BACKGROUND READINGS FOR LSC MEETINGS

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Excerpts from:

Mapping the Inventive Mind
David Perkins

Notes:

...let us put a key question on the table: what makes the inventive mind inventive, and how can we get more of it? To ask such a question is to look under the hood of invention and ask how the engine works. We do not lift the hood as often as we should. For a theme of such fundamental importance to human civilization, technological invention is substantially under-investigated. That acknowledged, cognitive science is one among several disciplines that has illuminated important aspects of the inventive mind.

In keeping with this, invention is a highly intentional and sustained activity, and a complex one. It involves identifying, defining, and redefining problems and opportunities (*often called problem finding*), pursuing them with ingenuity and persistence, negotiating relationships with a range of social entities.... The clear lesson of case studies is that no significant inventions today are the consequence of a single "eureka" moment. Such moments occur, but they are dramatic highlights in a long saga, involving much thought and many trials.

As the necessity for sustained focus suggests, invention is not a detached activity but a passionate one, demanding the right sort of disposition or character. Inventors care about what they are doing, often showing dedication to the point of compulsion and curiosity to the point of distraction from ordinary affairs. While many are driven by financial incentives, they are also very much caught up in the quest for a deeper understanding of how things can be made to work for a better world.

...With all that as backdrop, *what makes the inventive mind inventive*? Studies in cognitive science disclose that highly inventive people consistently display a range of abilities and character traits. ...at the core, the inventive mind displays transgressive cognition, meaning a tendency to cross boundaries in various ways, and a *practical-technological orientation*. Both of these characteristics receive support from technical knowledge, dogged persistence, and a *systematic and strategic* frame of mind, and further depend on socially oriented capabilities *concerning collaboration, leadership and coordination, market sensitivity, and entrepreneurship and intrapreneurship*.

Transgressive cognition.

Perhaps the most fundamental question we can ask about invention is where does the "newness" come from? A broad answer is that the cognitive process of inventive thinking is full of boundary transgressions—they cross boundaries all the time in various ways. Case studies of invention repeatedly show patterns of questioning received wisdom, borrowing ideas from one area to serve another, conducting basic inquiry to provide a foundation for practical invention, pulling back from an approach that is not working very well to strike off in a new direction, and so on. Thus, inventive thought transgresses boundaries of convention and

expectation, boundaries between fields and areas of practice, the boundary between the known and the unknown, the self-made boundaries formed by premature commitment to a particular approach, and more. Through skepticism, questioning, analogy, brainstorming, trial and error, exhaustive search, and in many other ways, inventors transgress boundaries to devise fundamentally fresh and more powerful ways of doing things.

Practical-technological orientation.

Besides its transgressive character, inventive thinking adopts a particular target: practical-technological innovation. It is this mission that distinguishes invention from other notable areas of creative endeavor in the arts, the sciences, and elsewhere. One fundamental criterion imposed by the practical-technological orientation is that the invention must work, not just on the laboratory bench, but in society. Innovation just to be clever and fresh and stimulating will not do.

As emphasized earlier, all this is more than a matter of knowledge, sill, and imagination; it also involves a distinctive profile of passion and commitment. Operating in a transgressive way calls for a strong spirit of restlessness and adventure, a willingness to step out of the mainstream and beyond prior solutions, a readiness to question one's own previous ideas and toss half-baked solutions into the trash can after learning what one can from them. Likewise the practical-technological orientation of the inventor is more than a particular specialization. It is a passion to make things work and a passion to solve this or that problem in an effective technology-based way.

Technically-knowledgeable: ...inventors are almost always deeply technically knowledgeable in their specialties... Invention rarely benefits from naiveté, although one can know a lot and still not be inventive....

Persistent: ...Virtually all significant inventions sit at the top of a tower of failures. Would-be inventors need to be psychologically ready for failure and ready to learn from it, and the social structures that support their endeavors need to be in it for the rough climb and the long haul.

Systematic: ...On the whole, invention is a strikingly systematic pursuit, despite the occasional opportunistic moment. It involves enumerating possibilities, careful testing of prototypes, targeting particular questions for investigation to inform the next step forward, seeking information from technical sources and colleagues. As just noted, it involves repeated cycles of learning from failure.

Strategic: In keeping with this, invention is also characteristically a highly strategic pursuit. Inventors use a number of strategies intuitively or deliberately for their problem finding and problem solving, for instance: subgoaling, defining and pursuing subgoals to systematize the development of an invention; repurposing, seeking new purposes for existing artifacts; and analogy, drawing on analogies to suggest approaches to the problem at hand.

