A B S T R A C T

Michigan State University, NASA, Space Camp, Challenger museums, and the Space Science Institute will create Mars Pioneer Learning Adventures, a high end, original, online multiplayer game. This game will generate interest in and learning about space exploration, astrobiology, and space science through a fun, educational, standards-based, real science experience that is engaging for girls and boys. Approaches to amplify learning from the game in the classroom will be developed and compared to game play at home and partnering informal science venues. Additional research will compare impact and appeal of didactic, discovery, and constructivist gaming elements.

Pre-proposal submitted to the National Science Foundation division of Informal Science Education, August, 2002.
RELEVANT RESEARCH

Learners have changed in fundamental ways. “The Games Generation has been raised with, and become accustomed to, the worldwide connectedness of email, broadcast messages, bulletin boards, user groups, chat, multiplayer games, and instant messaging” (Prensky, 2001, p. 57). According to a 1998 American Psychological Association report on video games, “kids who own video games spend an average of 90 minutes a day playing them” (Paravaz, 1999).

Extensive research has been conducted on the impact of violence in digital games (e.g., Cassell & Jenkins, 1998; Griffiths, 1999; Children NOW, 2001; Sherry, in press) but little is known about other learning from digital games. Most commercial games today are not designed to be educational, but they do require learning. Kids play games “not once or twice, but over and over and over again, for countless hours, weeks, and months, until they [are] really good at it” (Prensky, 2001, p. 38). Piaget called play “the work of the child” (Piaget, 1951). Games are one form of play. Papert (1998) suggests kids dislike school not because it is hard but because “it is utterly boring.” In contrast, complex games are “hard fun.” Games require serious learning to master. “The basic skill today is the skill of learning, and the best use of games is to leverage the tendency to enhance it” (Papert, 1998, p. 88).

Academia and industry are beginning to examine the educational value of games. In April 2002, Microsoft announced “the Learning Federation,” intended to bring researchers and businesses together to develop a game-based computer learning environments for use in the classroom (Branigan, 2002). Dede, Ketelhut and Ruess (undated) at Harvard developed Museum-based Multi-User Virtual Environments (MUVE) for two prototype middle school science curriculum units, based on the national science standards. In a small-scale pilot study of whether MUVEs are suited for use in school core curriculum, they found students mastered the River City interface easily and were engaged by the content, environment, and ability to collaborate. “…strong engagement persisted through detailed work in the Lab Notebook after [the] novelty effect had worn off” (Dede et al., undated).

New technologies hold great promise for enhancing science and math education. Teachers reason that if designers can make computer games so entertaining as to be termed “addictive,” why can’t some of that talent be used to design equally compelling educational materials? (AAUW, 2000) Prensky (2001) argues it must first be a great game, and only then a teacher. He identifies six structural elements of a game: 1.) Rules; 2.) Goals and Objectives; 3.) Outcomes and Feedback; 4.) Conflict/Competition/Challenge/Opposition; 5.) Interaction; 6.) Representation or Story. Shank advocates teaching through Goal-Based Scenarios (GBS) which must include a mission or task the learner genuinely wants to accomplish (Shank, Fano, Bell, & Jona, 1991). A GBS offers 1.) Thematic coherence; 2.) Realism/richness; 3.) Control/empowerment; 4.) Challenge consistency; 5.) Responsiveness; 6.) Pedagogical goal support; and, 7.) Pedagogical goal resources. According to Prensky (2001), toys, stories, and simulations are NOT games. “Toys have neither goals nor objectives. They are meant to be played with. As soon as you add a goal, it becomes a game” (p. 125). Similarly, story (narrative) becomes a game when interactivity is added, in the form of role playing. Tools are “interactive programs used to make other things.” Papert (1998) suggests tools should be easy to learn and easy to use, while games can be hard to learn yet still be enjoyable. Depending upon how it is introduced and structured, a simulation can be a toy, a narrative, a tool, or a game (Prensky, 2001).

Game designers cite “flow” as a key characteristic of good games. Csikszentmihalyi (1990) introduced the concept of flow, a common characteristic of optimal experiences. Flow occurs
along a vector separating boredom and anxiety. People experience flow when they are sufficiently challenged to do their best, yet not challenged too much beyond what they can achieve. In order for a game to continue to be challenging, to maintain a sense of flow, difficulty must increase as player skills increase.

