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The Grossmont-Cuyamaca Community College District is starting a year-long process to develop an Educational Master Plan that will serve as the blueprint for our future. The Educational Master Plan is a long-range, comprehensive document intended to guide institutional and program development at both the college and district levels. The priorities established in the Educational Master Plan will serve to guide College and District decisions about growth, development and resources allocation.

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2) Author: James R. Hagerty

3) Source: Wall Street Journal

4) Which of the following areas does this document best address? (Please select only one)

- ○ Society
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U.S. manufacturers have trouble finding talent to hire

By **James R. Hagerty**
Wall Street Journal
May 09, 2011 2:00 AM

U.S. manufacturing companies, long known for layoffs and shipping jobs overseas, now find themselves in a very different position: scrambling for scarce talent at home.

Large and small manufacturers of everything from machine tools to chemicals are scouring for potential hires in high schools, community colleges and the military. They are poaching from one another, retraining people who used to have white-collar jobs, and in some cases even hiring former prisoners who learned machinist skills behind bars.

Even with unemployment near 9 percent, manufacturers are struggling to find enough skilled workers because of a confluence of three trends.

First, after falling for more than a decade, the number of U.S. manufacturing jobs is growing modestly, with manufacturers adding 25,000 workers in April, the seventh straight month of gains, according to payroll firm Automatic Data Processing Inc. and consultancy Macroeconomic Advisers. The Labor Department's jobs report on Friday is expected to show moderate employment growth in the overall economy.

Second, baby-boomer retirements are starting to sap factories of their most experienced workers. An estimated 2.7 million U.S. manufacturing employees, or nearly a quarter of the total, are 55 or older.

Third, the U.S. education system isn't turning out enough people with the math and science skills needed to operate and repair sophisticated computer-controlled factory equipment, jobs that often pay $50,000 to $80,000 a year, plus benefits. Manufacturers say parents and guidance counselors discourage bright kids from even considering careers in manufacturing.

"We get people coming in here all the time who say, 'I can weld,'" says Denis Gimbel, human-resources manager at Lehigh Heavy Forge Corp., of Bethlehem, Pa., whose products include parts for ships. "Well, my grandmother could weld." He needs people who understand the intricacies of $1 million lathes and other metal-shaping equipment.

Manufacturers have anticipated for years that baby-boomer retirements would create difficulties. Among those who have tried to get ahead of the demographic curve—with mixed success — is Jeff Kelly, chief executive of Hamill Manufacturing Co., a family-owned company near Pittsburgh that cuts metal in for ships and machinery.

Hamill doesn't have any button-pushing work. The 127-employee company is constantly resetting and lathes to produce small numbers of parts to meet precise and ever-changing specifications. T no long, routine production runs.

One morning in late April, Trent Thompson, a 20-year-old Hamill apprentice wearing shredded jeans and a black baseball cap, was assigned to drill three holes in a piece of carbon steel about the size and shape of a hockey puck. To make sure he was spacing the holes exactly right, he scrawled a triangle and some trigonometric calculations on a notepad. Even a tiny error would mean wasting about $400 of metal.

In another corner of the factory, Bill Schaltenbrand, 59, was cutting bigger, more complicated parts. A computer had worked out where he should drill and cut, but Schaltenbrand, a 40-year veteran at Hamill, does his own math to double-check the plans. Computers, he says, sometimes "punch out stupid stuff." Part of Schaltenbrand's skill is reading blueprints with myriad numbers and symbols that would baffle most people.

In its search for talent, Hamill works with nearby vocational schools—serving on advisory boards, donating equipment and providing guest lecturers. Kelly helps organize a program called BotsIQ in which high-school students learn to build fighting robots. On a recent Saturday evening, he handed out trophies after

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a robot dubbed Grim Reaper 3, resembling a bathroom scale with spinning metal blades, flipped a rival called Black Mamba and left it in a smoking heap.

Through its ties to area high schools, Hamill met Walter Gasper about five years ago. Gasper, whose father is a mechanic, had good grades in high school and took college-prep courses. He says a counselor tried to discourage him from vocational courses, but he took them anyway because he liked working with machinery. Hamill signed him as an apprentice when he was 17 and let him work part time while finishing high school.

Last June, Kelly beamed as he posed for a picture with Gasper and the first-prize trophy he won in a national competition in which apprentices displayed metal-working skills.

Three months later, Gasper bolted for a new job with a Cheswick, Pa., unit of Curtiss-Wright Corp., a much larger maker of pumps and generators that buys parts from Hamill. Curtiss-Wright offered him about 40 percent more pay than he was getting at Hamill.

"I was just looking to further my career a little," says Gasper, now 21. Though he has no college degree, his annual pay tops $55,000. Unlike many young adults, he has no college debt.

Hamill's Kelly says he has raised wages 18 percent to 25 percent over the past two years or so, but still has lost about 10 workers in that period to Curtiss-Wright.

Greg Hempfling, a senior vice president at Curtiss-Wright, says he isn't poaching but merely posting job offers. The pool of skilled manufacturing labor has been "decimated" in the Pittsburgh area, he says, and that has forced Curtiss-Wright to advertise for help as far away as Detroit and Buffalo, N.Y.

Even some global giants are stretched to find enough qualified workers. At a U.S. division of Bayer AG that makes plastics and polyurethane, the average age of employees is about 52, says Gregory Babe, chief executive of the German company's U.S. business. The skill shortage "is a real issue, and it's going to get much worse," he says.

Bayer has had particular trouble filling positions in such areas as chemical-process technology at its plastics plant in Baytown, Texas, near Houston. A decade ago, Babe says, a job opening typically would attract 100 applications. "These days I get about 10," he says. After screening, Bayer often finds that only a couple are qualified. Some jobs have been open six to nine months.

"This place is five acres, and it's three stories tall," says Donny Simon, 55, who has worked in the plant since 1988. It takes time to understand how all the pipes, valves, pumps and feedstock tanks work together and how to avoid explosions or other accidents. Technicians need basic math and science for such tasks as calculating the rate at which dyes and stabilizing agents need to be added for specially ordered batches of plastics.

