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I really think of myself right now as really more of a warm up band to the focus groups that will follow as it is really your ideas that are what we want to elicit from this meeting today and to focus our attention on what we can do with our education institution in a period of sustained transition that is taking place around us. I am an intellectual historian and one of things that I want to accomplish this morning is to set a very broad context of what is happening in the world that we are working from. We are brought up in a process of communication change and we need to entertain the idea that that change may not simply introduce new tools and techniques into established frameworks and make those frameworks marginally more efficient and effective.

One of the questions that I think that is very important for us to entertain is how fundamentally the transformations that are taking place are going to effect the works that we do. By the pedagogical problem in the title that I want to address for a few minutes and then I would like to open things up for some sustained interaction with you, by the pedagogical problem, I mean that which not each of us individually addresses but the whole culture in a sense has to address in engaging effectively its educational tasks. If we think back to Middle Ages and earlier, prior to the wide spread availability of text and images, prior to the ability to stabilize those texts and those images that print brought with it, we might say that the basic pedagogical problem was to address the question, how much can a person recall having encountered the various cultural resources that were fundamentally and profoundly scarce so that the situation that people would find themselves in, if they were to get one shot at a text if at all, they would hear something once and they would have to, if they were going to use it throughout their career and life, they would have to carry that with them in their ability of recall.

Much of the cultural apparatus that is in pre-modern time is really a large scale mamonic. If you think of a gothic cathedral with all this sculpture and stained glass windows and images here and there, and a ritual, a lithegy that people pass through fairly regularly and they rehearse stories and the whole thing is designed to maintain the memory and to enable the memory to recall and hold in mind the important ideas of a culture.

The era of print I think has a significantly different pedagogical problem at the heart of it. It is no longer necessary to cultivate the memory and the recall to the same

degree. Books are relatively inexpensive, they are relatively available to most. They are manageable in huge collections, libraries and the like. But lets think about the book a little bit as a material artifact. Its not a very convenient object in many ways. It weighs a fair amount. It has definite physical limits that people have to respect. Meditate on the relationship between our division of subject matter and the physical characteristics of a book. To what degree is a subject scaled to what will fit into a book so that one can lift, one can open, one can manage. Is our division of knowledge as we divide it up, an attribute of the world around us or is it a constraint of the way we have to manage ideas in physical form.

I raise these simply as questions but I think that they are part and parcel of the pedagogical problem of that period from about 1500 to about the year 2000 where the time means for working with ideas, for transmitting knowledge, for having resources available to people, is in print and there are very real physical constraints of that medium that are deeply entwined with the way we think, the way we teach, what we understand a curriculum to be, what we understand the proper and natural strategies for communicating the tools and ideas of our culture are. I would argue that in this period from 1500 to 2000, very roughly speaking, it is not what I can recall but what do I know out of all that print material because the act of taking the knowledge and applying it to the world is actually a fairly awkward act. The book, only so many can fit in our backpack of our children or in our briefcases. And a lot of our education is structured so that we select, out of the great collection of books, a certain amount of things that I know, things that you know, that you can bring to bare, quickly and physically in their movements, your actions in the world on the problems at hand. The question that I think we face as we enter the 21st century is whether or not many of these communication developments are so fundamental that they are going to significantly transform these fundamental basic issues that the educational system must deal with. Are digital technologies significantly divergent from print material communication mechanisms that they will in effect change the basic pedagogical problem that our educational system at large is going to be structured, decade by decade, to deal with. I don't know and I am not going to propound any conclusive answer to that kind of a question but it is one that I think we have to entertain, continually as we act within our sphere of activity.

I would like to hypothesize for our exploration that indeed, there are features of our digital cultural resources that are profoundly different from our printed material cultural resources. That focus that have to do with what kinds of things, what aspects of our humanity we externalize into our cultural tools. Looking at what is externalized into books as a functioning apparatus in our culture, its by in large, the problem of storage and retrieval of information and ideas and the library as a system

as it has been developed over the last 500 years, is a very powerful, very large, storage and retrieval mechanism. I think the Library of Congress is approximately equivalent to 20 terabytes of unique information, not a small information system.

