[Biography] Douglas Engelbart's 50 year crusade has been, simply put, the pursuit of "getting better at getting better." His seminal 1962 paper Augmenting Human Intellect: A Conceptual Framework first visualized the computer not as an automating device but as an essential tool that could be used to help humans collectively cope with problems of growing urgency and complexity. The following years at his Augmentation Research Center at the Stanford Research Institute were a hotbed of innovation that saw the development of many of today's computing paradigms.

This innovation culminated in the 1968 "Mother of All Demos," a fit of technological prognostication rarely seen since. Drawing on his young team of mavericks at SRI's Augmentation Research Center, Engelbart orchestrated a presentation at the 1968 Fall Joint Computer Conference in San Francisco that saw the first public viewings of hypermedia, videoconferencing, email, the mouse, document versioning and many other technologies now taken for granted or, in some cases, not even fully realized 30 years later.

Even though many histories stop here, these innovations are only the initial artifacts of a much larger vision. Engelbart urgently believes that we must develop more sophisticated human systems to keep up with accelerating technological development or face certain worldwide collapse and destruction. He proposes this be done by developing C-Level organizations, or highly trained teams that can "churn up" innovative ways of processing human knowledge. Reaching beyond the overly simplistic and obselete paradigms of "ease of use" and WYSIWYG metaphors, this "bootstrapping" process of improving how we improve would result in a highly networked "Collective IQ" that would accelerate humankind's evolution alongside its tools.

Further information on Dr. Engelbart's expansive career is available on the Bootstrap Alliance's website at http://www.bootstrap.org.

Matt Mays: At your office at Logitech we talked about the computer being a symbol manipulator. When you talked about the Whorfian

hypothesis you said that, in addition to language influencing the culture, that the tools used to manipulate the symbols also influence the culture. How does the computer being a symbol manipulator influence our culture?

Douglas Engelbart: Well how did the pencil and the chisel and the brush and the printing press influence our culture? When the alphabet arrived there was just a huge impact.

Mays: How does the invention of the printing press compare to the invention of the computer. I remember you saying that the latter has even had a bigger impact on our culture.

Engelbart: Right. I just think that it offers us a significant step ahead in what you could call language, the way in which symbols and their structures can be assimilated by you. That it conveys much richer thought than it would take five sentences to do. So my intuition has said that there's real exploration to do because there's the alphabet… and where more have we gone with that? And associated with that is the marvel I keep having about our perceptual machinery in your head. I pick up this object and in one glance I know what it is. I didn't have to detail around it and everything else like that to tell what it is. Because you've gotten used to it, it only takes one glance. One glance at an eight character word and you've got it. You didn't piece together each character. But the same thing goes on looking around the room here so that's the kind of environment that we evolved in, with different people and then all kinds of natural wild environments.… you could quickly perceive what was happening even if it was pretty complex. That was a survival value. And boy, did we ever get advantage out of it. I just really marvel about reading, how effortlessly those words turn into concepts. So I say all that is old technology. The alphabet I gather was like five thousand years ago. Then there's different ways to get it on a page, paper. In the early 70s the people came up with saying this word WYSIWYG. Oh boy, they said, the displays are so high quality now that what you see there is what you're going to get when you print it out. That was the height of technological achievement for them. And by then we had been doing enough alternate and optional viewing to say "oh yeah, but that's all you get." See? What you see is all you get. That's a paradigm issue. We grew up looking at books and somehow that was the model of what a computer could help us do. And you say, God, the computer has more flexibility in shaping, coloring, intensity, motion of symbols and everything else that haven't even touched what you could learn to do. So I feel like we're not very far in being able to

couple our body and brains to it. The web has raised us a bit, but I feel like there's a lot more to go. But you mentioned paradigms as being the last issue, that's the kind of thing that everybody else just drops their jaw. We can talk about that. So how would you get that topic opened and really explored? C'mon guys, it's you that…

Joel Slayton: If you think about the history of software, it's a history that's a history of abstraction. In a way further away from the computer, from the hardware. If I want to get close to my computer I can get close to it by coding it, programming it. And the closer I get to it on a sort of one-to-one basis, if I'm programming it in assembly language, that's pretty close to the machine. But it's really hard to get stuff done. It's really hard to do anything. It's really easier to do things with a computer the further you're distracted away from it in the software. But those abstractions, the further you get away from the hardware so to speak, in the software, you start building models about what you think this is. Right?

Engelbart: I think I understand.

Slayton: You build models with what you think you can do with organization, information. What can you do with information? You can list it, you can correlate it, you can scale it, you can index it, you can reference it, you can do all these things but those are abstract ideas about the nature of information, about the nature of organization. Aren't those paradigms, and do those kinds of ideas about information lock us into an idea about the machine that makes it very difficult to escape from, to do anything else, to think differently?

Engelbart: Right. We're anchored.

Slayton: Do you have any words of wisdom on how to cut the anchor?

Engelbart: Well, I guess you have to explore and say, "what do I unconsciously assume about what's possible in the changing world, without giving it a thought?" That affects what I can accept or understand or believe. We're loaded with them. I just have had tremendous experience with them, in the way of getting bruises. In the first years people said, "use a computer for WHAT?" They were so expensive and such. I said, well, they're not always going to be expensive. But it was ludicrous. So I was laughed off the stage. I gave a talk to the research librarians in the country one time at an annual gathering, and I was telling them about this and then I said I think it's inevitable that the printed word is going to practically

diminish out of our world. Oh boy, the chill in that room just came at me and I lost the audience. (laughter) But that's the paradigm and I really believe it. But if you go around preaching that people are going to say you're out of it, that you're going too far. A lot of things that I've been adhering to are sort of turning out to be right. Don't lightly tromp along paradigms because you'll get bitten.

Stephan Hechenberger: I thought that the ideas you have for open hyperdocuments are truly new paradigms that didn't exist before--The way you structure your documents associatively.

