SIXTH

PERFORMANCE EVALUATION

OF THE

OCEAN DRILLING PROGRAM

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Executive Summary:
Major Findings and Recommendations

The Ocean Drilling Program (ODP) has been one of the most successful international Earth Science Programs. Over a period of twenty years, ODP has significantly advanced our understanding of Earth's history, structure, and processes through deep ocean drilling. Activities are now underway to preserve the scientific, technological, and experiential legacy of the Program, and ensure a smooth transition to the new Integrated Ocean Drilling Program (IODP).

Based on input from ~90 members of the international drilling community, meetings with the Program management and subcontractors, and review of phase-out and legacy documents, the Sixth Performance Evaluation Committee (PEC VI) makes the following *major* observations and recommendations. Additional recommendations are in the text, and a comprehensive list of *all* recommendations is in Section VI (page 35).

Completion of the Goals of the Long Range Plan

- ODP has done a credible job of addressing the spectrum of "Environment" and "Interior" themes showcased in the 1996 Long Range Plan (LRP). Contributions to both scientific themes have been substantial. ODP successfully implemented many aspects of the Strategic Implementation Plan; others were unable to be implemented.

- Most of the failures in accomplishing the goals of the LRP can be attributed to a combination of three factors:
  1) lack of long-term community commitment to complicated objectives, multi-leg program opportunities, and technical developments,
  2) technical limitations, including the use of only one ship, thus restricting areas available for drilling,
  3) flat funding since the development of the Strategic Implementation Plan in 1997. This limited what could be achieved, no matter how effectively ODP was managed.

Phase-out and Legacy Preservation Plans for ODP

Since the Committee was given its charge, the ODP phase-out plans changed due to the US IODP contract being awarded to the JOI Alliance (i.e., they are handing off to themselves). The findings of the Committee are as follows:

- Phase-out and legacy preservation plans for ODP are appropriate (with some timeline extensions) and are well underway within Logging Services and the Site Survey Data Bank (LDEO), and for Science Services and Publication Services (TAMU).
- Although the phase-out and legacy plans for Information Services at TAMU will be completed within an appropriate timeline, the Committee has identified one omission.

- There is no plan to develop a database of the collection of core close-up photographs taken on board the *JOIDES Resolution*. In addition, the Committee notes that there is no micropaleontological database in Janus linking species ranges and time.
- Plans for legacy preservation within Drilling Services are of great concern. Although recent plans call for the assistance of employed technical writers, there may be insufficient resources to complete the legacy documentation in a timely fashion. This will need further assessment within the next six months.
- No plan exists for preservation of a historical, systematic record of the public relations material, activities and resulting products produced by ODP.

PEC VI Recommendation 1: Monitoring legacy activities

JOI and its subcontractors should monitor progress on ODP legacy preservation on a routine basis, with a final external review suggested in FY'06 to ensure that legacy activities have been completed satisfactorily.

PEC VI Recommendation 2: Core close-up photographs

TAMU should develop a database of the collection of core close-up photographs taken on board the *JOIDES Resolution* and make it accessible to the scientific community. This project is of lower priority than others for Information Services and could be completed over a timeline longer than the planned phase-out.

PEC VI Recommendation 3: Public relations/outreach materials

JOI should develop a systematic record of all ODP public relations/outreach materials and activities, including to the degree possible those developed by individual member countries/consortia.

Effectiveness of JOI Program Management and JOIDES

The success of ODP is also widely attributed to the effectiveness of JOI Program Management and its subcontractors in delivering excellent services, and to the JOIDES Scientific Advisory Structure for providing sound scientific advice. The Committee believes that the ODP Science Advisory Structure model is an appropriate starting point for IODP, with some adjustments to deal with the shortcomings listed below. However, the Committee expects that the challenges of a multi-platform program may require revisions as operational experience is gained.

The Committee finds that:

- ODP did not conduct effective, ongoing program evaluation and assessment regarding the degree of success of the drilling in meeting the stated scientific objectives.
- ODP's education and public outreach efforts have been limited and piecemeal, reflecting the extremely limited commitment and budget for these activities.
- The array of ODP websites that exist has been detrimental to informing potential participants and the general public about the Program.

- The change in Publication Policy and formats in 1999 has resulted in a more distributed scientific legacy for ODP – one that is not as easily captured. This change may also have resulted in a loss of taxonomy and range charts of species from ODP.
- Enforcement of the "obligation fulfillment" policy for shipboard scientists has been weakened.
- The record of large engineering developments within ODP was weak, despite the success with numerous smaller drilling, coring and logging engineering projects.
- The short planning timelines throughout ODP have not only had budgetary consequences, but have also impacted cruise planning and staffing, and long lead-time purchasing.
- Communications between industry and ODP never fulfilled expectations. In particular, the Technology and Engineering Development Committee (TEDCOM) was not effective in providing long-term advice to ODP.
- The Operations Committee (OPCOM) was not fully successful in ensuring that operational plans were consistent with the scientific objectives of the scheduled program. There was less than optimal oversight by SCICOM of OPCOM activities related to leg planning.
- The interfacing of geophysics (for regional characterization and site-specific description) with drilling and sampling remained imperfect and unclear to proponents throughout ODP.

Recommendations for IODP

The Committee notes that many of its findings have important implications for activities within the new IODP. Although not specifically within its mandate, the Committee has compiled a set of recommendations that it wishes to pass on to IODP.

PEC VI Recommendation 4: Nature of IODP

ODP was borne by the good will of a large international scientific community who cooperated as volunteers to solve scientific problems and to overcome financial, political and cultural hurdles associated with the conduct of the Program. These same attributes will be a prerequisite for a successful new international drilling program. Despite the increase in complexity in IODP, management and advisory structures should be kept as small and simple as practicable to underpin IODP's integration and its proposal-driven nature.

PEC VI Recommendation 5: Internationalism

Internationalism along with scientific diversity was one of the greatest strengths of ODP. The advisory and management structure of IODP should maintain broad international participation extending beyond its membership, and attract scientists from all experience levels.

PEC VI Recommendation 6: Funding

Level funding led to unacceptable erosion in the ability of ODP to achieve the promise of the Strategic Implementation Plan. In the future, the funding agencies and their respective prime contractors must be diligent in attempting to provide financial resources over the long term if the scientific, operational, and implementation priorities of IODP are to be achieved.

PEC VI Recommendation 7: Partnerships with other programs

Partnerships with other international research programs will increase in IODP, and are very desirable. It will be important to delineate the scientific, operational, and fiscal responsibilities of each partner early in the planning process.

PEC VI Recommendation 8: Continuous legacy

One of IODP's highest priorities should be to establish the *continuous* gathering and documentation of information regarding its operations, with specific regard to the evolution of the shipboard and shore based laboratories and operations, engineering development (both small- and large scale), publications, and data management. This priority should be established throughout IODP at all levels and institutions. This priority can be best achieved by prompt establishment of a strong and centralized Information Services Center mandated and supported by the Central Management Organization (CMO), and by providing support for technical writers as necessary.

PEC VI Recommendation 10: Publications

The IODP publications program must provide for the widest possible dissemination of the Program's scientific achievements in a variety of formats so as to maximize the use of IODP data within a broad scientific community with different cultures.

PEC VI Recommendation 14: Planning timeline

ODP was limited by planning tied to annual budget cycles. The complexity of IODP will require long lead-time and long-range planning. While the Committee recognizes the reality of annual budgeting, it recommends systematic, multi-year operational program planning.

PEC VI Recommendation 15: Program evaluation

A rigorous and frank ongoing program of evaluation and assessment needs to be put in place at all levels in IODP.

PEC VI Recommendation 16: Education, public relations and outreach

IODP management should establish significantly more effective and sophisticated approaches to both Education and Outreach. These endeavors, although traditionally linked to each other, have different goals, and should be decoupled. Each requires substantive resources and its own strategic implementation plan. In addition, although education and outreach activities are being planned independently in the member countries, they should follow an overarching IODP strategic implementation plan.

PEC VI Recommendation 18: Planning oversight and control of project creep

The Committee recommends that SPC provide greater oversight of the planning process for each expedition to (i) ensure that operational plans are consistent with the science objectives, (ii) advise the IOs in containing project creep, and (iii) allow for better long-term planning in IODP. The Committee recognizes that this will require a change in the timeline for ranking and scheduling of proposals, and recommends the timeline for this process be reviewed.

PEC VI Recommendation 19: Role of OPCOM

IODP should reexamine the role of OPCOM in the Science Advisory Structure and make changes to ensure the best interface with the CMO and IOs in the development of operational plans.

TABLE OF CONTENTS

I. INTRODUCTION

The Ocean Drilling Program (ODP) has been a highly successful international partnership aimed at exploring Earth's history, structure, and processes through deep ocean drilling. Over a period of twenty years, there have been over 2600 scientists (some repeat) who have sailed on 110 cruises on the drilling vessel *JOIDES Resolution*, and numerous others who have requested samples from the core repositories. ODP completed shipboard science operations in September 2003 and is now in the process of completing its publication and database obligations for the final cruises. In addition, activities are underway to preserve the legacy of ODP, and to ensure a smooth transition to the appropriate entities within the successor to ODP – the Integrated Ocean Drilling Program (IODP).

Throughout ODP's history, Performance Evaluation Committees have been convened every 3-4 years to assess the effectiveness of the program both in achieving its scientific goals, and in providing the necessary services to the international scientific drilling community. At their June 2002 meeting in Granada, Spain, the Executive Committee (EXCOM) approved the Charge and Terms of Reference for the sixth Program Evaluation Committee (PEC VI) for ODP. The Committee was charged with addressing five specific issues:

- The Committee should assess to what extent the goals set up in the ODP Long Range Plan have been achieved, and to what extent the Program was implemented in comparison to the Strategic Implementation Plan 1998 to 2003 presented by JOI (1997).
- The Committee should examine all aspects of the phase-out program.
- The Committee should look at all aspects of the phase-out as it impacts the commencement of the new IODP drilling program.
- The Committee should assess provisions to present and preserve the legacy of ODP. This should include the legacy of cores and core repositories, the legacy of tools and techniques, the legacy of databases, and the scientific legacy. Since the science will not be completed for several years after the formal end of ODP, it is necessary to ensure that adequate plans are in place for carrying out this task until the end of the Program in the absence of an international oversight group.
- The Committee should assess the effectiveness of the JOI program management and the JOIDES scientific advisory structure, which was changed in the middle of ODP on the advice of a previous PEC, to determine whether these are the most appropriate models for the IODP and, if not, suggest changes.

The Terms of Reference also noted the fact that there would be no international oversight group in existence during the operation of PEC VI, and deemed it especially important that the Committee seek input from the non-US community.

PEC VI was set up by JOI in April 2003 – brief résumés of the members are included in Appendix 1 – and commenced work in May. In August, it was announced that the JOI Alliance (JOI, Texas A&M University, and Lamont-Doherty Earth Observatory) had been successful in their bid to manage the US component of the new IODP. This affected the phase-out and legacy plans as this group was now not only handing off to themselves, but was also in the position of trying to complete phase-out and legacy activities while ramping up for the new IODP with the same staff. Hence, the Committee paid particular attention to whether the JOI Alliance was maintaining a focus on legacy issues, despite the operational imperatives of IODP.

The Committee conducted a number of activities aimed at collecting opinions about various aspects of ODP from the international scientific community. These included:

- A questionnaire sent to the international scientific drilling community to solicit opinions on ODP Management Structure, Program Services, International Partnerships and Participation, and the ODP Legacy. (A copy can be found in Appendix 2.)
- Open sessions at the July EXCOM meeting in Bermuda, Cardiff University, and Southampton Oceanography Centre (UK) to collect input on the topics listed above.

Through these mechanisms, 90 individuals and one group (the Japan Drilling Earth Science Consortium: J-DESC) provided input to the Committee as shown in Figure 1.

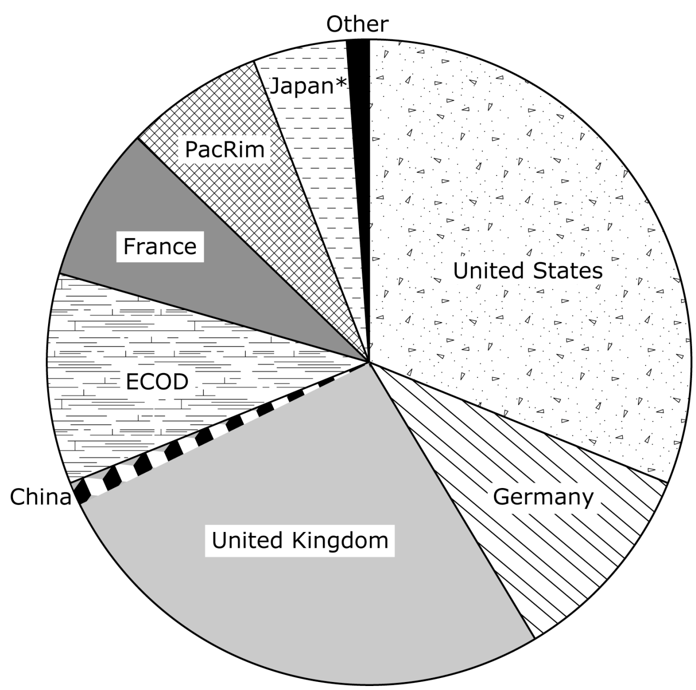

Figure 1. Distribution by ODP partner of input to the PEC VI Committee by 90 individuals and groups via questionnaire responses or open meeting participation.
(* - includes one group response from J-DESC.)