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Reasonable goals: One simple point is what the goal is not: to create Edisons by the millions. ...Realistically viewed, the cultivation of invention and inventiveness is not very different from the cultivation of other complex activities, such as artistry or skill at sports. With time, effort, and informed guidance, almost everyone can improve substantially....

...to be sure [these] general ideas are far from a blueprint, indeed hardly even a sketch. Still they point a helpful direction. It was noted at the beginning that invention, the oldest record we have of the creative mind at work, could also represent a fresh, exciting, and enormously productive arena of social development. We certainly do not know all we would like to know about invention and the inventive mind, but we know plenty to being to invent the inventive society.

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Learning to be human: A vision for the Liberal Arts
Lloyd J. Averill

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From chapter: Creating a Climate for Change.

Opening quote:

> *[The] future cannot be predicted, but futures can be invented.... The first step of the technological or social inventor is to visualize by an act of the imagination a thing or state of things which does not yet exist...He can then start rationally from the invention and forward from the means at his disposal until a way is found from one to the other.*[2]

Here are the essential ingredients in effective change-making, offered first in simple outline so that the read will be able to see the process in its totality.

1. Visionary leadership.
2. Administrative initiatives to authorize and energize change.
3. A clear statement of institution mission.
4. An enlarged "sense of the possible" among the institution's members
5. Arrangements for information-dissemination throughout the institutions, throughout the process, and for broad participation both in initial change explorations and in formulating final recommendations.
6. Anticipation of systemic implications and consequences.
7. Adaption of changes provisionally, subject to monitoring and modification.
8. Assistance to teachers and administrators in the development of new skills required for effective implementation of the new arrangements.
9. A reward system to encourage effective implementation.
10. Careful interpretation of the new arrangements in subsequent faculty and administrative in subsequent faculty and administrative recruitment.
11. Ongoing, long-term evaluation to test the continuing faithfulness and effectiveness of the new arrangements in relation to the agreed-up mission of the college.

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[2] Dennis Gabor, *Inventing the Future*. New York: Alfred A. Knopf, 1964. Pp. 207 – 208.

Social Creativity: Making All Voices Heard

Gerhard Fischer

Notes:

Abstract

The power of the unaided individual mind is highly overrated. Much human creativity is social, arising from activities that take place in a social context in which interaction with other people and the artifacts that embody collective knowledge are essential contributors. Social creativity is not a luxury but a necessity to address the problems faced by societies in the 21st century. Our research has focused specifically on complex design problems requiring the contributions of many stakeholders.

These stakeholders come from many different backgrounds, requiring cultural and epistemological pluralism to *make all voices heard*. We have developed *socio-technical environments* supporting these objectives in the specific contexts of urban planning, collaborative learning, and collaborative software design.

1 Introduction

The analysis of creative people and creative objects has demonstrated that most scientific and artistic innovations emerge from joint thinking, passionate conversations, and shared struggles among different people, emphasizing the importance of the social dimension of creativity (Bennis & Biederman, 1997; John-Steiner, 2000). On the one hand, interactions of humans with other humans and with artifacts and tools is not only needed but central to social creativity. On the other hand, people participate in such collaborative inquiry and creation as individuals, and individuals need time to think and reflect about their contributions to social inquiry or creativity (Fischer et al., 2005).

Complex design problems seldom fall within the boundaries of one specific domain; therefore, they require the participation and contributions of different stakeholders with various backgrounds. These different stakeholders speak with their own voices grounded in their individual backgrounds as, for example, an industry person or an academician, a natural scientist or a humanist (Snow, 1993), a teacher or a learner (Rogoff et al., 1998), a professional or a client (Illich, 1973), a software developer or a software user (Greenbaum & Kyng, 1991)....

2 Individual and Social Creativity

Social creativity does not necessitate the development of environments in which the interests of the many inevitably supersede those of the individual. Individuality makes a difference, and organizations get their strength to a large extent from the creativity and engagement of their individual members. Appropriate socio-technical settings, at the same time, can amplify the outcome of a group of creative people by both augmenting individual creativities and multiplying rather than simply summing up individual creativities (Fischer et al., 2005).

Individual Creativity.

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Creative individuals can make a huge difference in exemplary cases, such as movie directors, leaders of sports teams, and leading scientists and politicians. Individual creativity comes from the unique perspective that the individual brings to bear in the current problem or situation. It is the result of the life experience, culture, education, and background knowledge of the individual, as well as the individual's personal interest associated with a particular situation.

