in place (New in 04)
	Student Leadership Council effectively leading student programs, SWOT process effective, ERC leaders receptive to the SLC's recommendations for improvement, SLC has adequate resources to achieve its goals	Student Leadership Council is not effective, turnover in leadership not smooth, or ERC leadership ignores their input
	College level outreach programs beginning to increase diversity through connectivity with institutions serving underrepresented groups, an NSF-sponsored Louis Stokes Alliances for Minority Participation (LSAMP), and one or more of the NSF-sponsored awardees focused on diversity such as the Alliances for Graduate Education and the Professoriate (AGEP), NSF Tribal Colleges and Universities Program (TCUP), etc. (New in 04)	Students involved in the ERC at all levels are not diverse and there has been no effort to include female or minority serving institutions as core partners or outreach institutions or to involve students affiliated with the NSF-sponsored LSAMPs, AGEPs, or TCUPs (New in 04)
	Precollege outreach effectively involves K-12 diverse students and teachers in the ERC's research and education programs, engineering concepts based on the ERC's research are used in classrooms	Precollege outreach programs are inappropriate or disconnected from the ERC's research and education programs, no emphasis on diversity, no impact on precollege classrooms
	A cadre of ERC undergraduate and graduate students, graduated by the ERC's associated departments, is diverse in gender, race, and ethnicity at levels that exceed engineering-wide national averages (New in 04)	The cadre of ERC undergraduate and graduate students, graduated by the ERC's associated deparments, is not diverse (New in 04)
	If multi-university ERC, there is a partnership in education among the lead and core partner institutions that is impacting all	Education activities in multi-institutional ERCs are not coordinated and don't impact all the core partner institutions

	High Quality Effort	Low Quality Effort
Industrial / Practitioner Collaboration and Technology Transfer (Years 4-6)	Industrial collaboration program designed to achieve a collective, long-term partnership that impact the ERC's planning, research, and education activities.	Industry involved only on a project-by-project basis, no collective, collaborative partnership
	Growing or stable group of members across sectors appropriate for the ERC's vision (manufacturing, suppliers, other end users, etc.), key players are active in the center	Membership program weak, large numbers of firms are leaving, and/or major sectors are missing
	Members are impacting the ERC's planning, research, technology transfer, and education pro-grams; Industrial Advisory Board (IAB) active and effective; SWOT process yielding cogent advice to the ERC	Little involvement of industry in the programs of the ERC, IAB rarely meets, SWOT process not in place or outcome ignored
	Center-wide membership agreement structures the industry collaboration program with clear statements of fees, benefits, and intellectual property policies	Industry involved only on a project-by-project basis, no collective, collaborative partnership
	In a multi-university ERC, membership agreements and intellectual property policies yield an ERC-level partnership with members, as opposed to a collection of partnerships with each core partner university	Industrial collaboration amounts to an independent collection of partnerships with each core university involved.
	Membership fees provide sound level of cash for generic support of the ERC, commensurate with typical investments in academic R&D for the sectors represented by the firms involved	Low level of membership cash support for generic research, or most industrial supported is tied to sponsored projects
	Knowledge and technology transfer is significantly impacting industry/practitioners	Little knowledge or technology transfer has occurred, the center has had little impact on industry/practitioners
Infrastructure (Years 4-6)	Institutional configuration among lead, core partner, and outreach institutions is optimal given the vision, cohesive partnership in place	Individual center institutions operating mostly independently of each other
	Highly effective Center Director and Deputy Director, able to implement vision and provide capable leadership for the ERC and the university	Center Director and/or Deputy Director have not translated vision into operation, leader-ship skills of one or both are not up to the task
	Other members of the leadership team (research thrusts, education, industrial collaboration, SLC, and administration) are cohesive and effective in planning and implementing the research, education, industrial collaboration, and administrative aspects of the ERC	Some or all of these leaders are not effective and there are no plans to replace them
	Effective management systems that include outside input on planning, project review, and assessment	Management systems weak, planning and project review are conducted mostly or ex-clusively within the ERC and minimal outside input is included in other center activities
	High quality research team with appropriate mix of expertise that shares the vision	Research team is not strong or does not have the appropriate mix of expertise, operates independently
	Diversity strategy producing a team of leaders, faculty, and students that is diverse in gender, race, and ethnicity, at levels exceeding national engineering-wide averages (New in 04)	Little or no commitment to diversity at some or all levels
	High quality experimental and enabling equipment/facilities; test beds effective as planned	Experimental and/or enabling equipment/facilities lack critical compo-nents, are not state-of the art, or test bed development is not evident
	Headquarters and communications network facilitate interaction among students, faculty, and industry/users and participating institutions	Headquarters and communications network are effectively non-existent
	Effective partnership with university administration facilitates the success of the Center through policies that encourage its cross-disciplinary configuration, its diversity, and its partnership with industry	University administration does not facilitate the cross-disciplinary configuration, diversity, or industrial partnership of the Center
	Investment made by industry/users, university, and other non-NSF investors commensurate with their ability to contribute and benefit	Most or all sectors are below what would be expected
	Effective use of financial resources to achieve the ERC's goals, thrust and institution level budgets are appropriate for their roles in the ERC, timely allocation of funds, any annual residuals are below 20% of NSF support	Allocation of resources not commensurate with achieving the ERC's goals, long delays in allocation of funds, any annual residuals are significantly greater than 20% of NSF support
Strategic Vision and Value Added (Years 7-10/11)	Systems vision more challenging and evolving to sustain ERC past graduation	Systems vision has been lost or the systems vision has been fulfilled already
	Vision has resulted in output that is transforming or significantly impacting industry/practitioners, the workforce and society, more significant work planned	Losing sight of the promise of the vision and its potential impact
	Center is recognized as one of the leaders in the field because of its cross-disciplinary, systems level vision and significant output	Center is behind leaders in the field and center contributions are rarely recognized by the field as significant
	Research output is high quality and largely derived from interdisciplinary collaboration, extensive interdisciplinary publications in important journals	Research output is low quality; or if high quality, it resembles the output of a collection of single investigator projects
	ERC is producing broad-based and unique impact on technology (inventions, licenses, technology in use in industry or other arenas)	ERC has largely failed to impact technology and practice
	Significant course and curriculum impacts derived from the ERC's research	Curricular impact is minimal or could have been achieved without the ERC