Because it can't find enough candidates with relevant experience, Bayer this summer will for the first time hire interns to learn how to operate machinery at the Baytown plant. It plans to offer $18 to $23 an hour—unusually good pay for summer jobs—and to choose among students in "process technology" at local community colleges. Those who do well are likely to be offered permanent jobs.

Manufacturers are having trouble now partly because some of them stinted on recruitment and training when it was easier to find workers. Woodward Inc., a maker of parts for aircraft and power-generation equipment based in Fort Collins, Colo., for decades operated its own academy to train workers, but it closed it during a late-1990s cost-cutting drive. As a result, says Keith Korasick, who supervises manufacturing at Woodward's Fort Collins plant, "we kind of lost our pipeline of skilled machinists and technicians." Now Woodward is sponsoring two dozen students at community colleges in Fort Collins and Rockford, Ill., the company's other big U.S. manufacturing site. It pays their tuition and other costs for two-year programs in manufacturing skills. The students also are paid for 20 hours or so of work per week. To stay in the program, they need to maintain a grade-point average of at least 3.0.

Once the students finish those two-year degrees, Woodward aims to hire them for full-time manufacturing jobs starting at $25,000 to $48,000 a year.

As a high-school student in Fort Collins, Zach Wagner met Korasick and other guest lecturers from Woodward. Wagner, now 18, says he was interested in "computer stuff" and hadn't thought much about manufacturing. Most of his friends were heading for four-year universities. He considered doing the same, but he worried about running up debts. So he accepted a community-college scholarship from Woodward. He aims eventually to get a degree in engineering while working at Woodward.

Manufacturers say the U.S. education system doesn't produce enough students strong in math, science and engineering. About 5 percent of bachelor's degrees awarded in the U.S. are in engineering, compared with an average of about 20 percent in Asia, according to the U.S. National Science Foundation. In the most recent comparison of math and science test scores of 15-year-old students by the Organization for Economic Cooperation and Development, American students trailed far behind those from China, Japan, South Korea, Canada and Germany.

While community colleges and technical schools struggle to keep up with demand for skilled workers, some prisons are trying to help. At California's San Quentin prison, the machine shop offers training to prepare prisoners to pass exams demonstrating skills in such areas as operating computer-controlled lathes and mills. Some inmates get classes in calculus and trigonometry to help them work with machinery.

Swift-Cor Aerospace, a maker of airplane parts, has hired several former prisoners for its plants near Los Angeles and Wichita, Kan., and is happy with their work, says Cecilia Mauricio, human-resources manager.

The impending retirement of boomers isn't a problem for everyone. Advanced Technology Services Inc. of Peoria, Ill., sees the trend as a huge opportunity. ATS provides maintenance and related services for manufacturers. Jeff Owens, president of the company, says he expects demand for those services to surge as manufacturers can't find enough qualified employees and need to outsource more tasks to firms like ATS.

ATS now has about 2,400 employees in the U.S. and aims to reach 2,800 by year-end. Nearly a third of the people ATS hires come from military backgrounds, often with experience in fixing tanks or airplanes. Aside from knowing how to fix machines, the military vets are good at "being on time, being clean-cut," Owens says.

ATS also helps pay for 40-week community-college training programs for some people it hopes to hire, and it funds scholarships for engineering students at universities. Two ATS managers spend nearly full time working with high schools, attending career days, conducting plant tours and meeting with guidance counselors.

"They're out there selling the idea of working in a manufacturing plant—and trying to dispel the notion that it's dark and dirty and unsafe and boring," Owens says.

Henry Welsch, 36, is one of ATS's converts. For the first 15 years of his adult life, he worked as an insurance agent and claims adjustor and as a sales manager for a moving company. But he decided a couple of years ago that he would rather have a job that was more secure and provided steady pay rather than unpredictable commission income.

One problem: He had never worked with tools or machinery. "I was starting from just nothing," he says. He signed up for a nine-month manufacturing-skills course at Illinois Central College in East Peoria, Ill., and got a job at ATS in late 2009. That company assigned him to a Caterpillar Inc. plant, where he repairs machinery.

It was a rough transition. He had to prove himself to his new colleagues, some of whom, he says, were "a little rough around the edges." The job may lack glamour, Welsch says, but he thinks he made the right choice. "This is what I do in the daytime, and I go home and don't have to think about it."

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Please feel free to submit as many of these forms as you would like. Please answer the following questions for each submission:

1) What is the document we should review? : Carol S. Jeffers

2) Author: Between School and the Community: Situation Service-Learning in University Art Galleries

3) Source: The Michigan Journal of Community Service Learning (Vol 7) January, 2000.

4) Which of the following taxonomy areas does it fit into? (Please select only one):

- ☒ Society
- ☐ Technology
- ☒ Economy
- ☐ Environment
- ☐ Politics and Legal Issues
- ☒ Education
- ☒ Other: Arts & Culture

5) Relevance: Workforce Preparation for Arts Graduates

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Questions: lynne.davidson@gcccd.edu *Research, Planning and Institutional Effectiveness*

Michigan Journal of Community Service Learning *Fall 2000, pp. 109-116*

Between School and Community: Situating Service-Learning in University Art Galleries

Carol S. Jeffers
California State University, Los Angeles

This paper explores the possibility of implementing a new campus-based model of service-learning in the unique environments of university art galleries. Guided by critical theory and a Deweyan pragmatist philosophy, this model promoted the use of constructivist learning strategies by 63 preservice teachers. Serving as facilitators, these preservice teachers worked with a total of 210 visiting schoolchildren in small groups to: a) address authentic intellectual, aesthetic, and social problems; b) actively negotiate and construct new identities; c) share multiple perspectives on and meanings about art; and d) learn to think critically and creatively about complex issues of teaching, learning, and boundary-crossing. Data from a variety of sources, including pre- and post-course attitude surveys and preservice journals, were analyzed and interpreted to reveal that preservice teachers greatly benefited from their service-learning experiences and changed their views of art, teachers, and learning in art gallery-museums.

