Introduction and the PACS '82 Panel Discussions

André J. Duerinckx

INTRODUCTION

DURING THE PACS '82 Conference, two very interesting panel discussions took place. The topic of the first panel discussion was "Equipment Manufacturers' View on PACS." This discussion was held Tuesday, January 19, 1982, at 3:00 p.m., right after the key technical sessions on Architectures for PACS (Session 4) and Prototype PAC Systems (Session 6). The panel members were representatives of medical imaging equipment manufacturers. About 220 people listened and participated in this first panel discussion.

The topic of the second panel discussion was "The Medical Community's View of PACS." The panel members were all M.D.s, mostly practicing radiologists. This panel discussion was the conclusion of the 4-day PACS '82 conference, and took place on Thursday, January 21, 1982, at 3:30 p.m. About 90 people participated in this panel discussion.

Both panel discussions were recorded on tape by SPIE. A first transcript of these tapes was made by Sam Dwyer; Andre Duerinckx did the final editing.

We have limited the text editing so that readers will feel as if they were hearing a real animated conversation. Some parts of the text may sound unusual, grammar-wise, but I believe this will add to the value of these transcripts.

Statements found within parentheses, such as (laughter), (applause), (any other comments), have been added to reflect the audience reaction, or as an editorial comment.

We also provide a list (names & addresses) of all persons sitting on the panel and members of

the audience who stood up to make a statement or comment.

The Editor

André J. Duerinckx

PACS '82 Chairman

PANEL DISCUSSION I: EQUIPMENT MANUFACTURERS' VIEW ON PACS

Moderator

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Panelists

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From the Philips Ultrasound Inc., Santa Ana, CA [See current address on new Introduction.]

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André Duerinckx, PACS '82 Chairman

I encourage everyone to really participate. The panel members will make short statements and then we would like to get some lively discussion.

Bob Wake, Technicare

Thank you André. My name is Bob Wake from Technicare. I am the moderator for this section. I would like to congratulate André Duerinckx on how well structured the program has been. As André said, this session is being recorded, so you have to use the microphone to get on tape.

I will introduce the panel members. Paul Amazeen sitting next to me from Sound Imaging, Jim Dunn from Dunn Instruments, Joe Marion from General Electric, Carla Marceau from NCR, Frits Arink from Philips (The Netherlands), Paul Scheibe from ADAC and Bill Pratt from Vicom.

The format of this discussion is that each of the panel members will take four minutes, maximum, to state their key concerns regarding the future of PAC systems.

To lead off I have some brief introductory remarks that I hope will somewhat set the tone for this panel discussion. The Health Care Industry has often been described as the world's largest cottage industry. There are thousands of small companies, each with a tiny share of the market. I think it is significant that the largest health care supplier in the world has a grand total of three percent of the market. And our diagnostic imaging segment is really represen-

tative of this trend. No single company has much more than about 10% of the market share. So like almost every story, there is good news and there is bad news. The good news is that this market behaves kind of like an economist's traditional free market. No single supplier or buyer dominates it and the competition spurs the technology. The bad news is that there is no leadership in this market. No manufacturer, or no single user, really can act as a leader and establish product characteristics, price, whatever—at least not in the same fashion it is claimed that IBM does. So given that, what is really the purpose of this panel discussion?

Well, I think *first*, as everybody has seen, the subject of picture archiving and communication systems (PACS) has a lot of dimensions to it. There are technical, economic, regulatory, and in a sense even social dimensions. I hope this panel will serve to increase your awareness of the many aspects. The *second* is while the members of this panel are competitors, there is also a good history of manufacturers cooperating for the betterment of a market. Organizations such as NEMA (National Electrical Manufacturers Association) interacting with users have written quite a few standards in the area of imaging devices. And I think *last* and probably most importantly this is an opportunity for all of us, the panel and the audience, to learn each other's views and concerns toward PACS. The problems of PACS are many, complex, and are not going to be solved by one man or one organization operating in a vacuum. I think this form of interchange is probably the most essential step toward insuring the future success.

At this point I would like to introduce Paul Amazeen to discuss his one or two key concerns regarding the implementation of PACS.

PART 1: OPENING STATEMENTS BY PANEL MEMBERS

Paul Amazeen, Sound Imaging, Inc.

Thanks very much Bob. I am, without a question, the representative of the newest entity as far as manufacturing goes. In fact so new that we don't manufacture anything yet; that is about as new as you can get I guess. The name

of the endeavor is Sound Imaging in Sacramento, California, and we definitely are involved in some research and development work in diagnostic ultrasound. I have been involved with diagnostic ultrasound personally for some time, recently, as many of you here know, with General Electric for some period of time and prior to that with Rohe Scientific which was the predecessor to the present Philips Ultrasound, or at least a good part of it.

My key concern regarding the implementation of PACS is one that is probably very understandable with a new potential manufacturer of one of these imaging modalities: as we look at this kind of distribution network concept (i.e., a PACS) we become front ends. Manufacturers like myself and the others become the front end input to a PAC system and certainly in the past a couple of things have happened. The manufacturers, when producing instrumentation that was competitive, tried to find ways in which their particular product could easily be discriminated against some other manufacturer's product competing for the same market. Certainly that is still the case today. We all wish to bring something unique and in doing so we can make it very difficult to establish certain kinds of standards. However, I think we have an unusual opportunity here in the sense that if we look at what the manufacturers of CT, x-ray, ultrasound, etc. are doing, we see that they are building front end systems to at least the archiving aspect of things. I am particularly interested in knowing where things may go because we (at Sound Imaging) have everything on paper and it is easy to get out the eraser and erase things. That isn't so easy for somebody who has been long established and has certain approaches to their instrumentation design and certain ways in which they feel their products can be differentiated in the marketplace. So perhaps I have two key concerns, certainly with ultrasound. One is we are dealing with real time data, more and more. That is, the instrumentation that is coming out is addressing itself to the value of real time data. That means that the amount of data to be stored is very large, very significant. And secondly, how do we work together in order to set up standards so that our output part, the rear end part of our instruments, can in fact have certain common

characteristics so that PACS standards are possible. It can mean that medical imaging in general will benefit, the end user will benefit. Certainly that is our desire. We don't have any market unless there are people who buy our equipment. We want to make our equipment useful, so I think the setting of standards is going to be very significant, Thank you.

Bob Wake

The next speaker is Jim Dunn. We have so far throughout this meeting been fairly successful in describing for Jim a going-out-of-business situation, being that Jim is in the film imaging business. I expect Jim has some distinct concerns regarding the development of PACS.

Jim Dunn, Dunn Instruments

Yes, I have an announcement to make (laughter). Effective immediately Kodak has become a large bowling alley, DuPont is closing and we have closed our factory down for good. No, seriously, the main concern I have is that there will be a continued lack of consciousness on the part of image equipment manufacturers, the front end or image processing people, towards the role that hard copy does play. There has been conversation in the last day and a half of its demise and I propose that its use will become more selective and will change, but as long as human beings are involved with pictures there is going to be an ongoing need for high quality "print-on-demand" photographic record. In general, when people design the data processing systems, the last thing they give any consideration to is; "What is the interface signal to the hard copy device going to be?" At present most of the multiformatters are attached to the video signal which, as you probably know, has been optimized to refresh a video screen for viewing. The refresh rates and other bandwidth considerations (for the video signal) have been without any reflection on what they will do to the signal to the film recorder. So, basically we (i.e., the film imaging people) have been told to take the video signal that is there and make the best of it. Dr. Maguire mentioned this morning that he had nine film recorders and they were all

"crappy"; I think that was the adjective. I would like to suggest that you can't make a silk purse out of a sow's ear. We are given video data that is not held in conformity to video standards. Someone says; "Yes, we are giving you RS 170 video," and when you look at the signal you can't find a damn thing about it that conforms to the RS 170. It might be on a video cable, but it isn't 1 volt peak to peak. Somebody screwed around with the timing signals—with all due respect to General Electric and others (laughter)—and decided that some designer has to put his imprint on that signal and change it just slightly. When you sit on the output end with a film recorder, what it means is that each one of the signals is really no longer running optimally for film recording but is hanging on by a couple of megaHertz bandwidths by the skin of its teeth to make pictures. So, *my concern would be that the manufacturers of front end systems believe that film output is going away, and that there will be even less consciousness about the output of the hard copy signal*, whether it be video or a digital signal.

Bob Wake

Thank you Jim. Joe.

Joe Marion, General Electric

Thank you Bob. I know that all of you are sick of hearing weather jokes but I just can't resist the opportunity to say that I left Milwaukee to come out here. It was -20 and if any of you were up bright and early this morning and heard the weather forecast for rain, if this is rain in Southern California, I may never leave. I would like to address five points quickly. I might interject that these are kind of my personal perceptions. I have been struggling with this whole question for General Electric for two or three years now, in an informal sense, as probably the single modality in our division that is most digital. There really are five things that I have come to on a personal basis and they may not represent General Electric's total opinion. But, *in general*, I think that we have to consider this whole area on a broader basis than just PACS, in a sense that I would put forth the

premise that PACS is somewhat of a subset of total digital integration. I think we have to think that way. I haven't really heard anyone suggest that dealing with CT and ultrasound and nuclear imaging are really the same question. People have continued to look at them as separate modalities and I would put forth that really it's all digital information, it's all ones and zeros, it all looks the same. So we have got to come to the point of considering it as really digitally integrated information.

Secondly, I think there is an evolutionary development in this business and what we have been hearing over the last day and a half is the promise of the economic advantage in the archival area as the premise for PACS. I would like to suggest that really the driver of this whole area, PACS and digital integration, is more appropriately the perceived value and need to use the viewers and clinicians and that the real benefit is going to come from diagnostic efficiency. That is a much broader and more powerful motivator for us in the industry to develop a PAC system than strictly saying that there are economics out of the archival aspects.

Thirdly, I think there are multiple levels of the data requirements. I think some of this has come out over the past two days, but I would like to reinforce it. I look at the situation as an area of processing, diagnostic and archival. In the case of processing you are dealing with a large set of data, the raw data that you capture, which is then processed down to what we refer to as a display file. In diagnosis you are dealing with multiple sets of display files which you finally cull down to a single image or a reformatted image that highlights the point of the diagnosis you want to make. And, the archival or long time storage of this digital information.

This leads me to the *fourth* point and a couple of issues I would personally like to raise when one asks this question of how to deal with these data. The first one is: "What is it that the clinician really needs to see," because I think that will drive some of the development and the economics of this. If it is the raw data set and all of the information that is captured from each modality, that is a tremendous amount of data to deal with and it may make the problem even more attractive. On the other hand, if it is just strictly the diagnostic set of data it may be a

much lesser set that you have to permanently store and handle with the PACS. Secondly, I think there are some fallacies about the communication scheme, that we have seen in our own development. The fact that you can talk about a 2 megabit modem or transfer speed does not mean that it takes one second to transfer 2 megabits of information. I think that very important issues in looking at the advantages of PACS, are "How tolerant are people going to be of the delay in the digital transfer?" and "Are there alternatives to that?"

And, *last but not least*, I think the challenge to the industry is really one of looking at the high technology that we have heard discussed, such as the optical disk and other technology on which the government spent a lot of money. These are very costly systems. But I think the challenge to this industry is to address those technologies and find more or less a commercially economical solution. I think, if anything is going to come of this, that is what will come of it. Thank you.

Bob Wake

Thank you Joe. Next, Carla Marceau presents a rather different viewpoint, not being from the medical imaging community, but rather being from EDP. I think we have a lot to learn here. Carla.

Carla Marceau, NCR Corporation

First of all I would like to say something about the role of NCR and why I am here. NCR is, as many of you people here know, working with Sam Dwyer's group at Kansas University Medical Center. What we would like to do is to work with him as he develops his prototype system which he described this morning (paper 318-33). We intend to turn this into a product and to market it in the hospital area. So that sets a little bit of the background of NCR's role.

I see two major issues. There are lots of major issues in dealing with PACS, but there are two in particular. One of them is that despite the very great potential advantages of a PACS in the medical imaging community which we have

all been talking about now for two days, the critical element in the viability of the whole concept is the user interface. In this case, the user is the clinician who is actually looking at the images that are presented to him. These images have to get there at a speed that is acceptable to the clinician once he asks for them and the time that a clinician is going to wait for something is a lot less if he is interacting with an electronic device than if he is interacting with another human being. That is a significant factor. And also to develop at an acceptable cost, a realistic cost for hospitals which are in a cost bind, an acceptable interface. I was very happy that Dr. Koch (from San Francisco) got up this morning to talk with us about how he, or the clinician, actually uses these images and what he is actually doing with them. While you can't just always put an image on a CRT and expect it to be exactly what you want, this is going to be critical to get an acceptable operator interface. For the past 2½ years in another imaging area, namely the financial area, NCR has been conducting human factor studies to make sure that we have just exactly the right kind of interface to an operator who is a clerk at a bank, typically a fairly low paid clerk, so that the image interface to a human being will be the right one. There is going to be an even more delicate problem with PACS interfaces: those diagnoses have to be right; at least the system can't introduce error. It is going to be very hard for clinicians to have an idea of what sort of interface they want to a digital PACS system without actually having prototypes to work with. This is going to be a major role of the prototype systems. You can't just visualize this abstractly.

The second area that I want to touch on briefly is communications, protocols and message formats. Here, NCR is in a position where we would like to develop a system which will tie together all of these various modalities, bring the images to the clinician. Gee, isn't this going to be great! However, what we are getting is apples from one modality, oranges from another, and pineapples from another one, not mentioning any names. It is necessary to somehow find a way to protect the legitimate interest of the various vendors of the modalities, so that their secrets aren't being compromised,

while making it possible for all of these vendors to work together to bring to the clinician the capabilities that a PACS could have given him in improving diagnosis in hospitals.

Bob Wake

Thank you Carla. Next is Paul Scheibe. Paul.

Paul Scheibe, ADAC Labs

Thank you. I believe that the issues that have been discussed, and probably will be discussed this afternoon, are very important. Many of them are technical issues. The issue of standardization that was just spoken of, I think is quite an important issue that will probably end up resolving itself in the same way as the television standards did in the early 1950s with the establishment of the NTSC which did set about producing standards for color television and, in retrospect, did a very, very good job that is sufficiently good to last on the order of 30 years. Now, however, we see, for example, the emerging high definition television, that is around the corner from Sony and a number of other manufacturers, and that will require an entirely new look at the standards of transmission. So, standards are transient as far as I am concerned. They come and go.

One issue that I feel is with us, whether we like it or not, is the issue of regulation. I think that in the long run it ends up overshadowing almost everything else that comes by in the technical area. The issue of regulation is such that it interferes with the sale, the installation and the operation of medical systems right now. It has in the past. It will in the future. It isn't simply a local thing. We see it at the city level. Certain cities within the United States require a level of inspection for installation of medical equipment. We see it at the state level. We see it at the national level. And of course, we see it at the international level in the form of import duties and a number of import regulations. That is a pervasive thing. Somehow I believe we have to get a better understanding of these issues. We need to have a way of working with those issues because they will remain with us probably forever.

It is quite an insidious thing that is upon us right now and that is that it is very difficult, or relatively difficult to introduce anything that is new or innovative in the medical imaging area. The reason being that it is much less expensive—it is an economic issue—to introduce something under the guise of improvement or upgrading. You no doubt have more euphemisms than I do in that area. Simply said, “non-changing things” are much easier to introduce because notifications need be given that one is going to progress in interstate commerce for these kinds of things.

The really innovative things require essentially a new approach via the regulatory situation and as a result require a fair amount of money, lots of time, a fair amount of frustration in raising these things to the point that they can be used in interstate commerce. Probably, my personal feeling is that the most effective way to insure moderate cost of medical imaging equipment in the future is to allow market forces to operate in a regulation-free environment. The initial market transients will be curious, probably very wild, if that happened. However, I have an abiding confidence in the consumer that uniformly high quality will be dictated by the consumer after these transients have died out and one will be seeing modern components, modern design methods and modern manufacturing techniques being used again in the medical instrumentation industry. Thank you.

Bob Wake

Thank you Paul. Next to make a statement is Bill Pratt. Bill.

Bill Pratt, Vicom Systems

Thank you. Paul Amazeen began by describing his product-to-be as a front-end product. Well, my company makes a digital image processing display and I suppose it would be regarded a rear-end product. I want to make a few comments on the practical side of things in regard to the input/output problem that is going to face us. I have seen a large number of block diagrams that have dash lines and solid lines connecting all kinds of image networks with black boxes described as digital image

processors or image displays or whatever, and data coming from sources. I think we have a real Tower of Babel problem here that, without standardization, is going to exist from day one in these networks. There are maybe a dozen or so companies that make off-the-shelf digital image processing displays, and of course many many others make medical imaging equipment; and I don't believe any of it talks to any other right now and as far as I know none of it talks to networks very well at all.

If you look at a modern commercial digital image processing display, you find that you have three choices. You have a serial port. You have an RS 232 port that can go perhaps up to 19.2 kilo bits and that seems grossly inadequate to transmit images; perhaps control, information would be all right for that. You also have a direct memory access, a parallel interface using 8 or 16 bits in parallel, and that typically can operate at one to two megabytes per second. Now that (direct memory access) is a handshake tie between communication as was mentioned earlier. You are not getting two megapixels transmitted on a continuous basis. There is a lot of overhead associated with that. Furthermore, there is a great deal of software effort that is required both in the display processor and on the other side of the link, with whatever is going to be your communications modem. There is an awful lot of work to be done there. A lot of these new modem display devices also now have parallel bus structures where the busses are typically 16 bits deep. They are all internal busses right now but there is really no engineering reason why these busses couldn't be brought out to the outside world through a port, maybe a fiber optics port for communication. These busses have the potential of operating anywhere from 10 to say 40 megawords a second, where a word is 16 bits. I would hope that with the advent of higher speed communications, greater economies, etc., in these devices the preferred port would be the high speed port. But, for that to happen, it will take a great deal of standardization. Thank you.

Bob Wake

Thank you Bill. Next is Frits Arink from Philips. Frits.

Frits Arink, Philips Medical Systems Division

I would like to briefly state a few points about the characteristics of the business we are in, and secondly (state a few points) about the PACS issues as has been requested. I have an overhead here that summarizes my point (a first overhead viewgraph was shown). The industry so far has always been busy implementing new functions into existing systems. And, here (on the viewgraph) you see that you have an age or life period of equipment of about 15 years. It typically is the technical life. When you go into a hospital you may find equipment that old that is still around in diagnostic departments. So, when converting this technology to digital imaging technology you need to study the user requirements in addition to doing the engineering of basic components in the system. So, when you start with results that are available in the research labs and you want to convert them into industrial products you have to go into pilot projects and study the clinical needs and the behavior and procedures that exist in that environment.

Secondly, there is a continuous upgrading as exemplified by the image intensifying tube. We have seen a gradual increase from 6, to 9, and 14 inch and even higher diameter systems, which improved the low frequency drop and provided better detector quantum efficacies; TV chains of standard and now high resolution, higher definition; DVI systems and direct systems for noise integration, image hold, and other processing functions. The manufacturers have gone to great lengths to supply these functions in a way that is compatible with the existing environment. Also we see a similar attitude with the introduction of newer systems, such as NMR and patient information systems. The "radiology department operating system" for instance and the "PAC systems" will also have to interface to the existing environment. So that brings me to the following six points in the next sheet that characterized the problems we have. (A second viewgraph was shown).

First of all, when we look for a film replacement, which is one of the topics that has been discussed at this meeting, we need new large area detectors which do not exist yet. As I have shown on the previous slide about 70% of the

films made today are generated with medical equipment that does not have image intensifiers. So, we need totally new data acquisition systems, which obviously have to be designed for patient's throughput and for image quality if we want to improve on the present situation.

Secondly, the application needs to be defined for multidisciplinary viewing. It is not at all clear how images from various imaging modalities are being used and how this additional knowledge contributes to better diagnosis. This certainly is an area of on-going systematic study that needs further extension, I think. Of course, this also defines the need for image communication.

Thirdly, we have to consider the economic aspect of solutions. We have a very good reference now, i.e., the cost of the existing files in operation. Of course there is a price to everything and you have to judge the new activities with respect to the investments now being made.

The fourth point is that image processing may add to the quality of diagnosis or to the efficiency. However, in several cases, especially X-rays, this is not clear at all at the moment. To find out, academic-type research is required.

The fifth and sixth points are of a more practical nature. The fifth point is the need for compatible data formats. It has been tried in various groups now, including the IEEE, to come to a standard for image recording on magnetic tape and hopefully also on optical discs. This will also lead to the standardization of the data formats exchanged, which explains the higher levels in this layer structure of OSI recommendations for local area network communications. And the sixth point, of course is that one has to decide how to incorporate into the design of this equipment the user procedures that are different in the different departments of the hospital; user procedures are certainly different in different geographical areas and in different types of hospitals. I hope these six points have provoked you a little bit. Comments from the audience? Thank you.

Bob Wake

Thank you Frits (Arink). One disadvantage of going last is that most of the fruit has been

plucked from the tree. But, I will try to state my two concerns. My two concerns are really one. They are both standardization issues. There are the *technical* aspects of *standardization*, i.e., the physical, logical and interfacing. The other aspect that Frits introduced is the aspect that I will call *customer standardization*. A curious fact of the English language is that embedded in the word customer is the word custom. I think this is kind of indicative of the problem I see that installing a picture archiving system would require very distinct changes, I suspect, in the operating procedures of a radiology department: patient admission and scheduling; the whole mechanics of image interpretation, report generation and disseminating; all possibly could change. The alternatives are: either to force the user to change all their work habits to fit the constraints of this system, or to custom tailor each system to fit the radiology department's offering protocols.

The probability typically of changing people's habits is very unlikely. I think the cost of customization in every installation is going to be prohibitive. Hospital information systems have encountered this problem and have a difficult time coping with customization. A large fraction of the cost of hospital information systems has just been the tailoring to fit the particular users set up. It is a delicate problem because it is a people problem. But, I think the problem has to get resolved, probably better than it has in the hospital information world, to make PACS something that is commercially viable.

There are three members of the audience representing industry who would like an opportunity to make a brief statement. I would like to introduce Kal Vizu from the bowling alley in Rochester (referring to Dunn's opening remark, earlier during this panel discussion), otherwise known as Eastman Kodak.

Kalman Vizu, Eastman Kodak

Thank you. I would like to present a slight alternative way of going than has been presented in the last couple of days. PACS is and will be looked at as a filing-retrieval system, and a number of people have outlined the different types of filing and retrieving that are necessary.

There are such things as "active files" where you have to retrieve many times and you have to retrieve frequently. This type of file does warrant an on-line storage system and there is very little doubt that probably a serial digital bit stream format is the ideal way to go, because it is compatible for immediate transmission or retrieval. On the other hand, in the inactive area where there is a very low probability of retrieval and where you can have very large image data volumes, I don't think that (on-line storage) is the most cost effective way of going. And, so I believe that the predominant view, held by some of us who are involved in several of the different technologies that have been discussed here today, is that ultimately what we would like to see is an evolutionary system. I would like to see a *hybridized* system which is optimized to make use of all of the technologies available as much as possible, *rather than a revolutionary* system where you radically switch to another technology and give yourself Excedrin Headache #12.

Now I would like to address another thing that was pointed out to me that is kind of interesting. Earlier, people talked about film and the various digital transmission methods available, and what I sort of thought of is the situation that Mrs. Marceau addressed earlier when she talked about transmitting, for instance, checks. Transmitting images of checks is no different than many other images, the size is the only thing that is different. And the statement was made that bandwidth allotment and capabilities and whatever, favored the use of digital transmission modes. I would like to contend that this is not necessarily true. Let's say you want to send many many images from New York City to Los Angeles. Think of using a Boeing 747 loaded with microfilm and compute the bandwidth of that 747 (laughter). It is on the order of 10^{13} to 10^{14} bits per second (laughter) and it is going to be many years from now, I think I will retire before, when it is going to be seriously challenged (laughter). Now, if you were to take that amount of information which you can transmit in six hours with the 747 and you did it at 4 megabits per second, at the TV rate, it will take you 317 years. OK. So, this is what I mean: you have to hybridize, make use of the best of several different technologies, and marry them together. That is the

only chance you are going to have of having a decent usable system. Radical changes are not going to achieve very much at all except that maybe it will bankrupt all of us, I mean primarily the health care industry. Thank you. (Big applause).

Bob Wake

Thank you, Kal. I would like to introduce Ross Male from Bell Northern, who is working his way to a microphone.

Ross Male, Bell Northern

Representing the telecommunications type of environment, I would like to make a comment about the communications side of this PAC system. A lot of people over the last few days have been talking about a communications system which would cover some small area, typically within a hospital or a cluster of hospital buildings. Therefore, they have tended to have an architecture which is some sort of ring formation local area network. One of the advantages of this is the flexibility of adding devices into the system. On the other hand, people also talked a little bit earlier today about tel-radiology experiments, and in each of those cases the communication was over some type of telecommunications line. Now from what some of the speakers have said, it seems that one of the evolutionary goals of PACS is to go toward a mode of operating where you could have consultations between hospitals, with possibly quite large distances between them; such consultations would almost certainly have to go over some sort of telecommunications system. So, if the eventual evolution is likely to involve telecommunications links as part of the system, I wonder why all the systems described so far have concentrated on a ring type of local area network. What happens when you do this is that all of the data in the whole system have to go over the ring, which therefore increases your bandwidth requirements; on the contrary with the switch system, such as some type of star network, you would have a smaller bandwidth requirement on each element within the network. Also with the newer digital switches with software program control in them, you do have

a fair bit of flexibility in how you can make your connections, which was one of the advantages that people have been associating with the ring type local area network. So it is not clear to me that the case for a ring type approach has been proven and I would like to hear, during the following discussion comments from the viewpoint of the user requirement which would address the issue of the two approaches, or a hybrid approach, to putting together a PACS.

Bob Wake

Thank you Ross. I think your point regarding telecommunications has probably been overlooked here. We will try to pick this point up later.

PART 2: COMMENTS ON STANDARDIZATION BY PANEL MEMBERS

Bob Wake

I think it is fairly clear that the common thread of concern through the panel and through the audience is the issue of standardization. Brent Baxter gave me something I can read rather than be extemporaneous. The question to the panel is: "How would you react if professional groups, perhaps the AAPM (American Association of Physicists in Medicine), would require your firm to accommodate the standard digital exchange data format?"