	High Quality Effort	Low Quality Effort
Strategic Research Plan (Years 7-10/11)	Systems concepts and technology goals drive and integrate all levels of research	The strategic plan is not motivated by systems concepts and technology goals
	Strategic plan focuses on significant barriers and challenges, research leads the field and advances the state of the art, continues to evolve to sustain the ERC past graduation	Barriers and challenges are not significant, research is lagging the field
	Research effectively organized into well integrated thrusts that contribute to the vision, results being used within and across thrusts	Thrusts have little relationship to each other and the vision
	Team pursues new opportunities afforded by their cross-disciplinary interdependence	Team is not sufficiently cross disciplinary, opportunities missed because they did not achieve interdependence
	College-level outreach faculty and students are effectively involved in collaborative research that contributes to the vision	College-level outreach faculty and students are not effectively connected to the ERC's research
	Test beds have made significant contributions to research and technology and continue to evolve to explore and prove new enabling and systems level technologies and contribute new research opportunities	ERC has not effectively incorporated test beds in its research program, no new opportunities planned
Research Program (Thrust level) (Years 7-10/11)	Thrust and its projects contribute significantly to the goals and vision of the ERC	Thrust has little relevance to the goals and vision of the ERC
	Projects are appropriately cross-disciplinary and integrated, results effectively feed into other projects and thrusts	Thrust resembles a collection of single inves-tigator projects, most or all projects are iso-lated from one another, thrust is isolated from others
	Significant research barriers/challenges being addressed through high quality research methods	Research barriers/challenges are not significant and research methods are not advancing the state of the art
	Effective research management tools integrate doctoral students so their individual Ph.D. dissertation research is integrated to achieve thrust and ERC deliverables	ERC has not impacted the traditional Ph.D. culture, drilling down reveals a collection of individual dissertations with no integration or synergy
	Delivering results that are unique in the field, high quality publications in journals important for the field, increasingly interdisciplinary	Results do not appear to be unique in the field, could have been achieved by a collection of individual projects, minimal interdisciplinary publication
	Results significantly impacting industry/practitioners (patents, licenses, technology impacting industry and practice)	Little interest on the part of industry/practitioners in the outcome of the research
	Thrust team is cohesive, opportunities for cross-institutional collaboration effectively pursued	Faculty mainly not cohesive and/or opportunities for cross-institutional collaboration not pursued
	Appropriate allocation of funds at the project level to fulfill thrust and center goals	Thrust and/or a significant proportion of its individual projects are under funded
Education / Educational Outreach (Years 7-10/11)	Cross-disciplinary, cross-institutional education culture where undergraduate and graduate students work in teams flourishes and impacts beyond the ERC; significant commitment to involvement of undergraduates in research (ratio of graduate to undergraduate students is approaching 2:1)	Little or no cross-disciplinary, cross-institutional, and/or team-based interaction on the part of faculty and students, minimal involvement of undergraduates in research
	ERC continues to produce high quality educational output based on its research with a significant impact on the curriculum (impact on courses is required, new degree programs/options are optional) for undergraduate and graduate students and practitioners	Few if any research results have been integrated into courses for students and practitioners, little or no activity related to any proposed degree programs/options
	Strong program in place to implement, evaluate and disseminate education programs and curricular materials	Evaluation/assessment plans poor or they do not exist, personnel involved lack appropriate background for the task
	Students have ample opportunities to work with industry/practitioners	Few if any students work with practitioners at the ERC or on site in industry, industry hires few of the graduates
	Students beginning to have formal training in systems integration with industry/practitioners involved in the training (New in 04)	Students have little or no awareness of systems issues, no formal training in place (New in 04)
	Student Leadership Council effectively leading student programs, SWOT process continues, ERC leaders receptive to the SLC's recommendations for improvement, SLC has adequate resources to achieve its goals	Student Leadership Council is not effective, turnover in leadership not smooth, or ERC leadership ignores their input
	Precollege outreach effectively involves K-12 diverse students and teachers in the ERC's research and education programs, engineering concepts based on the ERC's research are used in classrooms	Precollege outreach programs are inappropriate or disconnected from the ERC's research and education programs, no emphasis on diversity, no impact on precollege classrooms
	College level outreach programs beginning to increase diversity through connectivity with institutions serving underrepresented groups, an NSF-sponsored Louis Stokes Alliances for Minority Participation (LSAMP), and one or more of the NSF-sponsored awardees focused on diversity such as the Alliances for Graduate Education and the Professoriate (AGEP), NSF Tribal Colleges and Universities Program (TCUP), etc. (New in 04)	Students involved in the ERC at all levels are not diverse and there has been no effort to include female or minority serving institutions as core partners or outreach institutions or to involve students affiliated with the NSF-sponsored LSAMPs, AGEPs, or TCUPs (New in 04)
	A cadre of ERC undergraduate and graduate students, graduated by the ERC's associated departments, is diverse in gender, race, and ethnicity at levels that exceed engineering-wide national averages (New in 04)	The cadre of ERC undergraduate and graduate students, graduated by the ERC's associated departments, is not diverse (New in 04)
	If multi-university ERC, there is a partnership in education among the lead and core partner institutions that is impacting all	Education activities in multi-institutional ERCs are not coordinated and don't impact all the core partner institutions