In a postmodern society, various conceptual and programmatic boundaries between schools, universities, and communities can be considered unnecessary, even "unnatural" (Anzaldua, 1987); they serve only to create a metaphorical place known as the "borderland" (Anzaldua, 1987; Garber, 1995; Hayes & Cuban, 1997). In service-learning programs, students are expected to cross borders that needlessly separate educational experiences situated in schools from those situated in communities. Service-learners must enter the borderland and explore its unfamiliar terrain, which can exist not only 'out' in the community, but also, on their own campuses. This paper explores the possibility of developing and situating a new type of service-learning in university art galleries, where knowledge is constructed and contextualized at the edge of the campus in a borderland that lies between school and community. A hybrid, as it were, this campus-based model promotes significant collaboration between preservice teachers (members of elementary art methods classes) and students from area schools in the largely unfamiliar territory of a gallery borderland. In so doing, this model identifies a type of service-learning experience that makes a difference to prospective teachers and schoolchildren alike.

Framework for the Campus-Based Model

Based on Deweyan pragmatist and constructivist views of epistemology, cognition, and learning, this model was designed to combine experiential learning, critical reflection, constructivist practices, and service in the context of the "unique educational environments" of the two galleries located on the California State University at Los Angeles campus (Zeller, 1987). In this model, then, service-learning and pragmatism are clearly connected and contextualized, as are critical reflection, thought, and action. Moreover, the notion that knowledge is both contextual and constructed is integral in the philosophy and design of the model (Liu, 1995). That is, knowledge of art, self, and others is actively constructed by students and preservice teachers in small groups or learning communities and situated in a particular place beyond the classroom.

This approach, which constituted a major component in two class sections of an elementary art methods course, invokes a kind of "border pedagogy" (Giroux, 1992). Such a pedagogy empowers students to cross borders, to work closely in order to understand themselves in relation to others—that is, to understand "otherness," and to reflect critically on issues of race, ethnicity, class, and cultural heritage. It strives to create a metaphorical borderland in which diverse cultural resources allow for the development of new identities and relationships (Giroux, 1992). Fleshing out the theoretical and pedagogical framework of this model, then, the art methods students (who are themselves ethnically- and culturally-diverse, typically first- or second-generation Americans of working class backgrounds), began by questioning their own perceptions that art museums represent opulent cultural spheres reserved only for upper class patrons. In so doing, they began to collapse real or imagined class barriers and develop new identities and relationships within the gallery borderland.

Preparing to Enter the Borderland

As a part of their professional preparation program, these diverse preservice teachers are required

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2) Author: National Research Council of the National Academies

3) Source: Washington, DC: National Academies Press, 2003

4) Which of the following taxonomy areas does it fit into? (Please select only one):

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- ☐ Politics and Legal Issues
- ☒ Education
- ☒ Other: Arts & Culture

5) Relevance: Information technology and creative practices (ITCP) as a bridge to social and economic development

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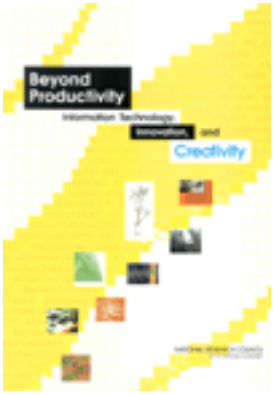

Beyond Productivity: Information, Technology, Innovation, and Creativity

William J. Mitchell, Alan S. Inouye, and Marjory S. Blumenthal, Editors, Committee on Information Technology and Creativity, National Research Council

ISBN: 978-0-309-08868-8, 268 pages, 7 x 10, paperback (2003)

Computer science has drawn from and contributed to many disciplines and practices since it emerged as a field in the middle of the 20th century. Those interactions, in turn, have contributed to the evolution of information technology – new forms of computing and communications, and new applications – that continue to develop from the creative interactions between computer science and other fields.

Beyond Productivity argues that, at the beginning of the 21st century, information technology (IT) is forming a powerful alliance with creative practices in the arts and design to establish the exciting new, domain of information technology and creative practices—ITCP. There are major benefits to be gained from encouraging, supporting, and strategically investing in this domain.

Summary and Recommendations

Creativity plays a crucial role in culture; creative activities provide personal, social, and educational benefit; and creative inventions ("better recipes, not just more cooking") are increasingly recognized as key drivers of economic development. But creativity takes different forms at different times and in different places. This report argues that, at the beginning of the 21st century, information technology (IT) is forming a powerful alliance with creative practices in the arts and design to establish the exciting new domain of information technology and creative practices—ITCP. There are major benefits to be gained from encouraging, supporting, and strategically investing in this domain.

INFORMATION TECHNOLOGY AND CREATIVE PRACTICES

Alliances of technology and creative practices have often emerged in the past. In the 19th century, for example, optical, chemical, and thin-film manufacturing technologies converged with the practices of the pictorial arts to establish the new domain of photography. Then, photographic technology became further allied with the practices of the performing arts, giving rise to the domain of film. The cultural and economic consequences of these developments have been profound. The emerging alliance of information technology with the arts and design has, this committee believes, even greater potential.

ITCP has already yielded results of astonishing variety and significant cultural and economic value. These results have taken such forms as innovative architectural and product designs, computer animated films, computer music, computer games, Web-based texts, and

interactive art installations, to name just a few. They have developed from individual, group, and institutional activities; the processes by which they have been produced have spanned both the commercial and not-for-profit worlds and the formal and informal economic sectors. The products of ITCP have begun to appear in many different countries, in ways that reflect cultural, economic, and political differences.

IT has now reached a stage of maturity, cost-effectiveness, and diffusion that enables its effective engagement with many areas of the arts and design—not just to enhance productivity or to allow more efficient distribution, but to open up new creative possibilities. There is a highly competitive race for leadership in this domain. The potential payoffs from success in the near- and long-term futures are enormous: billion-dollar industries, valuable exports, thriving communities that attract the best and the brightest, enriched cultural experiences for individuals and communities, and opportunities for global cultural visibility and influence.