In addition, the Committee examined specific plans presented by JOI, TAMU, and LDEO for phase-out in various documents and during a three-day meeting in October with

JOI, TAMU and LDEO representatives in College Station, Texas. The Committee also held a two-day meeting in November at JOI in Washington, DC, during which a conference call was conducted with the Site Survey Data Bank.

The findings of the Committee, together with recommendations, are reported in four sections that follow: Scientific Accomplishments of ODP, Phase-out and Legacy Preservation for ODP, the Effectiveness of JOI Program Management and JOIDES, and a final section discussing Lessons Learned during ODP and their Implications for IODP. Throughout, all recommendations are numbered sequentially; minor recommendations are designated by *italics*. Section VI contains a complete listing of all recommendations.

To aid in understanding the complex relationships between various management and scientific advisory groups, diagrams of the organizational structure as it existed at the end of ODP and the developing structure for IODP are both included in Appendix 3.

II. The Scientific Accomplishments of ODP

The Ocean Drilling Program (ODP) began operations in late 1984 and ended on October 1, 2003. During its first decade, community input to the science of the program was coordinated by two Conferences on Scientific Ocean Drilling (COSODs) - COSOD-I (1981) and COSOD-II (1987). COSOD-I identified twelve top priority scientific objectives within four broad thematic areas, while COSOD-II identified fourteen broad goals within five, more process-oriented themes. Since that time, a large number of smaller workshops on various topics have been held (see http://www.joiscience.org/JOI/Publications.html#anchor297700).

The 1990's saw development of two ODP Long Range Plans: the first in 1990 and the second, "Understanding our Dynamic Earth Through Ocean Drilling", in 1996. During its second decade, ODP became less driven by reconnaissance (a primary motivating force behind its predecessor, the Deep-Sea Drilling Project (DSDP)) and instead became more focused on coordinated studies of ocean-based processes. This shift was encapsulated by the 1996 Long Range Plan (LRP), which identified the "Dynamics of Earth's Environment" and "Dynamics of Earth's Interior" as the "vision for a new era of exploration." That process orientation motivated a major reorganization of the JOIDES science advisory structure in 1997; a similar process-based focus continues in planning for IODP (Appendix 3).

Assessing ODP in terms of accomplishing its stated scientific goals and objectives through time has taken a number of forms. In 1993, based upon ODP operations and proposals in the system at that time, COMPOST-I ("U.S. COMmittee for POST-1998 scientific ocean drilling") affirmed the success of ODP up to that point. However, it admitted that one drilling platform could not possibly deliver on all of the science proposed by the constituent community, and so it formulated an initial proposal for a multi-platform scientific ocean drilling program. A multi-platform approach that included riser drilling was later endorsed by the 1996 LRP as a requirement for post-2003 drilling, and such an approach is now codified in IODP. In 1998, COMPOST-II ("U.S. COMmittee for POST-2003 scientific ocean drilling") again reviewed the accomplishments of the program and reaffirmed a commitment to what was termed "investigator-driven science". Perhaps for the first time, it recognized that drilling is but a part of a cascade of activities that includes site-appropriate, pre-drilling (geophysical, geotechnical) characterizations and post-drilling utilization of boreholes (e.g., as observatories). It also emphasized education and outreach as a primary activity, and encouraged development of partnerships (e.g., with industry). All of these recommendations became an important part of the last five years of ODP and have been incorporated as fundamental tenets of IODP.

In 2002, SCICOM members made individual assessments of the ODP legacy in their own fields of expertise in response to a request from EXCOM to answer the question: "How well did ODP do in answering the questions originally asked?" Their responses are included in Appendix 4, and, as a group, they represent informed opinions of the successes and failures within the various thematic areas. PEC VI appreciated the transfer of this information by EXCOM, as it represents a broad, community-based assessment of the extent to which the goals set up in the Long Range Plan have been achieved.

II. 1 ODP's Strategic Implementation Plan, 1998-2003

ODP's Strategic Implementation Plan was written in 1997 to address science goals, technology development, and related deliverables for the end of ODP Phase II (1998) and ODP Phase III (1999-2003). It provided a model for achieving the scientific goals of the 1996 LRP, and an assessment of the technological and cost implications for carrying out the scientific objectives of the program.

Scientific Outcomes: Were They Achieved?

In assessing the successes and failures of ODP in meeting its scientific objectives, the sense of the Committee is based largely on the input from SCICOM members (Appendix 4). Although opinions of the extent of achievement within specific themes are varied, there are some clear successes that can be highlighted, and some areas where opportunities remain.

The Strategic Implementation Plan examined the scientific objectives contained within each core theme of the 1996 Long Range Plan, and defined the expected outcomes by the end Phase III (2003) as follows:

Theme 1: *Dynamics of Earth's Environment*

<u>Understanding Earth's Changing Climate</u>:

ODP will have (i) a first order global sampling of key climatic systems with resolution of decade-to-century scale variations and its impact on sea-level changes; (ii) calibrated high-resolution, orbitally-tuned geologic time scales, and extended them to at least 40 Ma or longer; (iii) better constrained controls on northern and southern hemisphere thermal gradients and heat transport, and (iv) documented the history of ice sheet growth, distribution, and decay in Antarctica.

<u>Understanding the History and Effects of Sea Level Change:</u>

ODP will have collected high-resolution records to test models of sea-level change to establish (i) the magnitude, age, and mechanism of past sea-level changes; (ii) the relationship between climate, Earth orbital dynamics, and thermal convection within the Earth's interior; (iii) how eustacy affects the age and character of basin-wide unconformities, and the distribution and composition of sediments between them.

<u>Sediments, Fluids and Bacteria as Agents of Change</u>

ODP will have (i) determined the composition, distribution, variability and global volume of gas hydrates; (ii) implemented routine fluid sampling and hydrogeological experimentation, and determined the coupling of subsurface fluid flow and geochemical processes in different tectonic settings; and (iii) explored the nature, distribution, and depth extent of the subsurface biosphere in upper crustal rocks and sediments, and evaluated a range of environments for a post-2003 biological observatory.

Assessment of the Successes and Failures of ODP with Respect to Theme 1

The Committee concludes that ODP has been successful in addressing the goals and implementation of Theme 1, "Dynamics of the Earth's Environment". Examples of the accomplishments include the recovery of high-resolution climate records and establishment of orbitally-tuned, high-resolution time scales covering large parts of the Cenozoic, identification of marine-terrestrial linkages in the global climate system, an increased understanding of the role of large ice-sheets in climate systems, and the first recovery of demonstrably uncontaminated microbiological specimens from deep beneath the seafloor. In addition to being important in their own right, these achievements have helped guide the research and educational agenda for IODP.

Despite these achievements, however, the available assessments have also highlighted some critical areas where opportunities remain. Spatial and temporal coverage of paleoceanographic material remains inadequate, at least in part due to the fact that ODP represented a single-platform operation responsible to disparate scientific communities. Critical targets remaining include (i) better climate records from the tropics and sub-tropics, and (ii) the recovery of deep stratigraphic sections from both active and passive margins. Operational barriers, high proposal pressure, and community impatience with commitments to single drill sites and discrete sets of objectives have often impeded scientific progress with regard to the recovery of adequate samples and complete stratigraphic sections. Although progress was made in the waning stages of ODP, the Committee remains concerned that IODP will not adequately address the exciting scientific opportunities that require a significantly greater commitment to thematic continuity and operational flexibility.

Theme 2*: Dynamics of Earth's Interior*

<u>Exploring the Transfer of Heat and Materials To and From the Earth's Interior</u>

ODP will have (i) laid the foundations of a global network of seafloor borehole seismic observatories, as part of the International Ocean Network (ION; and (ii) drilled two Large Igneous Provinces (LIPs) to determine the substantial interior-to-surface energy transfer represented by the emplacement of LIPs, the styles of emplacement, and their implications for mantle dynamics.

<u>Characterization of the Oceanic Crust</u>

ODP will have (i) compared the structures of fast and slow spreading crust down to depths of about 3 km, and evaluated the mass and heat budgets associated with the formation of oceanic crust; and (ii) tested the model of ophiolites as representative of forearc crustal sections.

<u>Hydrothermal Processes and Formation of Massive Sulfide Deposits</u>

ODP will have (i) determined the structure of a modern, three-dimensional analog of high grade, volcanogenic massive sulfide deposits formed at a convergent margin; and (ii) set up (through collaboration with InterRidge) one ridge-axis observatory and produced preliminary data addressing the temporal variability of active processes, in particular fluid circulation.

Mass Balance at Convergent Margins

ODP will have (i) produced estimates of subduction fluxes at Pacific convergent margins, including the relative importance of sediments and crust to the input flux, the spatial variability in subduction-derived fluids, and the net crustal flux recycled into the mantle.

Earthquake Mechanisms

ODP will have (i) assessed the role of low angle detachment faults during continental breakup at least one site; and (ii) developed an understanding of the initiation and propagation of earthquakes at a convergent margin, and the relations between fluid flow and geo-hazards."

Assessment of the Successes and Failures of ODP with Respect to Theme 2

The Committee finds that within Theme 2, Dynamics of the Earth's Interior, there has been substantial, and in some cases paradigm-changing, progress, and all the sub-themes have been addressed to some extent by multiple drilling legs. For example, while probing oceanic crust to great depths has not been achieved, ODP has made significant contributions to understanding its genesis and evolution, and revealed a surprising degree of variability in its structure. Three LIPs have been drilled since the beginning of ODP, and their emplacement environments have been determined. However, fluxes have been constrained in only one of them. ODP has begun to systematically address hydrothermal activity and lateral fluid flow within the crust. Studies of mass balances at convergent margins have also been quite successful, despite the presence of unstable lithologies. ODP has also made progress in assessing the potential role of low-angle detachment faults in continental breakup, as part of the broader theme of understanding earthquake genesis. Finally, ODP has begun to establish a network of holes for emplacement of seafloor borehole seismic observatories.

However, the Committee notes that specific goals for all five sub-themes have not been fully achieved. This variable success has been constrained more by technology limitations than by program commitment. Some technology limitations have been inevitable (e.g., the lack of riser drilling capability), while others have resulted from a less-than-optimal development of a technology to match proposed scientific objectives (e.g., the diamond coring capability). The latter is partly due to both insufficient resources being allocated for technology development, and to inadequate management of large engineering projects within ODP while simultaneously providing drilling services for day-to-day efforts.

Technology Development and Financial Resources

The Strategic Implementation Plan also made it explicitly clear that accomplishing such an impressive array of achievements would require resources. "If ODP is to be successful in executing this ambitious scientific plan, some critical technologies and innovations will have to be implemented in the near future. Those developments include: (a) higher resolution logs for higher resolution borehole imaging; (b) riser-less type mud circulation and drilling (including blowout preventer) to improve drilling depth, hole stability and core recovery; (c) microbiological systems for better detection and onboard analysis; (d) improved logging while drilling/coring, for more efficient coring and logging and better core log correlation; (e) advanced borehole observatories, for improved monitoring of active processes in-borehole; and (f) advanced CORKs, for improved retrieval of borehole data." Most of these technologies are now incorporated into thinking and planning for IODP, but only some were implemented in Phase III in ODP, mostly because of funding limitations.

Furthermore, the Plan also discussed four potential funding scenarios. Accomplishment of all stated science objectives would have required significant program growth. In fact, *funding became essentially flat for the last 6-7 years of the Program, resulting in low-risk science objectives being targeted, and limiting significant technology development.*

II.2 Scientific Legacy of ODP and Planning for IODP

In response to requests from EXCOM, the JOIDES Office and SCICOM engaged in a formal legacy activity: development (with a number of international author teams) and publication of "Achievements and Opportunities of Scientific Ocean Drilling" (*JOIDES Journal*, v. 28, no. 1, spring 2002). The *JOIDES Journal* issue, a "best-seller", consisted of a series of short articles highlighting progress and prospects on the 1996 LRP themes. This publication followed an equally successful 1997 U.S. compilation of abstracts entitled "ODP's Greatest Hits" and was followed by the second volume of "ODP's Greatest Hits" in 2003.

At approximately the same time, the IODP Planning Sub-Committee of SCICOM (IPSC) was in the process of completing a legacy portion of the IODP decadal science plan, "Earth, Oceans and Life - Scientific Investigations of the Earth System Using Multiple Drilling Platforms and New Technologies". That portion of the IODP Initial Science Plan (called "Major Achievements of Scientific Ocean Drilling" – MASOD) highlighted achievements in each of 26 thematic areas grouped under IODP's three new banners: "The Deep Biosphere and the Subseafloor Ocean, "Environmental Change, Processes and Effects" and "Solid Earth Cycles and Geodynamics". The IPSC summary of progress emphasized process-orientation as a primary means of making future advances, the interrelatedness of many of these endeavors, and by implication that future scientific ocean drilling must make use of advanced technologies (e.g., riser drilling, installation and monitoring of seafloor and sub-seafloor observatories, partnerships with industry) to achieve its goals.

SCICOM acknowledged that the legacy-based *JOIDES Journal* and the MASOD portion of the IODP ISP accurately portrayed significant scientific progress during ODP, and that they believe these publications to be the best current representation of the scientific impact of ODP (with the exception of concentrated work in some initiatives occurring near the end of ODP which has yet to be fully assessed).

II.3 Summary Findings

ODP has done a credible job of addressing the entire spectrum of "Environment" and "Interior" themes showcased in the Strategic Implementation Plan. High-resolution climate records have been recovered and orbitally-constrained time-scales of unprecedented resolution been established for large parts of the Cenozoic, the history of polar glaciations has been uncovered, crust-fluid interactions have been addressed, tectonic processes that drive the origin and evolution of continental margins have begun to be assessed, and the variability of oceanic crustal structure has been revealed. However, the "failures" of ODP involve a combination of lack of long-term community commitment (i.e., to technical development, to complicated objectives like deep or challenging [e.g., zero-age basalt] targets) and technical limitations (e.g., the lack of riser-based containment or insufficient access to mission-specific platforms for unique environments), combined with flat funding, which began at about the same time as the Strategic Implementation Plan was produced (~1997).

III. PHASE-OUT AND LEGACY PRESERVATION FOR ODP

The plans for phase-out and legacy developed by JOI and its subcontractors were put in place based on the premise that these activities would be completed in such a way as to facilitate transfer of all knowledge gained during ODP to another entity funded to conduct the U.S. component of IODP. When NSF awarded the JOI Alliance the contract to be the U.S. System Integration Contractor (SIC) for IODP in late September 2003, it became clear that the same organizations responsible for the phase-out and legacy activities of ODP would also be gearing up for IODP. Hence, apart from reviewing the phase-out and legacy plans to ensure preservation of all aspects of ODP, the Committee also asked the questions:

- Are there items within either the phase-out or legacy activities that are no longer necessary or are diminished in scope?
- How will the timeline for completion of all activities be affected?
- Can all phase-out and legacy activities, and start up of a new program, be accomplished with the same resources (staffing, funding, etc.)?

In reviewing phase-out plans, the Committee made use of a spreadsheet developed by H. Beiersdorf for EXCOM in 2000 that detailed the responsibilities of the various entities within ODP for each phase-out activity (Appendix 5) to ensure that all aspects of phase-out were covered. In addition, Appendix 5 includes a table with the revised timelines for all phase-out activities.

The original phase-out plan for ODP identified four primary foci of activities within the FY04-07 timeframe: i) completion of all activities associated with the field programs ending in FY03; ii) demobilization of all equipment, including proper storage, archival, and documentation; iii) preservation of the ODP legacy; and iv) preparation of the transfer of ODP assets to the appropriate entities (clearly this last item is no longer necessary).

The Committee has reviewed the phase-out plans for JOI, TAMU and LDEO and finds that completion of all activities associated with the field programs, and demobilization of all equipment, are appropriate and proceeding smoothly. The latter has taken a slightly different direction from that originally expected, as the equipment will be redeployed on the *JOIDES Resolution* for cruises early in IODP.

The legacy of ODP comes in many forms. The most obvious are the 320 km of core material from both DSDP and ODP that are housed in the four repositories (i.e., Scripps, TAMU, LDEO and Bremen), and the scientific data generated both aboard ship and during later shore-based studies. In addition, there are numerous technological developments (both successful and unsuccessful), lab procedures (both past and present), and other activities within ODP that require documentation. For the purposes of this document, the Committee has defined “legacy documents” as useable, transferable, digital documents that can be used extrinsic of the personnel that generated them.

III.1 Science Operations (TAMU)

Science Services

The Science Services Department appears to have its legacy responsibilities well in hand, although there will be some tasks that will be deferred or extended (expected timelines are shown in Appendix 5). Records of the development and execution of every cruise, a cruise participant database, safety documentation, lab cookbooks, instrumentation manuals and service records, and curatorial handbooks and sample records already exist, but will be reviewed and updated within the planned timeline. Other items considered of lower priority – documentation of components needed for each instrument/system, additional published technical notes, and the analysis of historical costs of the operation and maintenance of each instrument – will be deferred beyond the end of FY04.

The cores from both DSDP and ODP – perhaps the greatest legacy of all – are currently scattered in four repositories, and are deteriorating over time. A project is currently underway to shrink-wrap the cores to maintain moisture content and reduce mold growth. The goal is to have core wrapping at all the repositories completed by the end of FY04. In addition, consolidation of all core collections at the Gulf Coast (TAMU), Bremen and Kochi (IODP) repositories is under consideration during the early part of IODP.

The Committee notes that the IOs will agree upon, and then implement, a program-wide sample curation and management policy in two phases: i) for IODP cores collected beginning in FY04, and ii) for older (DSDP, ODP) cores, should the decision be made to move them. This will ensure that this important legacy of scientific ocean drilling will be preserved.

Information Services

The Janus database of the Information Services Department has grown steadily from 3 GB in 1996 to over 25 GB at present. All ODP data have been migrated to the Janus database except XRD (to be completed by end of FY04) and paleontology (to be completed by end of FY07).

All ODP data within the Janus database will be archived at the National Geophysical Data Center (NGDC). A prototype of how to transfer ODP data to the NDGC has been developed, and data transfer will take place through FY05. Other legacy documentation of policies and procedures related to information systems will be completed within the original time frame by the end of FY04.

One part of the ODP legacy that is not currently in the Janus database or easily accessible in any form is the collection of core close-up photographs taken on board the *JOIDES Resolution*. The current situation is that close-up photographs for all electronically published ODP Initial Reports and Scientific Results volumes can be copied directly from the publication. For paper volumes, requests for images in the Initial Reports can be made through the Data Librarian. Photos in the paper Scientific Results volumes may not be in the ODP inventory because many of them were taken by scientists post-cruise. However, the ODP photographers on board the drill ship take many more close-up photographs than are eventually published. Compilation of spreadsheets inventorying these was only begun around Leg 175, so there are ~75 Legs for which there is no database of these images.

The Committee believes that the collection of core close-up photographs is a valuable part of the ODP legacy, and steps need to be taken to preserve it. This is particularly important now that sampling of the archive halves of cores is permitted, as the images may be the only way that detailed pictures of highly sampled intervals are preserved. In addition, these images could be a valuable resource in the future for further studies of core textures, vein distributions, etc. where the core has since been sampled. Although this project should be of lower priority than those currently being undertaken, the Committee recommends that this database be constructed and included in Janus. Such a project should be completed over the long-term (i.e., by the end of FY06 – see Appendix 5).

A second area of concern expressed by the paleoceanographic drilling community is the total inadequacy of a database linking species ranges and time, which many feel should have been part of the implementation of Janus. (See also the concerns about species ranges and time charts being lost due to the publications strategy in Section IV.1) An example of a highly successful effort in this regard is that being conducted by the Ocean Drilling Stratigraphic Network, an initiative of GEOMAR and the University of Bremen. This provides the basic data requirements with a very minimal overprint of interpretation. Tables can be easily downloaded and converted into spreadsheets, and are easily searchable. This could serve as a model for future efforts in IODP.

Publication Services

The Proceedings of ODP went through a major shift in 1999 based on a mandate to cut costs and, as a result, hard copy Initial Report (IR) and Scientific Results (SR) volumes were discontinued. The IR volume was replaced by a booklet and a CD and was made available on the web. Publication of scientific results was encouraged in the outside literature, but an SR booklet and CD consisting of data reports and a synthesis chapter were published and also made available on the web.

Given the nature of publications, the Program's legacy activities will not be complete until FY07, but they are expected to maintain their original schedule. In addition to maintaining complete sets of DSDP and ODP volumes, old format print volumes will be digitized, eventually including the DSDP volumes. This project will be done in conjunction with the Texas A&M University Digital Library. In addition, all ODP volumes and reports will be put on microfiche/microfilm at very little additional cost. An ODP Cumulative Index is being designed to parallel the DSDP Index. Procedural documentation of departmental tasks, which already exist as flow diagrams and short summaries, will not be redone in great detail.

Publications Services appears to have its phase-out and legacy activities well in hand. Furthermore, the Publication Services Department is also providing support for the legacy documentation of other departments. It is clear that this department benefits from a set of clear and well-managed objectives. While their responsibilities through the years have ballooned, they have responded to these changes with effectiveness and creativity.

Drilling Services

Based on the assumption that they would not be responsible for IODP operations, the Drilling Services Department developed a comprehensive legacy plan in FY01 to catalog tools systems and important technical innovations, review their scientific benefit, explain tool operations, consolidate design drawings and specifications, provide a history of technical development, explain operational parameters, performance and limitations, and document legacy holes. However, with the advent of IODP, most of the Department's present efforts are at risk of being devoted to preparing for the upcoming IODP operations, leaving legacy matters to slip in priority. With limited resources, this is understandable, although very undesirable. The Department's plans, as presented to the Committee in College Station, appeared to be predicated on the premise that since the Program is essentially continuing and corporate memory is preserved, there is significantly less impetus to attack the legacy issues. As a consequence, operations manuals would be neither adequate nor transferable for many drilling/coring systems. Legacy Holes, an extremely important aspect of ODP and IODP, would not be properly documented.

The Committee's significant concerns about this situation were made known to Drilling Services, and the suggestion made that outside technical writers be utilized to assist in the documentation. As a result, a revised plan for legacy preservation was prepared and submitted to the Committee (Appendix 6). The revised plan for the documentation of the ODP engineering legacy is now broadly defined, and balances the dual responsibilities of creating the ODP legacy of engineering tools and services and providing support for IODP engineering activities. There are four core elements:

- A technical writing firm will be engaged to develop a documentation template and directory structure for engineering operations manuals. This initiative will create a uniform and codified structure for each Operations Manual to be produced during the ODP legacy documentation project. The template will be tested by the technical writers in conjunction with Drilling Services and Information and Publication Services staff by creating several of the more complex engineering manuals.
- The remaining twelve science overviews of ODP drilling tools to be used during FY04 will be created by ODP staff.
- A map of the ODP legacy sites, along with a summary of the engineering and scientific characteristics that define each site will be available on the web.
- All technical files, notes, and documents that have been used during the life of ODP will be sorted, inventoried, indexed, and archived at IODP/TAMU.

The Committee believes that these revised plans are adequate to relieve their aforementioned concerns. However, until this process is begun, it is unclear whether there are sufficient resources to complete the legacy documentation in a timely fashion. This will need further assessment within the next six months. The Committee notes with approval that TAMU is establishing an internal oversight group to review progress on all legacy items on a routine basis and to hold each Department accountable for completion of their responsibilities in this regard.

III.2 Logging Services (LDEO)

The Committee notes that one of the very positive legacies of ODP is that the scientific drilling community is now much better informed about how logging is integrated with drilling to produce good scientific results. Over the lifetime of ODP, logging has become an integral part of sophisticated hypothesis-testing through ocean drilling. Logging is also an example of a liaison with industry that was extremely successful; it represented a real integration of industry with ODP.

The Logging Services group at LDEO has completed all logging reports for the IR volumes and has most data on CDs and available on-line. This database contains all standard and most specialty logs and has been linked to the Janus core database at TAMU. Wireline seismic data are available on CDs, but have yet to be put on line. With regard to other database documentation, the processing procedures, history of each data type, notes for each hole and the documentation of the log database structure will be accomplished in FY04-05. Eighty-two holes of DSDP logging data have been processed and are available digitally. Processing of 77 remaining DSDP holes will be extended into FY05. While some 3rd party tool data are complete and online, others remain to be contacted and completed. Logging engineering development legacies, which include technology summary sheets, user manuals, and archiving of control software, electronics and mechanical schematics and unique spare parts, are planned to be completed within FY04.

III.3 Site Survey Data Bank (LDEO)

The ODP Site Survey Data Bank (SSDB) is scheduled to conclude its activities in FY'04 with phase-out and legacy plans that are appropriate. The Committee notes that there is widespread praise from the community for the work that the SSDB has done within ODP. As part of its legacy, small sections of seismic and navigation data to provide the context in which each drill site was drilled will be provided to the National Geophysical Data Center (NGDC). For the most recent 15 drilling legs, these data are in digital format; those from previous drilling legs are in hard copy, but will be scanned by NGDC. The rest of the data, as well as a database cataloging all the data, will be transferred *en masse* in the first instance to the entity responsible for this function in IODP (D. Quoidbach, *pers. comm.*).

The Committee notes that the Site Survey Data Bank has two functions – that of a library of data related to positioning of drillholes, and a service function related to the integration and preparation of all data into packages to support decision-making about site locations both prior to and during drilling operations. For IODP, it may be appropriate to consider whether these two activities should be housed in one place (as at present), or whether archiving of data is better done at a number of locations specializing in different data types, with a central office that then integrates data for the planning of a given cruise or expedition.

III.4 Public Relations/Outreach Legacy (JOI)

Public relations and outreach activities were cited as important activities for ODP in the COSOD-II report and, despite very limited funding, there have been some successes in this area, including documentaries, newspaper articles, and port call events. However, there currently appear to be no plans for preservation of a systematic, historical record of the public relations material, activities, and resulting products for ODP. Apart from the activities conducted by JOI and TAMU (for the years where the responsibility was split), other member nations and consortia likely organized their own outreach efforts. Ideally, a database of all public relations materials produced during ODP is desirable, although this may be logistically difficult to obtain. However, the Committee believes that an effort should be made to document public relations and outreach materials and activities as part of the legacy of the Program.

III.5 Micropaleontological Reference Centers

Micropaleontological Reference Centers (MRCs) provide an important service to both ODP scientists and the wider community, even though they do not receive any formal funding from ODP. Located at sites around the world, they afford scientists the opportunity to examine reference collections of microfossils of various geologic ages and provenance.

The Committee recognizes and applauds their commitment and achievements to date, and supports the on-going discussions within the IODP Science Advisory Structure as to how to best utilize the resources that the MRCs have to offer.

III.6 Summary Findings

The major impact of the start-up of IODP will be to stretch out the timeline for phase-out activities to varying degrees for most Services. The Committee finds that with only some minor changes to the established timelines, all planned phase-out and legacy activities will be completed within Science Services, Publications, Information Services, the Site Survey Data Bank, and Logging Services, with the current staffing levels. However, there appears to be the potential for some difficulties within Drilling Services in ensuring all necessary phase-out and legacy tasks are completed. The Committee considers it important that the completion of *all* legacy tasks be carefully monitored to ensure timely completion in the face of the operational imperative of IODP.

There are two sets of materials that will not be preserved in an accessible way under the current legacy plans:

1) the collection of core close-up photographs taken on board the *JOIDES Resolution*. This is particularly important now that sampling of the archive halves of cores is permitted.
2) the public relations/outreach legacy of ODP.

In addition, the Committee notes that one database that is lacking in Janus is a compilation linking species ranges and time.

PEC VI Recommendation 1: Monitoring legacy activities

JOI and its subcontractors should monitor progress on ODP legacy preservation on a routine basis, with a final external review suggested in FY'06 to ensure that legacy activities have been completed satisfactorily.

PEC VI Recommendation 2: Core close-up photographs

TAMU should develop a database of the collection of core close-up photographs taken on board the *JOIDES Resolution* and make it accessible to the scientific community. This project is of lower priority than others for Information Services and could be completed over a timeline longer than the planned phase-out (i.e., by the end of FY06).

PEC VI Recommendation 3: Public relations/outreach materials

JOI should develop a systematic record of all ODP public relations and outreach materials and activities, including to the degree possible those developed by individual member countries/consortia.

IV EFFECTIVENESS OF JOI PROGRAM MANAGEMENT AND JOIDES

The success of ODP can be attributed to the effectiveness of the JOI Program Management and the subcontractors in delivering excellent services, and to the Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES) international Science Advisory Structure for providing sound scientific advice. There is widespread praise from the community for the quality of services provided by the subcontractors and the dedication of the staff with whom the international scientific community has interacted.

IV.1 JOI Program Management

JOI, Inc. has been consistently responsive to JOIDES input and aspirations, and has worked hard to meet community expectations within the available, but limited, resources. However, at times, this did not always translate into delivery of the science in a cost-effective manner, and sometimes led to a gap between community expectations and the reality of the deliverables. There has also existed a dynamic tension between JOI, Inc. (as the prime contractor) and its subcontractors. This tension has not been constructive at times, and depended on the leadership at JOI, which unfortunately changed numerous times during ODP. The lack of stability at the Director level in the Program resulted in the partnership between JOI and its subcontractors not being as effective as it might have been.

The Committee has identified three programmatic areas in which ODP did not do an effective job, and one area in which decisions made by JOI Management have had an important impact on the scientific legacy of the Program.

Program Evaluation and Assessment

There has been a lack of frank assessment at all levels within ODP. Within the Science Advisory Structure, criticisms concerning the thematic panel assessments of proposals, and lack of guidance to proponents, early in the Program were partially addressed during the JOIDES reorganization in 1997, when nurturing of proposals (and proponent efforts) became a primary goal, augmented by external review prior to implementation. However, ODP was always reluctant to delete unworthy proposals from its system; hence proponents of ultimately unsuccessful proposals felt they should have been informed earlier of their limited chance for success. This issue has been acknowledged and is being addressed in IODP.

There has also been a lack of on-going, frank, post-cruise assessment by all parties of the success in meeting the stated scientific objectives. There was the tendency to focus on the successes, however limited, and not to rigorously analyze the failures. Although this was entirely appropriate in terms of presenting the accomplishments to the outside world, a greater degree of internal evaluation and assessment both by the ODP Program Management and the Science Advisory Structure would have served the Program well.

Education and Outreach

Another area in which ODP has done a poor job is in its education and outreach activities. There have been some successful educational activities (e.g. graduate students and post-docs as members of shipboard science parties; the Undergraduate Student Trainee Program; the Graduate Student Fellowships and the JOI/USSAC Distinguished Lecturer Series in the US; etc.) that have had impact on the Earth Sciences in terms of training future scientists. In terms of outreach, however, efforts have been quite limited and somewhat piecemeal, with no over-arching plan identifying constituencies to serve, outlining a strategy, and evaluating its effectiveness. In addition, the array of ODP-related web sites is confusing and a barrier to the newcomer; they are easily navigable only by someone who understands the infrastructure or organization of ODP.

This limited effort for all educational and outreach activities reflects the very small commitment of funds (presently ~$50K annually for JOI (K. White, *pers. comm.*)) for outreach activities. This has meant a reactive approach, making the best out of high-impact cruises and port calls, rather than a proactive, planned strategy. In addition, the handling of education and outreach activities by two offices – one at JOI and one at TAMU – through much of ODP resulted in a degree of competition rather than cooperation. The perception is that this relationship did not work well and may not have been cost-effective. The centralization of these activities at JOI was an improvement made towards the end of ODP.

The Committee believes that education and outreach efforts must be strengthened considerably in IODP with substantially more resources brought to bear in each of these areas as distinct activities. Although education and outreach activities are being planned independently in the member countries, it will be critically important that the CMO provide an overarching IODP strategic plan for coordinated education and outreach activities.

Large Engineering Developments

ODP has been highly successful in expanding its small- to mid-scale sampling and measurement capabilities through the development of new technologies and tools. Examples include development of the wireline-deployed hydraulic piston corer to recover high, quality, continuous sediment sections; modifications to equipment to enhance drilling capabilities; and development of the capability of installing instrumentation, such as broadband seismometers and CORKs in reentry holes as observatories. This has been done by Drilling Services at TAMU while simultaneously providing day-to-day shipboard engineering support for on-going cruises. However, the record of success with large engineering projects, such as the Diamond Coring System, is not as strong. This may in part be due to (i) the dual role of Drilling Services (i.e. day-to-day shipboard support and engineering development), (ii) their desire to provide science with the technology requested no matter how sophisticated and large a development effort may be required, (iii) the limited interactions between ODP engineering and industry (see Section IV.2 for further discussion), and (iv) limited funding.

The Committee believes that the management of ODP should have played a greater role in matching resources with program implementation plans. JOI in particular could have played a larger role both in making decisions concerning which engineering development plans were feasible to undertake given the available personnel and fiscal resources, and in managing the expectations of the community in this regard.

ODP Publications Strategy

In 1999, JOI mandated a major change in the Publications Policy and format of the ODP Proceedings volumes as a cost-savings measure (between FY96 and FY02, total annual costs for publications were reduced by >$500,000). By encouraging publication of scientific papers in the non-ODP journals as an alternative to publication in the Scientific Results volume, greater visibility of the Program and more effective dissemination of ODP data to the broader scientific community were envisioned.

Traditionally within ODP, statistical analyses of publication venues, numbers of publications, and other parameters have been used to address the visibility issue; these have generally proven inconclusive. For example, as can be seen in Figure 2, although the annual publication rate in a suite of nineteen high profile, peer reviewed journals has continuously increased throughout DSDP and ODP, as would be expected, there has been little change in the annual publication rate when normalized to the cumulative age of the drilling programs. These data suggest that there is no clear evidence, *one way or the other,* that *any* of the different publication strategies undertaken by the DSDP and ODP have resulted in a significant increase or decrease in external visibility as measured by peer-reviewed publications.

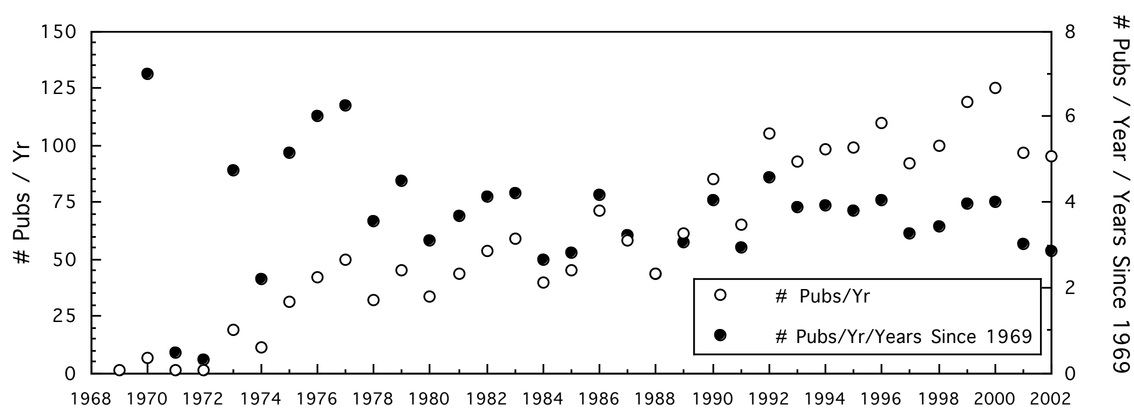

Figure 2. Annual publication rate of drilling-related papers in nineteen peer-reviewed journals for DSDP and ODP (open circles), and the publication rate normalized to the cumulative age of the Programs (dark circles).

Our surveys confirm that there are widely varying views in the international drilling community about the relative utility and effectiveness of the different publications formats, and the accessibility of ODP data. Some find the electronic and web versions superior and have no problem finding pertinent papers through the DSDP/ODP Publications Database available on the TAMU web site; others lament the ability to find information about one cruise in one place, and to have several ODP volumes open on their desk at once. Clearly, individuals find and use information in a variety of different ways.

One very significant outcome of the new publications policy is that it has resulted in a distributed scientific legacy for ODP – one that is not as easily captured as it was when there were hard-copy Scientific Results volumes to which all participants contributed papers. In addition, there are concerns that taxonomy and range charts of species are being lost as micropaleontologists fulfill their obligations by contributing specialized papers to the outside literature rather than a data paper on taxonomy and range charts to the Scientific Results volume. Another outcome is that the "obligation fulfillment" policy regarding the responsibility of cruise scientists to submit a paper for publication has been weakened, and is not as easily enforced. This may result in data being lost from the Program when scientists are not held accountable for paper submission.

IV.2 JOIDES Science Advisory Structure

ODP was entirely science-driven, and was borne by the good will of a large scientific community who cooperated as volunteers to solve scientific problems, and to overcome financial, political and cultural hurdles associated with the conduct of the program. Although complex in organizational structure, the JOIDES Science Advisory Structure was one of the most successful collaborative and coordinated avenues for science advice to a large, international program. It is a commonly held view that perhaps the greatest strength of the Science Advisory Structure was the level of international participation that brought to the discussion a variety of expertise, views, and perspectives. Members of advisory bodies were there as individual scientists to lend their expertise to the deliberations and, as such, had a responsibility to make decisions on the basis of scientific merit rather than on any other considerations. In addition, the knowledge of different geographic areas and the potential opportunities they provided to address significant scientific problems were critical to the global reach of ODP.

In 1997, significant changes were made to the JOIDES Science Advisory Structure, including replacing four thematic panels by two Science Steering and Evaluation Panels (for the Environment and the Interior), collapsing three service panels into one (the Scientific Measurements Panel) and creating an Operations Committee (OPCOM). The drilling community views these changes as very positive. The new Structure took a more nurturing role, and exhibited the flexibility to deal with both scientific and technical issues through *ad hoc* committees, working groups, program planning groups, etc. In addition, the Science Advisory Structure provided consistent, highly valued, and diverse international input, including that from non-member states.

There are, however, several areas in which the potential effectiveness of the JOIDES Advisory Structure was not realized; some of these are being assessed and changed in preparation for IODP.

Planning Timeline

One of the difficulties that JOI and the operators faced throughout ODP was the short planning timeline from the PCOM/SCICOM meeting at which an annual schedule was approved to the beginning of the first leg of that schedule. This not only had budgetary consequences, but also impacted cruise planning and staffing, and long lead-time purchasing. The latter was dealt with by the operators on the basis of their best assessment of which legs were likely to rank highly.

In IODP, many of the expeditions are going to be technically more complex and a longer planning cycle will be required. This is particularly the case for the complex drilling proposals for operations on the riser vessel. Long range planning, both in terms of annual budgeting as well as over the longer-term, will be critical to the success of IODP.

ODP-Industry Communications

Communications between industry and ODP never fulfilled expectations (with the exception of the successful relation in terms of logging operations previously mentioned). The Technology and Engineering Development Committee (TEDCOM), originally mandated to provide the scientific ocean drilling community with an "outside in" look at what industry was doing, became instead a semi-official advisor to the platform operator, but without power to enforce its recommendations. In addition, TEDCOM members were supposed to provide a long-term view on technology development based on their industry experience; however, they instead became caught up in short-term issues and evaluating current projects.

OPCOM Procedures

The Operations Committee (OPCOM) was introduced in 1997 as part of the new ODP Scientific Advisory Structure. Created as a sub-committee of SCICOM, its purpose was to remove logistical considerations from the ranking of proposals, thereby enabling ranking by SCICOM to be based on scientific merit only. OPCOM provided SCICOM with drilling schedules based on SCICOM's proposal rankings, and advised SCICOM on shore-term logistical and technological implementation of highly ranked scientific programs, as well as longer-term technological requirements for implementing the ODP Long Range Plan.

OPCOM was not fully successful in ensuring that operational plans were consistent with the scientific objectives of the scheduled program. Part of the problem was that oversight by SCICOM was not as in-depth as it should have been. This was partly due to logistical reasons – in the early years, OPCOM met after SCICOM and the proposed schedule or scheduling options were sent out by e-mail for vote thereby lacking any on-site discussion. In later years, OPCOM met during SCICOM and reported back on the last day of SCICOM's meeting. Although this enabled some discussion of the scheduling, there was no overall leg plan available for review. This led, in some instances, to parts of scientific programs being combined into a leg after the fact, thereby compromising the scientific objectives of one or other of the programs. This was done in an attempt to fit science programs of varying size into an inflexible schedule of ~60-day legs. In other situations, the expectations of the proponents and SCICOM for a leg, and the reality of what could be achieved within the program funding constraints, were widely separated. In addition, project creep occurred, as operational details were often added later by proponents that significantly increased the cost of a leg after it had been scheduled.

SCICOM Proposal Presentation Procedures

One procedural issue brought to the attention of the Committee relates to the presentation of proposals at PCOM/SCICOM during the ranking procedure. In ODP, each proposal under consideration was presented by a designated member of PCOM/SCICOM – the proposal "watchdog". These presentations tended to be uneven in quality – some proponents had provided their watchdog with a polished presentation, while others did not, or watchdogs had done little preparation. The perception of some in the community is that this influenced the ranking procedure significantly, and resulted on occasion in an excellent scientific proposal being ranked lower because of the way it was presented. During the transition to the new JOIDES Advisory Structure in 1997, this issue was discussed and the idea of bringing the senior proponent for each proposal to the meeting to make the presentation was considered. However, due to a number of factors, not least of which was cost, this was deemed not viable.

Site Characterization Requirements

The interfacing of geophysics (for regional characterization and site-specific description) with drilling and sampling remained imperfect throughout ODP. Proponents were unclear as to the data needs for the Site Survey Panel and Pollution Prevention and Safety Panel reviews, particularly for hard rock drilling. This problem is being addressed in IODP in two ways. First, platform operators will take over responsibility from proponents for providing geophysical surveys in support of hazard and engineering assessment of sites scheduled for drilling. Second, the Site Survey and Pollution Prevention and Safety panels are working together to design a web-based interaction between proponents and IODP that would provide advice on site survey requirements for the science being proposed. This would help proponents understand and respond to the geophysical requirements for scientific ocean drilling.

IV.3 Summary Findings

Despite these shortcomings, there is a clear sense in the international scientific drilling community that the Program worked well, that it delivered excellent services, and that, most importantly, the best science got drilled. The same model is generally thought to be an appropriate starting point for IODP, with some modifications to address the shortcomings described above. However, it should be expected that the challenges of a multi-platform program may require revisions as operational experience is gained.

V LESSONS LEARNED AND IMPLICATIONS FOR IODP

Throughout the course of its deliberations about ODP, the Committee noted that many of its findings had important implications for activities within the new IODP. Although not specifically within its mandate, the Committee has recorded the major implications for the new Program in this section, and compiled a set of recommendations that it wishes to pass on to IODP.

V.1 The Nature of IODP

IODP will be a much larger and more complex program than ODP and hence will provide new challenges for management and for the science community. One of the biggest challenges that the Central Management Organization (CMO) will face is to ensure that IODP functions as an integrated, international science program even though there are multiple platforms and operators.

In addition, while ODP required a huge human resource, IODP will require a considerably larger one. Consequently a larger and broader international scientific community has to be enfranchised, and the next generation of ocean drilling scientists have to be entrained. There is concern that the complex organizational structure of ODP, and now of IODP, may serve as a barrier to a new scientist trying to participate in scientific ocean drilling. It will be important that the organizational structure be as simple as possible, and the proposal process made as transparent as possible, to new participants.

PEC VI Recommendation 4: Nature of IODP
ODP was borne by the good will of a large international scientific community who cooperated as volunteers to solve scientific problems, and to overcome financial, political and cultural hurdles associated with the conduct of the Program. These same attributes will be a prerequisite for a successful new international drilling program. Despite the increase in complexity in IODP, management and advisory structures should be kept as small and simple as practicable to underpin the IODP's integration and its proposal-driven nature.

International Input to IODP

It is a commonly held view that perhaps the greatest strength of the ODP Science Advisory Structure was the level of international participation that brought to the discussion a variety of expertise, views, and perspectives.

There is both community and Committee concern that the reduced participation of non-US and non-Japanese scientists in the IODP Science Advisory Structure will result in scientific deliberations that are not as rich as in ODP. While panel membership is not completely tied to funding proportionality (e.g., the European consortium has three voting seats, compared to six each for the US and Japanese), participation is likely to remain limited as the number of partners has decreased. Both DSDP and ODP left a legacy of being open to participation by scientists from non-member nations in a limited way; it will be important for IODP to continue this approach. Possible ways include: (i) encouraging collaborative proposal writing; (ii) inviting non-member guests to panels to provide scientific or regional expertise; and (iii) enabling scientists from non-member nations to sail on expeditions when they can provide necessary expertise.

PEC VI Recommendation 5: Internationalism
Internationalism along with scientific diversity was one of the greatest strengths of ODP. The advisory and management structure of IODP should maintain broad international participation extending beyond its membership, and attract scientists from all experience levels.

Funding of IODP

One of the problems that ODP continuously grappled with over the last several years of the Program was the flat funding, which began in about 1997 (about the same time as the Strategic Implementation Plan was produced) and continued until the end.

Planning for IODP appears to have addressed many of the constraints in the provision of both technical capabilities and fiscal resources, which limited the scope and achievements of the last five years of ODP. Whether or not IODP will deliver on the impressive set of scientific promises made in the Initial Science Plan remains to be determined.

PEC VI Recommendation 6: Funding
Level funding led to unacceptable erosion in the ability of ODP to achieve the promise of the Strategic Implementation Plan. In the future, the funding agencies and their respective prime contractors must be diligent in attempting to provide financial resources over the long term if the scientific, operational, and implementation priorities of IODP are to be achieved.

Partnerships with Other International Programs

ODP's experience in collaborating with other international programs was quite limited, but included very successful efforts, such as the completion of several drillholes for emplacement of seafloor borehole seismic observatories by the International Ocean Network (ION).

Partnerships with international programs that have complementary scientific goals to those of IODP, are highly desirable and are likely to become increasingly important. Apart from the challenges of joint planning and coordination, issues related to where the scientific, operational, and fiscal responsibilities of IODP end, and those of the partner research programs begin, will have to be clearly defined if project creep and issues with third party tools are to be contained (these are discussed in Section V.3).

PEC VI Recommendation 7: Partnerships with other programs
Partnerships with other international research programs will increase in IODP, and are very desirable. It will be important to delineate the scientific, operational, and fiscal responsibilities of each partner early in the planning process.

V.2 Preserving the IODP Legacy from the Beginning

The ODP legacy task would not have been so large had there been procedures in place to gather a broad range of information – both short- and long-term – *continuously* during the lifespan of the Program. Although done successfully by many parts of the Program as discussed elsewhere in this report, others are faced with a significant retrospective task. Gathering this information from a historical perspective can also lead to a loss of critical information, and has handicapped the decision-making process during the Program itself.

IODP operations must be organized at all levels to build into the fabric of the Program itself the collection of a broad range of legacy information from the beginning of the Program. Specific examples include:

- Scientific data, and all associated information regarding its generation, capture, and dissemination.
- Decisions, and the decision-making process, for all aspects of the program,
- Written documentation of laboratory and policy evolutions. Why were some instruments installed, and why were policies enacted and implemented?
- The historical costs associated with operation and maintenance for various Program assets, including individual instruments, pieces of equipment, and laboratories. The JOIDES Science Advisory Structure was often hampered by not having readily available this and allied information. This contributed to the "over-expectation" issue (discussed elsewhere), and resulted in situations where the Scientific Advisory Structure would make recommendations with an unrealistic expectation as to their viability.

The Committee suggests the following possible implementation strategies:

Development of a Strong and Centralized Information Services Center (ISC)

The Committee is aware of on-going discussions within the IODP Science Advisory Structure regarding the development of a program-wide ISC, and strongly endorses this concept. The ISC, responsible to the CMO, should be the clearinghouse for IODP information as it relates to shipboard and shore based laboratories, coordination with publications, curation, and other aspects of the program, across IODP.

An issue of concern to many in the ODP drilling community was the absence of an archive of post-cruise quantitative data (geochemical, isotopic, etc.). Although all who worked on ODP samples were required to submit Post-cruise Data Availability Forms to the Data Librarian, this was difficult to enforce, and there was no formal database developed providing easy access. The ISC needs to consider how data that are not published in papers or included in IODP publications can be captured, and develop easy ways to provide data to the ISC as a way to encourage submission.

It is also important that standards of uniformity across platforms (e.g., during core handling and description) be addressed. Most importantly, the metadata associated with the prime data will provide a critical component of continuity and uniformity across IODP. The ISC must therefore play a visible and important role in the accessibility and documentation of the Program to the drilling and broader Earth Science community.

Staffing of Technical Writers in IODP

Throughout ODP, too much knowledge of ODP was resident with specific individuals associated with the Program. As the Committee was discussing various issues, it became clear that many lessons learned from the earlier DSDP-ODP transition had been lost due to generational changes in personnel.

Given the limited resources and the inherent competition between allocating resources to "operational necessities" versus "legacy documentation", the former will always take priority, yet the Program will suffer (both operationally and historically) by not successfully addressing the latter. Relevant information needs to be captured *in as near-real time as possible.* The Committee recommends that mechanisms ensuring this be emplaced within IODP. This may include technical writers, staffed or hired on a continual basis, to ensure that procedures, practices, and technological and engineering developments records are current and preserved, and that change is documented as it occurs.

PEC VI Recommendation 8: Continuous legacy
One of IODP's highest priorities should be to establish the *continuous* gathering and documentation of information regarding its operations, with specific regard to the evolution of the shipboard and shore based laboratories and operations, engineering development (both small- and large scale), publications, and data management. This priority should be established throughout IODP at all levels and institutions. This priority can be best achieved by prompt establishment of a strong and centralized Information Services Center mandated and supported by the CMO, and by providing support for technical writers as necessary.

PEC VI Recommendation 9: Species ranges and time database
IODP should consider building a database linking species ranges and time from the beginning of the Program. This will take effort and oversight by the micropaleontology community.

Publications: Strategies and Integration within IODP

The Committee endorses the ongoing review of publications strategies currently being pursued within the IODP Scientific Advisory Structure. The key issues will continue to be (i) data capture, (ii) dissemination of scientific results and Program information, and (c) integration with other aspects of the program (e.g., sample and data policy with regard to incurred obligations, curation, data management).

Of these key issues, aspects of data capture and dissemination will be greatly facilitated by the establishment of a centralized ISC by the CMO, as discussed above. The capture of pre-, post-, and ongoing expedition data and their integration within the ISC for use by Publications will be essential, so that Publications are no longer isolated from the other aspects of the Program.

Given the experience in ODP and the mixed reviews with which the change in ODP publications strategy has been met, the Committee believes that effective dissemination of information and high visibility of IODP requires acknowledgment that different thematic/disciplinary communities within the larger drilling community have different needs and cultures regarding publication venue and accessibility. The best way to respond to these disparate needs is to provide the flexibility to enable scientists to publish in the venue most appropriate to their individual needs, and also to ensure that databases of publications are easily accessible and kept up to date. Furthermore, there is wide community interest in ensuring that many critical data sets that are perhaps not appropriate for independent post-cruise publication in the peer-reviewed literature be captured (e.g., micropaleontological species taxonomy and range charts). IODP should aim to produce a range of products for the community – future deliberations on this issue should factor in both cost and methods of enforcement of the obligation incurred by members of the Scientific Party.

PEC VI Recommendation 10: Publications
The IODP publications program must provide for the widest possible dissemination of the scientific achievements in a variety of formats so as to maximize the use of IODP data within a broad scientific community with different cultures.

V.3 IODP Operations

A vast amount of operational experience with non-riser drilling, core descriptions and measurements and down-hole experiments has been made during the 20 years of ODP drilling. There is universal praise for the program services provided during ODP, and in particular, for the shipboard staff. Overall, safe and effective operations have been conducted in almost all parts of the oceans, except the high Arctic where drilling was not possible. By the selection in the U.S. of an IODP Implementing Organization (IO) with extensive corporate memory of the ODP operations, the Committee feels that optimum conditions for rolling over this valuable experience to IODP are present. However, IODP will be different and significantly more complex than ODP. The Committee has chosen to highlight a number of operational areas we feel require particular attention.

Project creep

Project creep refers to the growth in science objectives, proposed cruise activities, and "add-on" science that occurs after a highly ranked proposal is scheduled during the expedition planning process. In this phase, IOs, project PIs and/or other scientists with a strong interest in deploying specific instrumentation in connection with the project, develop a budgeted operational plan often exceeding by a large margin what was foreseen during the initial scheduling of the science. Project creep thus can have major financial and operational consequences and, towards the end of ODP, was becoming an increasing problem. This problem is likely to increase in IODP.

The Committee feels that, to some degree, project creep is a sign of scientific health and creativity. However, given the extent of the problem, more oversight of operational planning is required to avoid significant operations and budget problems. This must be done jointly between the Science Advisory Structure, the IOs, and the CMO – see Section V.4.

Third Party Tools

A "third party tool" is a tool or set of tools/instruments deployed in conjunction with a drilling project, but funded and operated by a third (i.e., external to the Program) party. They have contributed greatly to science accomplished during ODP, but have also created some difficulties. Their application, however, is not always trivial in terms of operations costs and complexity, and there is a natural tendency for tools, when proven effective, to become much in demand by the rest of the drilling community. Issues center around how decisions are made regarding which third-party, drilling-related tools and installations become considered as an essential program facility, financially covered by the drilling program, and possibly also operated by the drilling program.

During ODP, there was a policy developed for the deployment of third party tools during drilling legs, which set out a series of procedures and tests required prior to deployment. It is generally believed that the policy could have worked – if third party tool developers had followed it. However, no entity was enfranchised to police the policy, resulting in deadlines being missed, and tools being deployed without having completed all the pre-cruise requirements. It will be critical in IODP that the CMO enforce a third party tool policy and ensure that Implementing Organizations only allow those third-party tools to sail that have met the policy requirements.

During the ranking and scheduling process, the new Science Advisory Structure, and SPC in particular, will have to assess the extent to which each project relies on deployment of third party tools to complete its objectives. If the dependency is large, then the inability of suppliers of third party tools to meet the policy deadlines eventually must lead to non-scheduling of the project. It can then reappear in the ranking process once the critical tools have been secured and meet policy requirements.

A larger problem relates to the way in which IODP should cope with community pressure to adopt responsibility for popular experiments and tools. The answer is not trivial. On one hand, the argument could be made that only tools and measurements directly related to the drill core, including logging and core-log integration, and advanced sampling (e.g., biological sampling, gas hydrates, etc.) should be provided by IODP. However, strict adherence to such a conservative approach could easily lead to loss of significant science and science constituency. On the other hand, the prospect of IODP taking over entire operational and financial responsibility for a large suite of advanced tools is a reason for concern. The Science Advisory Structure will need to provide advice continuously to the CMO on how to balance program resources between direct drilling related costs and drill-hole augmentation by advanced instrumentation.

PEC VI Recommendation 11: Third party tools
IODP should develop a clear policy for third party tools for all IODP platforms, and that the CMO, with advice from the IO, should take responsibility for its enforcement.

Standardization of Procedures Across IODP Platforms

Through the years, ODP has developed a rigorous set of procedures for core handling, standard measurements, and core characterization, which has made comparisons between different projects (legs) as smooth and reliable as possible. The IODP will be able to build on this important resource. The challenge in IODP will be to make these observations not only project-to-project compatible, but also make them platform-to-platform compatible. In particular for the riser and non-riser vessels, this should be achievable through application of essentially identical laboratory facilities and procedures for measurements and core documentation. The Committee suggests that the two IO's of the permanently operating IODP vessels exchange lab technicians from time to time, or develop a plan to rotate staff between the vessels on a continuing basis. This would generate a platform-independent corporate culture of working with, and documenting the core, and ensure that small work improvements in the different core handling systems are implemented in a concerted way. This may also be extended to exchange of Staff Scientists.

The riser vessel will have some additional hole-characterization from the mud-logging system. Care should be taken to integrate this information into the IODP data structure. It is likely that both the riser and non-riser ship will provide new and useful continuous data regarding drilling conditions at the drill bit level. These too should be integrated into the new IODP data characterization of the hole and the core.

Procedures for core handling and core documentation on mission-specific platforms may have to be adjusted to the *de facto* situation for any given project lay-out. For the very basic core and hole description, standards similar, or very close, to those of the two primary IODP platforms must be followed – if need be, in a shore based interim facility. The IODP Science Advisory Structure will need to define the extent of this basic description. This needs to be done *as soon as possible* to ensure that the process of core description adopted for IODP is compatible with the overall IODP database. This will also avoid data migration problems at a later date in the Program. To help establish uniformity across all three different platform options, exchange of lab technicians from one of the two permanently operating platforms to mission-specific expeditions should be considered.

The Committee acknowledges potential problems with implementing some rotation of lab technicians and staff scientists across all three platform types, but nevertheless strongly encourages such systematic rotations. The more extensive the collaboration between the IO's at all levels, the healthier for the science and the unity of IODP.

PEC VI Recommendation 12: Standardization of procedures
IODP should develop a set of "guiding principles" for all platforms for all procedures (core description, data quality, sample handling, etc.), and put in place metrics to ensure that standards are maintained. ***In particular,*** *this needs to be done for core description as soon as possible to ensure compatibility with the IODP database, thereby avoiding data migration problems later in the Program.*

PEC VI Recommendation 13: Exchange of technical staff
IODP should consider a program of exchange of technical staff (and possibly staff scientists) across all IODP platforms. Although complex, this will provide more program unity and assist in standardization of procedures.

Pre-Cruise Shipboard Party Meetings and Staffing

The Committee noted that during ODP, some shipboard parties did not understand the Program's expectations of them, and consequently they did not develop a team approach to addressing the cruise objectives and collaborating on sampling and post-cruise science efforts. In order to address this, the Committee considered a suggestion to inaugurate pre-cruise shipboard party meetings, given the complexity of some of the planned cruises. This would enable all participants to better understand their expected roles as members of the scientific party, to become enfranchised in the goals of the expedition, and to begin to plan collaborative research and sampling efforts. However, the Committee is concerned about how economically and logistically feasible such pre-cruise meetings would be. In addition, the requirement to satisfy member countries' rights to sail scientists proportional to their membership fee while also covering the discipline expertise needed for an expedition, often resulted in ODP in final staffing being completed very shortly before the start of a cruise.

The Committee finds that there are other means to help solve these problems. Better dissemination of the results of the pre-cruise meeting between Co-Chief Scientists, the Staff Scientist and IO, and a web based interactive homepage for the shipboard party, are two options. When transit time to the area of operation is short, another complementary option is for there to be a brief gathering of the entire shipboard party 1-2 days in advance of the start of the drilling expedition.

In addition, there may be entirely new challenges with staffing of riser drilling projects of long duration. Several shipboard parties may be involved, and they may be flown in by helicopter if the drilling is not too far from shore. What are the limits of the number of scientists that can be involved in a project without spreading the sample material and intellectual benefits too thinly? How are intellectual property rights shared and defined? These are issues that all need to be addressed and translated into IODP program policy well in advance of the scheduling of such projects.

V.4 IODP Program Management

The IODP Science Advisory Structure (SAS) has just gone through a transition period of ~2 years *en route* to the beginning of the new program. Mandates written by the IODP

Planning Subcommittee (IPSC) and approved by the International Working Group (IWG) will be reviewed and revised over the next year or so. Some things will not change – the nurturing of proposals from the community, modulated by external review, and the interfacing of multiple international panels to optimize the output from community-based proposals, using a decadal science plan as a general guide. Only the details (number and functionality of panels and working groups) are likely to change.

An important role for the CMO will be to try to keep the offset between expectations of IODP and the funding realities from growing too large. The CMO must take the lead in keeping the community educated, and in promoting a general understanding that scientific expectations have to remain grounded in fiscal reality.

The development of good working relationships between the CMO and the Implementing Organizations (in Europe, Japan and the US) will be critical to smooth and efficient functioning of IODP. All must be committed to cooperation and communication. In addition, a firm commitment from the lead agencies and international partners to a well-supported and fully integrated program is required.

The Committee presents the following concerns and recommendations for consideration in the organization of IODP.

Complex Projects

The term "complex projects" is used here to denote drilling operations involving more than one platform, multiple phases of drilling, and/or extensive non-drilling activities integrated with, and depending on, drilling operations (e.g. downhole experiments/instrumentation; coordination with observatory activities, etc.). Attention has already been paid to the challenges of complex projects and riser drilling in the preparations for IODP. For example, the proposed advisory structure for IODP includes special planning groups for complex projects, and the interim IODP advisory structure has identified the need for much longer lead time in the planning process for riser drilling compared to non-riser drilling. The Science Advisory Structure and its timing of ranking procedures will need to adjust to reflect this new reality. What remains to be seen is the actual response by the community and the IOs to the recognition of these potential problems, and how the special planning groups can handle complex projects involving both riser and non-riser drilling with different lead-in times and site survey specifications.

It will also be necessary to define and establish an optimum mechanism for effective links between the IOs, the CMO, and the Science Advisory Structure. The Committee notes that a first joint meeting of the IOs was held in August, 2003 and that all participants reported enthusiasm for the meeting. The Committee strongly endorses the continuation of this kind of collaboration and sharing of resources and experience. Once the CMO of IODP is up and running, this body should be fully involved as well.

PEC VI Recommendation 14: Planning timeline

ODP was limited by planning tied to annual budget cycles. The complexity of IODP will require long lead-time and long-range planning. While the Committee recognizes the reality of annual budgeting, it recommends systematic, multi-year operational program planning.

Program Evaluation and Assessment

As was discussed earlier, ODP did not benefit from on-going, frank, post-cruise assessment of the success of operations in meeting the stated scientific objectives. In IODP it will be important that a program of evaluation and assessment be initiated from the beginning of the Program. Evaluation and assessment should reach into all levels of IODP, and should be used to continuously to improve the effectiveness of the Program.

PEC VI Recommendation 15: Program evaluation

A rigorous and frank program of evaluation and assessment needs to be put in place at all levels in IODP.

Education, Public Relations and Outreach

For IODP, strong education, public relations, and outreach program will be required not only to provide long-term societal support, but also to secure proper renewal and expansion of the scientific community forming the basis of the Program.