	High Quality Effort	Low Quality Effort
Industrial / Practitioner Collaboration and Technology Transfer (Years 7-10/11)	Industrial collaboration program designed to achieve a collective, long-term partnership that impact the ERC's planning, research, and education activities.	Industry involved only on a project-by-project basis, no collective, collaborative partnership
	Robust group of members across sectors appropriate for the ERC's vision (manufacturing, suppliers, other end users, etc.), key players are active in the center, members strongly committed to supporting the ERC after graduation	Membership program weak, large numbers of firms are leaving, and/or major sectors are missing, little commitment to the ERC after graduation
	Members are impacting the ERC's planning, research, technology transfer, and education programs; Industrial Advisory Board (IAB) active and effective; SWOT is yielding cogent advice that continues to strengthen the ERC	Little involvement of industry in the programs of the ERC, IAB rarely meets, SWOT process not in place or outcome ignored
	Center-wide membership agreement structures the industry collaboration program with clear statements of fees, benefits, and intellectual property policies	Industry involved only on a project-by-project basis, no collective, collaborative partnership
	In a multi-university ERC, membership agreements and intellectual property policies yield an ERC-level partnership with members, as opposed to a collection of partnerships with each core partner university	Industrial collaboration amounts to an independent collection of partnerships with each core university involved.
	Membership fees provide sound level of cash for generic support of the ERC, commensurate with typical investments in academic R&D for the sectors represented by the firms involved	Low level of membership cash support, not sufficient to contribute to the self-sufficiency of the ERC after graduation
	Knowledge and technology transfer is significantly impacting industry/practitioners	Little knowledge or technology transfer has occurred, the center has had little impact on industry/practitioners
Infrastructure (Years 7-10/11)	Institutional configuration among lead, core partner, and outreach institutions is optimal given the vision, cohesive partnership in place	Individual center institutions operating mostly independently of each other
	Highly effective Center Director and Deputy Director, able to implement vision and provide capable leadership for the ERC and the university, effectively structuring the ERC for graduation	Center Director and/or Deputy Director have not translated vision into operation, leadership skills of one or both are not up to the task, little or no leadership evident regarding survival of ERC after graduation
	Other members of the leadership team (research thrusts, education, industrial collaboration, SLC, and administration) are becoming cohesive and effective in planning and implementing the research, education, industrial collaboration, and administrative aspects of the ERC	Some or all of these leaders are not effective and there are no plans to replace them
	Effective management systems that include outside input on planning, project review, and assessment	Management systems weak, planning and project review are conducted mostly or ex-clusively within the ERC and minimal outside input is included in other center activities
	High quality research team with appropriate mix of expertise that shares the vision and contributes to its evolution	Research team is not strong or does not have the appropriate mix of expertise, operates independently
	Diversity strategy produced a team of leaders, faculty, and students that is diverse in gender, race, and ethnicity, exceeding national engineering-wide averages (New in 04)	Little or no commitment to diversity at some or all levels
	High quality experimental and enabling equipment/facilities; test beds effective	Experimental and/or enabling equipment/facilities lack critical compo-nents, are not state-of the art, or test bed development is not evident
	Headquarters and communications network facilitate interaction among students, faculty, and industry/users and participating institutions	Headquarters and communications network are effectively non-existent
	Effective partnership with university administration facilitates the success of the Center through policies that encourage its cross-disciplinary configuration, its diversity, and its partnership with industry	University administration does not facilitate the cross-disciplinary configuration, diversity, or industrial partnership of the Center
	Investment made by industry/users, university, and other non-NSF investors commensurate with their ability to contribute and benefit	Most or all sectors are below what would be expected
	Effective use of financial resources to achieve the ERC's goals, thrust and institution level budgets are appropriate for their roles in the ERC, timely allocation of funds, any annual residuals are below 20% of NSF support	Allocation of resources not commensurate with achieving the ERC's goals, long delays in allocation of funds, any annual residuals are significantly greater than 20% of NSF support
	Realistic and sound strategy for financial self-sufficiency when NSF support ceases	Weak strategy for financial self-sufficiency when NSF support ceases