By definition, there is no formula for creativity. But there are effective ways to invest in establishing conditions necessary for ITCP, in overcoming impediments, and in providing incentives. Furthermore, there are ways to recognize and reward creative contributions and to derive social benefit from them. In appropriate combination, these measures can add up to powerful strategies for encouraging, supporting, and reaping the rewards of ITCP. Development along with implementation of such strategies is the challenge addressed by this report.

MULTILEVEL STRATEGIES FOR ITCP

ITCP can be engaged at multiple levels—by individual artists and designers who deal with IT tools, media, and themes; in the structuring and management of cross-disciplinary research and production groups working in the ITCP domain; in directing educational and cultural institutions with interests in ITCP; at the level of regional development strategy aimed at fostering ITCP clusters; as an aspect of national economic and cultural policy; and in multinational collaborative efforts. All of these levels are important, and there are cross-connections among them. There is, therefore, considerable advantage in coordinated, multilevel strategies for encouraging, supporting, and benefiting from ITCP.

PROVIDING NEW TOOLS AND MEDIA FOR ARTISTS AND DESIGNERS

Individual artists and designers have experimented with IT since its earliest incarnations. Artistic exploration of the possibilities of computer graphics, for example, now extends back more than 30 years, and 40 years for computer music. As IT has matured and been assimilated into the mass market, the IT tools and media available to artists and designers have become both more diversified and more affordable. There are popular, standardized tools for performing such tasks as creating, editing, and distributing images, audio, and text; there are variants on standard tools customized to the needs of particular artists or designers; and there are highly specialized, purpose-built tools used by nobody but their creators.

To a software developer or an information services manager, it might seem that the keys to ITCP are simply equipment and software—developing and providing access to standard, commercial IT tools for artists and designers. This perspective is useful as far as it goes, and it can provide a good way to get started with ITCP, but in the long run it is an insufficiently rich or flexible one. We make our tools; then our tools make us.[1] Furthermore, software tools encode numerous assumptions about the making of art and design—precisely the sorts of presuppositions that truly creative practitioners will want to challenge. And the more software tools emphasize ease of use or familiar metaphors, the more they must depend on restrictive assumptions in order to do so. Such tools not only must be available, but they also must be objects of critical reflection; they must be open to adjustment and tweaking, they must support unintended and subversive uses—not just anticipated ones—and they must not be too resistant to being torn apart and reconceived. If creative practice can develop the powerful spaces and tools that it needs, like the electronic easel or electronic studio, these spaces and tools could help transform or enlarge the metaphors, spaces, and tools (office, desktop, files) that the rest of us have to work with.

The relationship between IT professionals and artists and designers will be of limited value if it is conceived simply as one of software (or hardware) producer and consumer. It should, instead, be one of flexible and thoughtful collaboration in which the roles of software designer and user are not rigidly distinguished. The advances made by IT researchers may suggest new forms of art and design practice,

[1]Inspired by Marshall McLuhan, 1954, "Notes on the Media as Art Forms," *Explorations* 2 (April): 6-13.

while the questions raised by artists and designers may provide new ways of thinking about IT—ITCP work challenges the boundaries of traditional disciplines. Modular, reusable and recombinable code elements may support critical reconceptualization more readily than closed, proprietary software products. Open source development may provide better opportunities for cross-disciplinary collaboration, customization, and reconceptualization than tools developed and marketed as protected intellectual property—no matter how powerful and attractive those tools may be.

PROVIDING OPPORTUNITIES TO DEVELOP ITCP SKILLS

In general, ITCP depends on opportunities for learning across multiple disciplines—some mix of the arts and design plus IT concepts and tools. The growing numbers of artists and designers becoming skilled programmers or hardware developers, like the smaller number of computer scientists and technologists engaging seriously with the arts and design, demonstrates that this is feasible. But it is not easy: Colleges and universities focus mostly on established disciplines, and the cross-disciplinary programs that do exist vary widely in their institutional support, effectiveness, and quality.

Like other professionals, artists and designers can do more with IT if they become deeply conversant with its capabilities and limitations. Achieving that result requires far more than training on standard tools, and it also demands an ability to understand tools and media critically—in cultural and historical context. Such critical thinking about tools is much less typical of education and training in IT, a difference that contributes to the asymmetric participation of artists and computer scientists in ITCP. To date, it seems that artists and designers have made greater efforts to engage IT seriously than computer scientists and technologists have made to acquire deep understanding of creative practices in the arts and design. It is easier to find designers who can program than programmers who can design, or composers comfortable with signal processing than specialists in signal processing who can compose or perform at high levels of proficiency. This imbalance could change, with outreach to the computer science community and interest in ITCP among those who provide funding and other incentives and rewards.

Although motivated individuals can and do acquire complementary IT and arts or design skills, significant ITCP work can also be produced by cross-disciplinary partnerships between computer scientists and artists or designers. This approach has the advantage of requiring that fewer skills be mastered by individual team members, and it is often essential for large projects, but there are some inherent difficulties. Progress in collaborative ITCP requires effective dialogue

between artists and designers and IT professionals. Differences in professional culture, styles, and values, as well as communication problems, can confound effective collaboration. Yet there are strong traditions of successful cross-disciplinary collaboration in architecture (particularly as computer-aided design/computer-aided manufacturing (CAD/CAM) technology plays an increasing role), in film production, and in the creation of video games, and there have been some successful pairings of artists and technologists to produce visual works, performances, and installations.

CREATING ENVIRONMENTS THAT SUPPORT ITCP

ITCP work can be done in many different places. And the diversity of venues matters, since each type of venue represents different tradeoffs and provides different combinations of opportunities, constraints, and comparative advantage. So an effective ITCP development strategy is likely to be a multivenue one.

ITCP venues may occupy physical or virtual spaces, be large or small, range from loosely organized collectives to formal programs, and be either free-standing or connected to established institutions. Specialized exhibitions, performance festivals, presentation and lecture series, conferences, Internet forums, and display and performance sites have all played important roles in the growth of ITCP communities. By contrast, mainstream arts and design organizations—museums, galleries, arts and design fairs, arts and design publishers, and so on—have played a lesser role, although they have begun to embrace ITCP more as the products of ITCP have played a larger cultural role and as these products have developed in quality and interest.