Games used in a classroom setting share many of the characteristics of informal learning. Essentially games can be used as a virtual field trip. Crane (1994) describes defining characteristics of informal science education: it occurs outside of school settings, is not developed primarily for school use, is not part of a formal curriculum, and tends to be a voluntary rather than mandatory activity. Most important, informal science education is “developed for out-of-school learning in competition with other, less challenging uses of time” (p.3). Digital games can bridge the gap between informal science learning and classroom learning. Traditional informal science learning experiences such as science museums are physically separate from the classroom. Scheduling, parental permissions, and travel are involved in taking a class to the museum. Science-based television documentaries air on a fixed broadcast schedule a limited number of times. They can be shown in the classroom, often requiring videotape copies and special licensing arrangements. An online digital learning game can be accessed from any classroom or home, at any time. (In fact, games can also reach audiences at science museum settings.) However, much more time can be spent with a game in a classroom or home setting, allowing for ongoing, repeat play without the need to travel.

Museum visits are infrequent and occur over short duration, typically 30 minutes or less of exhibit exploration to avoid “museum fatigue” (Hein, 1998). Museum learning is a developmental process – gradually over repeated visits to a museum children change from novice to expert visitors. Games can be created with much different expectations for repeat play and duration of play. Mastery occurs through frequent play of long duration.

Like a museum exhibit, digital games can expand their learning impact through appropriate scaffolding. Museums provide explanatory labels, maps, audio guides, docents, and advanced organizers (Hein, 1998). Digital learning games can offer “anchored instruction” allowing students to acquire knowledge to be used rather than facts to be learned (Shank et al., 1994). Other scaffolding can be embedded within the game itself or provided externally online or through teachers and parents. Signage at a museum might say “think of yourself as a geologist” (Hein, 1998). A digital game can allow gamers to be a geologist.

Many other important parallels between gaming and museums exist. Everything that the visitor experiences contributes to the educational role of the museum (Hein, 1998). This includes architecture, gallery arrangement, signage style, and staff composition. Likewise, incidental learning from the structure, characters, graphical style, and language of a digital game should be purposefully designed to enhance social and culture learning about inquiry-based science.

In museums, “the social setting of a visit is important. Children act differently on school visits than they do during overnight camping or when visiting museums as part of a family group.” (Hein, 1998, p 143). Similarly, the social context of digital multiplayer game play (in the classroom, home, museum setting, alone, with friends, or with unseen anonymous strangers) likely influences how children behave, what they talk about, what and how they learn. From a learning theory perspective, multiplayer games allow meaning to be socially constructed (Rieber, 1996, discussing Vygotsky). Classroom or home activities surrounding game play could also be designed to enhance and reinforce social construction of knowledge.
NEED FOR THE PROJECT

Intellectual Merit
We will bring together game designers, education scholars, informal space science experience designers, content experts, students, and teachers to design a large scale multiplayer game with high production values tied to National Science and Technology Standards for grades 5-8. Mars Pioneer Learning Adventures can be accessed in schools, homes, and at Space Camp, MarsQuest exhibits, and Challenge Center museums. The gaming environment will include many different “gamelets” addressing different science standards, deeply integrated into the overall game experience and narrative. The gaming environment will serve as a living laboratory for studying learning from games, comparing the appeal and impact of gamelets with different gaming elements and different approaches to learning, exploring application and implications of multiplayer gaming, and comparing game play and learning in different social contexts such as classroom, home, and museum settings. Using games in the classroom with innovative scaffolding can potentially amplify the learning benefits.

Broader Impacts
Mars Pioneer Learning Adventures will extend the rich tradition of research on learning from museum to the study of learning from a multiplayer digital game, exploring the learning and enjoyment potential of classroom, home, and traditional informal science venue play. We will also compare different kinds of game play within the larger context, incorporating didactic expository, discovery learning, and constructivist learning (Hein, 1998) within the overall game experience and compare their appeal and efficacy.

Integration of Research and Education
Game development will be inquiry-based and closely tied to National Science and National Technology Standards. We will work with teachers and students as members of the game development team. Education scholars, curriculum designers, and space museum professionals will help us explore how to integrate and scaffold game play into the classroom. The Space Science Institute plans to share with us the just completed summative evaluation of their NSF supported MarsQuest exhibit. Together we can determine implications for this project. Early review of the results suggests a strong interest by young people in space learning activities.

