The Dana Center

Fundamental Neuroscience and Architecture Workshop: Summary

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Rev. Patrick Russell, PhD. Barbara Gill. Fred Gage, PhD

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Sponsored by the Dana Alliance for Brain Initiatives and the Academy of Neuroscience for Architecture

A Workshop on Fundamental Neuroscience and Architecture

Washington, DC
December 04 2003

PREFACE:

This report has been prepared from notes and audio tapes made at a workshop held at the conference facilities of the Dana Foundation in Washington, DC. The version provided here contains the highlights, including the recommendations from the four working groups. These groups developed ideas and guidelines for four areas of importance to the Academy of Neuroscience for Architecture in formulating research projects that could help in building intellectual bridges between architecture and neuroscience.

A second version will be available, with a more in depth treatment of the discussions of each group, and especially of the discussion during the closing session. Anyone interested in obtaining a copy of this more detailed report should send an e-mail message or letter to ANFA. Requests can be sent to:

Dana Workshop Report Request
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A Workshop on Fundamental Neuroscience and Architecture
Washington, DC

Wednesday, December 03 2003
American Association for the Advancement of Science (AAAS)
Auditorium | 1200 New York Avenue NW

Public Film Screening of "Beyond Intuition"

Panel Discussion
Panelists:
John Eberhard, FAIA | The Academy of Neuroscience for Architecture
Fred Gage, PhD | The Salk Institute for Biological Studies
Alan Leshner, PhD | American Association for the Advancement of Science
Esther Sternberg, MD | National Institute of Mental Health
Alison Whitelaw, FAIA | Platt/Whitelaw Architects, Inc.

Thursday, December 04 2003
The Dana Center
David Mahoney Forum | 900 15th Street

SUMMARY HIGHLIGHTS

Fred Gage: Welcome to our meeting. Again, I'd like to thank the Dana Foundation, Dana Alliance, for helping to sponsor this, but also to let us have a meeting in this room.

John Eberhard: I wanted to make a statement about something I told our board of directors recently.

I think of myself as the scout who went out early into the territory to explore. Alison and her crew in San Diego I think of as the pioneers who followed up and began establishing the Academy. Then about six months ago, we established an Advisory Board and a Board of Directors for the Academy. The people who became active at that point I think of as the settlers. They followed the pioneers and began to settle in the territory that had been established.

B. Provancha, G. Cooke, M. Shinberg, J. Eberhard,
H. Akil, J. McRae, B. Brodt

Last night marked the beginning of what I'd call the developers. We are now at a stage where the Academy no longer needs to remember that there once was a scout. The people in this room and what we're going to do today essentially will establish the foundations for the future of the Academy.

[Note: Each participant then introduced themselves. What follows are a cross section of such introductory remarks]

Esther Sternberg: I'm Esther Sternberg.

If we as more basic scientists and clinical researchers do not pay enough attention to public health applications of our basic research, we are seriously remiss. This is a very important project that brings together both basic science, clinical research and practical applications that can have very important impact on all of us.

E. Sternberg and G. Chong

Gordon Chong: My name is Gordon Chong. From a practice perspective, the specialization that our firm's involved with is in health care and in education. In both of those areas, we're very interested in the neuroscience, but quite frankly, I think applications are a ways off. The third area of interest that I find fascinating is from an academic perspective and the opportunity to grow a second generation, a future generation of architects who understand the linkage between the brain and intuition.

Barbara Gill: I'm Barbara Gill and I'm with the Dana Foundation and the Dana Alliance for Brain

Initiatives, and I have to say it's a pleasure to be able to convene such a workshop as this.

The Dana Foundation's mission is for education and research, and we fund a broad range of research and brain research. The Dana Alliance for Brain Initiatives is a membership organization (we have several members here today) of neuroscientists and clinicians who believe that it's very important to communicate the progress and promise of brain research to the general public and to specific audiences.

We do reach out beyond our members and many people have joined us in this concept. One of the things we'd like to do is to foster dialogue, to translate that science to the general public and specific audiences. What could be more interesting than to bring two different communities together to see what neuroscience can do for them?

Fred Gage: The hope is today that we will come up with a real plan, not so much details of what the answers will be, but a way to approach this and that can sustain the enthusiasm that seems to be there in a really very practical way.