These activities will require a broad programmatic plan developed at the CMO level. In addition, there will need to be considerable effort at the national/partner level. The educational and outreach endeavors need to be decoupled from each other and substantial resources committed to each. It will be very important to define the constituencies to be targeted within each area, as there must be focus in order to have impact. This, as all other parts of the Program, must have a rigorous assessment and evaluation activity built in to measure impact of the various activities undertaken.

PEC VI Recommendation 16: Education, public relations, and outreach

IODP management should establish significantly more effective and sophisticated approaches to both Education and Outreach. These endeavors, although traditionally linked to each other, have different goals, and should be decoupled. Each requires substantive resources and its own strategic implementation plan. In addition education and outreach activities, although they are being planned independently in the member countries, should follow an overarching IODP strategic implementation plan.

Science Advisory Structure Procedures

Panels in the ODP Science Advisory Structure conducted their business in a relatively informal way (except for SCICOM and EXCOM which follow Robert’s Rules of Order), and in general, this worked reasonably well. However, there are concerns that the conduct of the meetings in English, combined with the relatively informal, and sometimes unbridled, debating style of the US has and will cause disadvantages for non-native

English speakers. In IODP, the differences in cultures among the member countries, the increase in the proportion of non-native English speakers, and the resulting differences in the styles of business conduct, will require considerable sensitivity and a change to more orderly meeting procedures to ensure that every Panel member has the opportunity to participate in the decision-making process effectively. The procedures should not, however, limit the frank and fair international evaluation of the scientific quality of proposals, and each panel member must take on the responsibility to actively participate and articulate his/her views without any national or regional bias.

A second and related issue is the potential implications of the balance of Panel membership for voting and decision-making. As in ODP, it must be made clear that members of IODP Panels are participating as individual scientists to lend their expertise to the deliberations and, as such, have a responsibility to make decisions on the basis of scientific merit rather than on any other considerations. In ODP, the possibility for allegiances to influence voting and decision-making was less (although it did happen) due to the large number of nations represented; in IODP, the potential is greater. Strong Panel leadership and a clear statement of the responsibilities of Panel members will be important to sound decision-making in IODP.

The other issue that arose in ODP was the uneven presentation of proposals being considered for drilling by watchdogs (discussed in Section IV.2). It will be very important to avoid this problem in IODP, with the best presentation being made for every proposal. The ideal solution would be to have lead proponent(s) presenting and advocating their proposal. Given the advances in communications, it may now be possible for senior proponents to make the presentation to the Panel via video link, if not possible in person. Another alternative would be to provide proponents with guidelines as to what they are expected to provide their watchdog for the presentation.

PEC VI Recommendation 17: Conduct of meetings
The IODP Science Advisory Structure should pay special attention to (i) conducting its deliberations in a way to ensure full participation of all members in the decision-making process, (ii) informing Panel members of their responsibilities to make decisions based on scientific merit and not on any other considerations, and (iii) ensuring the best presentation of every proposal under consideration. One way the latter could be done is via video link with the principal proponent.

OPCOM, SPC, and Control of Project Creep

The difficulties of project creep encountered by ODP must be dealt with by more involvement of the SPC in the expedition planning process. However, it will be important that funding constraints be kept in mind at all levels of the Science Advisory Structure, as well as by the scientific drilling community. Changes in the timing of ranking and scheduling of proposals, as well as in the way in which OPCOM and SPC interact could improve SPC oversight and communications on the plans for each project. This may require revision of the schedule and/or length of panel meetings, as well as changes to the timing of the entire proposal review process.

PEC VI Recommendation 18: Planning oversight and control of project creep
The Committee recommends that SPC provide greater oversight of the planning process for each expedition to (i) ensure that operational plans are consistent with the science objectives, (ii) advise the IOs in containing project creep, and (iii) allow for better long-term planning in IODP. The Committee recognizes that this will require a change in the timeline for ranking and scheduling of proposals, and recommends the timeline for this process be reviewed.

OPCOM

In ODP, OPCOM was not fully successful in ensuring that operational plans were consistent with the scientific objectives of the scheduled program. In IODP, the task of OPCOM will become more complex with the need to schedule up to three platforms in a given year. Since its function is operational in terms of delivering the science program, IODP should reexamine its role and and how it should best interface with the CMO and the IOs.

PEC VI Recommendation 19: Role of OPCOM
IODP should reexamine the role of OPCOM in the Science Advisory Structure and make changes to ensure the best interface with the CMO and IOs in the development of operational plans.

(Note: As of the December meeting of the IODP Science Planning and Policy Oversight Committee (SPPOC), OPCOM will no longer be part of the Science Advisory Structure, but instead will be a Committee of the CMO.)

IODP- Industry Contacts

In IODP, TEDCOM is being replaced by the Technology Advice Panel (TAP), whose mandate once again is long-term planning and advice on engineering and technology developments in industry that can be mapped (easily) into IODP. TAP's initial activities will need to be closely monitored to ensure that this is indeed the direction the Panel's deliberations take. Coordinated industry advice to IODP is being sought through a new body, the Industry Liaison Panel (ILP). The ILP is identifying important scientific problems to industry, fostering communication and collaboration with industry scientists (including submission of joint proposals), and facilitating data exchange with companies. It is too early to determine if these advisory structure changes will work in IODP.

PEC VI Recommendation 20: TAP and ILP
The Committee recommends that the activities of the new Technology Advice and Industry Liaison Panels be carefully monitored to ensure that they are focusing on long-term planning for engineering and technological developments (TAP), and development of communications and collaborations with industry (ILP), and that they do not become caught up in short-term programmatic issues.

VI. Summary of Recommendations

VI.1 Recommendations Pertaining to ODP

Phase-Out and Legacy Activities

PEC VI Recommendation 1: Monitoring legacy activities

JOI and its subcontractors should monitor progress on ODP legacy preservation on a routine basis, with a final external review suggested in FY'06 to ensure that legacy activities have been completed satisfactorily.

PEC VI Recommendation 2: Core close-up photographs

TAMU should develop a database of the collection of core close-up photographs taken on board the *JOIDES Resolution* and make it accessible to the scientific community. This project is of lower priority than others for Information Services and could be completed over a timeline longer than the planned phase-out (i.e., by the end of FY06).

PEC VI Recommendation 3: Public relations/outreach materials

JOI should develop a systematic record of all ODP public relations/outreach materials and activities, including to the degree possible those developed by individual member countries/consortia.

VI.2 Recommendations Pertaining to IODP

The Nature of IODP

PEC VI Recommendation 4: Nature of IODP

ODP was borne by the good will of a large international scientific community who cooperated as volunteers to solve scientific problems and to overcome financial, political and cultural hurdles associated with the conduct of the Program. These same attributes will be a prerequisite for a successful new international drilling program. Despite the increase in complexity in IODP, management and advisory structures should be kept as small and simple as practicable to underpin IODP's integration and its proposal-driven nature.

PEC VI Recommendation 5: Internationalism

Internationalism along with scientific diversity was one of the greatest strengths of ODP. The advisory and management structure of IODP should maintain broad international participation extending beyond its membership, and attract scientists from all experience levels.

PEC VI Recommendation 6: Funding

Level funding led to unacceptable erosion in the ability of ODP to achieve the promise of the Strategic Implementation Plan. In the future, the funding agencies and their respective prime contractors must be diligent in attempting to provide financial resources over the long term if the scientific, operational, and implementation priorities of IODP are to be achieved.

PEC VI Recommendation 7: Partnerships with other programs

Partnerships with other international research programs will increase in IODP, and are very desirable. It will be important to delineate the scientific, operational, and fiscal responsibilities of each partner early in the planning process.

Legacy Preservation

PEC VI Recommendation 8: Continuous legacy

One of IODP's highest priorities should be to establish the *continuous* gathering and documentation of information regarding its operations, with specific regard to the evolution of the shipboard and shore based laboratories and operations, engineering development (both small- and large scale), publications, and data management. This priority should be established throughout IODP at all levels and institutions. This priority can be best achieved by prompt establishment of a strong and centralized Information Services Center mandated and supported by the Central Management Organization (CMO), and by providing support for technical writers as necessary.

PEC VI Recommendation 9: Species ranges and time database

IODP should consider building a database linking species ranges and time from the beginning of the Program. This will take effort and oversight by the micropaleontology community.

Operations

PEC VI Recommendation 10: Publications

The IODP publications program must provide for the widest possible dissemination of the Program's scientific achievements in a variety of formats so as to maximize the use of IODP data within a broad scientific community with different cultures.

PEC VI Recommendation 11: Third party tools

IODP should develop a clear policy for third party tools for all IODP platforms, and that the CMO, with advice from the IO, should take responsibility for its enforcement.

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IODP should develop a set of "guiding principles" for all platforms for all procedures (core description, data quality, sample handling, etc.), and put in place metrics to ensure that standards are maintained. In particular, this needs to be done for core description as soon as possible to ensure compatibility with the IODP database, thereby avoiding data migration problems later in the Program.

PEC VI Recommendation 13: Exchange of technical staff

IODP should consider a program of exchange of technical staff (and possibly staff scientists) across all IODP platforms. Although complex, this will provide more program unity and assist in standardization of procedures.

Program Management and Planning

PEC VI Recommendation 14: Planning timeline

ODP was limited by planning tied to annual budget cycles. The complexity of IODP will require long lead-time and long-range planning. While the Committee recognizes the reality of annual budgeting, it recommends systematic, multi-year operational program planning.

PEC VI Recommendation 15: Program evaluation

A rigorous and frank program of evaluation and assessment needs to be put in place at all levels in IODP.

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IODP management should establish significantly more effective and sophisticated approaches to both Education and Outreach. These endeavors, although traditionally linked to each other, have different goals, and should be decoupled. Each requires substantive resources and its own strategic implementation plan. In addition education and outreach activities, although they are being planned independently in the member countries, should follow an overarching IODP strategic implementation plan.

Science Advisory Structure

PEC VI Recommendation 17: Conduct of meetings

The IODP Science Advisory Structure should pay special attention to (i) conducting its deliberations in a way to ensure full participation of all members in the decision-making process, (ii) informing Panel members of their responsibilities to make decisions based on scientific merit and not on any other considerations, and (iii) ensuring the best presentation of every proposal under consideration. One way the latter could be done is via video link with the principal proponent.

PEC VI Recommendation 18: Planning oversight and control of project creep

The Committee recommends that SPC provide greater oversight of the planning process for each expedition to (i) ensure that operational plans are consistent with the science objectives, (ii) advise the IOs in containing project creep, and (iii) allow for better long-term planning in IODP. The Committee recognizes that this will require a change in the timeline for ranking and scheduling of proposals, and recommends the timeline for this process be reviewed.

PEC VI Recommendation 19: Role of OPCOM

IODP should reexamine the role of OPCOM in the Science Advisory Structure and make changes to ensure the best interface with the CMO and IOs in the development of operational plans.

PEC VI Recommendation 20: TAP and ILP

The Committee recommends that the activities of the new Technology Advice and Industry Liaison Panels be carefully monitored to ensure that they are focusing on long-term planning for engineering and technological developments (TAP), and development of communications and collaborations with industry (ILP), and that they do not become caught up in short-term programmatic issues.

VII APPENDICES

VII.1 Brief Bibliographies of PEC VI Members

Susan E. Humphris (Chair) is a marine geochemist whose interests lie in the geochemistry of seawater-rock reactions in hydrothermal systems, and their role in the formation of seafloor mineral deposits and in global geochemical cycles. She has more than 25 years experience with scientific ocean drilling, having sailed during DSDP (Leg 54) and ODP (Leg 106 and as Co-Chief Scientist on Leg 158). She has served as a member and Chair of the JOIDES Lithosphere Panel (1988-1993) and as Chair of the JOIDES Science Committee (1996-1998). Humphris was also a member of the USSAC Conceptual Design Committee for the IODP non-riser drilling vessel.

James A. Austin, Jr. has more than 20 years experience with scientific ocean drilling. As a seismic stratigrapher and specialist in deciphering the sea level record of continental margins, Austin has served as a Co-Chief Scientist twice during ODP (the Bahamas, Leg 101, and the New Jersey shelf, Leg 174A). He has also served as Chair of the JOIDES Planning Committee (1990-1992) and as interim director of ODP at JOI, Inc. (1994). Austin was also a member of the IODP Planning Subcommittee (IPSC, 1999-2001), which developed the framework for IODP. He is presently serving as interim director of IODP.