Integrating Diversity
Today’s games are not “girl-friendly”. Content analysis of characters in top selling video games describe a “virtual wasteland for racial and gender diversity” (Children NOW, 2001). A growing body of research details differences in what girls and boys say they want from computer games and offers recommendations for girl-friendly game designs (AAUW, 2000; Brunner, Bennett, & Honey, 2000; Kafai, 1995; Laurel, 2001). In particular we are targeting girls and minority students, although all genders and ethnicities should enjoy and learn from the game. The schools with which we will work are low-income schools with a high proportion of minority students.

GOALS and OBJECTIVES

Goal
Mars Pioneer Learning Adventures will be an original multiplayer game designed using professional game production values, that will generate interest in, and learning about, space exploration, astrobiology, and space science through a fun, educational, accurate to real science experience that is engaging for girls and boys.
Objectives

1) To Create an original game: similar to Oregon Trail, SimCity, and Lewis and Clark, but with a uniquely space-age twist in a multi-player environment. This gaming environment will be a coherent, interlinked series of smaller "gamelets" which fit smoothly into the overall narrative and game play. Example gamelets might include choosing a crew to go to Mars, equipping the ship(s), or deciding how to get to Mars. The gaming environment's persistent state will remember each user keeping track of her score, where the user left off, her avatar and role choices, artifacts and notes each gathers during game play.

Creating the shell environment will be the hardest task, with user identity tracking and verification, communication, score keeping, navigation, and persistent features such as a searchable smart archive/knowledgebase, NASA live science feed for current space exploration news, and a Chief Scientist virtual character for consultation. While the shell is being developed, we will also begin to create gamelets, closely tied to fifth to eighth grade National Science Standards and National Technology Standards.

2) To generate interest in, and learning about, space exploration and space science: Based on Space Camp, MarsQuest exhibits, Challenger Learning Centers, Linked to National Science and Technology Standards. The Game Design team has developed a rough 40 page Design Document describing possible game details, phases, and narratives related to planning a mission, getting to Mars, and building and managing a human settlement on Mars. (We are aware of the controversies surrounding a potential human settlement. One or more gamelets will involve a group of protesters objecting to the idea of settling or terraforming Mars, allowing students to explore these ethical issues and come to their own conclusions.) Education researchers have investigated National Science Standards of grades 5-8, identifying 44 standards for which Mars Pioneer gamelets could be developed. We will also address National Technology Standards.

3) To develop a fun and educational game that is accurate to real science, engaging for girls and boys, extends outcomes of the NSF gender equity grant: We will incorporate game elements that are appealing to kids with particular commitment to building a virtual environment that is natural for girls and minorities. The PIs have visited Space Camp and participated in several days of missions and visited the Kalamazoo Challenger Center as parents supervising a class field trip. Under the direction of one PI, a team of doctoral students studied a fifth grade class of students who visited Space Camp. We have amassed a database of relevant space science resources and have established relationships with NASA scientists and educators.

4) To construct a laboratory for studying learning from games. Gamelets will be designed intentionally to enable testing and comparison of the appeal and efficacy of different game-based teaching techniques. Some gamelets will be designed for didactic, expository game-based learning, others for discovery game-based learning, and still others for constructivist game-based learning (as described in Hein, 1998, p. 25). We can compare the appeal and learning value of different gamelets.

5) To provide an exploration of integrating game-based learning in the classroom. We will work with teachers during the game design process and on curriculum plans for using the game in the classroom. Research will assess the impacts of this integration.

Target audience
Our target audience is English-speaking fifth through eighth grade children in the United States, Canada, and elsewhere, their teachers, and caregivers. We will also make the game available to Space Camp, Challenger Center museums, and MarsQuest exhibits in the United States.

**ESSENTIAL FEATURES OF THE PROJECT DESIGN AND WORKPLAN**

Game design principles and education theory converge on the need to deeply understand our audience. According to Prenksy (2001), games "are extremely culture and age specific. They reflect the overall culture we grew up in, the specific milieu in which we were raised, our own particular culture and ethnicity, and even our religion" (p.138). Mars Pioneer formative research will benefit greatly from our recently funded 20 month NSF Gender Research Project. We will be working closely with gender-segregated teams of fifth and eighth grade girls and boys, exposing them to a range of technological space learning experiences (video, simulations, games, planetarium show, etc.) Through this research we will derive a careful understanding of fifth and eighth grade girls’ and boys’ conceptions about Mars, space travel, astrobiology, games, youth culture, and the kind of Mars Exploration game they would design. For the Mars Pioneer Learning Adventures game development, we will also partner with two fifth and two eighth grade classes in nearby low income schools. Following design research techniques described by Cooper (1999) and Hackos and Reddish (1999), we will brainstorm with the teachers and students, come back and show them early prototypes and get feedback throughout the development process.