Mark Greiner: My name's Mark Greiner. One of the things that particularly interested us in the Academy was the fact that Steelcase had done research in co-development with MIT, with Stanford, and with Carnegie Mellon. We had been dealing in a lot of the technological influences on physical space from wireless computing to networks. Studying things like heating and lighting and all of the environmental factors. We had also associated ourselves with schools that were studying the human factors, the sociological side of work in processes.

R. Wurtz, M. Greiner and R. Peterson

But the work of the Academy starts at the other end of the spectrum in my opinion. It's coming down from the top. If you can understand what's happening in the brain, you're above all of these other levels. Then there's a layer of effectiveness which is our primary concern right now. How to do things faster but also doing things better in terms of the decision quality of the work experience. Above effectiveness is experience, making it a delightful experience, whether it's an experience in a hospital, in a school or in an office. Then above that is emotion. I think Neuroscience is even above that in terms of what the drivers are.

Randy Peterson: My name is Randy Peterson, and my background is as an architect. What I'm

looking for in this kind of an exercise is that we can blend these two fields. This isn't going to happen very quickly. I decided when I was 10 years old, 34 years ago, that I wanted to be an architect, and maybe in another 34 years, we can have some other fifth graders these days that are actually doing this as part of their daily practice and delivering really quality spaces and understanding how those quality spaces affect us as humans.

G. Cooke and M. Shinberg

M. Greiner and R. Peterson

Gilbert Cooke: My name is Gil Cooke. My primary interest is as an educator, helping to develop what I see as the first new frontier in architecture in many years. Progress in architecture is slow. When I was in school, the primary advancement was from using a piece of sandpaper to sharpen your pencil to using a device that went in a circle. The introduction of computers has advanced what we do enormously, but we always tell prospective students that architecture is the marriage of art and technology of esthetics and engineering.

A new frontier, introducing science, particularly neuroscience, to the study of architecture, I think, bodes well for the future of the profession, and the young people today are extremely interested.

PREFACE

Fred Gage: I have a few comments I'd like to make before we get started about what I hope we can achieve or how we might be able to do that. One of the things that I'm concerned about is that we might try to do too much. We might set our goals too high initially and become frustrated in our inability to achieve those goals. The initiative would slowly fall away because of lack of achievement.

One way I think we can avoid that is to be very clear about what our objectives are. What is it that we would like to achieve in this Academy? I think this gathering could help formulate a strategy or a plan for this Academy that could provide the foundation on which we could go forward.

B. Gill, F. Gage and J. Bromberg

Here are topics for our working groups.

1. The first. I think what I'm hearing is that there is a lot of information that may be out there already, there's information out there already that should be aggregated in a way, vetted, evaluated for its validity and then put together in a way that can be communicated, if vetted by some body that says that this is real empirically derived. That means tested, some sort of validation applied to it.

We could fund research projects to aggregate this information, and to this extent, it would mean leading up to thinking about databases.

2. The second point that I think I hear a lot of agreement on is education. The next generation of architects should have some understanding of the biology of vision, of perception, and of cognitive sciences. This should be integrated within the architectural curriculum in a way that's directly useful or may be directly useful.

Is there any way that this organization could facilitate that integration of what's already known in neuroscience about perception, about cognitive sciences, and help to facilitate the transfer of that information to those that might be able to use it in an applied way?

3. How do we design experiments that might fill in the gaps (of which there are so many

that it's frightening) in our knowledge, in the absence of our knowledge? So, there's two parts to that;

One is doing the experiment. How do you do an experiment in this field at the interface between neuroscience and architecture? What does it look like? What is the control? Can we do a historical experiment by looking two different types of buildings that are doing the same thing but have different properties and evaluate them prospectively?

How do you design and experiment is almost different but could be treated differently. What are the most important questions that we should be asking or encouraging? If you were to list the knowledge that you would like to have to share in this class or to pass on to architects, what are the most important things that you would like to have known?

John Eberhard: I think we're looking at the question the wrong way. We shouldn't try to say what architects need to know. First of all, architects don't know what they need to know about neuroscience. I thought the purpose of the group on hypothesis was to answer the question about how would we go about mining nuggets from such information. Somebody will eventually have to take those nuggets and produce them and turn them into hypotheses which could be tested in a neuroscience context, and I thought that's what this first group would try to do, is not answer the question now but to identify by what process should we go about establishing hypotheses and then look at what the imaging techniques are that could be applied to such hypotheses and eventually in graduate programs, some two years from now. We would have joint Ph.D. programs between neuroscience and architecture and then those questions, like what are the important issues to be looked at, will begin to be appropriate. But at this point, it's premature.

G. Cooke, M. Shinberg, J. Eberhard, H. Akil and J. McRae

[The participants then divided into four groups: 1) Hypothesis Formation; 2) Imaging Techiniques; 3) Graduate Study; and 4) Information Systems. In order to work more intensively on ideas that could be brought back to the entire workshop after lunch.]

AFTERNOON SESSION

Fred Gage: So, this is an experiment that we're conducting. The question is how do we know if our experiment is successful or not? What are our outcome measurements that will determine whether or not we are successful? What's going to happen is that we will have specific reports from each group that will become a charge to the Academy. A smaller subgroup to put this together in some synthetic way. Hopefully you will agree to look at the next version of the synthesis that comes out of this, and give your opinions.

Our goal is to use this as a template for a strategic plan for the Academy to move forward. I don't know where we are with that right now. We'll have to see how this comes out, but this clearly looks like it's going to be very useful.

GROUP ON HYPOTHESIS FORMATION

Esther Sternberg: We used the analogy of an ideal portfolio as one that that might include a range of research from basic research to translational clinical research. Studies could go both ways. They could start from the outcome effect that the architect is interested in measuring (that is, human responses) or one could study the neurobiological mechanisms that might subserve those responses.

E. Sternberg, G. Chong, J. Olds, E. Jackson and R. Noble

P. Milner, B. Brodt, E. Sternberg, G. Chong, J. Olds, E. Jackson and R. Noble

An example is skylights in stores related to sales. In other words, the study would be a correlational study between a practical outcome measure in different kinds of spaces or in different kinds of architectural designs that have different elements. Another kind of study would be clinical intervention-type studies; that is, prospective studies where you put individuals into different controlled environments and measure different outcome measures, including behavioral, emotional, brain, stress, immune function, etc.

There could also be basic studies in which one would address questions of how specific elements of architectural design could affect function of specific brain pathways, specific neuronal functions, nerve chemicals, hormones, etc., Tools that could be used on the neuroscience side would include neuroimaging, single neuron recording, etc., etc.

We talked about overarching questions that could be addressed and those are

encompassed by two categories. What and how. So, a how question would be how does the brain integrate architectural design elements into an emergent human perception? A what question is what are individual architectural elements doing to people who experience architecture?

What are the neural pathways of perception, memory pathways that are involved in integrating all of these and responding subsequently to these elements? What are the pathways for the emotional responses?

Such as, stress response centers, behavioral responses, decision making, creativity. You can make a long list on the neurobiological side, just as you can make a long list on the architectural side. Again we felt this was not what we should be doing in this exercise. Another important overarching question is how are these pathways integrated in the brain to allow us to perceive the space and take an action. Again it would involve the neurobiology of memory, of how one experiences spaces, different parts of the brain that are involved, like the hippocampus, different parts of the response to those spaces that could be involved, for example, the stress response. Are there particular elements in a space that induce or reduce stress responses that may impact decisionmaking or action or behavior or productivity?

There could be individual variables within a subject, between subjects, or there could be common factors that apply across the board. It's important to consider how gender, age and culture affect all of these questions, and also how the variability of the specific goal of the project, whether you're designing a health care facility, a laboratory, a place that is supposed to be relaxing for meditation or a place that's supposed to keep you alert.

We discussed how the variability of the goal might affect the various outcome measures that you're looking at, or how controllability of the environment might affect those questions. We talked about threshold factors. Some of these elements of architecture may affect individuals differently, depending upon the intensity or the threshold beyond which they become either positive or negative effectors, and that such thresholds need to be defined.

Robert Noble: From my point of view, it's the relationship between architectural design and human responses and neurobiological mechanisms is where the interest lies. To see how the users are effected is important and then, of course, how the architect's design decisions are effected.

Huda Akil: There is also the sustainability of it. In other words, if it's a place that is interesting and can continue to be interesting because you live there or you work there on a daily basis (versus a post office where you visits for only a few minutes).

GROUP ON IMAGING TECHNIQUES

Robert Wurtz: We came up with four categories of measurement that we think are doable now. We're not thinking of hypothetical future events but something that can be used immediately, and the four that we're going to talk about in detail later are: (1) Where people look and where they move, within an architectural setting. (2) Measure brain activity during presentation of certain presumably virtual reality events related to architecture. (3) Measure the chemical and hormonal responses of individuals. (4) Psychophysical measurements.

1) The question of the interaction of novelty and enduring qualities. So, for example, someone get used to the novelty of the chandelier in this room and over time, the novelty wears off. One issue that we wanted to address in these techniques was being able to measure repeatedly over time and to see the time course of what people are interested in or what they're responding to. The initial novelty that wears off might be the difference between ordinary architecture and great architecture; that is, the great architecture has enduring interest as opposed to just novelty.

2) The second area was an area that relates to affect; that is, what are the elements that we can measure that are more long-term measures of emotional response, stress, and a variety of things like that?

Superimposed on this, we thought, there are a whole series of variables. These are variables not in the architecture, but in the person who's using or viewing the architecture, namely their age, their culture, their gender.

R. Wurtz

Fred Gage: Let's just take the visual part of it and consider field versus laboratory. One experiment would be to have an individual walk into a field or a natural environment, an architecturally-rich environment, and measure eye movements. What are they attending to initially, and then what persists as a feature of that environment that they persistently look at over days, over weeks, and you do it across individuals. You go through this domain of age, culture and gender, to see whether or not there are elements of novelty within an environment which are universal or are they completely variable in terms of age, sex, and culture?

You could extract those pieces of information from it, but trying to figure out what element it is in a complex environment that is the attractive element for the eye will be a battle of trying to understand that. That's when in parallel perhaps or in a supplementary way, when we go into a laboratory setting with the same readout, which is the same eye movement, but now you have your list of defined elements, of shape, color, light, texture, sound quality, that are either individually presented in a defined environment where you get a baseline of hierarchical response, comparing them to each other, combining them together, you can imagine the number of experiments.

And then, what you may get in one sterile environment is a response of these elements in terms of novelty, which have greater novelty, which have less novelty, and then you get to then take that plane of response and superimpose it in a different environment. You can ask whether or not your attentiveness to novelty and the rate at which you habituate that novelty is context dependent, and if it is context dependent, what component of that environment is influencing the shape of the curve?

There is another point in neurobiology. There's a structure of the brain called the hippocampus and there are cells within the hippocampus that fire specifically when animals exist in a particular location within the room. They're called place cells, and it's absolutely a remarkable observation, that you can record from an individual cell in an individual animal and it will only fire when they are in one space. As soon as they leave that space, it's quiet and other cells fire when they're in different locations.

D. Weiner, B. Gill, P. Russell, J. Bromberg, R. Wurtz, and F. Gage

B. Gill, P. Russell, J. Bromberg, R. Wurtz, and F. Gage

Huda Akil: You were talking about space and how you perceive space and how different people perceive space. There are a lot of animal studies that show that males and females can encode space somewhat differently and that it's pretty hormonally-sensitive, depending on whether you have estrogen or you've taken estrogen out. How they remember it, how they code it, how they find it, again is orientation versus specific details. There's a whole body of work that speaks to that, but that might also be relevant in how you're designing. How it appears to males versus females, how they would encode the space, what they would be tracking. Whether they track a specific sign on this corner, then you turn left as opposed to a general orientation of heading north or south.

Esther Sternberg: I don't think that you can answer all those questions with one technique. If in Bob's study, you found a difference in length of look, then you would have to do visual analog scales and ask people when you look at this, do you feel happy, sad, disgusted, pleasant?

I think what Bob was saying is that first you need to make the observation, and then you can analyze what are the elements that explain that observation, whether they are the mood that's induced and then you can look at the chemicals or the single neuron firing or whatever is underlying it from the pathway side.

Patrick Russell: For the last 20 or 30 years, there has been a set of techniques that have given us for the first time direct access to the human brain in a controlled fashion. Prior to that, you could only do studies either via psychophysics, measuring the behavioral output of an individual, or brain studies in a clinical setting to see how damage to the different parts of the brain affects abilities.

P. Milner, P. Russell and B. Gill

Now there's a set of techniques that broadly speaking let us either make detailed spacial maps of brain activity by measuring where the blood flow is increasing in the brain during a certain type of task, or where the brain is most active as measured by delivering energy to that region.

Those give us fairly detailed pictures of brain activity regions. They are functional MRI and often doable with the kinds of MRI scanners in hospitals around the country. They have the advantage of being widely available.

Another technique is PET scanning and related techniques where radioactive tracer in the person's can measure brain activity.

The other set of techniques measures the electromagnetic fields emanating from the brain as a result of neurons firing. Electro-encephalopathy, EEG, and MEG. These techniques suffer from the drawback of not being very spatially pinpointable. You don't have as easy a time finding out exactly where in the brain the waves are coming from, but on the other hand, they give you a very temporally-detailed picture of the brain. You can see what's going on in time, at the level of a thousandth of a second.

The way these would be used in an architectural setting is the same way they'd be used in any other kind of study, but they are not absolute measurement techniques.

When you make a brain map, you rarely can interpret that by itself: for example show someone a picture of a building that you want to study and then interpret a brain map. Rather, you need to compare two brain states. In other words you need a good control state. If you want to measure how people respond to different lighting levels in a room, then you can make a map with the subject in total darkness and then begin to increase lighting and see how the brain responds differentially to that.

Any parameter in an architectural setting that you can change systematically, you could study in the imaging suite. On the one hand, the disadvantage is that you have to be very reductionist. You have to find some knob that you can turn and study before you come to the big picture of how does a person respond to a beautiful cathedral.

The most powerful imaging studies are the ones where you can both produce the brain map between two different states, what's going on in this person's brain, but also have an external measure of what that person's experience is to help interpret that map.

For example, if you want to study what the neural processes are that underlie our experience of either the novel aspect of a building or what we continue to experience of enduring value, you would do an imaging study as you show them the same building multiple times to see how their brain response is after they've seen the building initially and then later on. If you could be measuring the eye movement at the same time, there's a quantifiable measure of are they still attending to the building? Are they still looking around actively at the building?

Meanwhile, you can make a brain map that shows which areas are active when they first see the building and then as the novelty wears off and as measured rigorously by eye movement, you could then show which brain areas remain active after you've gotten used to the building. In other words, what parts of your brain are continuing to respond to that building after you've been seeing it for awhile.

Another thing you could do, is use the time-dependent techniques, EEG and MEG. Within this method you could then measure what in detail is going on in the brain with respect to one region talking to another. Is your brain in a more coherent state? Do all the different brain waves seem to add up from different parts of the brain or is it incoherent as a way of measuring how you respond.

So, that's just a very brief look at imaging techniques. Something has to be changed about the environment or about the subject's response in order to measure differences.

James Olds: You described very elegantly block design, fMRI imaging, brain imaging experiments, but there's also event-driven design experiments which basically are not so rigorously locked to switching a particular architectural element on and off but are driven by locking the energy delivery variable, the hematological response, to different aspects of an architectural environment as the subject was exposed to them.

I think an event-driven design actually could get you a lot in terms of human exploration of a virtual environment without having to reduce the system a priori to simply switching on and off an aspect of that environment.

G. Chong, J. Olds and P. Milner

Robert Wurtz: There's also some recent imaging showing that there's part of the brain that is active, depending on the emotion of the observer. This relates to the issue of affect that we were concerned about, and this might be a way of telling whether the particular architectural presentation was viewed as attractive or unattractive.

This, however, is dependent on a prior calibration of what the signals in the image mean to the brain, and at this point, I don't think that's really established, but it holds a promise of being able to get some idea of what the affect of the subject is during the time of the presentation.

Fred Gage: I will just say very briefly, that sweat patches and other measurements, blood measurements can be used as cumulative measurements of experience over time. You can get pretty short-term measurements, but you really don't know what the interval is very accurately in that, but they can be tremendously valuable for monitoring long-term changes.

Clearly, experimentally, we can use the patch more intrusively. The Academy may be able to design experiments within settings for which physiological measures are being taken for other reasons and biomedical reasons but superimpose our questions on it and get the samples in a controlled setting.

We were thinking that some of these measurements, chemical measurements, hormonal measurements, and other measurements that may seem intrusive, but if we were opportunistic, you could go into a hospital setting or whatever and to do that as an added evaluation.

You can use measures of salivary cortisol. It's not invasive, especially if you're studying kids. They love to spit. You can measure all sorts of things in spit. Stress hormones, cortisol, and these are studies that are routinely done in other circumstances. So, within three minutes of a public speaking or mental arithmetic challenge, children and adults of most cultures will have an immediate increase in their salivary cortisol response. It tails off after the challenge is over.

GROUP ON GRADUATE STUDY

M. Shinberg, G. Cooke, M. Tarampi, H. Akil, and J. Eberhard

M. Tarampi, G. Cooke, H. Akil, J. Eberhard, M. Shinberg and J. McRae

John McRae: We talked about creating an educational climate in which people are learning how to apply issues from the neurosciences and architecture together.

That was very important, because we didn't see architects trying to become sort of neuroscience experts or just to accept blindly, if you will, findings from neuroscience and applying them. Rather looking at a way in which schools would develop partnerships at the doctoral level.

We talked about layers; that is, layers in different ways, layers of complexity of knowledge, layers in terms of the range of background that people might bring to a topic, certainly the layers that you target information towards in terms of disciplines and so forth.

Prerequisites become very important and especially the undergraduate level. What do architecture students need to have under their belt, so to speak, before they move into sort of more solid discussion of these topics. Biology and other topics were mentioned there.

One way to reorient architectural education would be to translate the esthetic intuitive approach into a cognitive and perceptual toolkit; that is, like to turn the rock over completely the other way and force yourself into thinking about this from the different point of view suddenly frees you, releases a whole other potential way of doing things. It certainly removes that threatening aspect of the language issue that comes up. The issue of esthetics really gets in the way (perhaps from the standpoint of the value of it) but from the way we talk about it we kind of have this mystical approach that architects keep their cards close to the chest and thinking that they might have the Holy Grail there that no one else has access to. So, we need to look at it in a different way.

Huda Akil: Some students already take psychology or certain kinds of environmental psychology as part of thinking about architecture. It would be good to have evolved a logic for what neuroscience can do, not instead of, but in conjunction with psychology.

So, though we have hypotheses, sooner or later, we have to produce biological data if we are serious neuroscientists, and biology has a way of telling us stuff that we would may

never have thought about. So, for example, yesterday, I made some quick comment about how spatial memory and stress control and evaluation are in the same physical location in the brain. A priori, I may have, if I was very smart as a psychologist, tried to come up with that, but the biology brought my attention that this place, the hippocampus, that has the place cells that Rusty talked about, it is also the area that is richest in those receptors, those proteins that recognize the stress hormones.

So, you say, well, why is that? Where did that come from? Then you start thinking, well, maybe because a stress response is a very important way of evaluating an environment, space, whether it's safe or unsafe, and a space needs to be remembered not just in terms of perception and proportion but also its emotional value, its safety.

Memory is to a large extent enhanced by emotional responses and changes with time are dynamic. So, perception is dynamic, memory is dynamic, emotion, color, all of that.

The brain made it that way. But my point is that if you study the brain, you can ask your questions in a different way. Not every experiment has to be a neuroscientific experiment. They can be behavioral experiments.

H. Akil and J. McRae

John Eberhard: If we could develop a Ph.D. program that produced translators who could understand both architecture and neuroscience. Then instead of architects learning everything that neuroscientists learn or neuroscientists having to learn everything that architect's know, the translator could work back and forth.

Fred Gage: There's a difference, in the end product of what we do. Architects design buildings and they have a skill set with constraints. You're going to build something Neuroscience flourished because, it's really a research unfettered by constraint, any constraints. We have very few constraints. We can investigate anything we want and call ourselves a neuroscientist, whereas architects have to be able to prescribed things. There may be a translator phenotype that emerges, which is the researcher, the neuroarchitectural research person that's doing experiments and gaining knowledge so that the working architect has reliable information that they can apply to their practice.

But I'm less optimistic that the working architect is going to be able to be a neuroarchitect, that they're going to have that same background. It strikes me that there will be a different

discipline. There will be this great research field, but it's not going to be you guys out there that are going to have to become biologists.
You don't want to reinvent the wheel. You don't want to take an architect and turn them into a neuroscientist. We do not want you to learn brain cutting. Maybe there are some architectural students who want to learn brain cutting which is fine, which is what you're talking about, the researchers that are trained in both.

I think that what we need to keep in mind is that we want the other discipline to learn enough of the language, the goals, and the way we go about thinking and asking questions and problem-solving, so that we can see what problems can we solve together and what can we not solve together, because there are going to be problems that we can't answer for you and vice versa.

I think that the trick is that people from different disciplines must respect each other's area of knowledge, respect each other's expertise and say okay, I'm going to learn enough about this to become an informed consumer of the other person's area, so that we can work together to solve problems.

GROUP ON INFORMATION SYSTEMS

S. Akhtar, A. Whitelaw, R. Peterson, B. Provancha and F. Marks

S. Akhtar, B. Provancha, A. Whitelaw, R. Peterson, M. Greiner and F. Marks

Alison Whitelaw: There may need to be a new kind of professional, neuroarchitect or whatever we want to call them, that has a key role in some of these functions. Also the role of the Academy in the filtering and validation of the experimentation at both ends, both from the point of view of reviewing the hypothesis to validate its relevance and then the validation of the research when it comes out at the other end.

We started out with the concept that there is a lot of research (and the results of research) that are available to architects now that start to inform some of these issues that we want to look at. How do we as the Academy — what do we do with this information?

The existing published research falls into two categories. One is from the architectural side or the built environmental side, the other is from the medical scientific side. If we can extract hypotheses from these that appear to be relevant to the Academy and validate those, maybe that would give us some of the ideas for continuing research that will be sponsored by the Academy.

We feel that as time goes on, we may need to establish some kind of a subcommittee, an interdisciplinary committee, that can not only help identify but to also screen some of this research, to make sure that it's something that can either be promoted as just useful information to the profession of architecture or that can be formed as a hypothesis, sort of extracted out of it for further research and validation.

We went on to talk about the importance of the communication between the two disciplines. We feel that there's no substitute for this kind of venue, actually getting together and talking to each other in this kind of a situation, and we would encourage the continuation of that kind of venue, whether it's quarterly workshops or whatever. It's going to be various places in the country and John has already got a good start at getting a lot of these kinds of activities organized.

But then we need to be able to disseminate the information from the workshop proceedings, and we feel that in most cases, this kind of information won't necessarily have to be filtered further. There's a good chance that both disciplines may have interest in just

reading the proceedings of this kind of workshop.

One is the Academy's website. We felt that it would be important for the Academy to issue an annual report just summarizing our activity and the kinds of areas that we're starting to look into. Then there are various existing architectural publications and neuroscience publications in which we feel the exposure of the Academy's activities certainly would be of interest. Eventually, when we have an Academy with full office headquarters location and staff, then we'll have a much better ability to disseminate some of this information out of that office.

The needs for funding obviously are to support specific Academy activities, but also, if the Academy is really going to validate research as appropriate to the Academy's role, then the Academy should have also a role in facilitating funding for that research. That role should be either lending the Academy's name to the research or providing a database of funding sources that are appropriate to that research.

In general, the approach has been that the Academy will not so much be a research institute, that it will lend its name to and facilitate research that appears to be relevant to this discussion.

Robert Noble: I think the website is extremely critical and it will be the most useful tool. *The Scan* is excellent, needs to keep going and expanding. I read it. An annual report makes a lot of sense. I think that's got to evolve over time.

As far as the database goes for the application of everything that's going on, the summary of the articles, the summary of the research that's been completed, a summary even of research that's been initiated that could be on the website as well. Also any summary or information about the workshops and the seminars and the conferences would be extremely valuable. The entire array with a great indexing system and some sort of search mechanism on the site would be valuable.

F. Marks

Fred Marks: When we first established the website, neuroscience for architecture, we realized that we were fortunate to be able to make a statement about bridging science with the built environment. We know of no other organization that is making this link in the United States. We believe in time, as this subject becomes of greater interest to the general public,

that there will be competition. In an effort to maintain our status as the definitive source for information on this subject, we should make an effort right now to align ourselves with the best and the brightest in other affiliated organizations.

Fred Gage: Well, I think it's very encouraging to think of all the opportunities for funding that are available, both in the private and in the public sector. It might be true that in the initial phases of this, we're going to have to rely on private funding to get the smaller projects going, but that doesn't mean that we wouldn't have to start chumming the waters with public organizations to let them know that there are things to be done. Demonstration projects are probably where we're going to begin.

POSTSCRIPT

Barbara Gill: I have to say it was a great pleasure to be able to host you in this landmark building. This dialogue was fascinating. It's the type of dialogue that the Dana Alliance likes to promote and we'd just like to see more of it, and I hope you all get something important out of it and be able to move the Academy forward.

Fred Gage: It might not be too forward to also mention that there is the Dana Press which is a vehicle for publications.

Barbara Gill: If there's anything that we could use, we would. We could work with you. I would turn you over to our publishing arm and have you talk with them. There's some potential there, too.

Fred Gage: I imagine that we have the workings here of something that could develop into a position piece on this field (this field being neurosciences and architecture). There was a book published by Dana Press on neuroscience and ethics called "Neuroethics" which is now becoming quite an important topic and that initial volume, which is the proceedings of a meeting like this, turned out to be really quite extraordinary.

