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Planning for Research in the 21st Century at a Large Natural History Museum

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I have been serving as the Director of Research at the California Academy of Sciences for the past three and a half years, which puts me in a position to have had firsthand experience with the planning process that I will be describing for the future of the research enterprise at the Academy. In this presentation, I will first discuss why are we planning and why in the time frame that we have chosen. I will then outline the steps we have taken in our planning process and the sequence of events that have transpired over the past few years. Lastly, I will talk about where are we now in the planning process and conclude with a consideration of some of the remaining challenges that we face at the Academy?

Why Planning and Why Now?

Our planning process actually began nearly eight years ago in response to a number of stimuli, both internal and external, to our institution. The external stimuli included the approach of a new millennium, traditionally a time when institutions and cultures take a serious look at themselves — review their past, take stock of their present status, and look toward their future — and it is an auspicious time to do that. Our current Executive Director, Patrick Kociolek, who was then Director of Research at the Academy, recognized that profound changes were occurring in the systematics community, in systematic biology; and he wanted to see how well the Academy's research program was aligned with current trends in this field, to try to anticipate what additional changes might lie ahead in systematic biology, and to ascertain how well prepared we were to meet any new demands brought on by these changes.

Changes underway at that time affected just about all aspects of our research effort (see Jablonski and Ghiselin, 2004). These included challenges to and changes in the theoretical bases of systematic biology, even including our traditional systems of botanical and zoological nomenclature and their appropriateness for classifications based on phylogeny (see, for example, Härlin 2004). Previous analytical methods were under new scrutiny and challenged by new approaches (e.g., parsimony versus maximum likelihood and Bayesian methods for evaluating data, constructing phylogenetic hypotheses, and evaluating cladograms). Our tools were changing, perhaps more rapidly and dramatically than any other aspects of our science. Certainly the rise and widespread use of molecular tools were already underway in systematics; but the development of new tools for imaging, data analysis, data gathering, databasing, GIS, electronic publication, and use of the Worldwide Web were opening up a new set of powerful capabilities for increasing our output and broadening the scope of dissemination of new information that our research generates. We needed to know if we were in position to take advantage of these new tools.

Perhaps most importantly, we sensed that changes were occurring within the World community with respect to the perceived relevance of systematics and what it has to offer for discovery and description of biodiversity, for conservation, and for resource planning and management. There were, and are, signs that suggest that we may be entering a golden age for systematics, one in which there is a growing appreciation for what systematics is capable of delivering to society at large, as well as to the scientific community, if we make use of the tools and techniques that we have available to us now.

Our planning process also gained impetus from several internal stimuli. Most obviously, we were faced with an aging building complex that had inadequate, outmoded, and, at least in some areas, literally crumbling infrastructure. At a minimum, a basic facilities upgrade was urgently required. But more subtle stimuli were also operative. In 2003, we would celebrate our 150th anniversary as an institution. Such an event is another good occasion for an institution like ours to celebrate both its past and its present and reassess its directions with respect to the future. In addition, it was not an insignificant fact that, at that that time, we had our first non-rotating Director of Research at the Academy. Traditionally, that administrative position had rotated on a more or less regular basis; and Dr. Kociolek was our first "permanent, non-rotating" Director of Research. Whether he actually stayed in that position longer than his predecessors or not (which he did not), he was free, by mandate, to adopt a mindset that his predecessors did not have. He could look to the long term success of the research enterprise and begin processes that he could expect to guide and develop over a longer term. I think that this was a major factor resulting in the start of a most fruitful review and evaluation process.

It was already clear to everyone on staff, and especially to Dr. Kociolek, that we needed extensive changes to and upgrades of our physical facilities, our organizational structure, and our resources in support of research. At that time, we could not anticipate all the changes that were ahead of us, and both the pathway taken and our the goals have changed since this review and planning process began.

Steps in Our Planning Process

The planning process really began in June 1996, when the Academy initiated a "situation analysis" of its research enterprise. This was a combined internal and external review of our programmatic assets, our strengths, our weaknesses, our limitations, and the opportunities of which we might take advantage. At that time, we were not yet contemplating any major renovations of the physical plant; and minor renovations were all that we could expect to have approved for the facility in Golden Gate Park. The focus was mainly on programs, collections, human resources, and on what we could accomplish without radical changes to the physical plant. The main thrust of our assessment was on program.

In July 1997, a little over a year after the process had begun, and once the results of the situation analysis had been digested and distributed in a report, Dr. Kociolek convened a Research Division retreat to discuss and evaluate the findings of that report and, subsequently, to clarify our institutional programmatic aspirations. What could we hope to achieve? What was beyond our means? In what areas were we underachieving? What were we lucky that we had been able to do? We also wanted to formulate some specific goals and strategic initiatives for the research enterprise at the Academy to fulfill our aspirations. It was a wonderful session. We sat down and told each other to "dream the dream." What did we want to do, what did we want to be, and how can we achieve these dreams? Again, we were still constrained by a sense that we were not going to be able to alter radically our physical plant. With such a constraint, we kept encountering limits to

what we felt we could do; so this kept our focus mainly on program and what we might be possible within the existing facility.

In 1999, Dr. Kociolek became the Executive Director. With the change of administration came a new vision for the whole institution (see Kociolek, in this volume) and certainly for the Research Division. We preceived it as a great advantage for the Research Division, and for the whole institution, to have a practicing scientist as Director. The vision that Dr. Kociolek articulated, and with which staff agreed, was that of a fully integrated natural history museum, one in which research is at its core and permeates everything the institution does. In light of this vision, staff were then charged with re-examining just about every aspect of our programs, our organizational structure, our facility, our infrastructure, and the various collaborations that we had developed, both internally and externally. It was an incredibly expanding experience to start thinking about what we were doing on that broad a scale. It became clear immediately that this vision could not be implemented fully in the current or even modestly expanded facilities, and that wholesale changes in the physical plant were required. In turn, such a physical change could eliminate former programmatic limits and permit the growth of broader capabilities than previously conceived (see Kociolek, this volume).

Freed from former physical limitations, at least in theory, the planning process shifted to an evaluation of our program, present and future at three different level. First was our intellectual program – what do we want to do? For the Research division, the answers to this question had already been generated through the steps taken during the previous two years. We had a plan, an intellectual program, that we had worked out together. The next step for us was to integrate that plan with the plans and programs that were being developed in education, exhibits, and other public programs at the Academy. That was the main modification that we had to make to our intellectual program for Research.

The second level of evaluation was of our organizational program. What organizational structure would best facilitate the intellectual program for Research and, then, the integrated program for all the elements within the Academy. At that time, for example, Education was part of the Research Division; and the programs for these two major elements were too diverse to be administered together. Subsequently, our Education department was moved to its own Division of Education with its own director, and the office of Provost was established to coordinate the programmatic interaction and integration of these two major units. Within the Research Division, we looked at how we were structured to determine if the present organization of departments, or some other arrangement, would better enable us to implement our intellectual program.

The third and final level of evaluation addressed our physical program. What facilities do we need to carry out our intellectual program? Our present facility includes 13 buildings, more or less conveniently linked to each other, each built at a different time and presenting different infrastructural challenges and limitations. Freed, at least intellectually, from the constraints of the existing complex, we've focussed most of our time over the past three years looking at our physical program. Our evaluation included a careful new review of the current facilities, and their strengths and weaknesses. We'd just gone through this process with the situation analysis; but the new option of a major renovation of facilities provided expanded possibilities and required another look at what changes might be beneficial. What are our special needs? What are the major growth areas among our collections? What adjacencies are necessary or at least preferable? How would we rearrange departments, laboratories, and offices given the freedom to do so? What kinds of internal and external collaboration do we really want to foster, and what, if any, are the physical needs of these collaborations?

As part of this process, and in my capacity as division director, I made benchmarking visits to

about a dozen other institutions around the country that had recently built new facilities or renovated old ones. I saw the good, I saw the not so good, and I think we gained greatly from the experience of the other institutions. I found that curators, in general, are outspoken about their facilities; and whether facilities work well or not, you hear about it. Staff at every one of the institutions visited had stories to tell about things that went wrong (e.g., air ducts that passed through the middle of collections spaces). Obtaining such feedback was essential for evaluating our own planning, a good check to see if our ideas were in line with best practices and developments elsewhere. Let me cite four examples from among the many facilities visited.

Dr. Tom Daniel, of our Botany Department, and I visited the New York Botanical Garden's new wing (Fig. 1) that was designed exclusively for collections, but which was not yet fully occupied. Although there are a couple of visitor office spaces in that wing, at that time (2000) the location of staff office spaces in relation to the collection building had not been determined. Fron a collection standpoint, this is a fantastic facility, with fully a compactorized library and collections in a combination of new and old cabinetry (Fig. 2), all modified for the same moveable carriage system.

The Missouri Botanical Garden's Monsanto Center (Fig. 3) is another a wonderful facility with a superb spatial relationship between the collections and the research work area. We also visited the Research Institute at the Getty Center in Los Angeles (Fig. 4), mainly to view their 12-foot high compactors (Fig. 5). Because of the high cost per square foot for new construction, we were interested to see what the upper height limit might be for storing collections. Our conclusion was that 12 feet was probably too high for compactors for natural history collections. I also visited the new museum on the University of Oklahoma campus — the Oklahoma Museum of Natural History (Fig. 6). It is an institution endowed with abundant space, built on a 40-acre site with room to expand, so planners did not need to consider compactorization. Among several interesting features of this facility were perhaps the best facilities and protocols I had seen for quarantine and fumiga-

FIGURE 1. Exterior view of the new wing for botanical collections at the New York Botanical Garden, New York City. Photo by author.

FIGURE 2. View of a collection area in the new wing for botanical collections at the New York Botanical Garden, New York City, showing compact storage system and layout space. Photo by author.

tion of materials entering the museum. Figure 7 shows the museum's registrar standing next to an inflatable carbon dioxide chamber that is used to fumigate large objects or large quantities of incoming materials. The freezers along the back wall in the picture also are used to treat certain incoming materials.

CURRENT STATUS OF OUR PLANNING AND PROJECT

In response to our initial situation analysis in 1996, and largely as an outcome of our 1997 retreat, we generated a current status report. Among our findings were the following: (1) we currently have eight research departments in locations widely distributed throughout our building; (2) our facility is a complex of buildings that were added, one by one, over the last 70 year period; (3) our collections total more than 18 million specimens and are worldwide in scope; (4) each of our collections has particular geographic and taxonomic strengths, and most are ranked in the top ten nationally or internationally; (5) all of our collections are out of expansion space, or nearly so; (6) our collections are active and growing at an average rate of about 2% per year, though faster in the Entomology, Invertebrate Zoology, and Herpetology sections; (7) at present, collection growth rate is probably higher than at any other time in at least the last 50 years, this as a result of activities associated with grants through the BSI, PBI, and Tree of Life programs at NSF — all programs that foster intensive collection acquisition, if not curation; and (8) with regard to electronic databasing

FIGURE 3. Exterior view of the Monsanto Center, Missouri Botanical Garden, St. Louis. Photo by author.

of collections, our record is varied; whereas small to relatively modest percentages of the largest collections have been databased with specimen-level databases (e.g., Entomology, Invertebrate Zoology), others are fully databased (e.g., Herpetology). Our Anthropology collection, which is our smallest collection, not only has all of its specimens databased but most are already digitally imaged. At the other extreme is Entomology, our largest collection, with perhaps eight million specimens still requiring retroactive databasing, although we're doing a very good job keeping up with incoming material and have databased nearly one million new specimens in the last two years.

We also determined that our physical plant severely limits many aspects of our current program and will not support what we envision for ourselves in the future. In particular, we have very poor adjacencies. We also have inadequate laboratory facilities for the tools that are available or should be available to us now. With regard to the research personnel, we have a modest staff considering the size of our collection: 21 curators and another 10–20 research scientists (including post-docs, resident research associates, Emeritus Curators, and other researchers). In all, we have about 130 paid staff in the Research Division, totaling about 80 FTE's. At the moment, our graduate student population is steady at about 25; they are supervised by Academy curators or researchers. Finally, we have hundreds of volunteers, who contribute greatly and are essential to the work of our departments.

Another finding of the status report was that research staff are distributed too widely throughout the institution to facilitate frequent interaction and easy collaboration. Figure 8, a map of our current facility with the locations of our curators' offices plotted in different colors for different

FIGURE 4. Exterior view of the Research Instititue at the Getty Center, Los Angeles. Photo by author.

floors, shows that our scientists are distributed broadly, mainly around the periphery of the complex. We view this distribution as a negative.

We have an excellent institutional record of obtaining facility and collection support grants; and, in the last five years, we have had many more research grants awarded than in the past. Also, our record of modest research productivity and relatively low representation in so-called "high impact" journals has improved dramatically.

We currently have several successful collaborative programs in place for training students and young scientists in systematic biology, with virtually all of these having been established within the last five years. Figure 9. shows the expansion of our training program, for several "student" categories ("measures"), over the past 10 years, but most dramatically over the last five years. We now have formal joint programs with San Francisco State University (our most active program), and also with the University of California at Santa Cruz and Stanford University. We also share students with Sonoma State University and the University of California at Davis. This has resulted in a rapidly increasing involvement of our staff in the training of students at the graduate and undergraduate levels, especially over the past five years. Also, we've been very fortunate to have received substantial foundation support, specifically for the training of students from developing countries. We also have a program called the Summer Systematics Institute, which now has been running for eight summers, that brings undergraduates from all over the country to San Francisco to work directly with Academy scientists on real research projects. This program has enjoyed consistent and enthusiastic support from the NSF.

FIGURE 5. View inside 12-foot high compact storage system at the Research Instititue of the Getty Center, Los Angeles. Photo by author.

FIGURE 6. Exterior view of the Oklahoma Museum of Natural History, University of Oklahoma, Norman. Photo by author.

ASPIRATIONS AND GOALS

Based on our planning to date and following our extensive self-evaluation, we have articulated a set of aspirations that are shared throughout the Research Division. They include (1) excellence in whatever we do; (2) leadership in systematic biology and in the training of graduate students in systematics; (3) integration of the research with the other aspects of a natural history museum; and (4) collaboration, both within our institution and with scientists and institutions outside of our own walls. NSF is creating program after program that support these aspirations. The natural sciences today require greater levels of collaboration than we have been used to traditionally.

Those are our aspirations. What are our goals? We want to achieve high levels of productivity and quality in original scientific research. We want to foster multidisciplinary research, especially within our own walls. Such collaborations represent a return to our roots. The collections we have now really sprang from the recovery after the earthquake and fire in San Francisco with the return of the schooner *Academy* from the 1905–06 expedition to the Galápagos Islands. We had numerous Academy multidisciplinary expeditions to Baja California, to China, and elsewhere around the globe early in our history, and we're returning to this approach because it is still a good way to work. We want to play a major role in the training of the future generations of systematic biologists. We want to further develop the depth and breadth of our Academy collections. We make good use of them, and it's something we ought to do because we do it well. We want to make the Academy collections and the data that are associated with them more accessible and useful to the

FIGURE 7. View of the quarantine and fumigation area at the Oklahoma Museum of Natural History, Norman, with the museum's registrar standing beside an inflatable CO_2 fumigation chamber and "fumigation" freezers in background. Photo by author.

broadest as possible audiences. We also want to increase public and peer awareness of the Academy research enterprise as broadly as possible.

We plan to accomplish these goals through a series of strategic initiatives that include, among other, the following: Focus staff energies and resources on building leadership in research, which might include restructuring departmental units within the Research Division. We have eight research departments; and three of them are single curator departments, so some merging of departments may be productive. We have needed to review our curatorial appointments, promotions and review procedures, and salaries, and have recently made significant improvements in all of these areas, most significantly in salaries, so that we are much more competitive than we were just five years ago. We want to create a wide range of opportunities to elevate the intellectual environment of the Academy, particularly by attracting visiting scholars, offering postdoctoral fellowships, adding to our graduate student population, and offering undergraduate fellowships and internships, all areas in which we are making good progress already. We will require that our new facility contributes to this development even further. We wanted to create a center for biodiversity research and information, and this we have already done. Its charge is to foster multidisciplinary research and the preparation of broader and higher impact publications, based on syntheses of the work of individuals working collaboratively. Also, this office and center will be responsible for and facilitate development of information systems that cross disciplinary lines and are created in a way that makes them more useful throughout the institution and also externally.