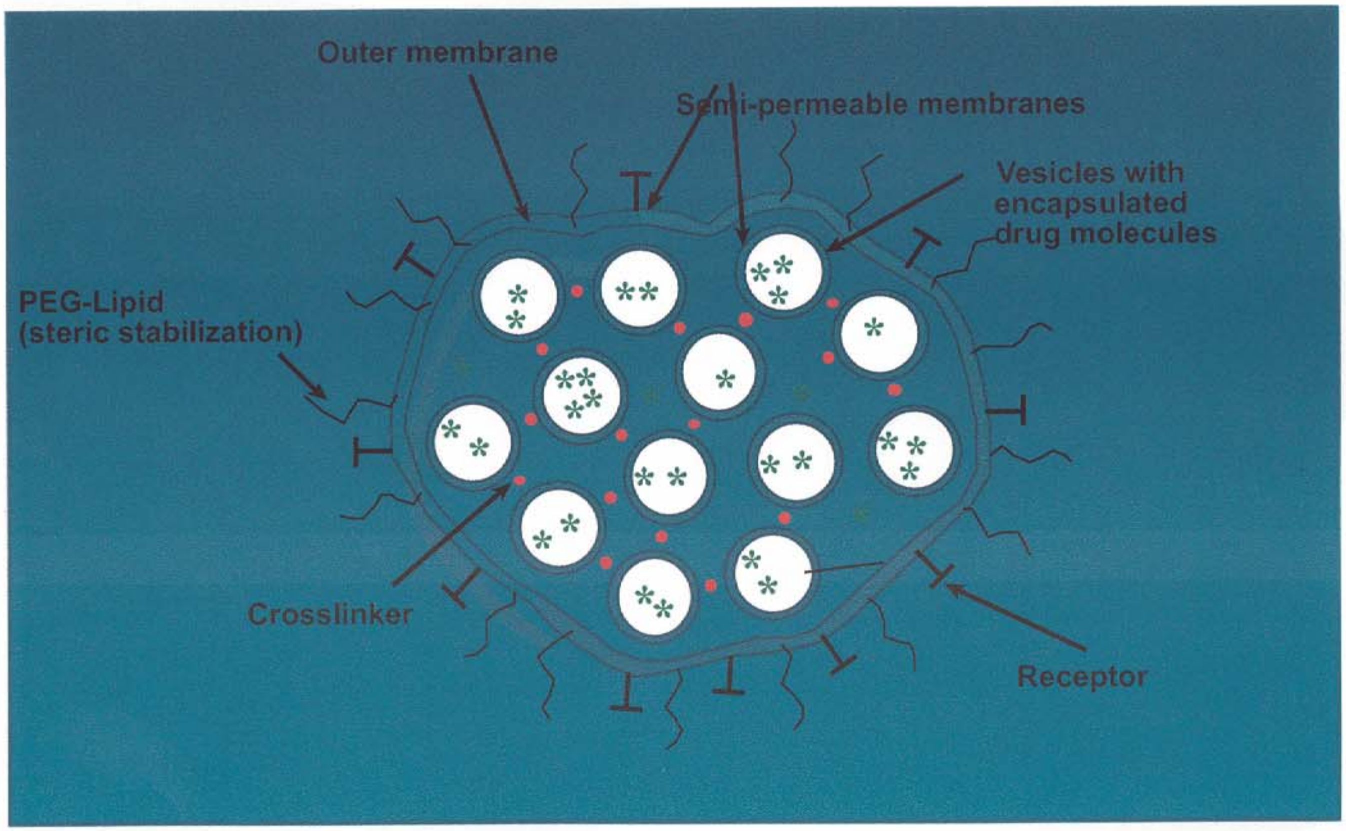
A4. Sample Nuggets Follow - -

A4a. Sample Nugget – PowerPoint Format

Vesosomes -Vesicle Encapsulated Vesicles

Matthew Tirrell - University of California-Santa Barbara

Slide 2 of 2



CTS-0103516-NIRT

A4b. Sample Nugget - - GPRA Format – Scientific Version

Government Performance Review Act (GPRA) Nugget - 2004

Tim Deming - - University of California – Santa Barbara
Darrin Pochan - - University of Delaware

Self-Assembled Polypeptide Vesicles

Goal and Approach: In the project, we have developed diblock copolypeptide amphiphiles containing hydrophilic and hydrophobic domains (diethoxyacetyl-modified lysine and leucine, respectively) that self-assemble into regular vesicular assemblies. These polymeric vesicles offer many advantages and opportunities over lipid vesicles (e.g. increased stability and tunable functionality) for applications such as drug delivery and packaging. The ethylene glycol sheath coating these vesicles should also impart them with good biocompatibility, similar to PEG, so that they would be expected to have a high circulation lifetime in the bloodstream. Our main goal was to elucidate the rules governing self-assembly of these amphiphiles, and how their molecular features dictate vesicle formation and properties. *In addition to Deming and Pochan, the other Co-PIs on this NIRT project are M. Tirrell and J. Zasadinski, Chemical Engineering, UCSB, C. Safinya, Materials, UCSB, and A. Butler, Chemistry and Biochemistry, UCSB.*

Research Accomplishments: This past year, we have focused our efforts on studying the roles of chain length and block composition on the assembly of uncharged block copolypeptide amphiphiles. In order to identify correlations between molecular structure and supramolecular architecture, it was necessary to develop a general processing protocol that would allow annealing of the supramolecular assemblies into more stable configurations. The block copolypeptide amphiphiles associate very strongly and essentially do not exist as single chains in aqueous solution. These properties, in many cases, result primarily in the formation of irregular aggregates if the polymers are simply dispersed in DI water. We have developed a protocol, using organic solvent (THF) and a denaturant (TFA) that allows annealing of these materials when water is added. Dialysis of the samples allows one to obtain regular assemblies in pure water.

Using this procedure, we have studied a number of amphiphilic copolymers where the length of the hydrophilic domain was varied from 100 to 150 to 200 residues in average length; and the hydrophobic domains were varied from 10 to 50 residues in average length, in increments of 5 residues. Using DIC optical microscopy, laser scanning confocal microscopy, and dynamic light scattering (DLS) as initial methods to study the assemblies, we have been able to identify some interesting trends. When the hydrophobic poly(L-leucine) domains are less than 20 residues in length, the α-helical conformation in this domain is less stable and a significant fraction of oblong or irregular micelles (ca. 100 nm diameter) are observed to form by DLS. When the size of the hydrophilic poly(EG_2-L-Lysine) is 100 residues, unilamellar vesicles were observed to form with a size range of approximately 2 μm to <1 μm diameter. When the hydrophilic block was increased in size to 150 residues, the vesicles were much larger in size, approaching 50 μm in diameter. Finally, when the hydrophilic segments were increased to 200 residues in size, membrane curvature was hindered such that the major structures formed were flat membrane sheets. With this improved understanding of how membrane properties are affected by copolymer size and composition, we have now begun to tailor the functionality of these materials for various applications.