Barbara Gill: And we're working with the AAAS now to publish the proceedings of a workshop that I mentioned earlier on neuroscience and the law. So, we would be willing to talk to you about that. As I said, I'll put you in touch with the editor-in-chief and think of things because that's part of our mission, is to make information accessible and to disseminate it.

Fred Gage: It may well be that this initial gathering of individuals is the nugget that then will lead to a larger, broader meeting which would take the information that we gather here and it would be worthy of a proceedings volume, and I think we have things that are being put on the table now that will allow us to do that perhaps in the future after we sort of vet through this written document. It may be a little early right now to go public, but who knows.

Attachment A - Participants

FROM THE ARCHITECTURE AND ENGINEERING COMMUNITY:

> William Brodt | experimental facilities engineer, Facilities Engineering Division, NASA
> Joyce Bromberg | director of space-planning research, Steelcase
> Gordon H. Chong, FAIA | principal, Gordon H. Chong & Partners
> Gilbert Cooke, AIA | dean, NewSchool of Architecture and Design
> John Eberhard, FAIA | founding president, The Academy of Neuroscience for Architecture
> Mark Greiner | senior vice president of workplace futures, Steelcase
> Frederick M. Marks, AIA | senior associate, Earl Walls Associates, San Diego, CA
> John McRae, FAIA | senior director of grants and development, The American Institute of Architects
> Pam Milner | vice president, SmithGroup
> Robert Noble, AIA | design principal/CEO, Tucker Sadler Noble Castro Architects
> Randal L. Peterson, FAIA | principal, HMC Group
> Bradley Provancha, CHE, CPM | director, Federal Facilities Division, Real Estate and Facilities Directorate, Washington Headquarters Service, Department of Defense
> Milton Shinberg, AIA | principal, Shinberg.Levinas LLC | professor, Catholic University
> Alison Whitelaw, FAIA | principal, Platt/Whitelaw Architects Inc.

FROM THE NEUROSCIENCE RESEARCH COMMUNITY:

> Huda Akil, PhD | professor, Department of Psychiatry, University of Michigan
> Fred H. Gage, PhD | professor, The Salk Institute for Biological Studies
> Barbara Gill | executive director, The Dana Alliance for Brain Initiatives
> James L. Olds, PhD | director, The Krasnow Institute for Advanced Study, George Mason University
> Rev. Patrick Russell, PhD | former staff member, The Neurosciences Institute
> Esther Sternberg, MD | director, Integrative Neural-Immune Program, National Institute of Mental Health, National Institutes of Health
> Robert H. Wurtz, PhD | principal investigator, Laboratory of Sensorimotor Research, National Eye Institute, National Institutes of Health

FROM THE NEUROSCIENCE AND ARCHITECTURE INITIATIVE:

> Saima Akhtar | research assistant, The American Institute of Architects
> Ed Jackson, ArchD | research consultant, The American Institute of Architects
> Margaret Tarampi, Assoc. AIA | research assistant, The American Institute of Architects
> David Weiner | producer of media materials

Attachment B - Working Groups

Our purpose here today is to develop ideas and guidelines for four areas of importance to our Academy in formulating research projects that could help in building intellectual bridges between architecture and neuroscience:

1. Establishing hypotheses appropriate to empirical experiments based on architectural intuition and/or social and behavioral research observations;
2. Proposing imaging techniques known to neurosciences that could be used in conducting tests of such hypotheses;
3. Suggestions for developing interdisciplinary graduate research between architecture and neuroscience
4. Where, when and what to do in organizing databases and publications resulting from such experiments;

GROUP ON HYPOTHESES (staff: Ed Jackson)
> Esther Sternberg
> Pam Milner
> Gordon H. Chong
> James L. Olds
> Robert Noble
> William Brodt

GROUP ON IMAGING TECHNIQUES (staff: David Weiner)
> Fred H. Gage
> Barbara Gill
> Robert H. Wurtz
> Joyce Bromberg
> Patrick Russell

GROUP ON GRADUATE STUDY **(staff: Margaret Tarampi)**
> John Eberhard
> Gilbert Cooke
> John McRae
> Huda Akil
> Milton Shinberg

GROUP ON INFORMATION SYSTEMS (staff: Saima Akhtar)
> Alison Whitelaw
> Mark Greiner
> Randal L. Peterson
> Bradley Provancha
> Frederick M. Marks