Individual creativity, however, has limits. In today's society the Leonardesque aspiration to have people who are competent in all of science has to fail because the individual human mind is limited (Campbell, 1969; Shneiderman, 2002).
Social Creativity. Creative activity grows out of the relationship between an individual and the world of his or her work, as well as from the ties between an individual and other human beings. Much human creativity arises from activities that take place in a social context in which interaction with other people and the artifacts that embody group knowledge are important contributors to the process. Creativity does not happen inside a person's head, but in the interaction between a person's thoughts and a socio-cultural context (Csikszentmihalyi, 1996).

Integrating Individual and Social Creativity.

Our work is grounded in the basic belief that there is an "and" and not a "versus" relationship between individual and social creativity. Creativity occurs in the relationship between an individual and society, and between an individual and his or her technical environment. The mind—rather than driving on solitude—is clearly dependent upon the reflection, renewal, and trust inherent in sustained human relationships (John-Steiner, 2000). We need to support this distributed fabric of interactions by integrating diversity, making all voices heard, increasing the back-talk of the situation, and providing systems that are open and transparent, so that people can be aware of and access each other's work, relate it to their own work, transcend the information given, and contribute the results back to the community. This process is illustrated (in part at least) by the "location, comprehension, and modification" cycle in software reuse (Fischer et al., 1991), the "collect/relate/create/donate" model (Shneiderman, 2002), and by the decentralized development process of open source communities (Scharff, 2002).

Individual and social creativity can be integrated by means of proper collaboration models, appropriate community structures, boundary objects, process models in support of natural evolution of artifacts, and meta-design. By integrating individual and social creativity, support will be provided not only for reflective practitioners but also for reflective communities. Even within disciplines, disciplinary competence is not achieved in individual minds, but as a collective achievement made possible by the overlap of narrow specialties (Levy & Murnane, 2004).

Leadership is an art
Max DePree

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How does one transform verbal and often abstract statements in steel and stone? We are all familiar with how the Greeks and the Romans left the marks of their culture in architecture. The Mayans, too, expressed their culture in distinctive buildings. Broadly, you might say that architecture deals with the relationship of people and the environment. As a company, Herman Miller deals with the relationship every day.

In thinking about facilities and their relation to corporate cultures, I consulted my dictionary about the word "culture." From a number of choices, most of which had to do with biology, I selected this statement: "a particular state or stage of civilization." To me this definition links rather nicely to the idea of a corporate culture, but leaves me with a question: How should we think about man-made facilities as a state or stage of civilization?

You can frequently be helped in efforts to understand a problem by asking yourself questions. Here are a few about physical places and social places. These questions lead me to think about the working environment in a variety of ways:

- Does what I do count?
- Does what I do make a difference to anybody?
- Why should I come here?
- Can I be somebody here?
- Is there *for me* any rhyme or reason here?
- Can I "own" this place?
- Do I have any rights?
- Does coming here add any richness to my life?
- Is this a place where I can learn something?
- Would I show this place to my family—or am I ashamed to show it to them—or does it just not matter?
- Is there anybody here I can trust?
- Is this place open to my influence?
- Does it help to understand architecture as a social response?

The physical environment matters a great deal, but it is not as important as the management environment. The physical environment is likely to be a consequence of certain elements of the management environment. In that sense the facility will reflect the context of a corporation, its leadership, and its values.

...Facilities can aspire to certain qualities as an expression of a civilization. Some of these qualities are readily apparent. Some are not.

A facility should be a place that people can possess. Taking possession of the facility in which we work is closely linked to the idea of ownership. There is a fundamental difference, after all, between owners and renters. It is fair to say that renters are no-fault owners.

Facilities should enable and empower people to do their best. Facilities, like managers, should be vulnerable. They should encourage a rising level of knowledge about corporate life: literacy about business, the competition, relationships, and ownership. Our facilities must encourage lavish communications.

A facility should be a place of realized potential It should be a "high touch" place. A place where we connect persons to each other and to technology in an effective and human way.

Now, having said all of these things, some philosophical and some practical, about facilities and the corporate culture, is there a way to be specific? Of course there is. We should make it our goal to create an environment that:

- encourages an open community and fortuitous encounters
- welcomes all
- is kind to the user
- changes with grace
- is person-scaled
- is subservient to human activity
- forgives mistakes in planning
- enables this community (in the sense that an environment can) to reach continually toward its potential
- is a contribution to the landscape as an aesthetic and human value
- meets the needs we can perceive
- is open to surprise
- is comfortable with conflict
- has flexibility, is non precious and nonmonumental.