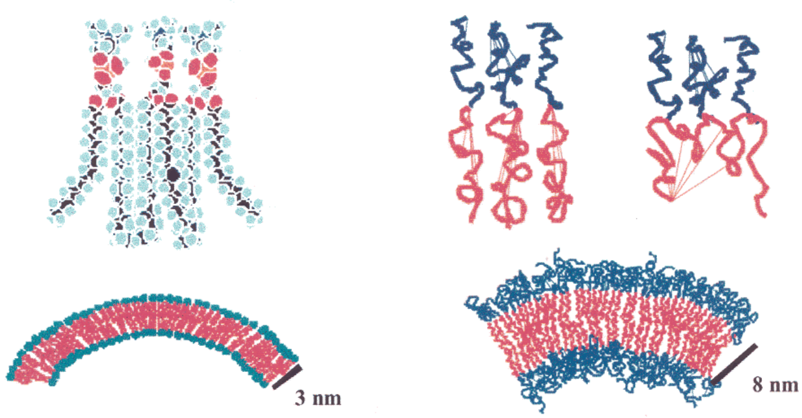
A Copolymer was prepared such that 70% of the L-leucine residues of the hydrophobic domain of a $K^P{}_{160}L_{40}$ block copolymer were replaced in a statistical sequence with L-lysine (K). At high pH, uncharged poly(L-lysine) is not water soluble and preferentially adopts the α-helical conformation. Under these conditions, incorporation of lysine residues should neither disrupt the hydrophobicity or helicity of the leucine-rich domain, nor should they greatly disturb the higher order assembly of the chains. Accordingly, aqueous suspensions of this sample at pH > 9 were found to form vesicles similar to those formed by the lysine-free copolymers. Protonation of the amino side-chains on the lysine residuesconsiderably enhances their hydrophilicity and also destabilizes the α-helical structure of the leucine-rich domain due to electrostatic repulsion of the like charges. The result should be a helix to coil conformation transition in this domain that is pH responsive, similar in concept to the mechanism used by some viral capsid proteins to effect endosomal release. We reasoned that such a change would also destabilize the vesicular assembly leading to porous membranes or even complete dissociation of the structures.

Such properties were demonstrated by formation of vesicles of the lysine-containing sample in the presence of Fura-2 dye at pH 10.6. Under these conditions, the excitation maximum of vesicle-encapsulated dye in the presence of external calcium solution was found to be constant for several days, indicating no dye or calcium transport across the membrane barrier. When the pH was lowered by addition of HCl, the excitation maximum of the dye was shifted within seconds, indicating near instantaneous disruption of the vesicle membranes and complexation of the calcium by Fura-2. These results demonstrate the ease at which functionality, and thus environmental response, can be incorporated into block copolypeptides.

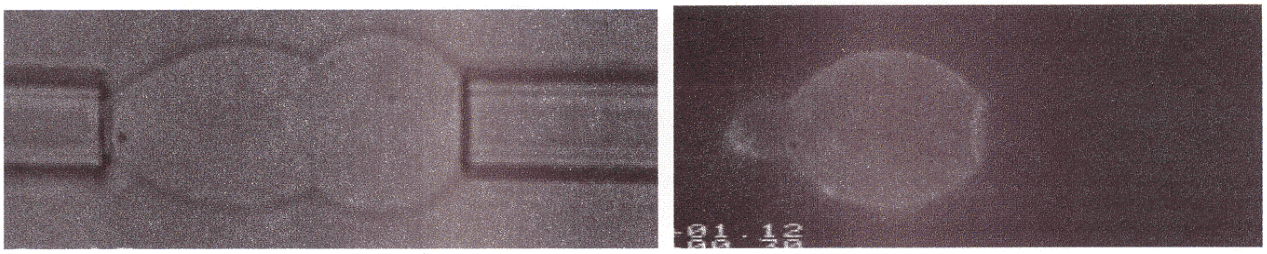
Scientific Uniqueness: While many types of polymeric vesicles are known, the vesicular structures developed here are the only ones that utilize protein strutural elements to drive vesicular assembly. Additionally, these polymers are easily derivatized by using differernt amino acids to incorporate the functionality of proteins into the materials, which is difficult in many synthetics. The rules of self-assembly in these materials, as they relate to polypeptide sequence and conformation, will not only allow the design and preparation of complex nanostructured materials, but also will help elucidate fundamental concepts of protein folding and assembly.

Potential Broader Technological Impact on Industry and Society: We have found that block copolymers composed of polypeptide segments provide significant advantages in controlling both the function and supramolecular structure of bioinspired self-assemblies. Incorporation of stable protein-like conformations into block copolymers was found to provide an additional element of control, beyond amphiphilicity and composition, that defines self-assembled morphology. The abundance of functionality present in amino acids, and the ease by which they can be incorporated into these materials, also provides a powerful mechanism to impart block copolypeptides with function. We feel this combination of structure and function work synergistically to enable significant advantages in the preparation of therapeutic agents as well as provide insight into design of self-assemblies beginning to approach the complexity of natural structures such as virus capsids.

NSF Program Officer:	Robert Wellek
NSF Award Numbers:	CTS-0242647
Award Title:	NIRT: Creating Functional Nano-Environments by Controlled Self-Assembly
P.I. Names:	Timothy Deming, Darrin Pochan
Institution Names:	University of California-Santa Barbara, University of Delaware



Comparing phospholipid (left) and block copolymer (right) vesicle membranes.



Adhesion and engulfment by receptor-bearing vesicles. Fluorescence image, on right, employs FITC-avidin only on left vesicle. (Glass micropipettes are ~8 um ID).

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National Science Foundation • 4201 Wilson Boulevard, Room 525 • Arlington, Virginia 22230-0001

A4c. Sample Nugget - - GPRA Format – Simplified Format

Government Performance Review Act (GPRA) Nugget - 2004

Tim Deming - - University of California – Santa Barbara

Darrin Pochan - - University of Delaware

Simplified Nugget - - Written for Typical Newspaper Reader. Note Title here is also simplified from the official Project Title below.