Some of our scientific instrumentation goes beyond issues of storage and retrieval to greatly amplifying our powers of observation. Telescopes and microscopes and various kinds of instrumentation that is your business to know much more about than I do but they are very powerful ways of extending the human senses to make judgment about the way the world out there acts. But it seems to me that the digital technology as cultural tools greatly amplified our ability to externalize major aspects of our basic intelligence. I am not an enthusiast of artificial intelligence but I think AI should really stand for amplified intelligence. The calculations that we can make with our digital resources are vastly more complex than anything we can make with a slide rule and traditional tools. Our ability to sort, compare, our ability to simulate, our ability to create collective phenomena, statistical artifacts, to begin thinking about things like El Nino, or any one of many, many phenomena that we are now aware of as having powerful determinative forces in our environment that are apprehendable only by taking innumerable different measurements over extended periods of time and correlating those in extremely large scale data management systems. All of this is extending very significantly into our artifacts, major pieces of our basic human intelligence and amplifying the power of all of that. And making, in many ways, fairly trivial some of the skills and some of the concerns that, until very recently, have been fundamental to the educational tasks at various portions of our endeavors we deal with. I remember four years ago, discussing with one of the young Gateway faculty members at Columbia, in the Engineering School, saying, "Why don't you put some real design problems, open-ended design problems, and have a group work on them in your freshman class?" He answered, "Well, they don't have any tools of design. They don't know how to make the right, the necessary calculations. They will be at sea. It will be putting to them problems that they will only get frustrated over because this is something that you have to pass through a disciplined encounter, with calculus and through the various..." And I, as a lay person, thought, yes, he must be right, he must be right. Now the same young professor is running a fascinating design introduction, putting to students in a powerful computer assisted lab, a task of creating whatever kind of toy you want to create. Figure out what you think would be fun for kids and use ALIAS and other computer assisted design tools to work on this. Think this is just one straw of many that indicate the ways in which a lot of the skills that had to be taught as pre-requisite to coming to grips with the basic activity of many different fields, are becoming so effectively computer assisted that they are no longer necessary pre-requisite, but in a sense can be work with from without leaping over them and if this kind of a trend continues for long, I think the

fundamental question that we are going to be asking throughout the entire educational system, will be less and less 'what you know', but much more 'what can you do? what sort of activities can you engage in effectively? what sort of groups of people doing things can you stumble into and say "Oh, I know what they're doing". I have come to understand what an astronomer does. I have come to understand what a surgeon does. I have come to understand what a lawyer does. I have come to understand what an engineer does.' And that, I can participate in those activities. And that this becomes more fundamentally the pedagogical problem we face.

Now, we as transitional figures who all learned in an educational system fundamentally geared to ask the question "what do you know?". Our assessment is built on that, our motivation. We are goading the students to compete with each other. To know more than their peer. The way we organize information in textbooks and things, its to apprehended and that "I know this", "I know that". While we very often have very little attention to working with kids, to help them understand what people do, how we move from where we are to a possible future of this sort, is the task I think that we have to face. I felt that one point that Eli made is very, very important. The professional development is not only of us faculty members, but it is also a new form of professional development for students going through the work that we do and in many ways, I think one of the keys to bringing up as faculty members is the task of helping our students see that they can learn with us in new ways. To address such a change in the basic pedagogical problem.

I want to stop these thoughts here. I probably articulated it a little bit more assertively as a hypothesis than I should have. I think we are very possibly in such a situation rather than actually conclusively in such a situation. But thinking about ourselves in such a situation I think is a very important way of bringing ourselves up for exploring the new possibilities of what we might want to do with our educational institutions and it makes us, I hope, aware of how many sided the task is. That the point that Nancy raised about incentives. Unfortunately, it's the whole problem as I have been trying to frame it, is not one of doing a discrete thing differently but somehow the problem of changing the entire integrated\ complexity of our institutional activities of the inserting into incentives and our basis of promotions, altering curriculum, altering motivations of students, altering expectations of employers, altering the flow of funding for different kinds of activities, no single direction will do the job, rather it has to be through the whole complexity of it and that is the most frustrating thing in this and the reason why its going to take a long time for these kinds of changes to work into our institutions rather then, again, historically, the printing press as a technology spread through Europe from 1450 to 1500, its educational effects were not really fully manifested until 150 years from the 1500 to 1650 or so. And it is not

because people then were more conservative or less responsive to new ideas, it is simply because of the human complexity of all of these institutional inner-relationships and the difficulty of inventing all the different new procedures, activities, forms of effort.

I would like to see what kinds of questions, frustrations, concerns, arise from this sort of perspective on things.