Much pioneering exploration of ITCP has taken place in studio-laboratories, which build on the tradition of earlier centers of cross-disciplinary research and education in the arts, design, and new technology of the time, such as Germany's Bauhaus in the pre-World War II years, the postwar New Bauhaus in Chicago, and the Center for Advanced Visual Studies established by Gyorgy Kepes at the Massachusetts Institute of Technology (MIT) in the 1960s. MIT's Media Laboratory has been among the largest and most visible, and it has generated affiliates in Europe and Asia. However, the Media Lab's combination of substantial laboratory and human resources with an atelier style of research and education, building on a consortium of industry funders, is difficult to replicate outside the context of a leading research university with strong industrial connections. Some universities, such as Carnegie Mellon University, have formed special cross-disciplinary centers that undertake ITCP, and several arts schools, such as the California Institute of the Arts and the Art Center College of Design in Pasadena, have transformed their curricula to incorporate

IT, yielding numerous focused ITCP activities. Some film schools have shifted their emphasis from traditional to digital production and distribution technologies, and most architecture and design schools have supplemented or supplanted drawing boards with CAD. Several universities have begun to develop cross-disciplinary study programs in aspects of ITCP. But a key challenge, particularly in times of tight finances, is to find effective ways to fund these programs—and to frame them in ways that are pedagogically sound and appropriately adaptive to the continuing evolution of ITCP.

In Canada and Europe, and emerging in Asia and Australia, major efforts are under way to develop standalone, government-backed ITCP centers. Such centers are typically conceived of as instruments of arts and cultural policy, rather than as equivalents of national research laboratories. This is an arena in which the United States lags. In principle, such centers can provide considerable flexibility and freedom of intellectual direction. On the down side, they are vulnerable to changes in government spending priorities, they can lose the very independence that makes them attractive if they shift to executing contracts from industry, and they are usually less able to draw effectively on the laboratories and human resources of large universities.

The technology required for ITCP can be expensive, and ambitious ITCP productions can require major funding. Given the breadth of ITCP, some funding is available through commercial channels. It normally requires close engagement with popular culture and mass audiences, with all the constraints and opportunities that this implies. This path is illustrated by the film and entertainment industries—these ITCP pioneers overcame difficulty and expense and now can produce major commercial successes. A focused example is the flourishing video game industry, a direct outcome of the rise of ITCP. It obviously would not be possible at all without the necessary IT, and its products define a new art form that also resonates with the general public. It has found some highly innovative ways to combine centralized research, development, and marketing with large-scale open-source strategies, and it has evolved unique distribution strategies.

Operating on a small scale and often producing innovative work through commissions from enlightened patrons is another group of players that straddle the boundary between commerce and the arts: Independent architectural design, product design, graphic design, and music and video production houses now make extensive use of IT tools and media, and they frequently have IT specialists on staff. In some cases, this amounts to little more than straightforward use of standard, commercial tools. But more adventurous and innovative houses have seized the opportunity, through IT, to open up some exciting new domains. This is particularly evident in the move of architects into CAD/CAM design and construction—with the resulting emergence of new architectural idioms—and the move of graphic designers into work that is more interactive.

Much important ITCP work occurs outside the marketplace. In addition to academic efforts, individual, independent artists and designers, operating mostly on a small scale, are responsible for a crucial

segment of ITCP. By virtue of their independence, they are well positioned to provide perspectives that challenge mainstream thinking and to engage industry as catalytic outsiders who can instigate new ways of thinking about products and processes. Many forms of traditional art production, such as painting and writing, are labor-intensive and modest in their requirements for investments in technology, but ITCP is often much more capital-intensive. This increased need for capital presents a chronic problem for independents; they often operate on a shoestring, struggle to get access to technology and expertise, and must make whatever technology investments they can manage from project-by-project funding. They usually depend on some mix of the gallery and patronage structures of the art world, arts foundation grants, and relationships with sympathetic educational institutions and corporations.

ITCP activity in all of these venues tends to cluster geographically. Fostering such clusters—with a vital mix of commercial, non-profit, academic, design and production house, and independent practitioner activity—can play an important role in regional economic development. There can be major direct benefits to local economies, and indirect (but potentially even more important) benefits in the form of better design and higher levels of innovation distributed over many sectors of the economy.

In addition, by its very nature, ITCP lends itself to efficient electronic connection of scattered islands of activity. Writers and photographers can submit their work electronically to distant publishers, architects can form geographically distributed design and construction teams, film studios in Hollywood can link electronically to postproduction houses in London or animation shops in Korea, and so on. That capability for connectivity is leading, increasingly, to multinational ITCP alliances and organizations. Such a capability can be particularly important in contexts—such as in developing nations—where the local culture supports some unique ITCP cluster and electronic connectivity adds value to that cluster by providing wider access to resources and markets. It is also important in contexts—such as those of Australia, New Zealand, and Singapore—where small but highly educated populations, combined with the effects of distance, make concentration on high-value, immaterial, information goods and services particularly attractive.

FOSTERING THE CULTURE OF INFORMATION TECHNOLOGY AND CREATIVE PRACTICES

Providing new tools and media for artists and designers, providing opportunities to develop ITCP skills, and creating environments that support ITCP are all necessary to form thriving ITCP clusters, but

they are not in themselves sufficient. It is also essential to foster the culture of ITCP—the flow and exchange of ideas among those engaged, the development of a sense of intellectual community, the representation of ideals and values, and the recognition and validation of outstanding work.

The academic environment, in particular, is central to the future of ITCP. That is where talent is cultivated, and that is where research and practice of various kinds can take place largely without market strictures. At present, a gulf exists between computer science and the arts and design. Although some computer scientists bridge that gulf—and contribute considerably to ITCP—that activity often happens outside their department. Although some arts departments have been skeptical of "new-media" programs, in general the arts and design on campus have welcomed ITCP more than have computer science departments. The lack of welcome from computer science departments reflects a lack of appreciation of ITCP's potential to contribute to the advance of computer science as a field, as well as concern about already tight curricula. At the same time, arts and design departments on campuses and arts schools have sought to internalize ITCP facilities and to develop their own research and teaching programs in ITCP. The situation echoes earlier efforts to formalize computer science as a field, establish a theoretical foundation for it, and provide it with some level of autonomy from its predecessor and sister fields. But it is important to explore the potential for constructive interaction between the arts and design and computer science before universities—and practitioners—conclude that "parallel play" is the way to go.