New Synthetic Bio-products for Antibiotics and Drug Delivery Usage

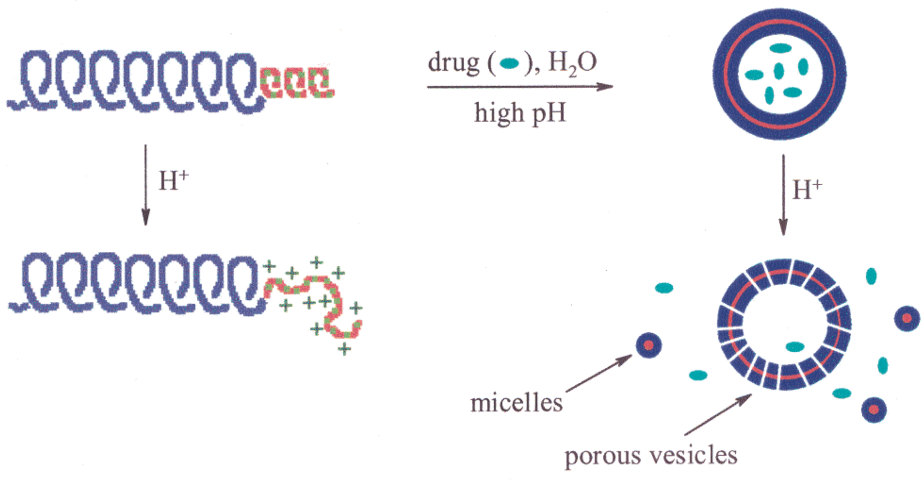
Molecular engineers and scientists have created substances called block copolypeptides to enable them to produce new synthetic bio-products for antibiotic and drug delivery usage. What the researchers have done is to mimic nano-scaled virus assembly by assembling synthetic materials into spherical shelled structures. The nano-shells are molecularly constructed from special self-assembled novel block copolypeptides. These surface-active protein-mimic polymers have the ability to self assemble and create a hollow interior and a special active shell. The new structures can be loaded with a range of pharmaceuticals, and then deliver this cargo to cells where they release their contents. The special block copolypeptides are chosen to have bio-compatible surfaces so that the drugs carried inside the shells are protected from degradation until ready for use.

This is a very challenging problem requiring a multidisciplinary team of engineers, scientists, and molecular biologists. It is interesting because it offers a new means of constructing nano-scale molecular containment systems that have a means of functionalizing the nano-scaled container surface.

What is noteworthy about this research is the ability to produce highly oriented self-assembled polymers at nano-fabricated interfaces - - an important step in interfacing "bottoms-up" self-assembled structures and "top-down" lithographically etched structures.

Program Officer:	Robert Wellek
NSF Award Number:	0103516
Award Title:	NIRT: Creating Functional Nano-Environments by Controlled Self-Assembly
PI Names:	Timothy Deming, Darrin Pochan
Institution Names:	University of California-Santa Barbara; University of Delaware

See Page 2 for Images.



Vesicle forming polypeptides can be used to encapsulate pharmaceuticals, and then release their contents upon stimulation

Permission for use granted.

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National Science Foundation • 4201 Wilson Boulevard, Room 525 • Arlington, Virginia 22230-0001

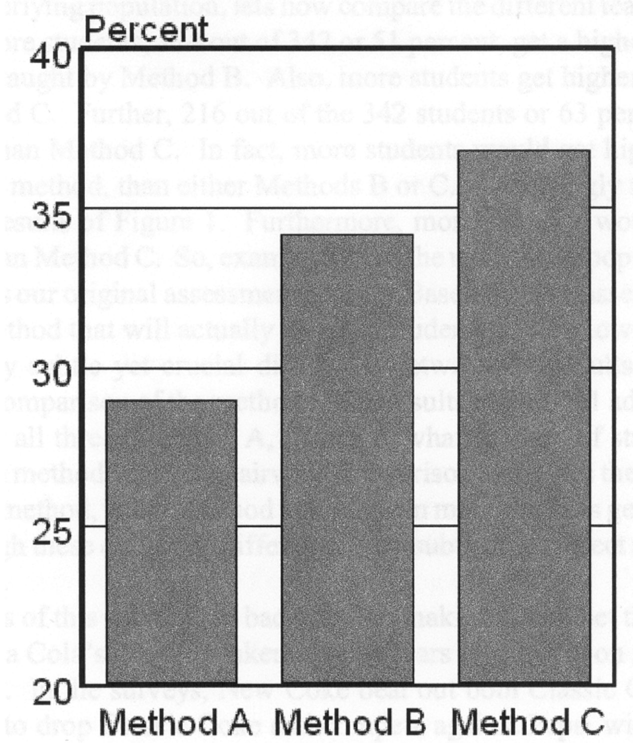
B. Comments on Assessments - - by George Hazelrigg

Beginning with the Clinton Administration, assessments and accountability became watchwords of the Federal Government. Without assessments there can be no accountability, and without accountability anything goes. Clearly this is bad. So clearly assessments are necessary. And few things could seem more American than assessments. Assessment methodologies abound. But most (methods) centers around defining objectively measurable goals, and then taking measurements to see how something rates against the goal. This, on the surface, seems logical and appropriate. Unfortunately, as is well known in the science of social choice theory, these techniques are fraught with mathematical paradoxes, dilemmas and failures. Indeed, contrary to the objectives of assessments, it is entirely possible that the assessment itself will degrade the performance of the system being assessed. Nor is this at all uncommon.

First, we need to recognize that all assessments represent, in some sense, an aggregation of data. Projects and research results, for example, are complex and multi-dimensional. There are myriad facets to every project, and no project can be fully captured by a single or even multiple indices. Thus, any finite set of measures will aggregate the complexity of a project into these finite measures. Now that might not seem bad in and of itself. And, indeed, in the right cases, it might be acceptable. But more often it is wrong and misleading, and in very subtle ways. Let me say at the outset that I have nothing against the collection of data per se. It can be plotted to make pretty graphs that can be hung on the wall for decoration and inspiration. Problems arise, however, when one tries to use such data aggregations in decision making. An example might help illustrate how assessments lead to bad decision making.