Engelbart: I like to call it a knowledge container. And the more ways that you can structure that and add properties to it that are meaningful when you try to manipulate it or view it the more valuable it is. I just have a feeling that it's going to get much richer, the way we have our knowledge containers. If the knowledge container I use isn't like yours in terms of being able to do the same things to them, it's a real pain trying to intercommunicate. I just had a lesson 15 years ago when we were part of McDonnell Douglas. So I talked to these guys that were interested in what we could do into talking to their Vice-President and seeing if they would really start letting us make a plan on how we could use the AUGMENT system and do it. So we did and the Vice-President said "well, I'll tell you, if you can go get key kinds of people in the various activities to buy into this then maybe we can start evolving it." So we went and got the people and got all turned on and excited, and then we got back and he said, "oh damn, I should have told you sooner. I was talking to IBM and DEC and Hewlett-Packard and none of them know anything about these crappy things you call links." So he says we can't play with it. We bumped smack into a paradigm that manufacturers of the computers just wouldn't buy. So the mid-level managers that knew a lot more about it said, "suppose you can get the people that set up the requirements and all for the airplane and then those that had done the different stages of design and get them ready to manufacture it, do you know the rest of the story?" I knew there was something to that, so they drew me a diagram of 3 stages of supplier corporations and in the first stage there might be a hundred of them out there that are actually involved closely in the design. And then there are the lower other levels, so there are something like 6000 companies that together are involved in actually designing and building the airplane. So you look at that say and how possibly could they use some really new ways of working with knowledge containers and portraying and manipulating them if each of them had a different one? You just couldn't. The instinct came to me that there's got to be one open environment. And

then you think, "does that belong to the vendor that can power everyone else aside and get total market share?" That would be a disaster. Because these vendors are out there aiming at market share alone. And they'll invest in improving the system if they think they need to do it to improve their market share. And they'll try all kinds of tricks and everything else to keep that market share going. The basic, basic fact is they haven't the slightest orientation about improving what I call the Collective IQ, the real capability of the organization. Not unless you have something like what I call the Open Hyperdocument System. The open source computer movement has sprung up and seems to validate that idea a lot. How are you going evolve more and better ways to do your thinking, portraying and manipulating unless the people doing that evolving are closely involved with the evolution of the ways to do it?

Slayton: If I understand one part of what you're saying…

Engelbart :   If only I did too. (laughter)

Slayton: … about knowledge and organizations. If I think about an airplane, the manufacture of an airplane, the first thing that occurs to me is that no one knows how an aircraft gets built. No one. There's no one that knows how to build an airplane anymore because the artifact of the airplane is so complex and involves so many people that that knowledge is dispersed. It doesn't belong to one person and it probably doesn't belong to the group. It belongs to the interactions or the associations between people and between organizations. That's a such a different idea about knowledge as much as it is a phenomena that our culture has found ourselves in more recently because of what we produce. We continue to produce a more complex world…

Engelbart: It's only going to keep on getting more complex…

Slayton: Agreed. So as that continues to escalate forward, does the knowledge base become increasingly dispersed?

Engelbart :   It becomes increasingly complicated, and if we're going to stay in control of it we have to be able to get repositories that integrate it. The ways to manipulate all that gets you so that you can really see if there are inconsistencies. There are already getting to be very interesting ways in which you can make a graphical chart of the way the different parts of an argument are tied together, to look at it for comprehension of it's status.

Slayton: Doesn't this imply that some of the authority for the decision making and the creation of the knowledge is going to be given away to the machine, to the processes, to the expertness of the computers, to the heuristics of generating the knowledge?
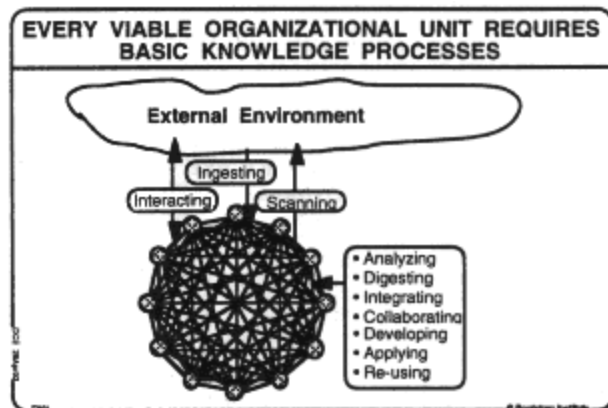
Engelbart: All I'm saying is you could have algorithms on a computer that can go analyze and take care of problems that a human couldn't follow. You have to depend on that.

Slayton: This goes back to what I was trying talk about at first, which is as we get further and further away, as we make the machines more abstract away from us, part of that abstraction is giving away decision-making. Is giving away control.

Engelbart: It's like when you're driving a car, doesn't the same thing exist there? You push the accelerator and all sorts of things spring forth and get engaged.

Hechenberger: I guess you could also think of it as an abstraction that focuses you on the essence of a subject matter--a way to use you bandwidth more effectively.

Mays: You talk about the Dynamic Knowledge Repositories at each level. Do you want to speak about that?

EVERY VIABLE ORGANIZATIONAL UNIT REQUIRES BASIC KNOWLEDGE PROCESSES

External Environment

Ingesting
Interacting Scanning

• Analyzing
• Digesting
• Integrating
• Collaborating
• Developing
• Applying
• Re-using

CODIAK: The COncurrent Development, Integration, & Application of Knowledge
Figure 6   6•1

Englbart presentation resources:
http://www.bootstrap.org/augment/AUGMENT/132811.html

Engelbart: This slide is just to show a collection of individual parties tied together in one what I call a "social organism" that any small or large group can be representing. And you say, hey, these are all the

connections that may have to be working in there. And somehow it's going to generate a knowledge product, that's to build an airplane. But in the meantime you have a lot of dialogue among everybody exercising their professional capabilities. There's also a collection of stuff from the outside world and you have to be integrating that into what's the current state of our plans, our knowledge, our understanding. That looks pretty accurate. You have to have that Dynamic Knowledge Repository and that's the kind of thing for knowledge containers, what kind of practices for tying them all together, etcetera. It just was obvious that the hyperdocuments and the links between things are just a terribly important part of that. There's a lot more in my head about what these knowledge containers have to be like. But then here's the picture on a larger scale. If you continue evolving you realize there's a basic set of capabilities that have to be exercised, and that is this COncurrently Developing Integrating and Applying Knowledge because you're developing a lot in here and you've got to be integrating it. Things that are dynamically applicable. That's your operating knowledge base. So that's what goes on in your head if this is you, any team, or multiple parties having to collectively go after solving something complex. That's the picture. So that's what was driving me all these years: how do you boost the collective capability of people to cope with complex, urgent problems? So this is the terminology and pictorial aspect that I've been developing.

Slayton: Yeah, but large organizations are inherently disorganized. They often don't know what the ultimate purpose of their trajectory might be but it gets discovered nevertheless.

Engelbart: We're not talking about that. This is what's got to come because whatever is common thing among them all, whether it's scattered or not complete or whatever, it's how well that organization can do it.

Slayton: So would this apply to, for example, a political organization?

Engelbart: Any.

Slayton: Any organization.