Building academic clusters is a nontrivial challenge. Not only are there cultural differences among the constituent disciplines, but there are also significant differences in expectations for funding, use of time, use of graduate students, definitions of what is acceptable work, and so on. Special centers, seminars, and other venues are being tried on campuses, a kind of institutional experimentation that is vital to developing ITCP. They help to frame and sustain ITCP projects. The time is ripe for academic experimentation with ITCP, from course content and curricula to institutional options and incentives.

Education, collaboration, funding, and professional advancement all depend on how ITCP is received. Because ITCP spans so many activities, there is feedback from the commercial space and popular culture—a powerful reinforcement on the design end—and there is more ambiguous feedback through academic institutions (faculty and administrators); publications, exhibitions, performances, and prizes, as well as those who select for them; and funders of research and the arts.

Because the field of ITCP is young and dynamic, ITCP production is hard to evaluate. Traditional review panels—representing funders; owners and managers of conventional display, performance, or publication outlets; and those making personnel decisions at academic institutions—may be hampered by their members' ties to single disciplines and the absence of a time-tested consensus about what consti-

tutes good work in ITCP and why. This problem is typical of new fields drawing from multiple disciplines, albeit aggravated by the contrast between computer science and the arts and design. It is offset somewhat by a flourishing array of conferences and other forums, in both virtual and real space, that provide a sense of community and an outlet as well as feedback. Effective evaluation, validation, and recognition of ITCP work are essential for this domain to progress. Building on traditions in the arts and design, prizes can be powerful for stimulating and recognizing excellence in ITCP.

A NEW FORM OF RESEARCH

ITCP can constitute an important domain of research. It is inherently exploratory and inherently transdisciplinary.[2] Concerned at its core with how people perceive, experience, and use information technology, ITCP has enormous potential for sparking reconceptualization and innovation in IT. In execution, it pushes on the boundaries of both IT and the arts and design. Computer science has always been stimulated by exposure to new points of view and new problems, which are ever-present in the arts and design. Because of the breadth of use to which artists and designers put different forms of IT, and because they typically are not steeped in conventional IT approaches, artists' and designers' perspectives on tools and applications may provide valuable insights into the needs of other kinds of IT users. The needs and wants of artists and designers can suggest new ways of designing and implementing IT. Engaging their perspectives is a logical extension of recent trends in cross-disciplinary computer science research.

Recently, for example, artists and designers have brought new concerns to the design and implementation of sensor systems, distributed control systems and actuators, generative processes and virtual reality, and the Internet and other networks. Their interests in performance and in engaging the public present challenges for system interactivity; their interests in improvisation present new opportunities for exploring human-machine interaction. Although artists and computer scientists have long interacted in such spheres as computer graphics and music, almost any form of IT may be adopted or adapted for uses in the arts and design. This flexibility of purpose parallels the plasticity of the computer itself—and that helps to explain why artists' concerns may motivate new combinations as well as new forms of IT.

It is important to recognize, however, that serious ITCP research goes beyond appropriation of established IT concepts and techniques for artistic or design purposes, or use of straightforward examples

[2]In transdisciplinary ITCP work, artists and designers interact as peers with computer scientists, a model that is described in detail in Chapter 4.

drawn from the arts and design to demonstrate the potential applications of new IT. It requires drawing on deep understanding of *both* IT and the arts and design to formulate scientifically interesting new questions in ITCP, and to see the subtle cultural implications of relevant new science. Issues arising from the arts and design have motivated challenging and important domains of computer science and technology research, such as three-dimensional geometric modeling and scene rendering directed at the practices and needs of designers and animators. Sometimes arts-oriented researchers raise cultural, social, ethical, and methodological questions for computer scientists that would not be obvious in a more narrowly focused technological context. Conversely, outcomes of computer science research may challenge artists and designers to rethink their established assumptions and practices (rethinking that includes an evolution from artifact creator to process mediator), as when architects engage the possibilities of curved-surface modeling and associated CAD/CAM fabrication techniques, or when photographers ponder the differences in the roles of digital and silver-based images as cultural products and as visual evidence. And there are areas, such as augmented reality, tangible computing, lifelike computer animation of characters, and user-centered evaluation of computer systems, that are probably best regarded as the joint outcomes of questions posed and investigations conducted by computer scientists and by artists and designers. These developments suggest that the value of ITCP lies not just in the capacity of each field to answer questions posed by the other, but also in the opportunity for each field to gain fresh, sometimes uncomfortable, perspectives on itself.

MAKING ITCP HAPPEN

The broad scope of ITCP implies that it derives funding from both commercial activity—notably in design and entertainment contexts—and non-profit activity. The latter is where support is particularly uncertain yet essential, since it is in non-profit contexts that much experimentation takes place and some of the broadest public, participant access becomes possible. The hybrid nature of ITCP tends to confound its funding. In the United States, exploratory and productive work in the arts and at the non-commercial frontiers of design is likely to be funded by private philanthropy, while in computer science the leading funders of basic research are government agencies, often in support of specific agency missions. Computer science research grants are larger (by an order of magnitude) than grants (or prizes) typically available to artists—and they tend to be tied to the advances in scientific knowledge or the specific kinds of applications of concern to their funders.

Advancing ITCP requires new approaches to funding. A first step is recognition by both the arts and computer science patrons that topics in ITCP are legitimate; next must come support for exploration of the intersections between IT and the arts and design, and with that support for new kinds of technical and social and intellectual infrastructure for undertaking and providing access to ITCP. Those new approaches, in turn, may require new skills and participants in funders' decision-making processes. Grant program definitions should specifically embrace ITCP, but without that, progress in ITCP will depend on grant seekers' ingenuity in influencing program definitions and relating their ideas to existing programs.