According to Prensky (2001) commercial games cost between three and four million dollars and take at least 2 years to develop. We face similar challenges to achieve high production values, strong gaming and strong learning components in a sophisticated multiplayer online world. We plan to license a multiplayer engine rather than constructing our own from scratch, to inherit a rich feature set and to focus our programming activities on game design and implementation.

User research and game content development can occur concurrently with game structure development. The game engine needs to support a persistent world, retaining individual user profiles, avatars, collected objects, user identity tracking and verification, score keeping, and online scaffolding features such as archive, NASA live science feed, and Chief Scientist. The game structure needs to enable easy, consistent navigation to and within gamelets and easy communication within a coherent narrative and seamless game experience. Once the game structure exists, we can deploy one or two gamelet prototypes and begin to test and refine them, while the rest of the game development continues.

**PROJECTED TIMELINE:**

**Year 1** will focus on game engine and structure development, multiplayer protocols and applications, audience research, content development, prototyping and testing of 3 gamelets.

**Year 2** will continue development and testing of gamelets and refinement of the multi-user subscription and management process.

**Year 3** will concentrate on research and refinement of the game, infusion with core curricula, curricular support within the classroom, strengthening of collaborations with informal science centers, and summative evaluation. Focus will be on extensive dissemination of the multiplayer game and research results.
SUMMATIVE EVALUATION PLANS

Formative research has been described at considerable length in the preceding section. As far as summative research, the idea of visitor studies is appropriate in museums and gaming. Many of the research methods and findings from museum visitor research reviewed by Heins (1998) can be applied to the gaming environment. Technologically, it is possible to track every mouse click an individual player makes. However, privacy issues for operating a web site for children and constraints on research involving human subjects, particularly research involving children, we will be forced to limit data used in published research based on specific parental permissions and child assent. Unlike a museum, it is not possible to observe unobtrusively game players in a natural setting as they play the game. A key strand of summative research will be observation of game play in a classroom setting, looking at the impact of whatever teacher scaffolding we develop. Summative research on impacts of the game in general will use an external evaluator. Studies in the classroom will be conducted by researchers on our team.

DISSEMINATION PLANS

Promotion plans
Promotion of Mars Pioneer Learning Adventures will include mutual promotion relationships with Space Camp, Challenger Learning Centers, MarsQuest Online of the Space Science Institute, The Sally Ride Club, and selected NASA programs. We have been securing agreements with these groups to promote their activities through our Site and they will promote ours. Often participants in face-to-face informal science activities want more follow up which the Mars Pioneer Learning Adventures can provide and likewise, participants in our Internet based program may desire a face to face experience. Working together we can enhance each other’s outreach efforts.

Other promotion and dissemination plans include securing linkages with space/science related Web sites, presenting research findings at AERA and NSTA, continuing our work with the NASA education network to inform their state representatives about the game, integrating this project into extensive education outreach activities already conducted by MSU, and announcing the game through the Michigan State University College of Education alumni magazine that goes to educators everywhere.

Plans for institutionalization of the project
Creating a safe gaming environment for school children will require members-only access to multiplayer aspects of the game where direct communication occurs. Although we can continue to run Mars Pioneers “as is” in single player mode without significant costs, maintaining the member list, monitoring access, and continuing to improve the game will require ongoing funding. We will explore commercialization of the game with Riverdeep, the leading producer of educational games, as a possible distributor. Alternatively there may be a modest membership fee.

Summary

We have gathered a strong mix of talent within Michigan State University and with national space/science partners. Together we share a commitment to produce a multiplayer space learning game of the highest caliber with appeal to young people and educators alike and which serves as a platform for research into a new generation of formal and informal science learning possibilities.
References


Cooper, A. (1999). The inmates are running the asylum. Indianapolis, Indiana: SAMS.