Engelbart: That's the model that I've been using to proceed on and it would probably be a good thing for me to have intensive dialog with people about it, but so far everybody goes "oh, oh, oh, ok...." (laugher)

Slayton: Let me ask one other question and then I'm going to shut up.

Engelbart: OK, we've got a signature on that. (laughter)

Slayton: Let's say within the organization you're looking for something that's trying to find something but it doesn't know what it's looking for.

Engelbart : Right.

Slayton: That happens all the time.

Engelbart: To any organism.

Slayton: Yeah, so it has move in a purposefully way of looking for something it doesn't know what it is.

Engelbart : Well this is oriented like this to say, "what are we trying to improve?" The collective ability. And if you don't have that operative integrated knowledge you're not in very good shape. With most organizations it's sort of a wonder that they get things done.

Mays: That's what the human does, looks for things that they don't know what they're looking for.

Slayton: Not necessarily. That can be software, that can be part of the abstraction of the software that I'm talking about. That you rely on, you rely on the software to make those sorts of discoveries for you. So you're going to follow that, you believe in that.

Mei Lin Fung: I have to interject. I think the natural conclusion of what Joel is saying is actually a world like (the movie) The Matrix. If you actually say what matters is what actually happens and that humans are just part of the process of which it occurs, you get to the Matrix world (where humans are a means to an end) along that line of thinking. I think what Doug is talking about is a human-centric world, which prizes the things that are most human in us. His idea of Collective IQ is really mimicking what we are doing in our individual brains but beyond an individual brain. The computer allows us to link between knowledge in a way that allows the group of people to act as if they were in fact one person. We've never thought about it in that way but it really extends our brains so that we can collectively act. If

you think about a high-performance team, they are high-performance because they act as almost one organism. Each person acts as though they know what the others are doing. And the idea of the Dynamic Knowledge Repository is to provide information in a way that links the members of the team to have even greater capability and allow even more people to become high-performance teams without needing the long length of the acculturalization of getting used to working together as a team.

Slayton: So that model assumes a level of expertise at the outset. You can think of organizations that have to develop a level of expertise in order to operate in a high-performance mode. So how does that knowledge get created or gained?

Engelbart: So that's the challenge. I've painted the picture, it's your job to… (laughter). I've done the hard part.

Slayton: OK, I'm on it.

Engelbart: If you're going to have a social organism that you're really trying to get collectively smarter, that can handle more and more complex problems that are rapidly moving, etcetera, it just seemed to me you have to have something like this for a set of capabilities like that.   Then there are a lot more subordinate capabilities and knowledge containers and all of that, but I'm just saying that's one of the targets.   I think I started painting this picture 15 years ago or more.

Alison Mierzykowski: I know that Cisco was developing that and I was sitting in on the meetings of creating this structure and figuring out how to do this. The difficulty that we seemed to have was figuring out exactly how to take the knowledge and make it so each section of it would be compatible so it could move around and be applicable. Not putting too much in or too little.   But the real block was communicating with the culture of the people that were going to interact with the tool they were trying to develop.

Engelbart: No kidding, your cultures have to evolve to be a more coherent, integrated group of people. But over all these years I've become convinced that if we don't get better at it the human race is not going to be able to make it because everything is going to be more complicated and moving at a rapid pace and we're not doing very well at collectively coping. One thing that I was thinking about is what if all of a sudden the marketplaces just collapsed? So how are they going

to get back up? Who is going to say "I'll use my money." Your money isn't worth anything so don't fool us. What would happen? How many billions of people, billions, would die in the first two months? Because they don't get food delivered to them because no one can go pay anything to the farmer. No one can pay anything to the transport. Besides, at the store you don't have the money to pay for anything anyway. So that's just a picture of something that's possible, and if we don't get more on top of it could happen. But there's lots of them. A friend of mine said you can really show that petroleum products are going to run out in 30 years, maybe it's 22, 28 or something like that. It's going to run out. So then what? You look at all the SUVs and gas guzzlers and cars and say my God, what are we going to do? You don't hear anyone seriously dealing with that problem. This friend of mine said of all the ways we can get energy… wind energy is not possibly enough. Tidal energy is not possibly enough. Solar energy is not possibly enough. And so on. Fuel cells? Well the only way you can get the hydrogen to run them is by electrolysis that takes electrical energy. So you're not getting ahead. So what about nuclear energy? If we built one 13 billion dollar nuclear plant every month until 25 years from now we'd have enough so we could do without the oil. So it takes that long and that much will in order to find the only way in which you could substitute for the fossil fuels. And how soon are we going to get oriented to realize it enough to get past the politics? Oil companies don't want people to know this.

Anne-Marie Schleiner: Do you think that the current state of the Internet has increased the Collective IQ in the last 20 years or so?

Engelbart: I think so in little awkward ways. We can talk about that. Questions of what's in the knowledge containers and getting them organized have to be involved so that at any given time you're no more than a few days or weeks or less behind in integrating observational fact so that it gets brought in and integrated. That might require changes all throughout the picture. Boy I'm glad I'm going to retire pretty soon and you guys…. (laughter)

Hechenberger: So if we were to be in that kind of network, is it a hierarchical organization?

Engelbart: That's yet to be designed. What are the roles? What skills have to be involved? I have a fairly strong feeling that we have to develop high-performance augmented support teams, a team that can go in together and really churn up all that stuff and develop a knowledge product that's consistent. I think that would be a terrific

target for a University research group. Put together a high-performance team that can do heavy knowledge work. Like going through all the email lists, collections like that, and saying, "what does it add up to be?" Can you verify what your conclusions are by pointing back to particular entries etcetera that establish something?

Geri Wittig: One thing I'm wondering about is the problem Alison brought up about the culture of the different workgroups being disparate and then that causes problems in terms of creating the collective. But what about the fact that that diversity is also a positive, and that those types of antagonisms can enable innovation? Does that fit into the model?

Engelbart: Well, we have to be talking about quite a bit more mature social setup than we have now, and the understanding of that, how it works together.

Mays: One of the things that is really interesting to me is was the experimentation around social systems that you did at ARC. Specifically I believe there was the LINAC, FRAMAC and PODAC structure. That's a little jump back there.

Engelbart: It's no fair picking on me. (laughter)

Mays: I'm saying they're interesting because they were ways you were experimenting. The FRAMAC was for determining the goals, the LINAC was for determining how to get to those goals. PODAC was organizations of people. What was your inspiration there to experiment, just as you were saying, to come up with more advanced social structures? What was your inspiration for that line of thinking, that it needed to be done?