In addition to monetary support, ITCP depends on resolving concerns about intellectual property rights. Not only does ITCP feature a broad range of content and a broad range of expression, but its production can also involve creative reuse or adaptation of previously generated content or expression. It also requires attention to the archiving and preservation of IT-based works, both those of a fixed nature and those designed to change through interactivity or other factors.

The rise of ITCP and the process of contemplating its future point to the need for better data on arts-related activities and trends. Although imperfect, the data available on scientific and technical research is better than that for arts activities. The lack of good data hinders effective planning and policy making.

RECOMMENDATIONS

Realizing the potential of ITCP requires actions on many fronts—by individuals, organizations, and funders of different kinds. The benefits will accrue broadly—in multiple sectors of the economy, geographic regions, and disciplines. Other efforts already address the roles of established arts institutions—museums, galleries, theaters, and so on—in relation to IT-based art works and performances. This report concentrates its recommendations on those most responsible for nurturing the talent and the explorations that are the essence of ITCP. The recommendations below build on discussions in the body of the report, which explores the ecology of creative practices and the components of the strategies through which ITCP can thrive.

For Educators and Academic Administrators

1. Support the achievement of fluency in information technology (IT), and the development of critical and theoretical perspectives on IT, by arts and design students through the provision of suitable

facilities, opportunities for hands-on experience with IT tools and media, and curricula that engage critical and theoretical issues relating to IT and to information technology and creative practices (ITCP).

2. Support educational experiences for computer science students that provide direct experience in the arts and design, critical discussion, and formation of broader cultural perspectives—not merely as semi-recreational enrichment, but at a sufficiently challenging level to raise hard questions about the social and cultural roles both of science and technology and of the arts and design.

3. Foster exploration of ITCP through incentives and experimentation with a range of informal (e.g., workshops and seminars) and formal vehicles (e.g., centers, awards)—in particular, by building firmly and boldly on demonstrated local (and often small-scale) strengths and productive relationships already in place.

4. Support curricula, especially at the undergraduate level, that provide the necessary disciplinary foundation for later specialization in ITCP.

For Foundations, Government Agencies, and Other Funders

5. Allocate funding not only to support work by specialists in established and recognized areas of IT and of the arts and design, but also to foster collaborations that open up new areas of ITCP.

6. Structure proposal review processes to encourage not only continued development of established and recognized areas of IT and of the arts and design, but also higher-risk, longer-horizon efforts to develop ITCP.

7. Provide program managers with more time and leeway to learn about new fields and new kinds of grantees; encourage mobility among grant makers, artists, designers, and computer scientists.

8. Develop a new grant-making category for tool (instrument) building, emphasizing designs that are extensible and tools that provide support for improvisation, and for providing broad access to the resulting tools. Expand research program support for work in aspects of distributed control, sensors and actuators, video and audio processing, human-computer interaction, information retrieval, artificial intelligence, networking, embedded systems, generative processes, and other technological areas that are critical to advancing ITCP, with a particular focus on arts-and-design-inspired applications of these technologies that extend beyond conventional uses.

9. Factor infrastructure and archiving and preservation needs into grant levels because this support is essential to enable future work in ITCP.

10. Support the establishment of new prizes for excellence in ITCP and the development of curated Web sites for its display or performance.

11. To support policy decision making, underwrite a better knowledge base—ranging from the history of ITCP to the details of who is doing what, where, when, and how—that parallels the knowledge base in scientific and engineering fields.

12. Underwrite research on the formation of creative clusters and the role that ITCP can play in promoting regional development.

13. Provide support for the creation and maintenance of networks of organizations (composed of participants from academia, industry, and cultural institutions) involved with ITCP.

For Industry

14. Seek opportunities to develop new products and services relating to the growing field of ITCP and to participate in the formation of ITCP clusters.

15. Pursue relationships with centers of ITCP activity, and seek opportunities to engage artists and designers who can contribute to the development of ITCP products and services.

For the National Academies

16. Organize a symposium series on Frontiers of Creative Practice (paralleling the Frontiers of Science and Frontiers of Engineering series) to bring together a cross section of young artists, designers, scientists, and technologists working within ITCP.

Beyond Productivity

Information Technology, Innovation, and Creativity

Committee on Information Technology and Creativity

Computer Science and Telecommunications Board
Division on Engineering and Physical Sciences

NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

William J. Mitchell, Alan S. Inouye, and Marjory S. Blumenthal, *Editors*

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Preface

Computer science has drawn from and contributed to many disciplines and practices since it emerged as a field in the middle of the 20th century. Those interactions, in turn, have contributed to the evolution of information technology: New forms of computing and communications, and new applications, continue to develop from the creative interaction of computer science and other fields. Focused initially on interactions between computer science and other forms of science and engineering, the Computer Science and Telecommunications Board (CSTB) began in the mid-1990s to examine opportunities at the intersection of computing and the humanities and the arts. In 1997, it organized a workshop that illuminated the potential, as well as the practical challenges, of mining those opportunities[1] and that led, eventually, to the project described in this report. Ensuing discussions between CSTB staff and people interested in the intersection of computing and the humanities or the arts, notably Joan Shigekawa of the Rockefeller Foundation, a participant in the 1997 workshop, culminated in a grant from the Rockefeller Foundation to study information technology and creativity (see Box P.1 for the statement of task).

This report should be read with two conditions in mind: First, it is, by design, a record of the project, filled with descriptions, observations, conclusions, and recommendations intended to motivate and sustain interest and activity in the rich intersection of information technology (IT) and the arts and design. Second, in this book form it cannot possibly convey the exciting possibilities at that intersection. Instead, it presents examples and pointers to sites on the World Wide Web and in the physical world where that intersection can be observed and experienced. We urge the reader to treat this report as a

[1]See *Computing and the Humanities: Summary of a Roundtable Meeting,* published in 1998 by the American Council of Learned Societies, one of three collaborators with CSTB in organizing the workshop.