BioSketches

Principal Investigators

Carrie Heeter, Ph.D., Professor of Digital Media Arts in the Department of Telecommunication. Heeter directs the Communication Technology Laboratory, where she has developed numerous award-winning K-12 education web sites, CD-ROMs, and VR experiences including the Microbe Zoo CD-ROM and web site, Personal Communicator CD-ROM and ASL Browser (winner of the Discover Magazine software innovation of the year award in 1995), and the Michigan 4H Children's Garden web site and learning interactives. She is Creative Learning Advisor for MSU Virtual University and teaches two online classes-Virtual Design Studio and Research for Designers. Heeter lives in San Francisco and is a full time professor for Michigan State University, working remotely over the Internet. Her research includes interactivity, cognitive and social remote presence, technology-enhanced learning, and the integration physical and virtual realities.

Rhonda Egidio, Ph.D., Director Virtual Interactive Training And Learning (VITAL) and Rehabilitation Education And Change (REACH), Professor, College of Education. Egidio directs projects that use the advantages of technology to create virtual learning environments. She has developed online course-based continuing education Web sites for Rehabilitation counselors and has taught educators to create online learning courses. Dr. Egidio’s course, EAD 860: Concept of a Learning Society, about the future of education, was the first online course offered at MSU in 1995. She has worked with state government to create fully functional, award-winning knowledge management E-Learn systems and has worked with auto-makers to create online learning communities and portals to higher education. Egidio will be able to assure that the site is accessible to those with disabilities.

Brian Winn, M.S., is an Assistant Professor in the Department of Telecommunication and Director of the New Media Center at Michigan State University. He has worked in the Comm Tech Lab since 1995 and has recently become a principal investigator, focusing on digital game-based learning experiences. Winn has worked in both commercial and academic environments, designing, creating, and researching award winning interactive multimedia for over eight years. He has extensive expertise in programming, interface design, game design, and project management. Winn received the Apple Distinguished Educator award in 2001 for his teaching and work in interactive media and game design.

Michigan State University Design and Research Team

James Gallagher, Ed.D., Professor of Science Education and Director of the Science and Mathematics Teaching Center. Gallagher has directed a research and development program on classroom-based assessment that has influenced the quality and effectiveness of teaching and learning in middle school science. He has been a leader in a national environmental education program sponsored by the Thai Ministry of Education that fostered cooperation between schools
Dr. Gallagher was a member of the writing team on the NRC’s *National Science Education Standards (1996)*, and he coordinated the development of AAAS Project 2061’s *Blueprint for Teacher Education*. He currently is a member of the International Steering Committee for the Third International Mathematics and Science Study. He was the 1998 winner of the Award for Distinguished Contributions to Science Education through Research, which is the highest award given by the National Association for Research in Science Teaching. Dr. Gallagher currently is Co-Editor of the *Journal for Research in Science Teaching*.

**Darcy Drew Greene, MFA, Associate Professor, School of Journalism.** Greene is a principle investigator in the Comm Tech Lab where she leads the *Storytelling and Evocative Interfaces* group. She uses her photojournalism and design background to approach the opportunities of new media, most recently producing a series of engaging, deeply personal patient information products such as the "Easing Cancer Pain" and "Completing a Life" CD-ROMs and web sites.

**Norman Lownds, Ph.D., Assistant Professor and Curator, 4-H Children’s Garden, Department of Horticulture.** Lownds directs all aspects of the Michigan 4-H Children’s Garden, including several very successful classroom outreach programs. He has developed the “Connected Classrooms” program where students and teachers connect with the 4-H Children’s Garden and Dr. Norm to enhance and expand their science explorations. Through this program, classrooms are connecting to scientists in different parts of the country, exploring science in the garden, creating web pages of their discoveries, and learning that science is interesting and fun. He has also developed a summer garden program, “Kid Curator,” and the award winning “Stories in the Garden,” where teens read to young children. Lownds works closely with the Communication Technology Laboratory to create the child-oriented 4-H Children’s Garden Web site (http://4hgarden.msu.edu) and the various explorations and activities there. Dr. Lownds also serves as the chair of the National Children and Youth Gardening Advisory Panel for the American Horticultural Society.