Q:

A: Certainly, we risk that. Let me .... I think one might reflect on the history of sports vis-a-vis the history of physical prowess in, very roughly speaking, say prior to the 1800's. The range of sports that people indulged in and who indulged in them, was relatively limited but if you look at the art, say of the Renaissance, the physique of the normal male that is represented at many different ages is often very, very well robust and strong, looks like a trained athlete because people were using their physical powers just in the daily conduct of life much more fully than they are now. So it is entirely imaginable to me that in 100 years, yes, in the normal range of things, most of intelligence that we take pride in as sort of disciplined skills that we have working in the world around us, will be done better by calculators, and this'es and that'es that are already being done, but there will still be people who take pride in that, much more than we take pride in our athletic ability now. But, I think why in the third grade, teach basic mathematical operation, that is a question that as a culture, we have to face because the externalization of those operations is so inexpensively available to anyone but...

Q:

A: Right, but you and I were in school, taught not to guess, taught not to estimate, taught to be accurate and fast in our calculations to a fairly high level of precision. One might argue that the being off by 20th decimal point is an artifact of our focusing erroneously on precision and speed of calculation rather than effective estimation to complement the precision and speed of the computer.

Q: .... challenge of learning together with the instructor because they are so use to the instructor being the instructor. Intellectually and emotionally, they might not be ready so we have a double problem of not only the content matter but also with the emotional and intellectual maturity ..... of the instructor working together with you and learning together with you. I think maybe not so much in a non-traditional school but .....?

A: Yes, I think that is an excellent example of the inter-relativeness of our educational provisions and it is the case. I do most of our practical work in K-12 schools and we are trying to introduce a much more group oriented active learning pedagogy into inner-city schools in New York City and elsewhere but it is very, very difficult and the structures are set up, and students come in and they go through the whole system with very set expectations and I think that's why the ELAs are very important, not only to provide concrete assistance on tutoring this and that, but also to help people open out their expectation and there sense of what they can do as students and there is, in many ways, a kind of conspiracy between the conservatism of the students and the conservatism of the faulty member.]

One project that I helped do, in a very elite secondary school, in aspiring to do things in the middle school and in aspiring to do things in the fringe of the curriculum but as soon as we started seriously innovating in 11th grade English where the students began to say "Gee, I no longer know what it takes to get an 'A' in this course and that is going to possibly mess up my application to college", nothing was possible. The teachers who to depart ran into a great deal of resistance from the students and from their parents.

These are the things though that we have to find ways to overcome. That is, the problem and it would be a shame given in the absolute level of performance that any of us, relative to the complexity of our culture, attains through our education. To say, well, let's back away from all these things because the system works well enough, I think we all have to recognize that we are much more ignorant than knowledgeable vis-a-vis the complexity of our work. It would be nice if we could make it work.

Q: Technology, on the one hand, is contributing to the dilemma and on the other hand, is a tool to address .....

A: Yes, I personally kind of feel that technology is an extension of ourselves. That we exists in bodies in the world and these are one of interesting things that Gateway is developing as a physics of the human body as a freshman engineering course. So all these technologies are extensions of ourselves and it takes us a while when we introduce changes in our technology to fill out the sort of spheres of experience that those changes make possible and in that sense, I think it is very much opening up really interesting opportunities.

I always like to remember a few things about the history of architecture. Until approximately the middle of the 19th century, aside from a very, very, very few special buildings, nothing was built in almost any culture around the world more than 5 or 6 stories high. Basically because the human lungs and heart and musculature make it hard to walk up and down stairs more than 5 or 6 floors multiple times a day in a building. The technologies of iron and steel and concrete and plate glass combined with electric motors for elevators and fans and forced ventilation and the like. Quite historical speaking, quite rapidly introduced the feasibility of a whole new kind of architecture and it has taken now a century plus to begin exploring the world around the functional and esthetic characteristics of that new form of architecture and I think we are very much in that sort of a position as educators with the new digital technologies. They are probably radically changing what can be attained and what the basic pedagogical problem is in our educational environments but it is going to take us a long time to live that out.

Q: Freshman teachers talk about internalization .....technology consists of analytical skills, ...

A: I think that clearly the latter, and increasingly the latter, that what I mean by the pedagogical problem, one can also say one dimension of it is what, if any, historical time are the forms of knowledge that are scarce and problematic for a culture and the basic challenge of digital networks is that they are making significant components of our repertoire of knowledge that in the past have been scarce and important and significant for the management of experience in our culture, are available and this will be created, not simply this year, but over a sustained period of time, a lot of questions, deeply difficult questions about which there is going to be very significant differences of opinions and views about what knowledge is of most worth and what problems imparting it to the young would need to met.

Some of the higher order thinking skills that you are referring to, I think, are possibly are also being externalized into some of our tools and what mix of them in different fields we should take for granted is, I think, one of the questions I normally raise with respect to something like engineering or really any field but I think it is a question that has to be raised and has to be argued about. Did I respond to your question?

Q: