APR 7 1975

<FEIGENBAUM>LICK.;1 WED 2-APR-75 12:44PM

Ed,
Here's my copy. -- Les

↑02-APR-75 0534 network site ISI
Date: 2 APR 1975 0534-PDT
From: LICKLIDER at USC-ISI
Subject: Retransmission of 'Easter Message' Earlier Sent to 'Ernest'
To: LES at SU-AI
cc: Licklider

The purpose of this Easter note is to bring you up to date on a development in ARPA that concerns me greatly -- and will, I think, also concern you. It is the continued and accelerating (as I perceive it) tendency, on the part of the ARPA front office, to devalue basic research and the effort to build up an advanced science/technology base in favor of applied research and development aimed at directly solving on an ad hoc basis some of the pressing problems of the DoD. Let me be clear that I am strongly in favor of ARPA's contributing maximally to the solution of pressing DoD problems. What concerns me is that, whereas I see the main hope in the creation of new methods and far-advanced systems based on new methods, the prevailing direction in ARPA is to do research within the specific contexts of military problems -- and not to do research that does not have a military 'buyer' ready to take it over as soon as the concept gets well formulated.

The present indications of this direct-application-oriented trend are strong pressures form the new Director, George Heilmeier, that IPTO 'redirect' the university AI efforts to work on problems (vehicles) that have real DoD validity, criticisms of the Speech Understanding and Image Understanding programs for not being tied directly into application projects that will be taken over and supported by the Services, strong emphasis on Software Technology efforts that will have effects in the short term (with strong pressure to de-emphasize longer-term research such as that on fully automatic programming), and, in general, a tendency to evaluate IPTO programs by asking people in the DoD offices (which would use or preside over the use of eventual applications of our stuff) what they think of the programs.

In the case of AI (or Intelligent Systems, IS, as the sub-element of the IPTO program is called in local paperwork -- IS now includes three sub-subelements: AI, Knowledge-Based Computer System Applications, and Intelligent Terminals), the situation is complicated by the fact that ARPA has been supporting basic research at a rather high level for more than ten years (has spent more than $50 million on it), and it is natural for a new director, or even an old one, to ask, 'What have we gotten out of it in terms of improvements in national defense?'. [Supermodern punctuation convention right there!] Unfortunately, most people who are asked that question answer 'I don't know' or even 'nothing'. IPTO tries to establish that pushdown lists, interactive debugging in source language, and even a big part of time sharing came out of AI and that AI systems such as Dendral, Mycin, and Macsyma actually do have expert-human-level capabilities or (in some areas) better, but there is in fact a big gulf between the perceptual sets of AI buffs and DoD administrators, and the latter really mean, when they ask about the payoff, where are

the intelligent weapon systems? They would understand intelligent support systems, but weapon systems dominate support systems in the prevailing psychological space, and even the Secretary of Defense has to work at it to get his people to realize that more is spent on operations and maintenance than on personnel and more on personnel than on procurement. In any event, this perceived lack of specific payoff from $50 million is a major source of dissonance.

Needless to say, we have all been working hard to accomplish two things:

1. To educate the new Director into a stronger appreciation of truly advanced technology and into a realization that the future is not to be won by making a lot of minor technological advances and moving them immediately into the Services. We point to time sharing and interactive computing, systems like DENDRAL and MACSYMA, languages like LISP, the ARPANET, highly realistic graphics with brightness gradations, color, and kinematics, and other such exemplars of real advances that have already been made and have had major effects. We point to the big advances that are now in the offing -- about which more later.

2. To improve the connections between IPTO programs and the DoD offices that ought to know about them, appreciate them, say good things about them, and be ready to take over and apply their applicable outputs. There is no doubt that IPTO is (and always has been) weak in respect of that kind of connection with the Department of which it is a part. During the time he was in DDR&E, George Heilmeier evidently heard a lot of criticism of ARPA, and of IPTO in particular, from the various DoD offices, and now he is determined to do something about it. The fact is, we in IPTO were working very hard to do something about it, but now we are under strong Directoral pressure to accelerate the movement.

Many of my remarks at the recent PI Conference were related to what I am telling you now, but I mean what I say here to be a stronger statement of the problem and an assertion that the problem is deeper than I then realized.

During the time since George Heilmeier arrived, we have taken advantage of every opportunity to brief him and discuss programs with him. He has given us a lot of time and participated actively in the discussions. He is bright and energetic; there is no problem about getting his attention. The problem is that the frame of reference with which he enters the discussions is basically quite different from the frames of reference that are natural, comfortable, and familiar to most of us in IPTO -- and, I think, to most of you. In my frame -- or in our frames -- it is a fundamental axiom that computers and communications are crucially important, that getting computers to understand natural language and to respond to speech will have profound consequences for the military, that the ARPANET and satellite packet communications and ground and air radio networks are major steps forward into a new era of command and control, that AI techniques will make it possible to interpret satellite photographs automatically, and

that 10↑10-bit nanosec memories and 10↑12-bit microsecond memories and 10↑15-bit millisecond memories are more desirable than gold. In George's frame, and to a greater or lesser (I think the latter) extent also in Alex Tachmindji's frame, none of those things is axiomatic -- and the basic question is, who in DoD needs it and is willing to put up some money on it now? We are trying hard to decrease the dissonance between the frames, but we are not making good progress. As one of my colleagues put it Friday, 'I think we are slowly holding our own with George'.

A little over a week ago, we had our 'Apportionment Review' in which adjustments to FY 76 funding levels were discussed. We have not heard yet exactly what the front office's conclusions were or will be (though we have been interactiong on the question); we expect to have a written statement on Tuesday, along with the other ARPA offices. My expectation is that there will be major deferrals in all our basic research programs. But we shall know more definitely very soon, so I'll not speculate further on that subject. The important thing will be not so much the size of the deferrals as whether they are defined as hedges against Congressional fund cutting (Such deferrals are necessary because we do not yet know what the action of the Congressional committees will be,) or as diversions of funds from basic research (or even exploratory development projects that do not have definite technology-transfer routes established) into definite applications.

As I mentioned at the PI Conference, the concept of 'silver Bullets' is important in ARPA, in George Heilmeier's view of what ARPA should accomplish. One of his main silver-bullet areas is underwater sound and sonar, and IPTO is in the process of 'buying in' on the HASP Project (Ed Feigenbaum's AI approach). Another is maintenance of vehicles with the aid of sensors and indicators that predict needs for maintenance, and we are trying to establish the fact that computers necessarily must play a central role in maintenance diagnosis and prognosis. A third silver-bullet area is Software Technology -- an all-out effort to solve DoD's software problem(s). (This is an IPTO area, and we are working hard to formulate it. George wants to get the Services and the software houses into the effort, as do I, since I have embraced the basic goal of this and see the Services and the companies that do DoD's software work as essentially the targets (and we need to have the targets working with and for us). An issue in ST is the degree to which AP can be kept in the program as the main hope of achieving a really fundamental solution. An important staffer on an important Congressional Committee seems (still) to be set against AP and even against ST, and all the other powers that be seem to be constitutionally against anything that won't get finished while they are still in their present jobs.

At present, George's list of important things IPTO can do for DoD is:

Get computers to read Morse Code in the presence of other code and noise.

Get computers to identify/detect key words in a stream of speech.

Develop speech-understanding systems (if there really is a clear use for them in the military). [This is a major come-about during the last few days. Earlier, he was very cool toward SUS.]

Solve DoD's 'Software Problem',

Make a real contribution to Command and Control. [George is not fully convinced about packet communications, yet, but he thinks we may have something in there somewhere.]

Help the Tactical Technology Office do a good thing in sonar.

[end of list]

Sadly, that list does not include some of the main items that are on mine. It is too late on Easter evening to give my full list, but here is one item from each of our seven programs:

Intelligent Systems

Develop a system that will guide not-sufficiently-trained maintenance men through the maintenance of complex equipment.

Advanced Memory Technology

Learn how to handle very large, distributed, redundant databases.

Image Understanding

Develop automatic photointerpretation.

Climate Dynamics

Develop the basis in modeling and array computing for evaluation of effects of major human projects/activities on climate. [As you know, ARPA is transferring this one to NSF -- but what I listed is more or less accomplished.]

Software Technology

Take the excessive cost, delay, and error out of software development and maintenance.

Speech Processing

Make it possible for people to communicate with computers in natural, continuous speech. ? artificial ?

[Let me list a second item here.]

Achieve good-quality, natural, recognizable speech with 500 to 3000 bits per second (through compression) so it can be made secure for DoD communication -- and also master the handling of

speech in packet communication networks.

Integrated C?3 Systems

Provide an integrated, coherent, secure, effective computer-communication base of Command and Control -- i.e., an ARPANET-like system with additional media (satellites, ground radio, aircraft radio), security, message services, database services, and so on, with the emphasis on integration/coherence.

[end of list]

What are we going to do about all this? Here in IPTO we are going to continue our interaction with George and get off to a strong start with the new Deputy Director who will be coming on board in a couple of weeks. We are going to try to sell them our view of the world, but we are going to be moving closer to their view, surely, in the process. We will be pressing on you in ways not natural to my philosophy -- not to get you to do research you do not want to do or to make compromises you do not want to make, but to get you to see the picture clearly as it is seen from here so you can make wise and correct decisions. And we will be asking you, as soon as we can arrange it, to come in and meet and try to influence the new Director and Deputy Director. Meanwhile, we are open to advice and counsel -- indeed, need it and will appreciate it greatly.

On the positive side, let me say that a lot of the offices in DoD and elswhere in the government have by now heard of IPTO and are impppressed with the technology the IPTO Community has created. There is some real support out there in the technical offices of DoD. Also on the positive side, let me say that the IPTO Program Managers have been doing a marvelous job. Their performance on the second day of the Apportionment Review was superb, and George Heilmeier realized he had really been in a session (and he acknowledged it).

On the negative side, the fact is that we are not making as much progress as I think necessary, and the timing in relation to my own plans is very poor. As most of you know, I have been thinking in terms of going back to MIT in September, and, unless, I can get a strong candidate-successor before the new Director, I am afraid he might take the occasion of my leaving to put a strongly applications-oriented person into the job.

My reporting on the problem at this time is not intended to sound a general quarters alarm; it is to make sure that you are aware that a serious problem exists in ARPA-IPTO and demands profound consideration by all of you. Please share this information with those in your organizations who should ponder the matter and will respect its sensitivity, and please call me to discuss any or all aspects of it. I'll keep you informed as the situation develops.

[Time Lapse. Now it is Tuesday Morning.]

Yesterday afternoon, Dave Russell and I spent another hour and a half with Heilmeier and Tachmindji. As a result, my perception

of the situation is a bit more definite. I'll add a few paragraphs to Sunday's message (which I decided to hold until after the Monday meeting) and send it off to you.

The 'directoral guidance' re Intelligent Systems is now quite specific in these respects: ARPA does not want to continue to fund the field in an open-ended stream-of-research way; it wants to redirect most of the AI research it is funding in such a way as to test or measure the present capability of the field to serve real DoD application needs, and it would like to see the support of basic research in AI either taken over by an agency such as NSF or, at least, shared more equitably than it is now. The transition will be handled insofar as possible to avoid damage to the field, but the transition will be made. In some instances, contracts in the IS area, or largely in the IS area, will be extended on a short-term (e.g., 6 mo.) basis while redirection takes place.
Dave and I are directed to discuss with other agencies the assumption, on their part, of a larger share of the over-all support of the field. For the time being, the over-all IPTO IS budget is not to be reduced, but it is necessary that the same funding level now cover some application efforts. Definite allocations of funds within the IS budget have not been directed, but it is clear that George is determined to bring about the shift to application and will direct definite allocations if he is not satisfied with IPTO's progress in effecting the desired change in direction.

The Intelligent Terminals sub-area of IS, which is a new sub-area, planned to be funded in FY 76, is not touched by the direction just mentioned, and its funds are not part of the basic-plus-applied total that is supposed to be the same in FY 76 as in FY 75. The IT program has been planned in such a way that its application and technology-transfer aspects are clear and definite, so it does not come under the pressure to shift from basic to applied.

In Image Understanding, the direction is less definite, but the pressure is strong to achieve actual applications of results in image coding, image enhancement, and image restoration, and the sense is that IPTO will have to determine and make the case for the plausibility of a program in image interpretation (alias, extraction of information from images, alias 'image understanding' in analogy with 'speech understanding') before actually setting out on an Image Understanding program. Again, the cost of application and technology-transfer work will have to come out of a total budget that is not greater than last year's.

The third basic-research area (the third of the three IPTO Computer and Communication Sciences subelements) is Advanced Memory Technology. It is almost wholly new in FY 76 and so does not come under the same kind of redirectional pressure as IS and IU. The Very Large Database Systems part of AMT is set up with strong attention to application and technology transfer. The Advanced Memory Concepts part has been planned as a quite-far-out program and therefore will have philosophical problems that may translate themselves into funding problems, but it is too early to tell just what will happen. The AMC Program Planning Committee (Berlekamp Commitee) is going to brief Heilmeier and others on (tentatively) April 17, and the situation will begin to clarify itself then.