**Punya Mishra, Ph.D., Assistant Professor of Learning and Technology, Department of Educational Psychology and a Research Associate with the Media Interface and Network Design (MIND) Lab.** Mishra has an undergraduate degree in Electrical Engineering, masters’ degrees in Visual and Mass Communications, and a Ph.D. in Educational Psychology. His research has focused on the psychological, theoretical, cognitive, and social aspects related to the design and use of computer-based learning environments. His other interests include cognitive psychology of science, visual literacy, and creativity.

**Mark Rosenberg, M.A., Education Systems.** Rosenberg has worked in K-12, Higher Education, and corporate settings involving innovative applications of educational technology during the past 20 years. A member of Apple's Advanced Technology Group and Classrooms of Tomorrow project, Rosenberg has also served as a project manager for several NSF grants in Mathematics and Teacher Education at Michigan State. Currently Rosenberg is working with the VITAL (Virtual Interactive Training And Learning) project at Michigan State, and with the Media and Technology Charter High School in Boston, MA.
Randy M. Russell, Ph.D. Russell is a developer of interactive, web-based visualizations for a web site to accompany a high school Earth science textbook. The Exploring Earth web site is being developed by TERC's Center for Earth and Space Science Education in a partnership with publisher McDougal Littell, and is partially funded by the NSF. He also developed a small interactive for the MarsQuest Online web site being developed by TERC and the Space Science Institute (in Boulder, Colorado). Prior to that, he worked for 5 years as a producer/project manager at MSU's Virtual University, specializing in science, math, and engineering courses. He has worked with faculty to develop more than a dozen Web-based courses, and taught a Web Design course for MSU's Telecommunications Department. He has been developing multimedia educational software (CD-ROM and Web-based) for 13 years, and has a strong background in space science (B.S. in astrophysics, M.S. in aerospace engineering) and education (Ph.D. in educational technology). He was the project manager for the NSF-funded Microbe Zoo project, which developed microbiology education software (Web site and CD-ROM) for children.

Christina Schwarz, Ph.D., Assistant Professor Science Education, Department of Teacher Education and the Division of Science and Mathematics education in the College of Natural Science at Michigan State University. Schwarz has an undergraduate degree from M.I.T. in Earth, Atmospheric and Planetary Science, and a master’s and Ph.D. in Education in Math, Science, and Technology from U.C. Berkeley. Before coming to MSU, she worked as an assistant professor in science education at Brooklyn College, CUNY, as a 4th grade science curriculum designer for a postdoctoral fellowship at Yale, and as an on-line education curriculum designer for WNET/Channel 13 in New York. Her research has focused on studying and developing students and teacher’s understanding of the nature of science, and in particular on using computer modeling tools to create epistemologically rich learning environments. Her other interests include constructivist approaches to science education, history and philosophy of science, sociological and cultural practices of the science classroom, equity, metacognition, and assessment.

K-12 Team
Leigh Graves is an Educational Technology Coordinator and 3-5th grade computer teacher at Detroit Country Day School in Bloomfield Hills, MI., where she also serves as the network administrator, web designer, instructional technologist, and repair technician. Graves holds a BA in Media Arts from Michigan State University. She is currently enrolled in the MA Digital Media Arts degree program at MSU, taking courses online about web design and interactivity while she continues to work full time. Her 5th grade students attend Space Camp every year. She will help the project capture the excitement of Space Camp from a child’s and classroom perspective, as well as teacher and technology coordinator. Her classes will be ideal testing grounds for prototype learning adventures.

Shirley Nuss, Ph.D. is a computer instructor in multi-media education grades K-5 at Cranbrook Schools/Brookside (www.cranbrook.edu), a private school in Bloomfield Hills, Mi. Nuss is also an adjunct professor in the Educational Technology Certificate Program for Michigan State. She
has a Masters degree in gifted and talented education and her Ph.D. in curriculum and instruction from Michigan State. Dr. Nuss has presented/lectured on a variety of "technology in education" topics at technology conferences in Michigan, Illinois, and Wisconsin. She has attended Space Camp in Huntsville as a teacher, and has studied the program through the University of Alabama/Huntsville. She participated in the initial field-testing of the National Geographic "Kidnet" in 1992 and was highlighted on CNN with her students in the program. She has served on the Greenfield Village Educational Advisory Board and has written educational materials for Greenfield Village. She recently won the Miro Excellence in Teaching Award at Cranbrook Schools.