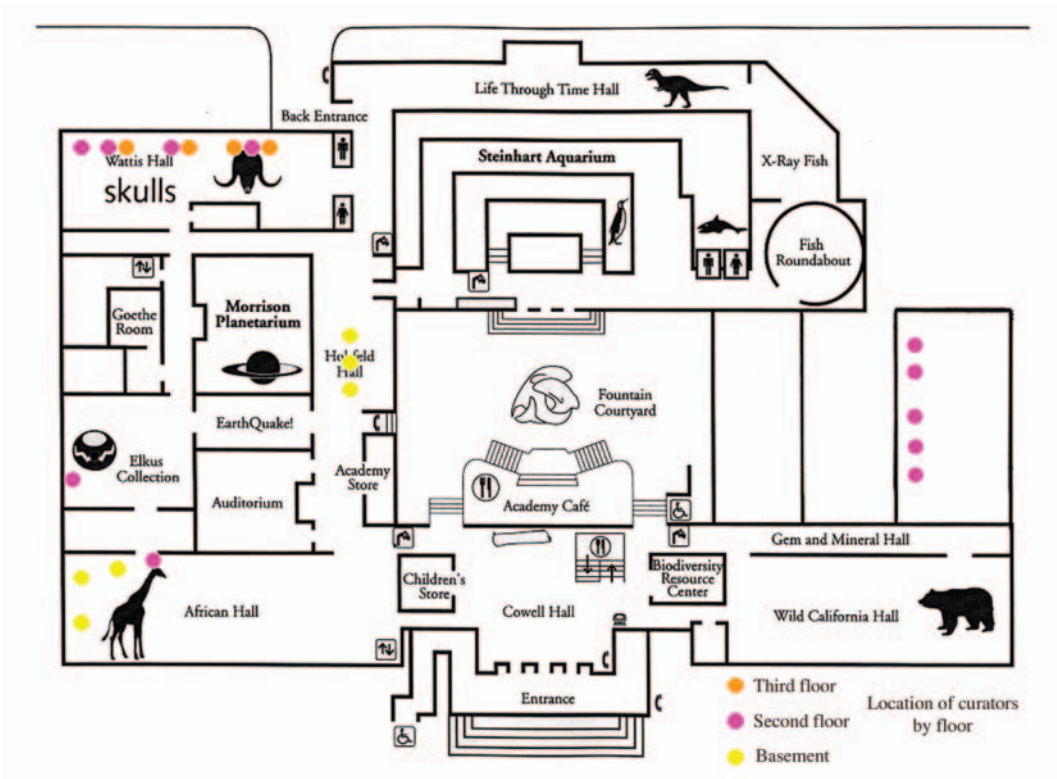

FIGURE 8. Floor plan of the present California Academy of Sciences, with the distribution of curator offices by floor (indicated by color circles [see legend]).

Goal: Training of the Next Generation of Systematists

measures	1991-92	1996-97	2001-02
# Postdoctoral Fellows	3	4	4
# Graduate Students Committees	18	14	26
# Graduate Students Supervised	0	2	24
# Undergraduate Interns	0	9	8
# Foreign visiting students/ young professionals	?	?	15

FIGURE 9. Goal: Training of the next generation of systematic biologists at the California Academy of Sciences, 1991 through 2002

Through our different cross-disciplinary discussions, we identified several geographical areas in which several of us plan to continue working collaboratively. Chief among these are Madagascar, China, Myanmar, the Galapagos Islands, and Papua New Guinea, areas that already represent both institutional research and collections strength. We want to continue to build on these strengths, and we want to recruit staff for this purpose. At the same time, because we, as an institution, must manage our collections for the benefit of the larger scientific community, we cannot ignore our responsibilities to that community. For instance, we feel an obligation to provide a safe haven for orphan collections through selective acquisitions and to provide working space for those who need to access those collections for. Thus, we recognize the urgent need to obtain additional space for research and collections.

Early on, we recognized and established a series of 15 or so assumptions that not only have guided us in our planning process, but that have survived the test of time and still remain in affect. For example, we assumed (1) that the research staff, departments, and collections would remain in Golden Gate Park with the education and exhibits programs; (2) that we would build the space required to accommodate fully our staff and programs; (3) that we would have ready access to our collections; and (4) that adequate space would be available not only to accommodate our existing collections but also allow for at least 20 to 30 years of growth.

Where Are We Now? — Challenges Ahead

At present, we are still in constant dialog with our architects, who continue to refine their designs for the new facilities in keeping with our programmatic requirements for space allocation and attributes, adjacencies, and fiscal concerns. Current plans call for a nearly complete dismantling of the present physical complex and then building of the new facility on our present site in Golden Gate Park. The demolition and rebuilding process is expected to take nearly four years to complete. This plan will require that we move our entire operation, including all collections, to an interim facility for that period.

For most of us, the sheer magnitude of the effort that will be required for the moves, first to temporary quarters and then back again a few years later, represents a daunting challenge. Not only do we plan on maintaining as complete a research program as possible during the period in temporary quarters, but we also will use this period to test many of our assumptions about appropriate adjacencies and spatial needs and attributes, how we will work in the future, and the effectiveness of our strategies for reaching our long-term programmatic goals. It should be an exciting and challenging time!

Literature Cited

Fisher, B.L. 2004. Problems in species assessment: a case in Madagascar. In: N.G. Jablonski, ed., Biodiversity: Past, Present, and Future. *Proceedings of the California Academy of Sciences* 55(Suppl. III).

Härlin, M. 2004. Naming clades: comparing phylogenetic approaches to biological nomenclature. In: N.G. Jablonski and M.T. Ghiselin, eds., The Future of Taxonomy. *Proceedings of the California Academy of Sciences* 55(Suppl. IV).

Kociolek, J.P. 2004. The California Academy of Sciences: 150 years young with a vision for the future. Pages 307–313 *in* A.E. Leviton and M.L. Aldrich, eds., Museums of Natural History: Past, Present, and Future. *Proceedings of the California Academy of Sciences* 55(Suppl. I)(15).