Finally (in this report of what I learned yesterday and how it shaped my perception of what is going on), the feedback from our Apportionment Review is going to slip a bit, and I will not know today (as I think I indicated I would) exactly what the 'reapportionment guidance' is.

From what I have said, you can see clearly, I think, that we are at a watershed in the history of ARPA-IPTO. Although the redirection is not wholly, or even to any large extent, in accord with my own philosophy of research support, it will at least remove or reduce the dissonance that has long characterized the relation of the IPTO program to the DoD organizations that are supposed to use the results of IPTO-supported R&D. At the same time, it will introduce dissonance into the relation between IPTO and its basic-research contractors. I am deeply concerned about my own role in the redirection -- whether to fight it, try to contain it, or join it wholeheartedly and try to steer it in such a way as to wind up with a larger, stronger, more productive enterprise. I have been about half way between the first two alternatives, but neither the half-way-between point nor either of the first two is really a workable position within ARPA. It has to be either leave and fight or stay and join -- and it is clear that to adopt the former course precipitously would have a very bad effect on the program. And it is such an important -- in many ways, absolutely crucial -- program!

One of the next steps is to get the IS PIs to come here to talk with George Heilmeier and Don Looft (who is the new Deputy Director, just now coming on board). I'll be contacting some of you about that in the near future.

Meanwhile, please let me hear from you. I need your counsel and help.

[Another time lapse. Now it is Wednesday morning.]

Let me end this message with a proposal: what the response of IPTO and the contractor community should be to the situation I have described. I am sure the situation is real. I am not just in a temporarily gloomy state. I have smoothed quite a bit, held back on composing such a piece as this for some time, not wanting to be an alarmist. Indeed, I would much rather talk with each of you personally about the situation -- face to face or on the phone, so I could react to your individual responses in real time. (I realize that the written word is no proper medium for this kind of communication, but there is not time for so many individual interactions, and I think I should get on with this.) Here is the proposal to which I invite your reaction:

IPTO should proceed promptly but deliberatlyy to construct a new modus operandi that will provide a new basis for very significant advances in computer and communications sciences, together with their application to improve U.S. defense, during the next ten years. The new game will wholeheartedly embrace the goal of bringing about applications of new technology. It will continue the present devotion to major scientific and technological advances (and not devote much time or money to merely incremental improvements), but it

will devote a much larger fraction of its resources to moving the advances into use. It will not, over a long period, be a zero-sum game. (For a time, until it proves itself, it will have to operate with a level or declining budget.) It will take advantage of every demonstrated success to increase both the basic research and the application budgets. But most of the growth will be in the area of present lack, in computer and communication engineering and applications, and there will be a significant shift in the center of gravity of the contractor community. The shift will give the university research groups an engineering arm , a marketplace, customers, users. Several 'industrial' contractors and several Service laboratories will be brought into the community, and maybe one or two more of the FCRCs. (The Lincoln Laboratory is the only 'Federally Controlled Research Center' in the IPTO contractor community in a major way.) Interaction between the university research groups and the engineering and application parts of the community will be real and strong. The university people will learn more about possible DoD applications, and there will be less basis for the belief (which exists in some quarters) that there is an active shunning of research vehicles that might appear to be related to DoD applications. The interaction will strengthen the basic work because there will be more feeback from real tests of the new ideas and because every star needs an audience and performs best before a big and enthusiastic one. Moreover, ideas will really start to move into use. The presently vast gulf between how software is created in some of the IPTO-sponsored laboratories and how it is created in the shops that produce DoD's software will narrow. It will take three years instead of thirty for spaghetti stacks to get from LISP to COBOL.

In short, IPTO should correct the present imbalance, should build up an engineering and applications wing to make the contractor community strong and capable of meeting the challenges that are not now being met well. This will remove the dissonance that is causing the present trouble and will turn grumbling into appreciation. In the process, it will do a very good thing for the basic science, which cannot really get along playing so much to itself as it now (allegedly and probably actually) is.

That is just a rough first cut and deals with objectives more than with how to achieve them, but it seems best to propose something for discussion rather than just to ask you to ponder the situation. Please let me have your reactions soon.

Regards

Lick