The faculty at Omega Institute of Technology have been trying to improve teaching techniques for the presentation of fundamental concepts in engineering. Two rather promising teaching techniques, Methods B and C, have been proposed as alternatives to the present approach, which we will call Method A. It is decided to test these techniques on the incoming Freshman class of 342 students. The class is divided into three groups of 114 each, and each group is taught three different topics, each with a different one of the three techniques. The teaching techniques are rotated among the groups, so that every student experiences every technique, and every technique is used on every topic. After each topic is covered, a standardized test is administered, and the student's grades are recorded. For simplicity, let us assume that the three groups are perfectly sampled, so that there is no sampling error, and all students' test scores are completely reflective of the knowledge that they gained from their studies so that the assessments are true and accurate. Thus, any problems that arise are strictly the result of the assessment method itself.

The question asked is, which teaching method is most efficacious? Efficacy is measured in terms of test scores. After testing the students, the faculty scanned and aggregated the test scores to determine which teaching method yielded the highest scores. The results are shown in Figure 1. Clearly, of the three methods tested, more students do better with Method C. The outcomes have been assessed and, of the three methods tested, the students taught by Method C get the highest grades. The choice to adopt Method C is now well rooted in the assessment, and this then is the choice taken.



What could be more straight forward than an assessment such as this? To be sure, Method C *is* the best method among the three tested. What could possibly be wrong? We get some interesting insights when we look at an underlying student population from which such a result as that given in Figure 1 might derive. Recognizing that different teaching methods work better for different students, the table below shows one possible student population that would yield exactly the results of Figure 1.

Relative Efficacy of Methods	Number of Students
A>B>C	99
A>C>B	0
B>A>C	75
B>C>A	42
C>A>B	75
C>B>A	51

Given this underlying population, lets now compare the different teaching methods by pairs. It is easy to see that more students, 174 out of 342 or 51 percent, get a higher grade when taught by Method A than when taught by Method B. Also, more students get higher grades when taught by Method A than Method C. Further, 216 out of the 342 students or 63 percent score higher when taught by Method B than Method C. In fact, more students would get higher grades if taught by Method A, the current method, than either Methods B or C. Surprisingly this result is completely compatible with the results of Figure 1. Furthermore, more students would get higher grades if taught by Method B than Method C. So, examination of the underlying population provides exactly the opposite insights as our original assessment results. Based on their assessment, OIT has elected to adopt a teaching method that will actually result in students getting lower grades.

There is a very subtle yet crucial difference between the results of Figure 1 and those obtained by pairwise comparison of the methods. The results of Figure 1 address the question, if all students are taught by all three methods, A, B and C, what fraction of students will obtain their highest grades for each method? But the pairwise comparison addresses the question, if all students are taught by only one method, which method will result in more students getting better grades? The surprise is that, although these questions differ only very subtly, the correct conclusions for each are diametrically opposite.

Do assessments of this sort lead to bad decision making? You bet they do! An outstanding example is that of Coca Cola's decision taken several years ago, based on survey assessment data, to move to New Coke. In the surveys, New Coke beat out both Classic Coke and Pepsi. So the obvious decision was to drop Classic Coke and compete against Pepsi with New Coke. But this decision cost Coca Cola dearly, and what they found was that, although New Coke was the most preferred taste when compared to *both* Classic Coke and Pepsi, it was the least preferred taste when compared *only* to Pepsi. And, indeed, Classic Coke was preferred to Pepsi, while New Coke was not, in direct contradiction to their survey results. This misuse of survey results cost Coca Cola big time, both in lost profits and lost market share.

Faced with results like this, many people suggest that the solution is to find the correct assessment methodology–aggregate the survey data correctly and these problems wouldn't happen. Correct aggregation of survey data (voting, for example), has been a topic of research in the field of social choice for literally thousands of years.

The following web site: http://www.maxwell.syr.edu/maxpages/faculty/jskelly/biblioho.htm lists many thousands of references on the subject. But perhaps the most notable is by Kenneth Arrow. In 1951, for his PhD thesis, Arrow provided a proof that essentially says there is no correct survey methodology. Specifically, Arrow's Impossibility Theorem is as follows:

> It would seem reasonable that a data aggregation rule should satisfy the following conditions:
>
> 1. If everyone prefers alternative *A* over all other alternatives, then the aggregation rule should select alternative *A*. (Dominance.)
>
> 2. If the group prefers alternative *A* over alternative *B*, and the group prefers alternative *B* over alternative *C*, then the group should also prefer alternative *A* over alternative *C*. (Transitivity.)
>
> 3. The group preference of *A* over *B* or of *B* over *A* should not depend upon the existence or non-existence of alternatives *C*, *D*, *E*, etc. That is, it should depend only upon the preferences regarding *A* and *B*. (Irrelevance.)
>
> 4. There should not be a dictator who decides upon the group preference independent of the preferences of any other persons in the group. (Dictatorship.)

Arrow's Impossibility Theorem states that *any* aggregation rule that guarantees satisfaction of the first three conditions necessarily violates condition 4, that is, any rule that satisfies the conditions of dominance, transitivity and irrelevance, is of necessity a dictatorship. Ergo, no "correct" aggregation method exists. Nor will one ever be found.

Arrow, who is currently Professor Emeritus in Economics at Stanford University, won the 1972 Nobel Prize in Economics for his proof. The proof has stood the test of time, and it is thoroughly vetted by both the economics and the mathematics communities. It is a profound proof that has serious and deep-reaching impact on many fields, including engineering. (For Example, it is a proof that sensor data fusion is a bogus approach, no matter what method is used.) But its import for assessments is that *all* assessment methods lack mathematical rigor and, hence, *all* assessment methods can lead a decision maker astray.