BOX P.1
Statement of Task

A series of discussions among a cross section of the arts community and experts in computing and communications will be organized. These discussions will crystallize new ways of conceptualizing joint opportunities and new approaches to the arts (and/or IT [information technology]). They will explore what would make the most conducive environment for IT-arts exchange on an ongoing basis, considering physical and virtual options. They will address possible mechanisms to sustain the discussion, such as funding and institutional support. Finally, they will culminate in both a coherent description of potential futures and an agenda for action, action that bridges the different communities as well as action most appropriate for one or another.

primer and guidebook and to seek out instances of IT and creative practices—ITCP—directly.

COMMITTEE COMPOSITION AND PROCESS

The study committee convened by CSTB featured an unusually eclectic group of individuals (see Appendix A for biographies of committee members). Characterizing most (or all) of them as experts on particular subjects would only begin to suggest the talents of this group. Collectively, the committee had expertise and experience in the intersections of information technology and music, the visual arts, film, and literature and in art history, architecture, cultural studies, and many of the technologies pertinent to ITCP. The committee did its work through its own deliberations and by soliciting input from a number of other experts (see Appendix B for a list of those who briefed the committee). It met first in August 2000 and five times subsequently in plenary session. Additional information was derived from reviewing the published literature, monitoring selected listservs and Web sites, and obtaining informal input at various conferences and other convenings. During the editorial phase of the study, facts were checked for accuracy with either authoritative published sources or subject experts.

The diversity of this committee made it a microcosm of some of the communities it hopes to influence with this report. That diversity posed challenges in the conduct of this project that will be echoed in attempts to learn from it: Conversations among people with different training and professional experience can be confounded by jargon and

prejudices as well as by differing knowledge bases—even when those people share interests. The completion of this report attests to the potential for technologists and artists to find common ground, not only in undertaking creative work, but also in contemplating options for making such work easier to undertake and more widespread. But finding this common ground sometimes proved to be a formidable challenge.

The productive interaction among committee members was captured in some of their career developments during the course of this project. Chris Csikszentmihalyi, for example, left Rensselaer Polytechnic Institute to join John Maeda at MIT's Media Lab. Michael Century left McGill University for Rensselaer Polytechnic Institute. Natalie Jeremijenko was hosted by Jim Crutchfield for a month's professional visit at the Santa Fe Institute. And John Maeda was inspired by the project to build "a new online Bauhaus." These and other developments attest to the dynamism and creative energy of the people who have been exploring the intersection of IT and creativity.

Although the report refers to several companies, products, and services by name, such reference does not constitute an endorsement by the committee or the National Academies. The committee did not evaluate any product or service in sufficient detail to allow such an endorsement.

ACKNOWLEDGMENTS

The committee is particularly grateful to Joan Shigekawa of the Rockefeller Foundation for initiating this study. She approached CSTB with a conviction that the time was right for a conversation among people of different backgrounds about how to enhance and sustain the intersection of information technology and creative practices. We appreciate her guidance and support through the study process, including her participation in two committee meetings, occasional relay of useful information, and continuing demonstration of interest in the process and the eventual results.

In addition, we would like to thank those individuals who provided valuable inputs into the committee's deliberations. Those who briefed the committee at one of our plenary meetings are listed in Appendix B. Others who provided us with important inputs include Bill Alschuler (California Institute of the Arts), Howard Besser (New York University), Shari Garmise (Consultant, Washington, D.C.), Samuel Hope (National Office for Arts Accreditation), Sharon Kangas (Center for Arts and Culture), Anna Karlin (University of Washington), Ruth Kovacs (The Foundation Center), Joan Lippincott (Coalition for Networked Information), and Laurens R. Schwartz (Consultant, New York City). We would also like to acknowledge those organizations that hosted committee meetings: the American Institute of

Graphic Arts, New York University, Stanford University, Pixar Animation Studios, and the Massachusetts Institute of Technology.

The committee appreciates the thoughtful comments received from the reviewers of this report and the efforts of the National Research Council's report review coordinator. The review draft stimulated a comparatively large volume of comments, many of which provided additional reference material, relevant anecdotes, and observations to bolster or counter the committee's earlier thinking. The comments were instrumental in helping the committee to sharpen and improve this report. In particular, Simon Penny of the University of California at Irvine provided an unusually extensive and thoughtful set of comments that served to improve the quality of this final report.

Finally, the committee would like to acknowledge the staff of the NRC for their work. Alan Inouye served as the study director with overall staff responsibility for the conduct of the study and the development of this final report; his effort to bring the report to completion was exceptional and demanded far more of his time than anticipated. Marjory Blumenthal, director of the CSTB, provided essential guidance and input throughout the study process, drafted and edited a number of sections of the final report, and was both helpful and patient in bringing the committee process to a successful conclusion. Margaret Marsh Huynh had primary responsibility for the administrative aspects of the project such as organizing meeting logistics; her efforts made a particularly complicated and demanding process run smoothly. Consultants Laura Ost and David Walczyk generated initial drafts of several sections of the report; Ms. Ost also edited several chapters. Susan Maurizi edited the manuscript for publication. David Padgham and Jennifer Bishop provided research assistance; Ms. Bishop also created several of the original figures that appear in this report (including the cover design). The committee also thanks Janet Briscoe, Janice Sabuda, and Brandye Williams of the CSTB, and Claudette K. Baylor-Fleming and Carmela J. Chamberlain of the Space Studies Board for their support of the committee's work.

William J. Mitchell, *Chair*
Committee on Information Technology and Creativity

Acknowledgment of Reviewers

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report:

Anna Bentkowska, Conway Library, Courtauld Institute of Art,
Howard Besser, New York University,
Sandra Braman, University of Alabama,
Donna Cox, University of Illinois at Urbana-Champaign,
Robert Denison, First Security Company,
Steve Dietz, Walker Art Center,
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Paul Kaiser, Independent Artist, New York City,
Alan Kay, Hewlett Packard Company,
Clifford Lynch, Coalition for Networked Information,
Simon Penny, University of California at Irvine,
Bill Seaman, Rhode Island School of Design, and
Mark Tribe, Rhizome.org.

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release. The review of this report was overseen by Edward Lazowska, University of Washington. Appointed by the

National Research Council, he was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

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