Engelbart: Damned if I know. (laughter) Year after year, if you're really thinking about this need you get to believing that the sooner the world wakes up and starts going after it… this may make the difference. So how we get it going, how do we get started?

Mays: Is that what you saw yourself doing at ARC with those structures?

Engelbart: Oh yeah, we though that could start building something like that and when we got thrown out of the research world that was a huge disappointment. And then in the industrial world we could never really quite get it off.

Mays: Again that transition into the industrial world.   This is an ironic ad I saw today.

Here you have a world famous cellist who has spent 30 years of his life learning how to play a complex instrument saying he wants his computer to be "easy to use." You were at SRI, that was a research group. A lot of that didn't translate once it went to PARC and became product development.

Engelbart: A lot of it didn't get to PARC because they had a very different mind set. They weren't interested in the "hyper."

Mays: So how do we get that back?   How do we get the research back?

Engelbart: Well that's one of your jobs. It's the paradigms again, how do you get people to think that there's some coherent pathway that they could follow? If someone is just pointing and grunting it doesn't sell very well.   So how do you get people talking about it and challenging their paradigms?   How much do you think the way we think can change productively?

Mays: Do you think that's possible in a free market?   With this emphasis on product development?

Engelbart: Well how did we ever develop a coherent vocabulary? That's an open-source evolution.   So we have to say that there are

many, many things that are just evolution. So I use the term "facilitated evolution" more and more to say that this is the only way that I can see that our society can do this kind of growing. It has to be an evolutionary process, and nobody is smart enough to tell you where you ought to be at any given time. So there's a whole frontier of all the different things. So how do you start charting out that frontier? People say I'm going to build this thing, I'm going to build it this way. If you use that kind of model I was talking about to build a DKR you find out all the different things people are trying and how are they working. So that you and your organization can pick who you work with, and they have to have ways to asses the Collective IQ of your organization. I just drool at the thought of that thing coming out, it would just be great.

Mays: So when you say that you mean developing a benchmarking for the acceleration, the growing of the Collective IQ, or what exactly?

Engelbart: What's the measure, relatively speaking, of how effective is your organization? It's like in the software engineering world there are these maturity levels that they talk about. So they have measures inside an organization that can give you rating. That's a serious thing. So it becomes very serious that there's got to be essential and effective measure relatively speaking of what your Collective IQ is. Because, boy, when it starts to get used more and more how many organizations are going to stand for it if they say, "we're only rated 80 and there are some people who are up to the 90s!" An organizationally relative IQ, see. So that people start saying, "I'm not so sure I want to work with this organization because it's not growing me." All sorts of dynamics start to happen.

Jennifer Henderson: I have a question about the slide before this one where it talks about COncurrently Developing Integrating and Applying Knowledge. I guess my questions is how, or by what criteria, did you decide that this model would address the problem statement that you had about more complex problems occurring with greater rapidity? How did you decide that that model would address those problems?

Engelbart: I don't know, you get to trying things and say that that's as good as I can do for a model of what I'm now thinking about. It's very handy at creating a lot more intensive dialogue with people to say OK, what are the weakness there, what are the real objectives in doing that?

Henderson: It seems to be in contrast to the FRAMAC that Matt was mentioning earlier, the FRAMAC had a certain set of goals. This is a tool that seems to be goal independent.

Engelbart: Not if you say that I'm trying to build the highest Collective IQ that that organization can practically get, because every opportunity that the outside world offers me, the smarter I am about rearranging resources so I can take advantage of it. Or with every threat that's out there, how quickly can I make some simple adjustments that will steer me by and safeguard…

Henderson: You're right, I didn't quite state that correctly. What I meant was that if I was the Mafia I would want to be a smarter organization, and if I was the Catholic Church, I'd want to be a smarter organization. And in so in the sense of goals, not as in Collective IQ goals, but in the sense of the values of the organization this seems to be a neutral model.   In other words if you were the Mafioso you could use it or if you were the Pope you could use it or if you were the director of…

Engelbart: Yes.

Slayton: What is your working definition of expertise? Because to me there's a big difference between having expertise and having knowledge.

Engelbart: Applicable knowledge basically.

Slayton: So it's the ability to apply the knowledge which seems to me…

Engelbart: That's right. (laughter)

Slayton: A minute ago it did strike me that you said it's the model that seems like the right model because in a way that was an exercise in expertise. What I mean is that it relies on a certain level of intuitive understanding of the problem.

Engelbart: This is just loaded with intuitive results and that's why I mentioned several times I really need to talk with many of these different topical categories and have serious dialogue with people. What if it were data, how would you break that down? Because there could very well be flaws that nobody has shaken me on yet. One of the reasons is no one talks about it much. All they say is, "why did

you say this?" "Why did you say that?" One of the things someone pointed out was that if B is something that improves the core activity A, and C activity improves B capability, what's going to improve C? You're going to need a D and an F and so on. I said "oh yeah, that's what I need, smart people like you." All the way down the line they are all things that are improving improvement capability. So I got around that real problem by just saying that the improvement infrastructure in society has many aspects to it but it's been a common element, one we have to pay special attention to because it's going to improve all kinds of things in our society.

Slayton: OK, so does C have intuitive knowledge of B, and does C have intuitive knowledge of A? Or is only a requirement that C have…

Engelbart: Objectively.

Slayton: … expertise?

Engelbart: I thought you were going to say objective knowledge rather than intuitive.

Slayton: The reason I use intuitive is that my sense of what that means is that you developed a level of expertise that you can recognize patterns in something. And that it is not a magical thing that happens, it's a product of having developed the expertise factor. But I wonder if your model is what I would call a flat hierarchy, where C only knows B, B only knows A.

Engelbart: It needs to know something about what's up above it. We did more abstraction from there that kind of makes it more practical thing. Many organizations are spending money on improving the A. So how do they know what can improve and how do they know about improving the capability of improving B? So that's the kind of thing that you depend on a consultant. Well where does the consultant get knowledge?   How much hands-on experience have they had in something that's really out-front new, and you'll find in the upper levels?   So you find that it really looks like there isn't enough conscious thought about that C activity, and it would be really handy if you could go into an organization and say what percentage of your gross budget is spent on A, B and C? It would be very interesting.

Mays: So to play history buff again. In looking back at your own experience at ARC, was there a C level organization in ARC and what was it?

Engelbart: Well everybody… it was distributed among people that all were saying, hey, we can change this, we can improve this.   And it just need an active eye.   Some people were a lot more effective at it than others.

Mays: Looking back, did NLS (oNLineSystem) act as the DKR, the Dynamic Knowledge Repository?

Engelbart: No, the NLS is a toolset we developed and used at ARC to get better at what we were doing. Our tools allowed us to evolve. That's when I experienced and became specifically interested in the connection between facilitating the co-evolution of the human and tool system.

[tape change]

Engelbart: …so facilitating the evolution in a big sense is like saying if society really invested in a collectively developing sea they'd collectively be building a knowledge repository about what that frontier is like. Who is discovering what about what? Who is moving into where? What are they using for techniques? What kind of traps have they found, etcetera, so that then every organization can look at that and can decide for itself. Because that's facilitating their evolution.

Mays: Would you say often an executive of a corporation operates on this level?

Engelbart: They might, but it takes…

Fung: There's a live example in front of us right now. Early a question was asked about the Internet and it how helped us improve the Collective IQ. The nature of warfare has changed now because of the Internet. The existence of Al-Qaeda as a guerilla organization was not possible before the Internet. Al-Qaeda is a C scout out there. The challenge to us as a society is whether or not we are going to use the tools that are available and our own smarts to change our paradigms to utilize what we potentially could do. Al-Qaeda has in the most unfortunate way has shown us that you can in fact use these tools in vastly different ways. It's like introducing tanks and the cavalry charging the tanks.

Slayton: I think what is interesting here is that as you start to consider a relationship with D, E, F, G, Z and so on the membrane, the border,

between the environment the organization sits in and the organization itself starts to dissolve.

Engelbart: I don't think we have to worry about that yet. The thing is that we move on here is that it shows a number of organizations. Suppose you've got this array of organizations and they each have got their A, B and Cs. And they all are interested in improving the same capability vector. Then if you join together and pool your resources at the C level, be pretty competitive, you could get much further ahead in seeing what that frontier is like and where you are going. That leads to the next slide. You put them all together and call it an improvement community. Many consortia are like that. So if we are worried about our organizations being able to evolve fast enough and effectively enough we ought to look at whether there is a known way to set up an improvement infrastructure. And can we improve that? Can the Collective IQ of that consortium be boosted it could do a much better job than that? So that is where you get the bootstrapping idea of saying of all the capabilities to work on in an organization it looks like a Collective IQ is a very important sort of thing because as much gain as you make in that, feed it back into this C community and run it that way. We started calling that bootstrapping a long time ago. You know the little story about lifting yourself up by the bootstraps? In electronics there is that thing called bootstrap circuitry. You take the output and feed it back into the input so the higher this went the higher that went etcetera. So that's what I carried over. I have to admit that when I was 14 I read about Paul Bunyan. As big as he was couldn't quite see over those trees. So he reached down to his bootstraps and lifted himself up and a 14 year old kid thought that was just great. Anyway, let's go to the next slide. That's like saying if you could get that equipped and active, in this kind of knowledge repository, with whatever it takes to make that effective, you can do bootstrapping. So you say that's a network community. We have been distinguishing for many years what an ordinary old improvement community is versus a networked one. It is very important to start organizing NICs (Networked Improvement Communities) and trying to get them started pulling themselves up by the bootstraps on this. What if we get a special NIC set up whose members are NICs? And what they are doing is collaborating in this mode on how to become a more effective NIC? That is what we just figure is a way to get lots of compounded value out of what to do and that is what we call a Bootstrap Alliance. Sort of set up as an organization waiting to be populated with NICs. We've had a number of things that almost got going as NICs and then they didn't quite… maybe they're waiting for you guys to get out there and spark up the world.

Slayton: How do you become an official NIC?

Engelbart: You talk to the Bootstrap Alliance to see if you qualify because the early NICs are probably going to be pretty shaky. One of the problems that we found is we find people who say, "oh, we already have two or three NICs". But these are probably just the like the C communities, the basic ones and they're not doing this yet. It's a hard time telling them that they are not a NIC yet.

Slayton: You just hurt me.

Mays: How does the C level have an exponential effect on the B and the A level? How much of that was influenced by the ideas of cybernetics and feedback?

Engelbart: During WWII I got drafted into the Navy and trained as an electronic technician. They taught you about a lot of different practical electronics, it was only later when I moved to theory and went to college. One of them was the bootstrap circuit, the way they got the radar beam to go very steadily across. They called that the bootstrap circuit. And I thought, "isn't that clever." So I remember that.

Henderson: Were you influenced much by Buckminster Fuller and his train of thought? You talked about the bootstrap circuit and how that influenced you…

Engelbart: No, I never quite could get him in phase with myself. The Navy owned a little village on an island on the Philippines and that was where they would bring people and you would live in there before you would be assigned to someplace else. So I was wandering around there and I found an interesting sign that said "library" out there in a stilted cabin. I climbed up and knocked. There was a neat little library and shelves and books, and I started reading during my time there. One interesting thing is that out of hundreds of hundreds of guys in that place no one else ever came in there. But I came across that Life Magazine article and it was talking about Bush and his Memex. I just was really thrilled by that but I had no way of knowing how soon or how much that affected me until years later. When I wrote my conceptual paper in 1962 I had to really admit he had really provided a lot of really good ideas.

Mays: Speaking of Bucky Fuller, through your career what was your interaction with art? Have you had any interaction with art or artists? What's your view of art?

Engelbart: My mother was a farm girl who just had an eye for it, she always liked to go to art exhibits and all but was way too poor to do anything about it. Then my wife, who unfortunately wasn't that poor, was really a fan too. She had an uncanny eye, etcetera. There was an art committee at Stanford for instance that every six or seven weeks would have a meeting. What I noticed pretty soon is that when they would be looking at different things in the exhibit and she'd make a quiet comment, at first if one of the big shots heard her they'd say "oh, no." But after a few months of that I began to notice that they really deferred her opinions though. I don't have the same perceptive sensitivity to it.

Mays: Did you ever have any artists-in-residence at ARC?

Slayton: Do you think that art could be a NIC?

Engelbart: No, it's just an individual organization.