Conclusion: ***The use of assessments in support of decision making is not mathematically correct, and can lead to exceptionally poor choices.***

Where does this leave us? Can we do nothing? The real problems center around the fact that few people have the mathematical background necessary to do assessments and use them in a useful way, and that intuition alone leads to highly improper use of assessments. The only correct approach to use of data in support of decision making is to employ classical decision theory. That said, it is possible to do useful assessments?

First, if the decision maker is precisely clear about the objective of a decision making process and if there exists a measurable index that represents that objective fully and precisely, then it is appropriate to assess that index, and this index may be used in support of that specific decision but no other decision. Further, suppose the measurable index is a function of two or more variables, themselves indices. Then it is appropriate to assess these indices, provided that their *only* use is to compute the overall index.

Second, I can support the use of assessments to provide display graphics and inspirational material, provided that there is a clear understanding that they are not to be used in support of decision making of any kind. This includes case-study assessments that illustrate the good stuff we do. Nuggets are a great example of a useful assessment. They are convincing, and correctly so, in showing that at least some of the research we fund provides results that are beneficial to society. But they do not address questions regarding efficacy of research funding, effectiveness of the programs overall, or questions regarding research priorities. Any use of them for these purposes could be rather misleading.

Ain't nothing simple, and assessments surely aren't an exception to this rule. To design assessments that are useful and beneficial, one must be a specialist in the mathematics of assessments. And, unfortunately, the intuitive appeal of assessments can lead the unwary far, far astray. Beware!

C. NSF Committee of Visitors / Assessment Duties

COVs are currently required to perform an award impact assessment (AIA)—in addition to reviewing the processes of handling proposal awards and declination which relies on the NSF merit review process. The mandatory NSF template for COVs includes the following AIA-related assessment instructions and questions (quoted from the NSF PAM):

"The COV report should provide a(n)…assessment of NSF's performance in…the quality of results of NSF investments in the form of outputs and outcomes that appear over time. The COV also explores the relationships between award decisions and program/NSF-wide goals in order to determine the likelihood that the portfolio will lead to the desired results in the future."

Items to which the COV must respond in detail, citing award numbers and content, include the following:

"A.4.1. Overall quality of the research and/or education projects supported by the program."

"A.4.3. Does the program portfolio have an appropriate balance of high risk projects?"

"A.4.4 Does the program portfolio have an appropriate balance of multidisciplinary projects?"

"A.4.5. Does the program portfolio have an appropriate balance of innovative projects?"

"A.4.10. Does the program portfolio have an appropriate balance of projects the integrate research and education?"

"A.4.11. Does the program portfolio have an appropriate balance across disciplines and subdisciplines of the activity and of emerging opportunities?"

"A.4.13. Is the program relevant to national priorities, agency mission, relevant fields and other customer needs?"

"A.4.14. Discuss any concerns relevant to the quality of the projects or the balance of the portfolio."

"The following questions are developed using the NSF outcome goals in the NSF Strategic Plan. The COV should look carefully at and comment on (1) noteworthy achievements of the year based on NSF awards; (2) the ways in which funded projects have collectively affected progress toward NSF's mission and strategic outcomes; and (3) expectations for future performance based on the current set of awards. NSF asks the COV to provide comments on the degree to which past investments in research and education have contributed to NSF's progress towards its annual strategic outcome goals and to its mission…"

"B. Please provide comments on the activity as it relates to NSF's Strategic Outcome Goals. Provide examples of outcomes (nuggets) as appropriate…"

D. Original Charge to Task Group - - See next page.

Draft

4D/ENG Policy Memorandum No. 04-0

Subject: Awards Impact Assessment Task Group July 14, 2004

Introduction: Effective August 1, 2004, the Awards Impact Assessment Task Group is established within the Directorate for Engineering (ENG).

Responsibilities: The Task Group is responsible for recommending how ENG should determine the impact of its investments in research, education and innovation.

ENG's mission is to enable the engineering and scientific communities to advance the frontiers of engineering research, innovation and education. Although, in the short term, it is difficult to link specific research and education projects with longer term impacts, the overall linkage has been demonstrated time and again, and underpins the public's confidence in the value of Science & Engineering (S&E) research and education.

Examples of performance indicators that have been used or considered in the past include:

1. Major external awards to engineering and science PIs (Draper, Waterman, NAE, Nobel)
2. Published and disseminated results, including journal publications
3. Development of a field of investment (e.g., research, funding level, inventions, patents
4. Role of NSF-sponsored activities in stimulating innovation and technology development
5. Use of products or results beyond the research community
6. New tools and technologies, multidisciplinary databases; software; newly-developed instrumentation, and other inventions
7. Education, workforce, diversity:
    - CAREER awards /outcomes
    - Students supported
    - PIs from under-represented groups / changed demographics
    - Student, teacher and faculty participants in NSF activities
8. Studies / Assessment
    - Customer survey (PIs, grantees)
    - Committee of Visitors (COV) reports
    - Electronic Information System (EIS) data
    - Nuggets
9. Leveraging of NSF investments to obtain other resources
    - Partnerships
    - Follow-on support

Membership: The membership of the Task Group is as follows:

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Wellek, Robert	rwellek@nsf.gov	CTS	Chair

NOTE: Other members were added later.

Operation: The task group will gather and analyze performance data, review current ENG policies and practices, and provide data, analyses and recommendations to the Engineering Management Group (EMG) in one or more reports. The task group will be guided by the EMG - - as to specific and timely topics to address. The task group will meet regularly and remain in force until dissolved by the EMG.

John Brighton
Assistant Director for Engineering

Distribution:
All ENG Staff