Advisory Circle:

Tommie R. Blackwell, Ph.D., is Senior Vice President for Advancement and Spatial Technologies for the U.S. Space & Rocket Center® (USSRC) and Executive Director of the U.S. Space & Rocket Center Foundation. She is responsible for scholarships, grants, management of the brand, non-traditional revenue development, and all fundraising activities for USSRC, U.S. SPACE CAMP/ACADEMY® and AVIATION CHALLENGE® programs. As Sr. V.P. for Spatial Technologies, she envisioned, developed and initiated a new operational division at USSRC, The Geospatial Training & Application Center (GTAC), to conduct geospatial technology applications training for various market segments and businesses. GTAC embraces and promotes new technologies from the space program.

Marcia Brummitt, Chief Operating Officer Imaginary Lines - Sally Ride Science Club

Suzanne Cornelius, Ph.D., Deputy Director Training and Development, United Space Alliance (USA).

Paul Dusenbery, Ph. D., Director of the Space Science Institute (SSI). Dusenbery received his B.A. in Physics from Whitman College in 1972 and his M.S. and Ph.D. in Physics in 1975 and 1978, respectively, from the University of New Hampshire specializing in space plasma physics. In September of 1989, Dr. Dusenbery became the Program Director of the Magnetospheric Physics Program at the National Science Foundation. He remained in that position until June of 1991, when he returned to the University of Colorado. In October 1992, Dr. Dusenbery was appointed Executive Director of the Space Science Institute that is a nonprofit research and education institute located in Boulder, Colorado. Dr. Dusenbery has been active in a variety of areas in solar-terrestrial physics research and has served on many research and education committees. He served on AGU’s Education and Human Resources Committee for two terms and was chair of the Space Physics and Aeronomy (SPA/AGU) Public Information Committee. He is a member of the Boulder Valley Algebra Task Force and a member of the Board of Directors of the Colorado Science Center. He is the Project Director for the multi-agency supported museum exhibitions: Electric Space, MarsQuest, Destination: Mars, and Cosmic Origins. Dr. Dusenbery has also developed innovative workshops for scientists and engineers
about formal and informal education. He has recently been awarded a multi-agency grant to
direct education and outreach for the National Space Weather Program. This multi-faceted
program has produced a mini-exhibit for museums and a web site called the Space Weather
Center, space weather brochures and posters, and an event-based high school curriculum called
SpaceStorms.

James Fitzgerald, M.S., NASA Aerospace Education Specialist, NASA Glenn Research Center
at Lewis Field. Fitzgerald's assignments include working with astronauts during education events
from the Shuttle, participating in the development of NASA Liftoff to Learning Video Program,
developing and reviewing NASA education products, aerospace education workshops, student
programs, public presentations, working with education leaders in the states of Ohio and
Michigan, addressing the media, presenting at numerous state, national and regional education
conferences, and presenting to a wide variety of audiences using video teleconferencing, and
other distance learning technologies.

Karen Flammer, Ph.D., Senior Vice President Imaginary Lines. Flammer is a space physicist and
director of the EarthKAM project,

Kathy Godin, Flight Director, Challenger Learner Center at Kalamazoo Valley Museum,
Michigan. Kathy serves as a Network Training Consultant for the Challenger Center. She is also
a 2002 Solar System Ambassador for JPL/NASA. She is a member of the Michigan Science
Teachers Association and has presented at its annual conference.

Christopher McKay, Ph.D. Planetary Scientist with the Space Science
Division of NASA Ames. Chris McKay received his Ph.D. in AstroGeophysics from the
University of Colorado in 1982 and has been a research scientist with the NASA Ames
Research Center since that time. His current research focuses on the evolution of the solar
system and the origin of life. He is also actively involved in planning for future
Mars missions including human settlements. Chris has been involved with polar research since
1980, traveling to the Antarctic dry valleys and more recently to the Siberian and Canadian
Arctic to conduct research in these Mars-like environment.

Virginia (Suzy) Young, Ph. D., Acting Director, Advanced Systems Directorate, Aviation and
Missile Command, Research, Development & Engineering Center at the U. S. Redstone Arsenal.
She has a Ph. D., Computer and Electrical Engineering, Vanderbilt University, MBA, and BS
and MS in engineering. She has worked in Robotics for over 20 years and currently manages an
organization responsible for the generation of new concepts for the military in both aviation and
missile technologies. She also heads the AMCOM team in the development of robotic battlefield
systems to include robots for mine clearing and replacing other hazardous roles for soldiers.