Slayton: Based on the purpose of the organization and its expertise and knowledge would you think …

Engelbart: One thing it did do though …

Slayton: Are the arts excluded from NICs? That wouldn't be fair. (laughter)

Engelbart: About 1974 or something like that when we'd had four solid years of really improving we started to sell service over the ARPANET to people to get some real users and cultivate them. And that turned out to be an extremely important value in the evolution of that. Then a year so after that I wanted to get going, generating a term I called "knowledge workshop." If you've got one of your own you'd talk to the people, sort of the way you do your knowledge work collectively. So like in a tool workshop you need an architect that sort of knows which tools to put there, how many you need of this, how the material flow would flow there. Is that guy qualified to use that shaper or milling machine? So I said let's have a Knowledge Workshop Architect. Each one of the customer organizations generally had to be a government agency or had to be able to be on the government-run ARPANET. If they were going to buy service from us they had to assign

somebody to be the Knowledge Workshop Architect and fund them to come to meetings every three or four months. And that was pretty good. So then we sold them as the Knowledge Workshop Architect Community. What is the acronym for that? KWAC. Everybody said you can't do that. I said sure, people well accept that. And they said no, no, no and ridiculed it. So when they all got together one of the first things they did was elect one of them to be the coordinator of the group. And he promptly named himself the Knowledge Workshop Architect King." King KWAC. So that's how much it affected their reluctance to sign on. That just helped a lot. Having that kind of a group. And so we saw when we started to talk about NICs that we need to get together communities like that. Every participant organization, we said, needed to supply somebody like that… and not a programmer. We also said that they'd have to provide a full-time architect and another full-time party that would help to collect information. And a quarter-time person that we called the "executive liaison" because we found that it's very hard to get a clear picture to the executives in an organization why all this is good and what it would mean. So we wanted them to pick somebody that they felt could understand what we're doing and also would understand their world and could be the liaison. I think those are good ideas.

Mays: This sort of idea of a NIC does have a lineage in fact to your original role in the ARPANET. Basically from what I've read there was a discussion about needing a NIC without knowing what a NIC was. Did they know what they wanted or did you basically develop what a NIC was?

Engelbart: The NIC came along years after.

Mays: So it is just a coincidence that there was the same acronym for what you were actually doing at ARC? There was no correlation there?

Engelbart: We weren't calling them the same but there was a lot in common. The Knowledge Workshop Architect Community was a pretty good way to start getting cooperative incorporation of a collective.

Mays: When you first got on the ARPANET there wasn't the concept of a NIC, the actual acronym came …

Engelbart: …in the 80s. We were finally putting together the A, B and C communities and the NICs. The early 90s as a matter of fact.

Henderson: Given your interest in language and symbols that might supercede language some day, I wonder whether there are any graphic designers or people like Edward Tufte whose work you've looked at and thought that they might have to seeds of what might be the future. Language about language?

Engelbart: That would be interesting but I never have. I would really like to talk to some deep theoretical linguist who has thought about how our sensory perceptual machinery works and how much beyond the terms and words we are using now could that sensory perceptual thing cope with more complex stuff. One thing I think would be really fun is I'm going to take up the Artificial Intelligence guys that have been a plague in my life for all these years and say, "great, you bring me your sentence parser and I am going to have that parser running ahead of a person who is reading and parse the sentences and then give the different parts of speech a different color brightness or maybe actually a diagram." Just to see if you got used to it if it would speed up your comprehension of a successive chain of sentences. It could.

Slayton: This is similar to one of the claims that PARC made when they did the "future of reading" exhibition at The Tech Museum a few years ago. One of the exhibits that they had was a demonstration of reading that would display one word at a time to you very, very quickly. Through their research they claimed that they had made comprehension levels increase dramatically when the text was taken out of context in that way. What do you think about that?

Engelbart: I wish I would have known about that. Can somebody write down a note and give me…

Slayton: I'll give you the person that was working on that. I'm not sure if they're there anymore.

Engelbart: I can track him down.

Slayton: I use Herbert Simon's text in my class teaching art students about complexity and how to think about software and coding as an art medium. Making software as art. In his text he says this about in the context of talking about learning: "If achievements exceed aspirations satisfaction is recorded as positive, and if aspirations exceed achievements there is dissatisfaction."

Engelbart: I must be a very dissatisfied guy then. (laughter)

Slayton: I think his notion of a system that could produce a knowledge or expertise was really more based in a kind of complexity that resulted in it producing just a kind of satisfying answer, the most right answer, not the optimal right answer. Because producing the optimal right answer is so computationally intensive, you have to account for everything. Thinking about your model, would you think of yourself as an optimizer? Are you looking for the most correct solution in devising these sorts of models or are you looking for solutions that allow for organizations to improve in an improved way, but not an optimal improved way? These are two very different things and they require different sorts of strategies or structures.

Engelbart: I never thought about…and I don't know how to get started.

Fung: I would say that Doug is trying to describe a framework which would be the minimum set that was required to start the improvement process.   For example he says we can't design in fundamental structures which are proprietary in this augmentation system. So he's not going for the optimal. He is saying that even though what he's talking is complicated, it is the minimum that he knows for us to deal with this degree of complex/urgent problems. That the way computers work today don't facilitate, for example, disaster teams where people come together as teams of strangers trying to do complex coordinated things. The way we have designed computers don't support that. What Doug is saying is that in order to support that kind thing we have to think in this evolutionary framework kind of way because we can't design now with the way we work something that would allow ad-hoc teams of strangers to come together professionally.

Slayton: I guess the point I am trying to make is that in the design it becomes perhaps computationally more feasible to produce a non-optimizing system than an optimizing one. And it may be quicker to the realization of systems of improvement.

Engelbart: Well that's what cut-and-try evolution is. You want to get an improvement infrastructure that doesn't get locked into anything like that until it runs. There are a few more slides beyond that to get to the whole augmentation system. So if you start building on that you start seeing these capabilities in that infrastructure.   You talk to technology people that say, "it's the technologies that make it." But capabilities are a mixture of the tools plus language, methodology, custom procedures, organizational structure etcetera, etcetera.   So I decided to give the respective names of tool system and human

system to those two. It's the difference between augmentation and automation. Automation can come in and automate some capability procedure and would stay there and still do the same thing. The real impact comes in because then you start changing the procedures. The whole of office procedures is very different from when they used to talk about office automation, bringing word processing in and things like that. So I talk about co-evolution and look for examples of that. The biggest one I can think of was when the hunter-gatherers started to use agricultural equipment so they could settle down for their crop growth time. Pretty soon they decided that it was useful owning property and with that came inhabitants and with that came trade and then villages. Huge changes in the human system.

Mays: But there definitely seems to be an emphasis throughout on the training part of it.