Paul Amazeen, Sound Imaging, Inc

I can answer that: "Violently!" Let us look at a quick example of why my reaction would be so violent. If we look at the RS 170 standard that was mentioned a little while ago by Jim Dunn, the manufacturers who are building various imaging systems, such as ultrasound systems, have given lip service to the RS 170, according to Jim (Dunn), but not necessarily always following through in the actual design of this equipment. Certainly there is no requirement on the manufacturers that they must build only systems where the output has to be RS 170 compatible. If they want to allow the user to use various standard video tape recorders and so forth, generally speaking they have to conform

to that more or less, to some degree anyway. Asking a professional group to actually require manufacturers to do this, I think, gets us into a lot of difficulties.

First of all, again, we come back to the problem that various manufacturers will feel that they have various approaches to solving technical problems and they each believe in their approach, and I think there are advantages to it. The manufacturers would like the opportunity in the free market to be able to present their approach, and as soon as we have one particular group that may or may not have vested interest in going in certain directions whatever they may be, how good intentioned they may be, I think we are asking for something that just isn't going to work. I just can't believe that the manufacturers at almost any level, as small as I am.

STOP: The end of Paul Amazeen's comment was not recorded. Tape ran out. The beginning of comments made by Jim Dunn were also not recorded.

Jim Dunn

. . .of listening to the customer, and not have to rely on regulations.

Joe Marion, General Electric

I guess to any extent I would take more of a positive viewpoint toward this if for no other reason than that I think we are all wasting our time here if we can't come to some grips with some amount of standardization. Because unless you limit it strictly to one manufacturer's integrated department, which of course there may be some advantage to, business wise, to some of us, you are never going to achieve the end results, which is obviously the advantage that you would like. I guess I would put forth the alternative that might suggest that there probably is a common ground that would allow us to have our cake and eat it too. I think we already see that, at least in the CT world where there has been a trend that suggests the following. If you had an earlier scanner product and you have had all this archival information, when you buy a new machine with a different set of archival, you still have to have a means

of getting back to that (old) archival. And, I think that the net result is that we the manufacturers more or less have an obligation, and have been forced to some extent, to develop some interfaces to that old archival set of information, by maybe converting as much of it as we can to the new format. So, I would suggest that maybe what we can all do is continue to exist in our own environments with our own format, but if someone wants to put forth the standard all it is going to do is slow down the interface in terms of how you deal with the outside world. But, certainly digital data can be converted from one format to another, so if you talked about a common display format, for example, there is no reason why you could not manipulate that information and put it in that common format. So, I think there is room for it. If that is what it is going to take to get the industry to address those things, I think we as manufacturers can continue to live in our environment but we could also address a common format.

Bob Wake

I think Bill Pratt is anxious.

Bill Pratt, Vicom Systems

I don't think coercion is going to work at all. I know an example of that is that several years ago the Federal Government, the Department of Defense to be specific, commissioned the development of a language called ADA. They have said that at a certain point in time, which is coming up rather soon, all software products that the Federal Government, at least the DoD, buys must be programmed in ADA. Well there hasn't been any great revolution towards ADA and it is most likely now that it will never happen. So even a force like that can't obtain what they want.

Carla Marceau, NCR Corporation

I would like to see a voluntary effort on the part of the various manufacturers to come up with a standard format or standards for communications and formats for display, or at least an openness about the format that they use.

While it is true that you can convert from one format to another, and from one communications protocol to another, what I would not like to see happen is the situation that we have in the telecommunications protocols. The Chairman of the Board of NCR has estimated that about 25% of the entire programmer effort in the country is devoted to trying to match other communication protocols. A sheer waste.

Bob Wake

Paul, I think you have had some personal experience, as have I, in the exact arena. Would you care to perhaps comment on the voluntary effort aspect?

Paul Scheibe, ADAC Labs

Well, I basically think that the voluntary effort is the only practical way to go, even though in the short term it ends up hurting companies like our company. I believe that the customer is probably the best force to get going in the direction of providing standardization. For example, we found that we can sell many of our systems because of the RS 170 standardization at the video port. We find an economic advantage there, and eventually that word gets to the other manufacturers.

The second point that I see is the aspect of government regulations of these (standards), I agree completely with Dr. Pratt. It turns out to be something that is to a large extent non-workable, unless it is of the variety that absolutely constrains interstate commerce, and that has happened in the past occasionally. But, it hasn't happened recently in the standards area.

Bob Wake

Frits, do you have any comments?

Frits Arink, Philips MSD

Yes, only briefly. I think there are two in standardization. One has to do with the device functions. We all live with IBM compatible floppy disc drives and things like that. And, so it is of great benefit I think that we have that kind of standards. Whether the video standards

are also of much benefit I personally don't know.

The second area is the application functions. We have seen this problem arising in the data formats that have been used in CT scanners. It is virtually impossible to read each other's floppy discs and review images and display them on a different viewing console.

Now here of course you enter the area of protection of a certain manufacturer and this has given problems in some areas. I think when it comes to any type of standardization, such as the one we think of now for image formats, that it will be extremely difficult to introduce. Nevertheless I feel it is desirable to come to some kind of alternative standards. Maybe that can be done on the level where these standards are sufficiently generic and such that it leaves open various possibilities without restricting compatibility.

PART 3: COMMENTS FROM AUDIENCE ON STANDARDIZATION

Bob Wake

Any comments from the audience on this issue of standardization?

James Carlson

I am Jim Carlson from a small community hospital. I agree with the idea that you can't force standards from the outside. But, I like the following idea. The AAPM committee works on standards that they feel they should propagate to the members of the AAPM, and then the members of the AAPM in turn make use of this information when advising hospitals and physicians on the best way to purchase equipment. In other words, if we have an educated consumer out there, the educated consumer will in turn educate the manufacturers. The manufacturer's best interest is to follow some of these standards that make it possible for the customer to get the most for his dollar. So when the customer buys something it is compatible with other equipment that he may want to buy; (this is better for the customer) than being locked into a particular manufacturer because he made a mistake at one point in his buying process.

Bob Wake

Very well put.

Jason Zielonka, Massachusetts General Hospital

Hi, this is Jason Zielonka, M.D., from Massachusetts General Hospital and Harvard Medical School. I am somewhat shocked, dismayed, and angered at what I have just heard, in two senses.

The first sense is from my perspective as a physician, which is: I happen to sit in an industry which has self-imposed standards and also some standards that are there for very good reasons. When I as a physician order digitalis for a patient, that is a USP standard. I don't order "almost" digitalis, "sort-of-like" digitalis, "my version of" digitalis. That standard is there to protect the consumer, the ultimate person who puts that pill into his mouth. Likewise, when I buy a piece of equipment it has certain standards associated with it. If it is a radiographic piece of equipment, there are guarantees that the amount of ionizing radiation on the table surface is at a certain standard level or lower, a level that is designed to protect me, the user, and the patient who gets onto that table. That is not a standard that is primarily set up by a manufacturer. It is a standard that is there because of the federal government. It is there for everyone's protection and it is not someone's idea of what might be a good standard. Any manufacturer can say that his piece of equipment has a lower ionizing radiation level at that surface, and that may make me purchase his equipment, but he can't exceed the standard. It strikes me then as a little unusual that, if I am interpreting images of a patient and if that patient comes in one day and is imaged on manufacturer X's equipment and I have 128×128 pixel $\times$ 8 bit images, and he comes in six months later and is imaged on manufacturer Z's equipment and now I have $128 \times 128 \times 8$ bit images, that the only way, the only standard I have for comparing them, is to take Jim Dunn's piece of equipment and Kodak's film and hang the two images up side by side. If I don't do that and I make a mistake in diagnosis because I looked at two CRT images of data that were not compatible, the patient doesn't sue you, he sues me, and if that patient runs into

problems I feel badly about it, and that is due to a lack of standards. I think that if you were that patient you wouldn't talk about the marketplace and an entrepreneur coming up with a better idea for doing things. You would recognize that there are some items which should be proprietary and should be free and open to the marketplace. But there are some things that, for the protection of either the purchaser or the protection of the end user, have to be standardized in this industry.

Second point. The economics of the PACS situation may very well not be determined by radiologists. Some of the economics may very well have to do with what the government will or will not allow, and some of the economics may have to do with the fact that any sort of archival system can be recognized as potentially handling much more than medical data images. The system that goes into a hospital may very well be the system that is chosen by: the hematology and chemistry groups who have to send data from their laboratories to patient floors; the billing system that wants to make sure that costs get distributed appropriately through the hospital; the imaging section of the hospital; the television service providers, who have cables already connected to most patient floors and are running cables through a hospital; and probably several other individuals in a hospital. My hospital may be unique with 1200 beds and a fair number of procedures. I may be able to buy my own system to put in exclusively for radiology. But a 300-bed hospital might not be able to do so and the choice of equipment might therefore be one that serves the entire institution. And, if your systems don't interconnect to it, it may very well be that the only picture archiving system in most of these hospitals, ten years from now will be film jackets and Polaroid Film. (Loud applause.)

Bob Wake

Any comments from the panel on Dr. Zielonka's statement? (Laughter).

Joe Marion, General Electric

Let me just express one thing that I know has been of concern for us at some point and to

some extent addresses what Dr. Zielonka just said. There is a reverse paranoia, I think, on the manufacturer's part when you consider that, in the first place, we are in business to increase the wealth of the stockholders and all that; motherhood and apple pie. But it gets down to the point that as part of that you have to protect; there is a protectionism attitude. If I had an open standard, from a market point of view I would have to ask: "How can I have a competitive advantage?" We would still be at the 128×128 matrix, 8 bit or less, EMI format for CT if it weren't for the entrepreneurial and free business attitude of the manufacturers to expand beyond 128 to 320 and S12, and it may go further. But, if you set a stake in the ground today and say that $S12 \times S12 \times$ whatever will be the standard, that is going to be a deterrent to innovation by the manufacturers when they want to improve their equipment. The other thing about the paranoia of manufacturers, I think, is that we are somewhat protective of that image because no matter how that image goes out, you can distinguish one manufacturer's image from another. When you look at it, whether it's on a CRT, whether it's on a view box or whether it's on a brochure, you only relate to that image. I say: "That is a certain manufacturer's CT image." I don't say: "That this is a certain manufacturer's CT image made on another manufacturer's X-ray film that was produced from a Dunn camera with a Tektronix monitor in it." You don't relate to the chain of events that created it, you only refer back to that. And, from our viewpoint I think we are somewhat concerned about that because, if there were a general format, anybody could modify that image information, and in the process of modifying somebody could make a mistake and put an image up that had left and right reversed. If such were to happen, is there a possibility that we may be a party to the suit? Well, our lawyers sometimes get concerned about that. So, I would like to know what the rest of you may think. I think there is a general concern in the business that some of that protection of the format is for our own benefit as well as yours. We know what we can deliver by our format. We can't guarantee it from a standard type of format.

Paul Amazeen, Sound Imaging Inc.

You mentioned earlier that you wanted provocative questions. Boy did you get one! Am I awake! All wide awake now. I think there are two key points here and perhaps a little bit of misunderstanding also.

There are certainly safety standards. There are issues of safety and goodness knows those have been long and hard enough to adopt. There is an awful lot of equipment out there today that does not meet some of the standard safety requirements, such as UL for example, that most of us have accepted. There are those issues of safety. That is one thing. That is not what we are talking about here.

The second thing is efficacy. Sure, when you go to diagnose that image there are a lot of aspects about that image making that apply to the efficacy of that instrument. Is that instrument really going to do something for you? That is way way outside the area of some particular standards, such as an RS 170 which we all may want to accept for practical reasons or not.

I think the important point here is that we are certainly interested in standards. I certainly am, as a new potential manufacturer, extremely interested in what the standards are going to be. It is very easy for me to accommodate them, all I have to do is get out the eraser and erase them, as I said before. However, when you look at the evolution, and in some cases revolution, that the imaging industry is going through, the changes that have been made over the mere past 10 years, which is a very short time, are astounding! Let us look back to ultrasound, which I happen to know the best of all. Analog scan converters were de rigueur not very long ago, certainly a lot less than 10 years ago. They were the only thing available. So we are going to see changes in the instrumentation that will have fundamental effects on the ability to make those images and as Joe (Marion) said a moment ago, if we had accepted certain standards a mere 4, 5 or 6 years ago, you wouldn't see the expansion in some of the imaging modalities and some of the improvements that we have seen. So there is a big question here as to what the most effective imaging is. That is important to me, and to hundreds of people like myself

who are obviously going to create new things in the growing market places because we believe we see ways of doing the problem better.

The more you put standards or regulations on our ability to make the instruments more efficacious the more you really are hurting yourself. That is entirely different than the actual safety precautions. There is certainly not a problem in accepting those. Let us just be very careful that we allow ourselves to set standards which have meaning. Usually these have more economic meaning than anything else. I can go out and design a different kind of video tape recorder and not accept RS 170 but I would be foolish to do that. It's not economical to do that. Somebody may come up with a better standard with which we do develop better ancillary equipment Fine! Certainly we would like to know such a standard as far ahead as possible so that we, the manufacturers, can incorporate it. At least I want to do this. I am desperate to do this as a matter of fact. But what I really am afraid of is that some outside group with a certain point of view, a certain lack of knowledge of what may be going on innovatively in an industry (comes up with an inappropriate standard). All these imaging industries are innovative, growing, expanding technologies, i.e., technology-driven industries. This is quite different from the example that was given earlier about certain drugs and the efficaciousness of these drugs. I really think there is a distinct difference between drugs and what we are talking about. And so in order to allow that mechanism (of growth) to continue, I think it is important that we be careful about how we develop the standards; that's all.

Bob Wake

I think we have some more comments from the floor.

Fred Klein, Hughes Aircraft Company

I am Fred Klein from Hughes Aircraft Company and I designed one of the two analog scan converters that we just talked about (see earlier comment by Paul Amazeen) some 11 years ago and it is still used today to a small extent; we have gone mostly to digital. I have had some

experience with medical and other applications. Now, I know the concern of the good doctor. But I also know that the same image can be enhanced in different ways on the same piece of equipment made by the same manufacturer and look entirely different. And if you enhance it in way A and in way B to get two different pictures, and when you compare them you might accidentally end up with the wrong diagnosis; that has nothing to do with the standards with which the picture was made. But, on the other hand, I was involved once, many years ago, with trying to help a very-well-known manufacturer follow a government requirement when the standards were set for automatic zip code reading on packages for the U.S. Post Office, the predecessor for the postal service.

One of the government specifications was that the camera had to automatically focus from a distance of 2 inches to 24 inches and accurately read the zip code within one second. The government engineer who reviewed our effort apologized for it. Of course nobody could build a camera like that! We couldn't store the image; the whole thing fell through at that time. I don't know what kind of standards they have today. But the standard simply killed the whole idea. I am sure that we all want to follow standards.

I would like to correct one more thing. I think that most of our video does not meet RS 170 standards which is a broadcasting standard, but RS 330 which is a closed circuit TV or 343 which is high resolution TV. Am I correct?

Paul Scheibe, ABAC Labs

No, in our case it is RS 170. It includes the equalization pulses etc.

Fred Klein

Then you must limit yourselves to 485 lines, when you obviously have 512 bits available to store. And that is the main reason most of us want to go a higher line rate because we have 512 bits and the doctor can benefit from it too. So can the patient.

Bob Wake

I think we have another comment from right on the aisle.

John Dobbs, Analogic

I am John Dobbs from Analogic. I am reminded of the situation in the physics community about 1965, when we were trying to decide whether to go to the NIM standard nuclear instrument module package. All of the manufacturers hated it. "It isn't good for anybody," they said. Finally, because everybody was funded by the AEC they all went to NIM modules. I was a graduate student at that time, but I didn't like the NIM modules. I didn't think they did a good job. They were sort of trying to be all things to all people. But I think in retrospect it was good for the customer. It was good for the physics community. The NIM modules probably made every system, every individual element, more expensive, but it made systems cheaper and it made it possible to put together systems from various manufacturers and it was a generally good thing. I think that people tend to pick at standards on the basis of little issues, but it is much better to all speak the same language and then go to a whole major improvement rather than to make tiny tiny little improvements which prevent everybody from talking to each other and make the whole business more complicated. It is as though we all insisted on speaking our own version of English. We wouldn't be able to talk to each other. Actually, we have a bit of a problem that way anyway (laughter). But, it would really be bad if somehow the whole world decided to speak exactly one language and define that language forever and made it illegal for anybody to develop new ways of speaking or new languages. But, it is also equally bad to have a constantly "changing-in-minor-ways" situation. I believe the whole industry, certainly all the customers, perhaps not all the manufacturers, would be better off if there were standards which could grow and which could change, but standards.

Bob Wake

I would like to comment on that from personal experience. I think the NIM standard fit a valuable need; but having personally worked to try to fit a multi-channel analyzer into a NIM packaging, I believe that they can be misused.

It's a great way to break your back of trying to, if you will, almost expand the scope of the standard far beyond its original intention. I think Dr. Zielonka's point was very appropriate but I think we have to, as we were saying, consider the rapid advance in display technology. Quite frankly, considering the differentiation that the manufacturers seek, is that (i.e., the display technology) an area where we really want to try to force a standardization? The answer is "of sorts" and yet there is no source.

Jef Kouwenberg, University Hospital in Leiden, The Netherlands

I am Kouwenberg, University Hospital Leiden. Just a little remark about standards. I am not speaking standard English. Sorry about that (laughter). I think standards are determined by the market shared by manufacturers and seldom vice-versa. I heard Mr. Scheibe say that he is intending to follow a standard just to reach a market share. I think it's a wise decision. Related to standards is, I think, continuity. I think Carla Marceau said that there is need for pilot projects, the need for prototypes. I think the organization that is accepting those pilot projects should be aware that once you have stuck to that pilot project you could not easily change to another manufacturer.

Alfonso Zermeno, MD Anderson Hospital

I am Al Zermeno of MD Anderson Hospital. As a member of the AAPM I was fascinated by the question and the responses that I have heard. I was wondering what your responses would be, and would they have been different, if we said that the American College of Radiology might have requested this standard or demanded some sort of standard, in view of the fact that they are the user, so to speak. With this I would think that we need some sort of liaison between the manufacturer and the user. The technology is so complex; I would feel that the AAPM may be a very good starting place for such a liaison in a sense that 99 to 100% of us work in hospitals, shoulder to shoulder with radiologists day in and day out and some of us are very familiar with their problems.

PART 4: GENERAL DISCUSSION ON PACS

André Duerinckx

I would like to make a comment on standards that is sort of important and we will talk about it tomorrow. However, I do want to point out that, as far as I can tell, all I have read about standards is standards about how to transfer an image, not so much standards about the global system. So, I would like to come back to the global system and I would like to ask everybody on the panel: "What do you personally think about the image credit card idea?" (Laughter.) It's a cake to develop a short-term archiving system which is digital. But as Kalman Vizu pointed out, maybe we still need the Boeing 747 with lots of films and maybe we need a solution to that problem too. So, what do you personally think is going to be the solution for long term archiving? (Silence.) Maybe I can't get an answer, eight answers, or no opinion or whatever.

Bob Wake

Personally, André, the credit card idea is probably very well in tune with the point that Kal (Vizu) made in terms of "Trying to force an abrupt transition would be chaotic." The credit card may be a way to manage the transition. I personally, without having looked at the numbers, question the long term viability given the capacity of Titanic storage media and the (need for an) ability to keep multiple redundant copies virtually online. But, as a transition I can see where that could have value.

Any comments from the panel? (no further comments relating to the "credit card" idea were made at this point)

Bob Wake

I would like to focus on the transition issue. I realize that standardization is an important issue. There is a session on it tomorrow and let's leave it for discussion in that session. But I think Kal (Vizu's) point on transition was very critical. I think you can accuse us all to some extent of playing technologic futurists, in terms of assuming that we can make an instant jump and a very radical jump from the way a radi-

ology department is operated today. I think Kal brought that into focus. Are there any comments?

Jim Dunn, Dunn Instruments

Yes, I think that the beauty of a photograph or a film hard copy is that each human being is equipped with some kind of device up here that can decode those images. They need not be passed through some power-dependent device that has to look at the media in a certain way and translate it. So, I see the value of hard copy and possibly we will use it differently (in the future). It may turn out that film will be around as the archival medium but it will not carry full size images. We may start to produce microfiche on-line rather than as an off-line second step process, possibly as bridging these modalities. I see that Harris in their laser work has come to a new substrate that is silver halide on gelatin. It sounds close to film (laughter). So, I think Kal's point is a very valid one in that it is going to be a bridging process and the media will maybe be used differently. But there is a certain intrinsic value to pictures that can be looked at directly, or even enlarged with a projection lens. I know they lack all of the sizzle of a credit card that can be placed into some electronic marvel which will then beam pictures up to you. But, you know, in the next five to 20 years, if you look at the end-place systems and you look at the medical community and the reading room environment where the diagnosis or interpretation is made, it's not going to change to squirted electrons on phosphors overnight. So, I see it as a slow and gradual process, remembering that the informed decision, reached by the physician, many times comes up in the privacy of the reading room. I don't think that is going to go away or change dramatically overnight.

Dr. Carter, Boston City Hospital

My name is Dr. Carter. I am from Boston City Hospital. I would like to respond to the point that Carla (Marceau) raised. That is: "How do doctors function?" Perhaps it became less relevant after this morning's presentation from ADAC (paper 318-27); we may not have to function I think; (laughter) we may be pro-

grammed out of function; maybe we deserved to be programmed out of the way. I think sometimes that we are a nuisance. But for the meantime we are there and I think we will be there for at least this transition period that has been talked about. The reason I think we deserve to get into some trouble is that while we do some things very well, we do a number of other organizational tasks extremely poorly. You saw in the last two days some slides of various X-ray file rooms, and I am not sure whether it is appreciated what the degree of the problem is. But there are certain kinds of studies which disappear at the most alarming rate. We have to do audits every now and then in an X-ray department and you will find after six months that certain types of studies may have disappeared at the rate of anywhere between 30 and 50%. So we have an enormous problem going on in almost every X-ray department throughout the country. This is not any long term storage but it is even sort of an immediate storage. I would not like to even begin a discussion as to how many X-rays are repeated because the chest film done yesterday has disappeared. Of course it is never the radiologist's fault, you must understand that (laughter). But it is his fault if he has been unable to keep control over it for that length of time.

The problem mentioned this morning, that you need to look at body scans and to a lesser extent head scans in multiples of 9 or 16 images in order to evaluate them, I think that is very real, out is also short term. (Such simultaneous viewing is needed) during moments that reading is being done. And I am not sure that you need to store that number of images or that you will ever need to recall that number of images. And I would have thought that those must be mechanisms by which you could get that number of images available for within a 24-hour period without having a permanent hard copy; maybe a reusable one.

What I really wanted to say to Carla (Marceau) is that what those new methods of getting information are doing to medicine is something really much more dramatic than most of the medical profession has yet realized. It's an enormous revolution, probably a feeling that we don't know how to handle it. We really need

help desperately. We have a feeling that diagnosis is going to be much more of a formality by the year 2000, that Star Trek is really going to happen: you will be able to run some kind of probe over a patient and you will have an answer. What we will need to do, and spend our energy doing, is learning how to manage that disease when it is being diagnosed. We are desperately looking to this kind of group of manufacturers (to learn) how to organize a hospital, not simply just an X-ray department during this transitional period. We need help in management of all areas of the hospital, and the flow of communication as one of the key aspects is really what we need you to help us with.

I think the business about systems is a non-issue in a sense because I think that in my small area we have spent somewhat over 3 million dollars in the last two years. It is very easy to find that many learned people talk about technology and have a posture about how secure that technology must be kept. When you hand it over to your marketing colleagues you will be surprised how flexible it becomes when you dangle a large check in front of them (laughter, applause).

Joe Darlak, Louisiana State University

I would like to echo some of the remarks that were made here. Certainly someone was saying that you have got to stick with film all the way. They just haven't been listening, because many of the computer management systems that we have seen crop up all over the country are those that were necessarily developed because of the tremendous problem that exists at all levels and the "film-loss problem" is a real problem. We really have to look at that. And, there is no way that we can stay where we are right now. Before we know where we are going we have to look at where we are and where we were; and I think we know where we were.

Now, the point about the transition phase. The gentleman from the bowling alley up in Rochester, New York, (i.e., Kal Vizy) mentioned this quite squarely. We will not be able to convert, change everything that we are doing, overnight, next year, the next three years, the next five years. There is no way that we are going to replace and convert those millions of

X-ray units out in the market place that are being used by the consumer. So we have to be very careful. We need a radical departure to do things in a way that will help the medical profession do a better job: increase the throughput; decrease the cost; and increase the value of the information of that data. All of those images that we are getting—we are losing those. We are losing control of some of those things. The system that we have been talking about for the past day and a half and for the next two and a half days or next two days is something that is urgently needed.

Bob Wake

One last comment from the floor.

Steve Horii, New York University

My name is Steve Horii. I am from NYU and I would like to make a couple of comments.

First comment: about the sudden disappearance of films. I think in reviewing reasons why we don't think it's going to happen we have had a tendency to have a rather self-centered view. That is, those of us from large academic institutions who are thinking about putting in PAC systems, now even we don't think film is going to disappear entirely. One of the reasons I think it is not going to go away is that there are a large number of private physicians out there who still want to see their patient's own films. They want to have the patient bring the films and they want to be able to look at them. It's a very common thing. Even if they aren't radiologists they still want to see those pictures. They still want to see that PA and lateral chest. And, that kind of requirement, if we changed to an all digital system, would mean being able to put viewing stations in all private offices. I just don't think that is going to happen right away. I still think there is a need for films as a physician-to-physician interface.

The other comment that I would like to make is relative to the way CT scans are read on film vs video. And, we have found, at least I have found, that I use a combination of both things. I have discovered that the little controls for window width and level are extremely important. I make a lot of my decisions about whe-

ther lesions are solid or cystic, what the numbers in the liver look like, how these numbers change, and how the appearance of things changes as I shift those levels. And, I adjust them so that they look good to me as I am watching them on the screen. And then I make photographs of them for sort-of archival purposes. And, as I am reading the films, I use the film as a reminder of what I saw on the video screen. . . (*part of the statement is missing, because of a short interruption in tape recording*). . . But I also think it is important not to let the control over the window width and level be left in the hands of a technologist alone. I think this is something the radiologist has to interact with.

Michael Goitein, Massachusetts General Hospital

Michael Goitein, from Massachusetts General Hospital. I am concerned that we are giving very bad advice to our friends in industry. I sincerely hope that they are going to be wiser than we have been in the last couple of days.

We are selling PACS as a system that provides advantages: that you can keep track of your films and don't lose them; you can compare studies that now you can't compare; and that you can consult with remote locations. Almost everything I have heard has been a restriction of what we now do. We are familiar with computer systems that don't let you do things that you otherwise could have done if you had just talked with the guy.

We are talking here about a major restriction of spatial resolutions. Now the problem of storage is not new, it's been worried about for at least 20 years. People spent a lot of time a decade or two ago talking about miniturization onto 35-mm film or other formats. That effort went down the tubes because the images weren't judged to be satisfactory. I think we'd better think very very hard about the experience and why it didn't work before we start throwing away the resolution of the large film.

Another thing that we are seeing thrown away is the number of images. I made a kind of mental count of the number of view boxes that were shown on the slides that were presented at this meeting. It was rare to see a slide of current reading room where there weren't at least 12 and probably more view boxes. I would hazard

the average hospital has well over 1,000, maybe even tens of thousands, of view boxes dotted around the place. They are there for a reason. We'd better find out what that reason is before we cut the number down to 16 or whatever it is that is being proposed.

Scanning through images is very very important. Pick up a book and you can flip through it far faster than a computer could help you. We'd better be sure that we can scan through a folder before we throw it away. And, consultation is a very very tricky issue. Consultation isn't just looking at the same image, it's looking the other guy in the eye and discussing what is going on with him, and we musn't forget that.

Finally, I have a little nightmare that I want to share with you: that we will go all digital and then some wise guy is going to wake up and invent film (laughter, applause).

Bob Wake

Are there any comments from the panel?

Joe Marion, General Electric

Bob, I just have a couple of last things to say. Back to André (Duerinckx's) original question (about "image credit cards") and somewhat on the transition and on the credit card. I guess one of my concerns that would be controversial would be that I have heard a couple of comments, outside of the general session, made to me about the prospect of the legal standards of going to a PACS system. In a sense I would put forth that in a transition until you get total regulatory or whatever approval that digital storage device is an appropriate legal record. We may cover more of this in the standards session. There is going to certainly be some redundancy of the systems, so I think the transition is true, that until you do get that approval there is that question.

And certainly systems that employ film or other known media but record digitally may have an advantage in that aspect in that film is recognized; what's the difference whether it is digital or analog? There are techniques that potentially can produce combined analog and digital information. So, I think film still does

have a tremendous potential. Another controversial thing that I would like to put forth about on-line archive is: there is something very secure in the reliability sense about a storeroom full of film. Sure it could get flooded and it could catch on fire and whatever else and could become destroyed. But, I would subscribe that the reliability of film storage is a whole lot more than any on-line system. If you have an on-line optical disc and it fails, then it fails in a similar fashion to magnetic discs; the heads wipe across that disc; it's gone forever. So, I know this will be controversial. Carla (Marceau) is already nervous about that. I think we have got to address that in looking down the road to this all digital aspect.

And last but not least, I think, is the question that I put forth to the radiological community and clinicians present here that as you look at this data set and you look at the question of the credit card, one of the things that makes the credit card attractive is the difference in scenario between saying: "I am going to store a large amount of data on-line" vs treating things in an individual patient record. Sure you can still do that on-line, but the credit card I think is indicative of the system that says: "individual patient records." I think what will make that or break it is the usefulness to the clinician of that information gathered together, in a sense of: "Is he a specialist or a generalist?" I mean if the world is a series of specialists there may be a controversy in having all of that information consolidated in one place. On the other hand, if the world is going to go back towards generalists and one person is going to review all of that information and integrate it and come down with a diagnosis, then it makes a lot of sense. So, I would like to hear from the community in terms of: "Where do you see the future going?" Is it going to be specialists and generalists?", because that will help us decide which of the scenarios make sense.

Bob Wake

Carla.

Carla Marceau, NCR Corporation

I would like to respond to the last comment on the floor. I will leave it to the people from

RCA and Philips to talk about disc head crashes on optical discs. I think if we call the “transition period,” between quotation marks, that time during which film is still around, it is going to be a very long time indeed. We have been in the data processing area for 25 or 30 years. I don’t know of any systems that don’t have printers. Hard copy will be with us always; and the need for hard copies, the desire to hold it in your hands; to have something real there and not just something flashed across your CRT. Also, in general in the data processing field there have been lots of futuristic comments about: how people will not have to travel to conferences anymore, and here we are; everyone is going to work at home instead of at the office. And yet—Kai (Vizy) likes that idea—the thing is, everyone still works at the office, because of all those things you learned when you were talking to someone at the coffee machine. Everybody comes to conferences like this because of all those people you meet and the things that you learn at the coffee break, and lunch and so on.

The consultation is always going to have to be here. Whatever systems we have are going to be tools for people and are not going to dictate, can’t dictate the way people are going to work.

I would like to make one final comment on, I don’t want to get back to standards and standardization because we can go for days on that one, but I guess on an attitude of openness. In the short term people often see the short term advantage to their own particular company to put up barriers to the flow of information, to hide formats and protocols, to do things in a non-standard way. And, we see a lot of that. My belief is that it is a bit like protective tariffs and may have some short term advantage. In the longterm it is better for the customers and for your shareholders and for your company to have an open exchange.

Bob Wake

Thank you Carla. We have examined some pretty difficult problems here and it is now my job as the moderator to summarize it. I look at my two pages of notes and I have just more questions and very few answers. I think I am

confident of one thing at least: that the solutions when they are found are going to come from the people in this room. I think Carla’s last statement was extremely appropriate. I think the open attitude that I hope you felt is going to be what it takes to make it happen. So with that I would like to adjourn the panel discussion, thank the audience and thank the panel members.

Ralph Colby, RCA

Interjecting a last statement. Excuse me for a moment. Could I make one comment? Being that I am a manufacturer representative of all three: the magnetic tape, film generation and also optical discs. We see in the future that all three technologies are going to still be around for quite a few years because we make magnetic tape recorders, and we make laser beam film recorders, and we make optical disc recorders, and it will be around for quite a few years so there is no worry.

Bob Wake

Would you give us your name and affiliation?

Ralph Colby

Ralph Colby from RCA.

Donald Rauh, Technicare

Bob. May I make a comment? I think that one thing has been overlooked in this discussion, and that is that when you can archive pictures you can archive the rest of the patient record. And, the rest of the patient record suffers from at least as poor retrievability as the radiology pictures do now. But, in developing the ability to retrieve those records there is, incumbent upon the manufacturers of such systems, a great deal of responsibility to make that information secure. And that is going to conflict with the responsibility to make it accessible and that is going to be a very difficult problem to solve and I think it deserves a lot of work. I am a little bit concerned that this issue has not been raised thus far.

Bob Wake

That was Donald Rauh from Technicare. I appreciate your raising the issue Donald. I think Kansas City, May 1983, would be an appropriate place (laughter). I want to thank the audience and thank the panel. (Final applause.)

PANEL DISCUSSION II: THE MEDICAL COMMUNITY'S VIEW ON PACS

Moderator

William Glenn, M.D., Multiplanar Diagnostic Imaging, Inc., 2730 Pacific Coast Highway, Torrance, California 90505, (213) 539-5944.

Panelists

Professor Joseph Darlak, M.D., Radiology Department, Louisiana State University Medical Center, 1452 Tulane Avenue, New Orleans, Louisiana 70112, (504) 568-4646; **Professor Dieter R. Enzmann, M.D.**, Radiology Department, Stanford University School of Medicine, Stanford, California 94305, (415) 945-6767; **Robert Gayler, M.D.**, Johns Hopkins Hospital, 592 Carnegie Boulevard, Baltimore, Maryland 21205, (301) 955-6200; **A. Everette James, Jr., Sc.M., J.D., M.D.**, Professor and Chairman, Department of Medical Imaging and Radiological Sciences, Vanderbilt University, Nashville, Tennessee 37232, (615) 322-3450; **Dr. James L. Lehr, M.D.**, Chairman of Computer Committee, A.C.R., University of Chicago, Department of Radiology, 950 East 59th Street, Chicago, Illinois 60637, (312) 947-6143; **Professor Carol Newton, M.D., Ph.D.**, Department of Biomathematics, University of California/Los Angeles, Los Angeles, California 90024, (213) 825-5800; **Professor C. Leon Partain, Ph.D., M.D.**, Director of Radiological Sciences and Nuclear Medicine, Department of Radiology, Vanderbilt University, Nashville, Tennessee 37232, (615) 322-3190; **Jason S. Zielonka, M.D.**, Massachusetts General Hospital, Harvard Medical School, Department of Radiology, Division of Nuclear Medicine, 55 Fruit Street, Boston, Massachusetts 02114, (617) 726-8782.

Participants from Audience (in order of appearance)

Joseph L. Marion, General Electric Co., Medical Systems Division, P.O. Box 414, Milwaukee, Wisconsin 53201; **Jef Kouwenberg**, University Hospital Leiden, Basis, AZL-gebouw 50, Rijnsburgerweg 10, 2333 AA Leiden, The Netherlands, 071-147222 (x5260); **Robert H. Wake**, Vice-President, Nuclear Medicine Division, Technicare Corporation, 29106 Aurora Road, Solon, Ohio 44139; **Robert Hindel, Ph.D.**, Manager of Advanced Marketing, Philips Medical Systems, Inc., 710 Bridgeport Avenue, Shelton, Connecticut 06484; **James M. White, Ph.D.**, Advisory Scientist, Advanced Technology Department, IBM System Products Division, 1001 W.T. Harris Boulevard, Charlotte, North Carolina 28257, (704) 598-2616.

André Duerinckx, PACS '82 Chairman

I think we can start with the second panel discussion, which will be the last activity of this conference. The Chairman of this Panel is Dr. Bill Glenn from Multi-Planar Diagnostic Imaging Inc. I want to say that what you are about to hear or say will be recorded, so please do use the microphones; don't say anything without using microphones. The same goes, of course, for the panel members.

Two of the name tags (for panel members) are missing but everyone will be introduced.

Bill Glenn, Multiplanar Diagnostic Imaging, and moderator

Some of the panel members received three questions. Three very general questions and I will repeat the three very general questions which sort of represent broad guidelines about which they might like to comment in this panel discussion. You are certainly not limited to that.

- Number 1 - How would PACS change the practice of medicine?
- Number 2 - What reservations might the medical community have on issues of confidentiality, data security, those kinds of issues?

- Number 3 - What is your particular view or experience with shared services or distributed medical systems?

Those are all very, very broad questions. I would like to introduce the panelists starting from this end and working toward your right. They are Dr. Zielonka from Massachusetts General Hospital in Boston; Dr. Everette James from Vanderbilt; Dr. James Lehr from the University of Chicago; Dr. Joseph Darlak from LSU; Dr. Robert Gayler from Johns Hopkins; Dr. Dieter Enzmann from Stanford; Dr. Carol Newton from UCLA; and Dr. Leon Partain from Vanderbilt. I would like to start with Dr. Zielonka on this end, ask him and each of the panel members to give an overview of their background. I have given their institutional identifications and cities, but maybe they can identify the particular aspects of their background, such as clinicians, engineer, computer scientists, that relate to their comments. They are by no means limited to these three broad questions. We have asked that, in order to be able to get out of here by 4:30 p.m., they each just make brief statements. If any of you would like to pop up and go to the microphone and identify yourselves and your institutions, make it very informal, address your questions to any individual or the panel as a group. Please don't hesitate to do so because it is informal and this is for you. So, Dr. Zielonka.

Dr. Zielonka

Thank you, Dr. Glenn. First, let me start off with a 10-second biography. My undergraduate training is in electrical engineering and computer science from MIT. I am also a physician with board certification in nuclear medicine; I practice clinical medicine about 50% of the time, the rest being devoted to research and teaching. The institution I am from is a 1200 bed university-affiliated private hospital which has a semi-variety of PACS in place and I will talk a little bit more about that later.

First, to try and answer the three general questions relatively briefly. How would medicine change in terms of its practice? In the ideal situation it should not really change. The reality of how medicine is practiced, however, is such

that there would be changes and these would be improvements. The ideal is that any patient who comes in for a radiographic study should have that study interpreted in the light of any previous studies using any other modality. It is rather clear how an archiving and communications system would facilitate that process. The reality of today's situation is that archiving is on the basis of the type of file room that you saw pictures of; that the communications service is often on the basis of someone hopefully finding an item within that file room, bringing it to the physician, the comparison being made and then either an oral report or eventually a written report going back to the referring physician. How successful that is often depends on the institution, on how long the patient has been in the hospital, on how interesting that patient's disease is. The films that disappear most rapidly from our file room are the ones that are ideal teaching cases because they end up in someone's private teaching file.

With respect to distributed services, that has always been a tremendous issue within medicine. I think the comparison that Dr. Lippmann (see paper 318-373) made to six year olds, generals and executives as having one particular feature in common is appropriate: they would like what they want *now* and, very often, what they want is something that they can call their own; this applies very definitely to physicians also. I don't think it should, but the reality of the world is that often times it does. The fact that a hospital may have an IBM mainframe or CDC mainframe or anyone else's mainframe doing business applications, billing or perhaps already installed as a word processor, as a patient scheduler, as anything else, usually plays no role in the decision of someone else to purchase a completely different system with no intercommunication facilities. The net result is that often distributed systems do not work well and they don't work because of the physicians involved. Now that doesn't mean that that is the way it has to be. When 10% of our gross national product goes for health care and when everyone is concerned, whether it is you paying the bill directly or through your insurance company or through the federal government, at some point reality has to arrive in the medical

profession and the fact that computer scientists can in fact make computers, at least pass information back and forth, means that that should happen. Hopefully what we can do is also make sure that the information that is passed back and forth is interpretable in the way in which it was intended.

Third question, (what are my) reservations about legal issues, medical issues, anything else about PACS? There are two prime requirements, two prime reasons why archiving and communications hamper us. One of them is the legal requirement. It is required by state law that any patient, (as far as the) medical record (is concerned), has the privilege of having that record kept for a number of years. If that were not a requirement a great many patients would probably have their films converted for the silver, whether by patient request or by physician or hospital administrator choice. There is however another aspect which is: if you are going to practice a decent level of medical care you would like to have an image available. I don't think PACS affects that except to make it better.

Bill Glenn

Dr. James.

Dr. Everette James

I guess I see most things from the viewpoint of my primary responsibility as Chairman of a Radiology and Radiological Sciences Department which, we hope, interleaves basic scientists and physicians. We have about 1200 beds located on a university campus serving both the veterans hospital and a university hospital, 41 staff, 17 of whom are Ph.D.s or combinations of M.D.s and Ph.D.s.

My own background is that I went to college on an athletic scholarship to be a creative writer. I found out that didn't pay; so I was sent to medical school, wanting to be a lawyer. That's why it took 14 years to get a law degree. Then I got into radiology and found out if you were an English major there were some problems involved, and I went back to graduate school and did graduate work in the basic sciences. I have tried to establish (a radiology)

department in which you would have people who understood most of the aspects of the basic sciences and some of the clinical needs and could articulate those. And I think that is one of the biggest problems that we are going to have in changing medicine through some of the technologies. And that is, that we need to do a tremendous public relations job on our colleagues in medicine and I think (also on) some of the people who have responsibility for the allocation of resources and also the responsibility for running of institutions. And I hope that this will be the kind of thing that we will be able to do from conferences like this.

Data access is a problem, obviously, and we will have to change some of the concepts of the "best evidence rule," and thus evidence does not have to be the hard copy film emulsion image; but I think that we will have to change precedents there.

With regard to distributed services, the complexity of those requires that the scientist and clinician get together. Hopefully we will have a group of people in which that will be embedded in a single person who will act as the interface person in between. That is about as much as I would like to say now because I think maybe we should move through these (statements by panel members) fairly rapidly and then maybe we can respond to some of the questions.

(A note is being handed to Dr. James). I am getting (a note), I'm sorry I can't read that. Bill, I am having trouble (reading this note). Somebody said: "A white Chrysler needs to be moved," is what it looks like.

Bill Glenn

If any of you are related to a white Chrysler station wagon, license VDP509; it needs to be moved right away.

Dr. Everette James

You see that's the problem, I just saw "VD needs to be moved" (laughter); I knew Bill knew me from the Mass General but I didn't think he knew all that much (laughter). I will

pass this on to my colleague next who I remember because I think I interviewed him one time. That was before he joined his group in Chicago and I'm sure he has thought better of that (laughter).

Dr. James Lehr

After reading the note I decided to scoot over just a little (laughter). I am Jim Lehr currently at the University of Chicago. As I recall I majored in physics in college but in the midst of graduate school saw the light and went off to medical school. Still, there is a bit of the physicist in me and I tend to like an axiomatic approach to things. So, I want to start with a single observation that I don't think anybody would disagree with, and then see where that leads us in talking about the conference. The observation is this: that every department of radiology in the country has PACS. Everyone archives pictures, communicates them and all that stuff. The problem is that these are manual systems. Often times they perform very poorly. On the other hand, despite their weaknesses we radiologists have learned to live with them. If you remember then that everybody already has a PACS, the problem we are looking at really is: how and when or whether, in fact, we should automate these systems? That reduces us to a problem that people have written books and books about and that is: How do you automate currently existing systems? I think, I can't summarize all those books, but in general it looks like you begin to automate them when it appears to somebody to be cost effective to do so. And, another observation I would make is: one of the first things you want to do in automating currently existing systems is to document that system very carefully and very exhaustively. And, my observation is that although we heard some papers at the meeting about how radiology PACS currently work, I think the level of documentation is not very good. I would not want to undertake automating the current systems if I didn't have more documentation and more detail than I have seen at the conference. Another consequence, I think, is: probably, converting PACS to more automated systems would be a little slower than we think.

Another thing I want to point out to you. You saw two papers earlier this morning about radiology information management systems (papers 318-61 and 318-62) which has been an interest of mine for a long time. I don't think there is a survey, but my personal guess is that there are about 200 to 300 radiology departments in the country operating with this kind of online system. And, that has several implications for automating PACS. First of all, if you run a department and you have to manage all these films you can do it much more cost effectively and much better with one of these computer assisted PACS or CAPACS. Another thing, and the consequence of that, is that if you can do it more cost effectively you may not have such a nice increase in your benefit cost ratio when you move to a totally automated system. Another key thing about these, as was pointed out by somebody this morning (318-61), a radiology information system will go hand in glove with automated PACS. I don't think you will ever see PACS without an information management system. Finally, these systems being out there in as many departments as they are, provides you a very good way to get the kind of documentation of existing radiology systems that you need to design most cost effective automated PACS. And, having said that I can't resist pointing out to you that the American College of Radiology Computer Committee has recently published a book dealing with radiology information systems: *A Planning Guide for Radiologic Installation* (a series of fascicles); Part 9: Computer Information Systems, 1981, (an ACR publication). I think people who are interested in implementing automated PACS would do well to read a copy of that. The committee is also sponsoring a meeting in Boston (the 7th Symposium on Computer Applications in Radiology, April 26-28, 1982, Boston), I believe it starts around April 26 and some of you might be interested in going.

Finally, one hopeful thing on the horizon is that our current manual PACS are being very severely stressed by a lot of emerging diagnostic modalities. I think this will tend to make manual PACS, the stuff we are using now, less and less cost effective and will tend to make totally automated PACS more and more cost effective.

I assure you that we are not going to use nuclear magnetic resonance just because it's a digital image. We are going to be using it because we can see things we could never see before; we can make diagnoses we could never make before.

So, in summary, I think we will see automated PACS eventually. I think it's a classic problem of automating a currently existing system and we ought to apply all of the knowledge and watch out for all of the mistakes that everybody has made before.

Joe Darlak

I am Joe Darlak, LSU Medical Center, working at Charity Hospital, a small place with 1600 beds and 1600 files. You have seen a demonstration of some of these files and I am prepared to show you a few more. The files I am referring to are those mattresses that the patients sleep on. Underneath the mattresses we will find films, and not to infrequently either, like everyday.

My background is that I went through medical school in Buffalo. I worked as a scrub nurse for a couple of summers and I decided I couldn't hack surgery. I went into straight medicine intern in Boston and got tired of starting IVs at 2:00 in the morning and decided to join the Army. I stayed there for 22 years. I have seen all of the problems. I have been stationed in Europe for six years, in Japan for two years, on the West Coast, East Coast, and places in between. I always tell somebody I moved so much because I couldn't hold a job, but that was part of the military routine, to move every two or three years whether you needed it or not. But I found that, particularly in the federal government, federal environment, many times we had patients who were transferred from one point to another because the expertise was not available. The films that were made at the originating hospital or in the clinic had to be repeated when we came to the medical center and it seemed to me, very early on, that we had to do something else to retain these copies, these images, the histories and everything else that was being lost. This is what PACS is all about to me. As a matter of fact several years ago I started out on a little crusade

of my own trying to talk to everyone in industry and in the pictorial system to see whether or not we couldn't get something started in this regard.

One comment about this. When I first went into radiology in 1958, one of the first statements I made in the X-ray room was: "Let's go look at the X-ray picture," and I was admonished by my professor's saying "it is not a picture." And here we are some 20 odd years down the road, and we feel very comfortable with the phrase now and I don't think it will change. But I do think... Would you put on slide #7, on both trays (apologizing for the large number of slides). I was prepared to give a 10-minute dissertation. We will try to turn down the lights.

At Charity Hospital you have to be aware of the fact that we have two medical schools, LSU and Tulane University. It is a very active training hospital, a very active trauma hospital. Everyone with major trauma from Louisiana, west Mississippi and east Texas will be referred there. The file room is (shown on the slide) to my right; it would accommodate perhaps 8 or 10 months up to 14 months of films. On the left side is the result of that overload. You see those films there (pointing to the left slide), they are ready to go down to the file room, down in the basement. OK. And that (next slide, showing piles of film lying on floor) is the result of that basement. Now that was one of the points we tried to make. Those films are no longer available. The law says that we have to keep those for a minimum of five years in some states, seven in other states, but the fact is that once they are down there, they are just not available. Now the question is: Will a PACS system improve the quality of medicine? It has to, because those images should become more accessible and available to us. When somebody comes to the emergency room, we can track and find out what exams they had, we don't have to repeat the exams and so on and get the lab results. I mean that is basic. And that has been covered I think almost ad nauseum, I think everybody's got the point about that. The question (that remains) is, (about) film, whether one needs a hard copy, or a soft copy. I think both of these media will find their place. We are not going to ban any film, we can't. But we will have to find a better way to manage the images. Many of these computer systems we are talking about

have been developed primarily to manage films. (Poor film management), that is the problem; Films that are lost; Lost, stolen, misplaced or what have you.

The management of records will be improved (with a PACS). There is a question about confidentiality, but I think it is more important to note that what we are striving for is to have those records available to the professional, the people who are taking care of the patient, and the rest will have to take care of itself. We will have to, of course, impose the necessary security on the records in order to make sure that they are not in the improper hands, but finally we will be able to have the information (needed) to better take care of our patients and improve care, the level of care and increase the throughput.

And, this is the question about shared services too. We have five other Charity Hospitals that will be linked by coax cables or otherwise, in Louisiana. It is our aim to link these hospitals together in order to provide service and expertise that may be lacking in those hospitals. So, I think that only if we develop a PACS type of service in house will we be able to extend our expertise or our assistance to these hospitals on the outside. And, that is all I have to say at this point.

Bob Gayler

Bob Gayler. I do general diagnostic radiology in an approximately 1100-bed hospital. I think the reason I am on this panel is that I was involved with a project that has now been ongoing for about three years. It involved, first, two laboratory experiments: (1) transmitting routine radiographs over slow scan lines initially, and (2) then in digitized form over telephone lines; and then (it involved) trial interpretation of these. I therefore saw how a group of 12 radiologists did looking at television images of chest X-rays, abdomen, skull and various spine and extremity films. And I have some comments that they made about this sort of (television) image which provides I think the same source of reaction that any radiologist would have looking at routine films. I will share some of those (comments and reactions) with you.

First of all, film quality was perhaps more important with the television image than it is routinely in that everyone missed the bright light or the hot light or whatever the local term is for areas relatively dark on the film. Zooms were felt to be essential in the format we used which was a 17 inch diagonal, 512 × 512 system. This was important in skeletal work as well as in the chest. One of the toughest areas diagnostically was the lung parenchymal pattern. Pneumoconiosis for instance was routinely missed, small pneumothoraces were a problem; fractures were usually seen. As one might imagine, the tougher the case initially on the film, it was even tougher on the television image; certainly no surprise to anyone. The speed of the video system was bothersome the way we used it; the system did have a setup time of about 15 seconds for each new image; we had simultaneous viewing with two monitors but that probably wasn't enough for some modes. People were a little uncomfortable and had a lower confidence with the video image; also no surprise. The systems that we used were very easy to learn and I think this technology is certainly readily available so that there is not much learning time necessary for the radiologist in the simple operational aspects.

From a technical standpoint, flicker is a problem and previous speakers commented on the fact that it is tiresome to look at a video image for a very long period of time. Our setup requires looking at 25 images in an afternoon over about a three hour period and people felt that that was a lot of work. So that provided some input into exhaustion. There will be a field trial starting within the month, theoretically within the week, but it hasn't started yet so I am not sure. This will involve looking at 10,000 transmitted images in and around the Washington area and we will be archiving 500 of those for very intensive study. Those (500 images) will be available if any of you wish to get involved after the fact with looking at those archived images. The report of the trial so far is in the August 81 issue of Radiology in a limited form and has been published in a full booklet form by The MITRE Corporation, McClain, Virginia, and I will be happy to give you their catalog number afterwards if you would like a copy of that.

Dieter Enzmann

Dieter Enzmann from Stanford Medical Center. I am a neuroradiologist with absolutely no engineering or physics background. In fact, my undergraduate major is experimental psychology. I would like to address this PACS problem in a rather general fashion and touch on some of the intangibles in designing such a system.

I think that a concept that is probably obvious, but something that maybe should be reiterated, is that the PAC system needs to adapt to medicine; it's not the reverse. Medicine will not adapt to a PAC system. I think one of the corollaries of that statement is that this translates into understanding behavior of M.D.s and specifically radiologists. Implicit in that is that we have knowledge of that behavior. I think what all of us should understand is that we have very little knowledge of that behavior at present. We are dealing with an area beset by a large number of unknowns and uncertainties, both in the technology but also in the medical practice. So the PAC system is not simply putting together the correct pieces of technology that communicate (but) rather (and) more specifically we need to define what the specific purpose of that system is. I think what I want to iterate at present is: we are very short on that information. A technique that we have tried to use in our own attempts at attacking this problem is one of modeling (see paper 318-60). We attempted to design a model to address the problems that we are trying to solve. As even evident from our very simple investigation which was one to attempt to model an archival technique. And simple data such as film usage was unavailable to us to really plug into the model. If one of the purposes of a PAC system is to increase the efficiency of image handling then even rudimentary data such as the use of cine films, CT images, ICU chest films, to analyze that problem, is unavailable to us at this time.

I think a second problem which again is somewhat of an intangible, that all you ought to be aware of, is more philosophical in nature; that is the problem of information glut. Its now relatively painless for us to produce an enormous number of images. Film had one positive

aspect and that is by its sheer cost and physical handling required, film was a retardant to over-imaging. I think, at least from the radiologists point of view there is a very deeply ingrained philosophy and that is: never to throw away an image that might have important information on it. To struggle between that particular philosophy and the PACS system is going to be strong and difficult to address in the future. The question is: What do we archive? The radiologist is unwilling to throw away images, what do you save? Currently we do a lot of morphologic imaging and that is relatively simple, we can often pick the best image and save that. However, the question arises now, with multiple images to save, representative images: Do we save the best image, do we save the raw data? We are slowly in the state of transition to now include a fair number of physiologic images that are beyond just mere anatomy. And the question again will arise and probably more importantly: What do we save? Do we save every image? Do we save selected images? Do we save the bottom line analysis from that physiologic data? Or do we save functional images? All of these require fairly detailed analysis, probably before PAC systems are instituted.

Another, I think, obvious point which has not been well addressed is that a PAC system will function differently for different users. And there is a fair amount of individuality in radiologists. So, I think in designing a PAC system, one of the major points should be that it is flexible and adaptable to change. I would caution that because we are in uncharted waters and are faced with a fair number of uncertainties that we do not commit early to any form of dogma in this design. Thank you.

Carol Newton

Carol Newton, UCLA, Department of Biomathematics with a joint appointment in radiology. My original graduate training is in physics and mathematics. I saw the light and went to medical school at the University of Chicago. In fact, I guess I shared quite a bit of my background with Dr. Lehr and my fondness for the University. And now I've really gone bad and become a biomathematician working primarily in the medical area.

Question 1. How will PACS change medicine? I don't think we will fully know this and I agree passionately with the last speaker when I say that they really are going to have to adapt to real needs in medicine rather than be driven by the interests of people like myself who at times get so carried away by the magic of the technical details. It really is going to have to adapt to medicine. I therefore was very much impressed by the final speaker, Mr. Vanden Brink and his urge that we do very careful market research, very much down to the realities of what the physician needs today. But at the same time I think we must all be mindful that that is not where the physician is going to be tomorrow. It is going to be and should be a gradual process. I remember a meeting in Uppsala in 1972 ("Radiation Treatment Planning Meeting," August 7-11, 1972, Uppsala, Sweden) when a number of us throughout the world who are interested in computers in radiation therapy (did get together). At that time the kind of graphics that you would consider to be routine today, the interest in optimization that you would consider to be fairly acceptable today, were considered far out and not even worth a consideration. Four years later at a meeting in Gritiken practically every manufacturer there had an interest in and addressed these particular items. So we must stay close to the real market. We must stay close to real medical needs. But those medical needs are going to change. Now where will they change? They will change in a few places where experimental programs such as that of Sam Dwyer's at the University of Kansas (paper 318-33) are going to drive changes in the clinical setting. And I was most interested in the work of the preceding article by the Naval Regional Medical Center in San Diego (paper 318-30). Because, there is a very special need for a remote diagnosis that may pave the way to the development of this technology because of its being an acceptual need. In any event, it is going to be a gradual process and demands and needs will advance. So the question is: In what direction will they advance? Well, to do this I think that we have to recognize that cost is a major consideration here and that the quality of the images that one wants to deal with are an important element in the cost.

So I come back to my last panelist (Dr. Enzmann) and talk about the need to interface to the physician as soon as possible and as thoroughly as possible. In particular, just exactly how refined do the images that the clinician will use diagnostically have to be? What can you get along with for a given diagnostic goal? Now, the naval researchers in San Diego addressed this, for a certain number of real clinical images. They came out with two figures, (one) for the more refined diagnoses and (one) for those that can deal with more gross anatomical details. This is good beginning work. But I haven't seen in this conference, in proceedings of some other conferences or in the literature, enough studies in the area of the evaluation of real medical images for their diagnostic content by an expert in the field. And this is one thing I would like to see a great deal more of. For instance, the outcome of such a thing might even decrease the cost of archiving as we know it today. It might mean that we can microfilm in much cruder manners and much more compressible manners than we are doing today. It may have an immediate spin-off for archiving. It may also show that with a certain amount of training, in the new kind of mode of representation, that a radiologist can get along with less information content in the film. And this in itself would have some advantages. Now this is all very fine but who is going to pay for these studies? We have seen very fine evaluation studies theoretically and in more reproducible manners by people like Daniels, Brown and others that analyze the information storage requirements of various types of images.

Again, I think we come down to a problem here when we go to the real studies (based) on phantoms and so forth. Phantom studies are more quantifiable, more standardized, i.e. where standardized phantoms are used, (but) they move farther away from the radiological goals of diagnosis. In other words you have a tradeoff between the two and this is an area of perplexity that I will just pass on to you, but the bottom line is this: I think we must find out what the minimum amount of information is that the radiologist can get away with for defined clinical goals and we must do so in the setting of real radiological images. To do anything like this and test the known hypothesis

of: "This is as good as that" is, as you can well expect, going to require a large study and then the question comes down to: Who is going to pay for this study? Is the manufacturing community going to pay for it? I bet you have a hard time getting the federal government to pay for it. And frankly I see that as being the bottleneck for this whole business. I think if you can't crack that one you're not going to crack the field. Anyway, that is just a guess that I pass on to you to argue about.

Down the line, maybe one of the most interesting outcomes of all this is that we will go back and ask ourselves again: How do we read a film? Do we really at one time when we look at the Gestalt of that film need the same kind of image as when we come down on it to ask: is that a tumor in the lung, are these platter atelectasis, what am I seeing here? And, maybe this process will give us another kind of hierarchy. We have talked about hierarchal storage and so forth. Maybe it will give us the hierarchy of zooming where we have at the background of our archival system a very refined image but that we selectively scan it in terms of region, and in terms of coarseness of the image we present. And this then of course leads to technology of interactive terminals where the user, and I think particularly the men in the Navy now, may rapidly get a series of films from a ship or of the man in a hospital, or woman in a hospital may get a series of films to fairly low and coarse reproducibility but then may be able to zoom down on that to more refined areas (see also paper 318-54).

(STOP: Tape sound cut out here; new tape side started.)

Carol Newton still speaking

I think the bottom line is that we just need more studies on the real films to begin to see what we require in information content.

Leon Partain

A brief anchor leg here, my name is Leon Partain. My job is Director of Nuclear Medicine at Vanderbilt University Medical Center. Before medical school my formal background included a Ph.D. in nuclear engineering and

10 years experience in computer instrumentation systems and after medical school residency training in diagnostic radiology and nuclear medicine and certification in both of those two areas. This has been intriguing to hear the comments by fellow panel members. I hope we have some agreement, disagreement and response from you in just a minute.

I kind of like Jim Lehr's implication that perhaps the clever four letters PACS maybe need two prefixes, "automated computer based PACS" and then we could have ACT PACS conferences perhaps. At least that would be a little bit more descriptive I think. In terms of changing our life and work style I believe and like to think that we will have more and new kinds of information at less risk because of some of the new modalities. We must recognize that we are living in a technology explosion and these are exciting days to try to be responsive to that. With regard to reservations: costs have already been mentioned and my own feeling is that at this perhaps premature stage in the evolution of PAC systems we see solutions being proposed where specific questions have not been asked yet. That is to say, we need to define the purposes of these systems as has already been proposed. We need indices of performance for PAC systems prior to the evolution and design and distribution of PAC systems.

With regard to the desirability of shared and distributed systems, we might all agree that the days have long since gone when we can work in isolation in ivory towers and not in cooperation with many different kinds of disciplines. I believe and feel that it is inappropriate to suffer on either side of the great physician syndrome or the great scientist syndrome. That behavior and lifestyle and tradition is in my judgment really inappropriate and unjustifiable and unacceptable. Therefore, if I understood the comments of my two colleagues on my right (Drs. Enzmann and Newton), I thought I heard the suggestion that the PAC system should be defined for the medical system or (be) adaptable (to it). If I understood what they said, I think I disagree with that and would take the opposite viewpoint in that we in medicine who are responsible for the delivery of health care must be adaptable to new technologies. There is, I would like to suggest, nothing sacred about the

needs of the physician. In fact the needs of the physician are not an end in themselves, but are means to an end. I think the PAC system can be part of the evolution of a changing system of health care in this country. And, granted that I may have misunderstood the intent, that would be my feeling; that it is high time for us to adapt these technologies and consider the end result, mainly the delivery of health care to patients.

My specific small assignment was to comment on nuclear magnetic resonance imaging and where I thought it might fit in the field. Two comments I would make are that if the potential is as real as some of us think it will be, there would be an increased percentage of digital images. But that is not the reason why NMR is exciting; it's because new information is available that we hope will improve the quality of health care. Thank you.

Bill Glenn

Well, you have heard from, on my count here, eight different panel members with varying backgrounds from all parts of the country and hopefully some of you will leap toward one of the microphones there, and Joe Marion is about to do so, and address agreements or disagreements to individuals or the entire panel.

Joe Marion

Joe Marion from General Electric. First of all I would like to say that while you were all speaking I did a quick calculation based on the number of beds that you all described for your institutions and concluded that we have about 35% of all the U.S. institutional beds collectively in our presence here today.

I would like to concur on a few points and express maybe one thought that the group could comment on. I would like to concur on the need for more systems study. As a representative of a manufacturer, I really think it is in our best interest if we try to very well understand what the requirements are, and what the systems requirements are, before we charge off trying to put a group of our hardware together that to some extent you might have to invest in and we might have to support later on

that really doesn't do the job that you want it to do. So I very much concur with that thought.

Secondly, I would like to express some concern about the question that was addressed by several of you and I think it is one of the key questions for this whole PACS issue. It is the question about what I call collected data set vs diagnostic data set, and which is it that's really going to have to be permanently stored and maintained and referenced? I would subscribe to the fact that, if it is the collected set, that is an awful lot of data to deal with and it only adds complexity to the problem. I think you have to help us understand whether that is really what needs to be stored.

In addition to that I really like Dr. Darlak's charts or slides of the file room. It really brings home very succinctly, and a picture is worth (a thousand words, just how serious the problem is. But I would also like to leave you with the thought that I don't really personally think it's going to be possible to put everything on-line. It may be that we're all sitting here 50 years from today and somebody has a slide up on the chart that shows a room like that (referring to a slide shown by Dr. Darlak) full of optical discs. I don't know, I'm implying that I don't think that we will ever reach the state where all of that information could be readily at your fingertips and on-line. So, maybe it is a poor system today but maybe its parallel to the future.

And last but not least I think is the question of generalists vs specialists. I would like to propose that maybe the panel consider this question a little bit. In the sense of a generalist: if that is the direction that the medical community is headed, I think it fits rather nicely with PACS because PACS to some extent has the ability to bring all of that information collectively together. And, that would lead us down the path toward one type of development. On the other hand, if as the world has progressed over the past several years towards specialists that may not be necessarily appropriate. I think we really need more guidance in this area. And, I would like to hear some comments if possible.

Bill Glenn

I felt Dr. Zielonka's pulse go up here so I think he's dying to make a comment.

Dr. Zielonka

I'm not quite dying to make it, but let me try and address both of those issues.

First of all, on data set. Many times in a radiology department a patient will have what may be referred to as "a splash file" made up; splash file or some other terminology. What it basically is, is: that set of key films that has been particularly useful in making the current diagnosis. And I suspect what may end up happening in some future PACS is that two sets of data become stored. One is a long-term archival slow form of storage, perhaps magnetic tape, perhaps something else, where any films or any images that have been taken are stored. And there are certain people who will need those. I think Michael Goiten in his example of radiation therapy (paper 318-68) gives you an excellent example of where many films, other than those required to absolutely make the diagnosis, are necessary at a later time for another purpose. On the other hand, for direct, quick comparison, a "splash file" may be all that is necessary to be readily accessible for a patient.

For the second issue, generalists vs specialists. Most institutions, if they are large enough, will read films out on a specialist basis. But the bottom line is that there is only one patient and somewhere there is only one physician who ends up deciding what to do with that patient. And as that patient goes through the process of diagnosis, the specialist who does CT scanning may want to look at the films or the images that were taken by the specialist who does skull films and they may need a third opinion in addition. I think there has to be a difference between formal interpretation, i.e., who looks at a study and makes the official reading, and then all the other people who in fact also interpret that study and who may need access to it.

Bill Glenn

Any of the other members?

Jim Lehr

I don't think you (referring to Joe Marion) are asking the question you mean. We talk

about radiologists in our place as either modality oriented specialists or organ oriented specialists. I sometimes think I am organ oriented. What we see, as new modalities like NMR come along, is that we tend to get radiologists who get real hot on those technologies. For new technologies that is very useful and indeed we still do have ultrasound physicians. But as the technologies get a little more mature, we find that our G.I. radiologists, for example, want to do the G.I. CT. They want to interpret the G.I. nuclear medicine. And, so I think we may specialize along disease systems rather than modality systems. I think what is really worrying you more is whether we are going to specialize along modality lines.