It is important that we be prudent stewards of corporate assets and at the same time avoid savings at the cost of good long-range planning and a quality environment.

It is important that we keep future options open. This will demand real discipline because there is always a great drive to pin everything down if possible.

It is important that everyone understands the context in which our facilities function and the context and value they create for us.

It is important that we avoid an overcommitment or rigidity to a single function or need. Experience has shown us that we need varying utilization patterns open to us and that we need open-ended growth possibilities. One of our goals is to build *the indeterminate building.*

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Report on Places of Invention: The First Lemelson Institute
The Lemelson Center for the Study of Invention and Innovation

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Findings (pp. 16 – 17)

The findings of the Institute offer insight into the qualities of physical space that are conducive to innovation; the ways that creative people shape the spaces in which they work; and common creative features among places ranging from the garages and basements of independent inventors to academic or government laboratories to regions and cyberspace.

Places of invention that "work" share some common features.

- **Flexibility**. Truly creative spaces are flexible. They are easily reconfigured, modular, and responsive to the needs of different people and different projects. It can be shown that as buildings and spaces become more solid and permanent, so do their occupants, often with a resulting waning of creativity.

- **Leadership**. Places of invention are characterized by managers who articulate and promote a clear mission, support individuals' research freedom in pursuit of that mission, encourage interdisciplinary teams, and manage with a "soft touch" characterized by minimal hierarchy and bureaucracy. Often, an influential mentor is responsible for originally bringing a group of creative people together.

- **Communication**. Creative places make it easy for people to discuss, share and argue ideas, whether in the laboratory or the cafeteria. By maximizing both formal and informal contact between individuals, such spaces encourage cross-fertilization of things.

- **Balance between inclusion and seclusion**. In order to succeed, inhabitants need to balance their need for solitude with their need for interaction with others. Essential to achieving this balance is giving the individual private, personal work space, while at the same time offering inviting communal spaces, especially those that foster interdisciplinary and multigenerational interaction. A space that is dictated and inflexible is unlikely to success as a creative space.

Similarly, individuals working in creative spaces exhibit some common desires and tensions.

- **Arrangement of the space**. Creative individuals want to arrange, modify, and adapt their personal work spaces to meet their own needs and whimsy. It is almost a cliché that creative people have messy spaces and espouse a hands-on mentality.

- **Control and lack of control**. Chaos and lack of control are vital to creative people. It is crucial to remove them from normal, predictable surroundings, and to give them the freedom to do what they want if they gather the resources needed.

- **Tension between planned and unplanned spaces**. Is it possible to "plan" for spontaneity? Probably not. Planning creative spaces seems to work best if done in stages, with evaluation and adjustment along the way.

The idea of "flow" or continuity is an actor throughout the history of invention.

- **Science v. technology**. While definitions of "science" and "technology" abound, it is more useful to see science, technology, application, invention, and art as part of the continuum of creativity. This viewpoint is useful in understanding the changing nature of the inventive process from the late 19th to the 21st century.

- **Temporal nature of creative spaces**. Creative institutions have life spans. Over average, research laboratories, for example, are productive for about 20 years. It is important to examine how the factors that make a creative place successful in the beginning may come to stifle it later on. Creative regions exhibit a similar, though longer-term, pattern. Questioning what resources exist, how long they last, what the competition for them is, and given those factors, how long the institution's way of operating can be sustained, will begin to explain this phenomenon.

- **Encouraging interdisciplinary, multidisciplinary interests**. Invention brings together knowledge from different disciplines to create something new and exhibits a long history of mapping ideas from one field onto another.

- **Connections across time and topic**. Linkages are important to understanding the history of invention. One of the inventor's most powerful tools is his or her ability to create analogies. The act of "transgressive cognition," or the ability to leap over intellectual barriers, is a constant.

Merton Flemings, Massachusetts Institute of Technology, shared his experiences over 60 years at one of the foremost places of invention. MIT embodies many of the characteristics…essential to creative places. It has a clearly stated and supported mission, leadership "with a light touch," a strong commitment to interdisciplinary teaching and research, academic independence within research groups and among faculty, and tolerance for the sometimes chaotic and organizationally "messy" conditions that promote creativity.

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