Engelbart: Well, you have to evolve until it… yes. You are not much good to society until you learn how to talk, right? So yes, there's all of that in there. And then they provide skills, knowledge and the training for that. So all of it depends ultimately on these basic human capabilities. Sensory, perceptual, cognitive, mental, motor. I always winced when I heard people talk about computer human interface as an important thing. That's only going off to the tool system side and you've got to think about the human interface to all the rest of the stuff on the left side too. So really it's the whole augmentation system that the interface between the human and his augmentation system that needs thinking and care. You can almost take a given individual and say, "what are the primary capabilities for you to exercise your role in society and what are they dependent upon down there lower." Great, you do that and you say "let's go for a design team." Well it would end up having the same nature of a thing but more complicated because there are more people involved. And you start going on until you get to say, "what's a university?" Oh, it looks like that. So does a picture of a whole country. One of the very exciting things is in the last month we started to get involved a little bit with the World Bank's Knowledge for Development plan and we get to make a presentation about that. Oh boy! If we could get this evolutionary thing supported to make it start working right it would be great for a lot of developing countries. How can you make a NIC out of a bunch of countries?

Mays: What is an example of an organization like this? During your days in aerospace did you feel like you began to develop this sort of …

Engelbart: I hadn't even thought about it by then.

Mays: Do you have any examples of an organization that has implemented a C-level point in the capability infrastructure?

Engelbart: No, but that's kind of the thing. I don't have the energy to do that and try to get enough momentum going anyway. But if I found some people that were interested in that and understood the organization of capabilities for individuals and organizations that would be really fun to see how much more you could learn about that.

Mays: There seems to be a more recent emphasis on talks with governmental organizations. Since governments aren't obligated by this product development process you're seeing governments as important to this?

Engelbart: Oh yeah. Our American government has gotten pushes by the President and Congress about going into e-government. Make electronics pay off a lot more for helping agencies do their best for their customers, the American public. So we attended a workshop about that kind of thinking recently. So there are all kinds of levels of it.

Hechenberger: It seems like the way politics works involves a lot deception rather than clarification. So why would people in politics be interested in such a system that encourages the creation of knowledge?

Engelbart: You are right! They might not like that or what it leads to because it could be harder and harder to hide things like the corruption in the way money is handled in Washington. The technology is moving that way. Have you gotten anybody to tell you much about nanotechnology? Thinking about things on the nanometer. I have been involved with people… the scaling stuff I did in the 50s just really turned me on about that so in the 80s I met somebody who had coined that term and is very active in it. He was seriously talking about being able to build things by taking individual atoms and assembling them in an appropriate way. Like I mentioned before, when they're that small they are just tremendously fast and very rugged. They can sort of flow around in the air so they conjectured that you could have sensors that are floating around in the air with ultra-wideband broadcast output telling everything it sees. And you say, "oh that is interesting, is there nothing about you private life that you feel like could be private?" Is the public going to get together and outlaw that kind of stuff? They can but with outlaws it might be extremely hard to

control and find. So maybe everyone would have to accept that they are under constant surveillance. One subset of society that would really not like that would be the Mafia. But if that's the price for getting the Mafia disabled it maybe you'd think it could be worth it. And also a lot of corruption factors. Anyway, big changes... like manufactured food. They can make these little mechanisms smart and small enough so they can get into your blood stream and can get carried all around and then get out and go inspect local cells and all kinds of places. Detect cells that where injured and repair them so people would live indefinitely. That excites some people, see. What would it be like after you get to be more grown up than I am? I said to him that I'm getting kind of tired of this. Anyway, there are some very exciting possibilities and also quite scary things that could happen but one of them is that they could manufacture little factories that could take care of manufacturing almost anything we have. What would happen to our economy? That could really mess it up.

Jack Toolin: Stephan kind of touched on this and I have been thinking about that for a while. On one of your first slides you had the body of knowledge gathering and above it was a kind of cloud structure which was the external environment. What happens if that external environment is another ball or network of knowledge that's trying to get from you and you're trying to get from it so there's kind of a competition. That model kind of assumes that the external environment is disinterested and kind of ambiguous in a way as opposed to being another Dynamic Knowledge Repository that is in a sense kind of competing with you. That might be another model of it.

Engelbart: The smarter you are the better you are able to sense dangers, threats and devise a plan and adopt it. So yes, I'm assuming that there would be. But if we get smarter and smarter about how to run a society hopefully we can get dissent, wars and stuff out of there. But certainly with this nanotechnology coming along it just looks very much like we lose control of being able to limit technologies and such. We'll have all these little spies floating around or who knows what. Another one of these things they can build is very, very minute things that will be a factory that could make other minute things and turn them loose. And so what makes you think they are going to keep making the same kind of thing you designed in the first place? They'll evolve and start making all kinds of things, dangerous things, or making other factories and pretty soon you got a huge number of these things so that the air is thick with all these little creatures. As they get smarter and smarter I keep asking these nanotech people, "why would they want to keep humans around?"

Slayton: Wouldn't they argue that something like a programming language is analogous to that, in that you create a system for making other things and you turn it loose in the world and with the help of human involvement and human design it's used to produce an endless number of possible results? Some of which are not good and some of which are. Boy, that is a tough call. Who is in the position to make decisions of not allowing something to be because it had the potential of going awry?

Engelbart: Well there is very good chance that humans just would loose control of their environment.

Slayton: Then on the other hand somebody said in 1925 or so, "hey I've got this great idea called the Interstate Highway system and it's a great idea. Let's build it all over the US. We will be able to get from point to point, and we'll be able to move around quickly from city to city. It will change the transportation infrastructure of our country. We'll be stronger, better, more powerful, more efficient. Let's do it." But nobody really took into consideration that it was going to carve the country up into zones of economic haves and have nots. That it would end up creating interchanges of novelty and homogeneity at the cost that the country would spread across the world. When do we stop and think about what we're doing?

Hechenberger: How can you think about it. It is computationally irreducible. It has to be executed to be able to know how it is going to turn out.

Fung: Which is actually what Doug is talking about with co-evolution. We as human beings have to understand that we have a problem we have to face and we have to figure out how to work differently to cope with these kinds of challenges. In the previous slide he separates the tool system and the human system. We have not consciously acted on the human system. What Doug is saying is that we have to think about governance and ethics and all the kinds of implications of rapid change. The accounting scandal is just one of them which we we're working through and Doug has spent over fifty years on this quest to say "wake up guys!" We are creating things but we also have to be intelligent and smart to think about how we cope with what we've created. It's not easy and we won't work it out the first time but we will co-evolve. Things will happen. We respond and so on.

Henderson: I think raising the Collective IQ is one way to address all that. I am in school so I am trying to raise my Collective IQ so I subscribe to this myth whole-heartedly. But at the same time I am not necessarily certain that raising the Collective IQ will actually help us make decisions any differently than we have for the past fifty years. There is some evidence to that on both sides …

Engelbart: Then the measure would be that you have not raised your Collective IQ. That's basically how you measure it. How quickly and effectively can you understand what is going on, marshal all your resources, make a plan, do it.