Dr. Joe Darlak

I would like to echo that a little bit more because many of us have specialized more or less in ultrasound or in angiography because these are time consuming examinations and there are physical barriers that exist. Many of our medical facilities are fragmented and that's the point about this whole (PACS) discussion. We have to better link the areas together, whether its the building across the street; or down one floor when the elevator is not working; or in the separate little building next to the main building. The problem is that if you're doing one type of study in one arena and the other study has to be done somewhere else because of physical constraints, you are dubbed as the specialist in this and someone else is doing the other procedure. But we are all in the main, diagnostic radiologists, we are all trained to do all of these procedures and we all have attained a certain degree of expertise. The only problem is that it is difficult to be everywhere at the same time and we find that many times we have been spread rather thin. If there was some better way to get these images, get this data, get this patient to us where we are, then we could do a better job and perhaps improve the whole level of diagnostic radiology, but not only that; the level of medical care in the ivory tower as well as in those little clinics and small hospitals that are looking to us for expertise. I agree with you (referring to Joe Marion) about the fact that there is more system study required. I think

everyone will agree with that and I would like to offer Charity Hospital as a test site.

Bill Glenn

Any comments either coming from the panelists or from the floor.

Jef Kouwenberg

Jef Kouwenberg from the University Hospital of Leiden. I really enjoyed this conference. I found it very stimulating. The only problem is that it was so intensive that I did not get a chance to improve my English. I am not a radiologist, as I have said (see panel discussion #1), so I will not discuss pictures, or anything like that; except for those pictures I saw of your department, Joe. I think the slide showing the mattress (with film hidden under it) has nothing to do with archive problems. I think it showed a set of dirty pictures hidden under a mattress.

I think there is at least one person who is convinced about the necessity of integration. PACS means communication. When we are dealing with these problems of departments trying to handle the information, we could compare it with departments who are trying to install an inter-departmental telephone system. The telephone system is used to communicate. One department develops a telephone system without knowing what the others are doing; and so is Department B and C. Within each department it is really working nice. People can communicate within the department. Someone will get the idea to make a call to the other department. Then it appears that the plugs are all different, he is talking and there is a very strange sound because the baud rate or that kind of stuff is not correct. After several years the hardware problems are solved and the connection can be made from Department A to B. Then suddenly it appears that the voice coming through the telephone is talking in a different language. They cannot understand each other. They have solved the hardware problems but they have not solved their information problems. They have not established their standards. I think this, and everybody knows it, is of the big problems: to have stan-

dardization in the hardware. That hardware standardization has been impressed very much at this conference. But the standardization of the information itself, the procedures between different departments, is a tremendous problem, much worse than the hardware, I think. Then after the communication and hardware problems are solved, the information can go from one department to the other. Then there is another problem. Are M.D.s really willing to share the information? Because that information no longer stays under this control. It is very nice to have pictures and films in your drawer. You can say: "That is mine, I lock it." But once you are sharing information you add a new dimension to it. Because management can control your actions. They can control the quality of the handling within a department. I wonder whether you regard it as a problem. Are M.D.s willing to share the information?

Bill Glenn

I think they would share it if they could. One of the words that you used I would like to comment about. I haven't had a chance to say very much because I don't know very much. But, currently radiology is lurching itself around the corner and becoming much less film oriented and much more digital oriented.

I know this will be controversial, so somebody will want to respond to this. But, suppose that for the business of picture archiving we just forgot all about film and worried about what is already digital, that is, ultrasound images, nuclear medicine images, CT, digital radiography and NMR. Now, the PA of PACS reduces very simply to picture formats. That is something that people can get their mouth around in terms of 320×320 or 512×512 and how many bits deep. The standardization of image formatting for picture archiving purposes from what is already digital, would be tough to achieve. But it would force manufacturers of different kinds of CT instruments and different kinds of digital images, that is a two-dimensional array I believe, to conform to something that would allow the different kinds of pictures to come out on the same tube. You can carry it a little bit further. This conference is very much about a communication system, point-to-point on a

map. If you have digital information and you want to put it from here to there you really can't, at least not right now because the information content of radiographic images is so enormous and available data rates are so infinitesimal that it is like trying to empty a lake with a garden hose. It's useless. But that is going to change very soon because the astronauts are going to kick out of that space shuttle enough communications satellites and enough new transponder space is going to become available that digital images can go from dish to a satellite down and to somebody else and avoid all the land line problems and all of the . . . that requires protocol standardization to send those images from point to point. So it seems to me that one of the issues that a conference such as this might address is: *to temporarily forget about film; address what is already digital*. Bite that off and try to recommend or initiate a standardization process for digital picture format and communication system protocols. Now to some extent some of those things already exist, and that is an issue, or a set of issues, that perhaps people can respond to.

Dr. Joe Darlak

Can I make a comment in view of your remarks. I think that we, working diagnostic radiologists, have been out in the field, we have seen the millions of standard X-ray units out there that create the film. I think that is where the problem is. I think that we should have a parallel effort, that we need some fast film scanning device to get it into a PAC system. I think that that is where the major emphasis should lie. I know its easy to go digital, but some of us don't have that 25% of our equipment or effort in digital radiography.

Dr. Carol Newton

One more point?

Bill Glenn

Well, one point, if you fail to take a step for medical communication of images and soak up some of what will become available in communications space on those satellites, then

porno kings will get it from you and you won't have it in the future.

Dr. Carol Newton

Just the issue of the question of sharing. It seems to me that you have probably got, with the security codes and special keys, as good a system as any for limiting the availability of these films to whomever you wish to have them. So, that is the last point the speaker from the floor brought up. I don't regard that as being too serious if its well done.

Jef Kouwenberg

I think it may create a situation that (allows) management to make quality control checks. In our situation where medical records are stored, sometimes it appears that lab results are not correctly interpreted, that a wrong diagnosis is made. There are things that can be revealed when the information is made available. Then there will not be the issue of making a PACS with locks on that image information because there are people who are entitled to see that information and it is no longer information reserved strictly to the person who made that diagnosis. That is the problem I see.

Bill Glenn

The gentleman in the blue suit.

Bob Wake

Bob Wake from Technicare. I disagree almost completely with your premise, Dr. Glenn, in stating that radiology departments are becoming digital. I think, somewhat in agreement with Dr. Partain, we have really yet to start to wean the radiologist from film. If you take our most successful digital modalities, CT, computerized nuclear medicine, I don't think anyone can question that the video represents what you get on film. You certainly aren't losing anything on the video. And secondly there is no question that there is a lot more data available in the display and its abilities for interaction than are captured on film. And yet I suspect

that only a very small fraction of radiologists are interpreting from the video displays.

Dr. Jim Lehr

Since I worked in CT, let me respond. I by-and-large agree with you. The reason is that the human engineering in all of the displays for all the systems in CT I have seen, is so uniformly poor that no computer user.... I mean when you show these systems to people who are good in computer science they throw up their hands and wonder who clobbered that together.

Dr. Jason Zielonka

Let me disagree again somewhat briefly. We offer short courses for physicians who are particularly interested in computerized nuclear medicine and would like to come spend a few days learning the techniques. One of the things that invariably amazes them is that we do 90% of our diagnosis directly from the computer CRT. The film is placed in the jacket as a permanent record in case anything else should get lost. But, our diagnosis is made from the computerized display.

Bill Glenn

Yes sir.

Robert Hindel

Bob Hindel, Philips Medical System. I have heard a number of very interesting papers that ranged from very realistic to something very fancy like Dr. Lippmann's (paper 318-73). I would like to address an issue that Dr. Carol Newton started and that is: Who is going to pay for all of this? Now, industry is obviously thinking very seriously about how to make a product out of those various suggestions. And I have been listening to a great number of people and one of the key elements in any discussion or conversation, is to find a realistic partner. Now a realistic partner can assess technical possibilities, limitations in terms of medical applications, but also whether this suggestion will ever become a meaningful business or not. If it does not become a meaningful business, you have

created something of very short life and it is going to die and collapse somewhere; whereas, if there is a realistic, that means businesslike cooperation, you have helped to create something which finally grows and becomes generally useful.

Joe Darlak

May I make a comment on that? Without too much background in statistics or research as to the cost of running various functions in the department of radiology, we spent one week looking over how much money we could save in just installing a radiology management system at the Charity Hospital. That is eliminating repeat examinations; keeping track of the films; decreasing costs of interpretation, reinterpretation, all the time spent in overhead and so forth. We came up with a nice conservative figure of \$765,000 in savings. Now that's part of the tradeoff and I just feel that this is probably the tip of the iceberg because our budget is a couple of million dollars, for just expandable.

Jim White

Jim White from IBM. I have one question, just as a point of curiosity. If it is worth that much, why don't you hire a few more people to file these things away? Are these films really worth something to you if you let them get stashed away like that? As an individual who once in awhile has to go and have a film made, this is very bothersome to me.

Joe Darlak

I guess I have the film problem. Let me tell you this. I have only been in this location for a little bit over a year and I am there because it is a challenge and it is not going to stay that way very long.

Jason Zielonka

Let me give you another answer. My hospital spreads over 19 buildings and is adjacent to a river. I do not have sufficient space to place most of those films. Two of my buildings happen to be National Historic Landmarks. I can't

change anything around them. We actually thought about building floating pontoon items on the river and if it wouldn't freeze we probably would. The basic problem is that people don't solve all of the filing problems. If a film is misfiled, it's as good as lost. And, when you have a nine digit patient identification code, the probability of a number being transposed is significant.

The other thing that "more people" doesn't solve is the patient who has two or three studies in a single day. Most people find hospitals uncomfortable places, they want to get out as fast as possible, and if you can get three studies done in the same day, you would like to have that done. Now, how does the film that was taken at 9:00 in the morning get to the person who is taking your next study at 11:30 so that he can see what the abnormality is, so that he can tailor your exam? One advantage of PACS which film doesn't have and most other modalities don't have, is the ability to have multiple copies at more than one place.

Dr. James Lehr

Let me just point out to you that there are lots and lots of medium and small hospitals in the country where PACS works beautifully. Generally they are community hospitals. In the file room they have a mature woman who is very ungenerous and if the films should happen to leave her department she remembers where they went and which doctor has them and God help him if he should come and ask for another one (laughter). You know the patients aren't as sick. There aren't as many radiologists. Generally the physicians in the hospital outside of radiology don't want to see the films, they want the answers so they can take care of the patient properly and get on the golf course. In big hospitals the systems become so large that they really are unmanageable.

Bill Glenn

Let me make a couple of comments about film. I am not anti-film and I'm not anti-computer. As a matter of fact, when CT came along, with a modest background in playing with the computer, I was the ultimate button pusher.

And so for literally the last three out of the last four years I did all of my clinical case interpretation on CT work, which has largely been CT spine work, from a CRT. So, I was totally hooked. I never relied heavily on the film. The (CT) facility that we had was not something that we derived from what was available from the manufacturers, as far as how the images pop-up and how they are oriented on the scope. We had our own crew that had done for several manufacturers a much better job than those CT manufacturers could do for themselves. So assuming that we were very swift at that sort of thing, lo and behold we had to switch back to film and I became three times more efficient in the work that I could accomplish in any day. And the PAC system that we have in a very narrow CT facility which is an outpatient facility is a growing rack of films and a growing library of tapes. So, this being hooked to a CRT is the optimum thing. It slowed me down after awhile and there is a place for film.

We are also involved in something else and that is picture archiving and communications over long distances, doing digital image processing for what will probably be 100 different sites by the end of this year. There are issues of picture archiving and common formats and the issue of standardized communication protocols in order to do for those hospitals what we have done for ourselves and to bounce pictures back and forth over long distances. These issues are a challenge to an organization and a meeting like this; they have got to take a bite some place. The film problem is enormous. There may not be anything you can do about that in the short term just because of the size of it. But the trends in storage and communication and computing power and image display will require from a group like this, some creative efforts instandardization.

Joe Darlak

May I make one more comment lest I forget. Earlier this week, I think yesterday, Jim Dunn mentioned something about the headaches that the people get from looking at CRTs for a prolonged period of time and this may be a fact. This may be so but it does not compare to the 25 or 30 headaches I get with film I can't find.

Dr. Everette James

I think one of the problems that we are having, and I am sure the manufacturers are having too, is deciding what to archive. Somebody mentioned that awhile ago and so for personal reference, we have been working with three digital units and we got into the problem of the rapid data acquisition and trying to decide what to archive. And we found that the only individual who could make that decision was the person who knew the most; we were in an angiographic mode. So in order to implement that, we had the most senior individual personally there for the longest period of time. That is a very costly way to handle things and if you worked it out in dollar amounts as a department chairman you probably would find that you could take the film and then use that person's time much more efficiently. It is a little bit like the handling of the films by radiologists. In my department I do everything possible so that a radiologist does not have to put his hand upon a film, or place it on the view box and certainly does not have to look through the jacket. I am paying him too much per hour to have him engaged in that activity. If I can pay someone who makes a tenth of that to find the film, based on the number, then I would like to do that and I think that is one of the things that we have to decide and decisions about what to archive is very easy if you can afford very high priced individuals to make the decision. We have got to work out some kind of automated way or we have to make some compromises.

Bill Glenn

Any comments from other panel members?
Any more comments from the audience?

Joe Darlak

I would like to make one comment to say that the organization and the audio-visual support of this conference and the people who have attended and presented papers have just been superb. I am very happy to have been invited (applause).

Bill Glenn

That is a well-deserved comment for the people who set this thing up. I think what we will do is, let André now make the final remarks. So we will call this panel to an end. Thank you.

André Duerinckx, PACS '82 Chairman

I would like to thank all panelists for participating and everybody participating in this meeting. I think it was a very interesting, interactive meeting. Sam Dwyer asked me to invite all of you next year in May to Kansas City, Missouri, to attend the second edition of this meeting. And we hope that all of you will bring some new results, some new facts, and some new ways of interacting about this important topic. Thank you very much (applause).