Henderson: But I would suggest that just because you understand what is going on it does not necessarily mean you can change your decisions.

Steve Durie: And your reaction.

Henderson: And maybe part of what you are getting at is something that Brenda Laurel suggests. That is we need to develop more models of predicting how our behavior, like spreading an Interstate across the country, will affect more parameters than just mileage or goods flow through the country.

Slayton: I think it's a very, very difficult thing. What we are talking about are systems that are at a complexity level in which there are tendencies to adapt themselves often without human intervention or design. We are talking about things like the economy and in the end, nobody knows how it works. It is not that the knowledge is invested in the expertise of an individual or even a small group. It is dispersed and consequently the adaptation can move in directions that aren't controlled. It's only in retrospect that we look back and say we could have just done that or if we have just thought about this we could have avoided that circumstance. Trying to devise a way to intervene or insert oneself in that process seems to me just incredibly difficult. I'm with you but it seems just incredible difficult.

Fung: You could just stop there, it might be impossible but I would also say that the main framers of the US constitution were in fact C-level thinkers and the framework that they put in place enabled the growth of the economy over the last 200 years.

Slayton: But they certainly couldn't have foreseen the manifestation of that economy in advance. They might have been able to devise a rule system for making rules…

Fung: They devised a checks and balances system which allowed adaptation as things changed.

Slayton: … a mechanism for creating rules for making rules about rules about rules to control things. That's ingenious. I think it's ingenious, but knowing what it's going to do is a whole other story.

Engelbart: Where would you guys like to take it?

Slayton: I think artists have a tremendous amount to contribute to the study, research and thinking about the thinking about these problems that goes well beyond the notion of the artist as a person that is expressing just observations about the world. They actually can also reposition themselves in this new cultural landscape in such a way as to be players.

Engelbart: What do people sense would happened to the world of art if this stuff starts to move?

Slayton: I think it is art.

Engelbart: What's going to happen to the world of art? This part of the world. The knowledge part. What would happen?

Schleiner: I think there has been a change in the way artists are working now related to the growth of the Internet. More in collaborative groups. A lot more social interaction. Not so much alone in the studio. And more like they way musicians work. People working at home more and the Internet connects them so they can create work on the computer at home. Electronic musicians also work that way. I think there are some important changes that are happening. Also the ability to have dialogs with people who live in completely different places. Things evolve out of that communication between artists. So art communities aren't restricted to one local area. They are spread out over the Internet.

Engelbart: The artists that you're talking about are full-time artists? Part-time artists?

Schleiner: It depends. It's always a challenge for artists how to survive. Yes, some of them are full-time and maybe there is better funding for the arts in Europe than there is here.

Kristin Cully: What's the importance of that distinction?

Engelbart: If they're full-time artists they hardly have enough time to be involved in this.

Slayton: Their studio might be this. Working in a group, working in an organizational structure in which they are a member and contributor in which they de-emphasize their personal autonomy and begin to work in a collective towards goals that are outside of themselves. It puts moves them out of the traditional notion of being in a room thinking about themselves to being in a room and thinking about others.

Engelbart: Could you think of having 150 people closely collaborating around the world and produce an object of art?

Slayton: It happens.

Fung: I would postulate that art is a knowledge product that when you have something like "A Day in the Life of Africa or Australia" and photographers say, wow, that is a collective knowledge product which you gives new knowledge about place you could not get knowledge about.

Slayton: I think the most important change has been in the notion of authorship. There has been a major shift, not because of the Internet, but over the past 30-40 years as authorship has shifted away from the autonomy of the individual to the authorship of the organization and the collective and distributed knowledge. I would say that in many senses runs parallel to this line of reasoning and thinking and is the reason we invited you here and why we are interested in your ideas.

Engelbart: I would be interested if people could get a picture of what the world of art would be like in 50 years when this stuff has started to affect the way the world works. What would be new and different about the world of art? Does media change if any? From painting to sculpture? Have you considered poetry art?

Slayton: Sure, but it's the ideas that art is about. In the same way you could ask the question, "what would science be in 50 years or 20 years?" What will it look like. A similar answer is forthcoming, which

is: it will be what it is about. It will be about the ideas it will invest itself in, and the ideas that art is investing itself in are, I think, reflected by these notions about information, organization, communications, networks...

Engelbart: Is the concept of aesthetics just central to art?

Slayton: No.

Engelbart: OK.

Slayton: I mean is it important to art? Certainly. Is it central to art? No. They can argue with me. That's OK. (laughter) I think I'm beginning to cross a boundary point of expertise.

Durie: Maybe it is changing the definition what aesthetics means to artists. What they value in terms of aesthetics. Is it formal things about objects or is it elegance of concepts or being able to illustrate relationships that weren't apparent before? Those can be brought forth and aesthetics used as criteria when looking at those things.

Hechenberger: Knowledge organization can be the aesthetics. It does not have to be visual.

Durie: No more than sound is visual or music is.

Slayton: Which implies that art may not have to have content in order to be art. It may just be the knowledge organization for the production of the content.

Mays: The idea is the machine that makes the art.

Slayton: It's pretty rich, huh? (laughter)

Engelbart: Well why don't we switch and you guys are start to tell me how the arts are going to change.

Henderson: One of the things that is changing and will continue to change is the distribution channel for art no matter what media you work in. The best way to get it out, not in a gallery or a museum, is over the web. So that allows you to take art from the traditional public spaces to Internet spaces if you work in sculpture or if you work in digital media, either way.

Engelbart: I am just trying to think of some art media that would work that way.

Henderson: Well you could take Roding's sculpture, like "The Burghers of Calais." You could take a picture of that and you put on the Internet and it's there now. And you can go and look at that instead of traipsing over to the Stanford campus next to the museum there and checking it out live. Makes it more accessible is another way to put that.

Slayton: There really needs to be a distinction between the distribution of traditional forms or a traditional artifacts that exist exclusive to the network and artwork that is inherently based in the media of the network itself. Stuff that you could only do through it or with it. The same would be true with software and computers and so on and so forth.

Engelbart: Think of merging …

Slayton: Do you know that a lot of people think of you as an artist? Has this crossed your mind? People do think of you as an artist.

(Engelbart assumes boxing stance. Laughter.)

Slayton: That is a good thing.

Engelbart: My mother my sister and my wife, all of them are dead now, would probably cheer that.

Slayton: And that's a good place to stop. Thank you so much for coming. This is where Kana comes forward and starts playing piano for us.

[Transcription Editor: Matt Mays, Stephan Hechenberger]