Helmut Beiersdorf is a marine geologist (retired from Federal Institute for Geosciences and Natural Resources, Germany) whose activities centered around prospecting and exploration of seafloor mineral resources, and processes of their formation. He coordinated the German scientific contribution to scientific ocean drilling (DSDP & ODP) from 1975 to 2001, and sailed on the Glomar Challenger in 1979 (DSDP Leg 69, Panama Basin). He represented Germany in the JOIDES Planning Committee from 1975 to 1987, and 1990 to 1993. He was member of the JOIDES Central and Eastern Pacific Panel (1987 –1990) and JOIDES Executive Committee (1993-2001), and was Chair of the latter 1999 and 2000. He was also a member of the COSOD and CONCORD Steering Committees.

Hans Christian Larsen is a marine geophysicist with primary interests in the formation of rifted margins, mantle plumes, and large igneous provinces. He has been involved with ODP since 1987, serving in a wide range of JOIDES panels including Planning Committee, and as Co-Chief Scientist on two ODP Legs. He chaired the North Atlantic Rifted Margins Detailed Planning Group (Legs 149, 152, 163, 173 and 210), and was a member of the IODP Planning Subcommittee (IPSC, 1999-2001). He has served as Director of the Danish Lithosphere Centre since its inception in 1994.

Arthur E. Maxwell is an oceanographer-marine geophysicist. His primary interest is in sea-floor heat flow and marine tectonophysics. He has been involved with deep sea drilling and coring for nearly four decades. This began with the early Mohole Project and continued through the JOIDES drilling programs. He has been both a member and Chair of the JOIDES Planning and Executive Committees. He served as Co-Chief Scientist on Leg 3 of DSDP.

Richard W. Murray is a geochemical paleoceanographer with interests in the distribution of major, trace, and rare earth elements in marine sediments and in studying climatic change through the Pleistocene and Holocene. He has 15 years of experience in scientific ocean drilling, and has sailed on four ODP cruises (127, 165, 175, 185) with his graduate students participating on several others (188, 199, 206). Murray served on the U. S. Science Advisory Committee (USSAC) from 1997-2000, the JOIDES Scientific Measurements Panel (SciMP) from 1997-2000, and is currently co-chair of the IODP's SciMP. He was also a member of NSF's Review Panel for the 2003-2007 ODP Program Plan.

Kensaku Tamaki has focused on ocean floor tectonics in the Western Pacific and in the Indian Ocean. He was Co-Chief Scientist on ODP Leg 127 (1989) in the Japan Sea, and developed a model of continental rifting and back-arc basin formation. He was the Japanese delegate for the ODP Science Committee (SCICOM) between 1997 and 1999. Since 2000, he has also been the Chair of InterRidge, a term that will continue until 2004.

VII.2 Questionnaire Sent to the International Drilling Community

Dear Colleague:

We are the Performance Evaluation Committee (PEC VI) that is reviewing the legacy of ODP. One of our tasks is assessing "the effectiveness of the JOI program management and the JOIDES scientific advice structure...to determine whether these are the most appropriate models for the IODP, and if not, suggest changes." To refresh your memory, we have attached to this email a PDF file that contains the diagrams of the JOIDES panel structure and the proposed IODP panel structure.

We are writing to solicit your help in assessing the overall management of the Ocean Drilling Program (ODP), and to brainstorm on potential improvements for the new Integrated Ocean Drilling Program (IODP) which begins on October 1 of this year. There are several issues where you can help us get an accurate picture of the community's thoughts if you would kindly answer any or all of the following questions.

A. The ODP Management Structure

1. From your experiences with ODP, what has worked, and what has not worked, in the ODP scientific advisory panel structure? Please indicate the types of involvement you have had with ODP (e.g. panel member, PI on proposal, shipboard scientist).

2. The proposed scientific advisory structure for the IODP is modeled from the existing ODP/JOIDES structure. Is this an appropriate model or do you see a need for alternatives or major modifications in the structure and its procedures?

3. Do you think the IODP structure will improve communication and effectiveness? Why or why not?

4. How have you experienced the overall management of the ODP; i.e., the role of JOI in overseeing the main contractors and supporting the advisory structure? Are there changes you would like to see in the management of IODP?

B. Program Services

5. Are there activities within ODP (for example, relating to provision of shipboard technical staff, curation, data management, shipboard lab facilities, shipboard scientific party makeup, engineering services, logging services) that need to be changed in the more complex, multi-ship IODP, and how would you change them to make them more effective?

6. Has the new publication strategy (i.e. the current abbreviated Initial Reports (IR) and Scientific Results (SR), with most post-cruise publications ideally being published in the outside literature) resulted in increased, decreased, or has it not affected, the visibility and output of the program?

7. Do you believe that the new publication strategy has increased, decreased, or has it not affected, the flow of information and data from the program to the larger earth sciences community?

8. Are there any changes in the publication strategy that you would like to see?

C. International Partnerships and Participation

9. Do you think there has been good coordination and communication among the international partners (e.g., funding agencies, national research structures and research groups within the community) in ODP? Do you have suggestions for improvements?

10. Have you been satisfied with your interactions with ODP? What changes would you recommend to improve interactions between IODP and (i) individuals, and (ii) member nations?

D. The ODP Legacy

11. How is the legacy of the ODP (samples, data, scientific results) best secured? Are there specific areas that you are concerned about and feel require particular attention?

Of course, we welcome any and all comments you may have on other subject matters as well.

Please respond to Dr. Susan Humphris, Chair of the Sixth Performance Evaluation Committee (PEC VI, membership listed below), and note that your individual responses will be held in confidence.

We thank you in advance,

Performance Evaluation Committee VI (PEC VI)

Susan Humphris, Chair, Woods Hole Oceanographic Institution, USA, shumphris@whoi.edu
Jamie Austin, University of Texas, Austin, USA, jamie@utig.ig.utexas.edu
Helmut Beiersdorf, BGR, Hannover, Germany, beiersdorf@bgr.de
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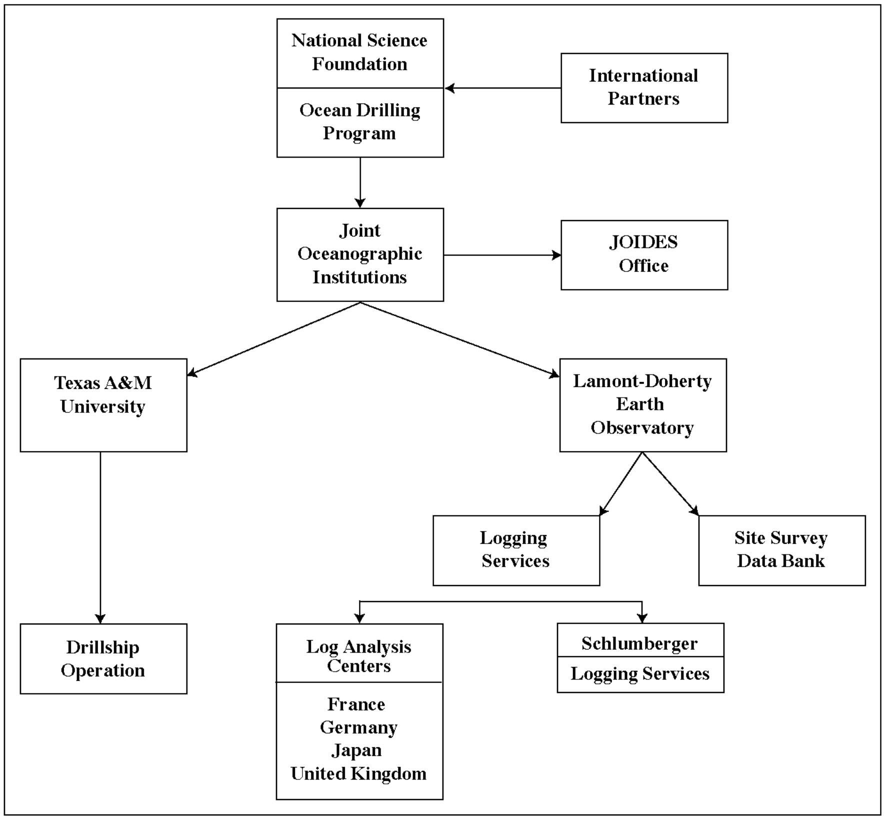
Kensaku Tamaki, University of Tokyo, Japan, tamaki@ori.u-tokyo.ac.jp

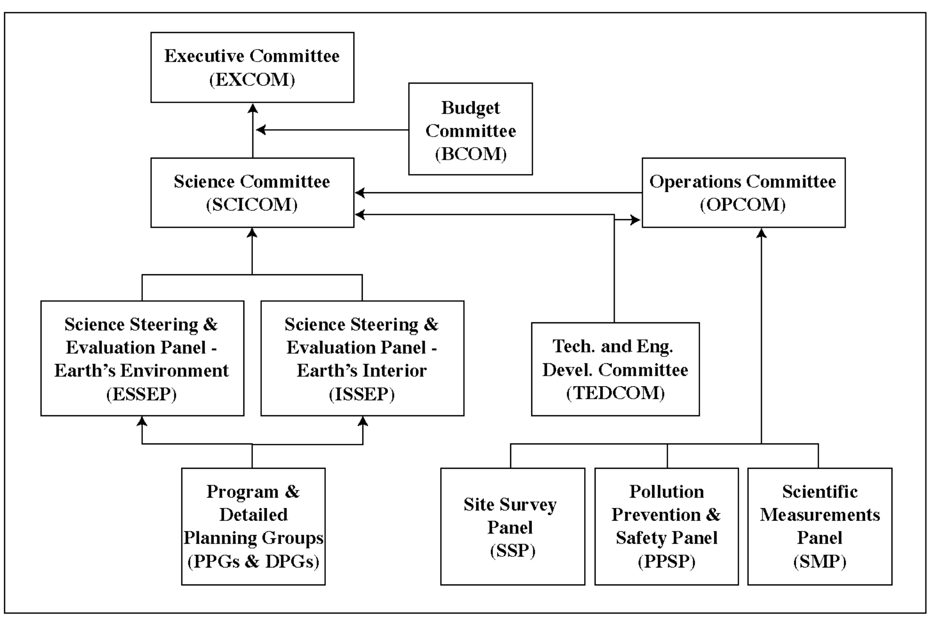
VII.3 ODP and IODP Management and Scientific Advisory Structures

Organizational Structures of ODP

1. Management Structure

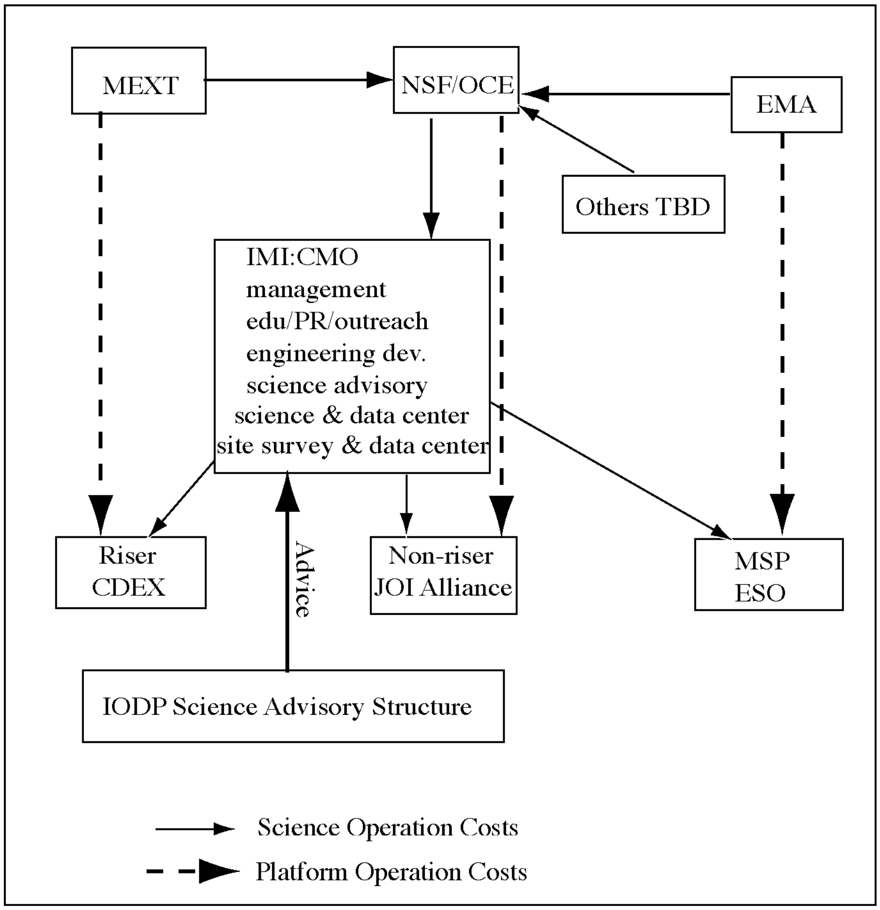


2. Science Advisory Structure

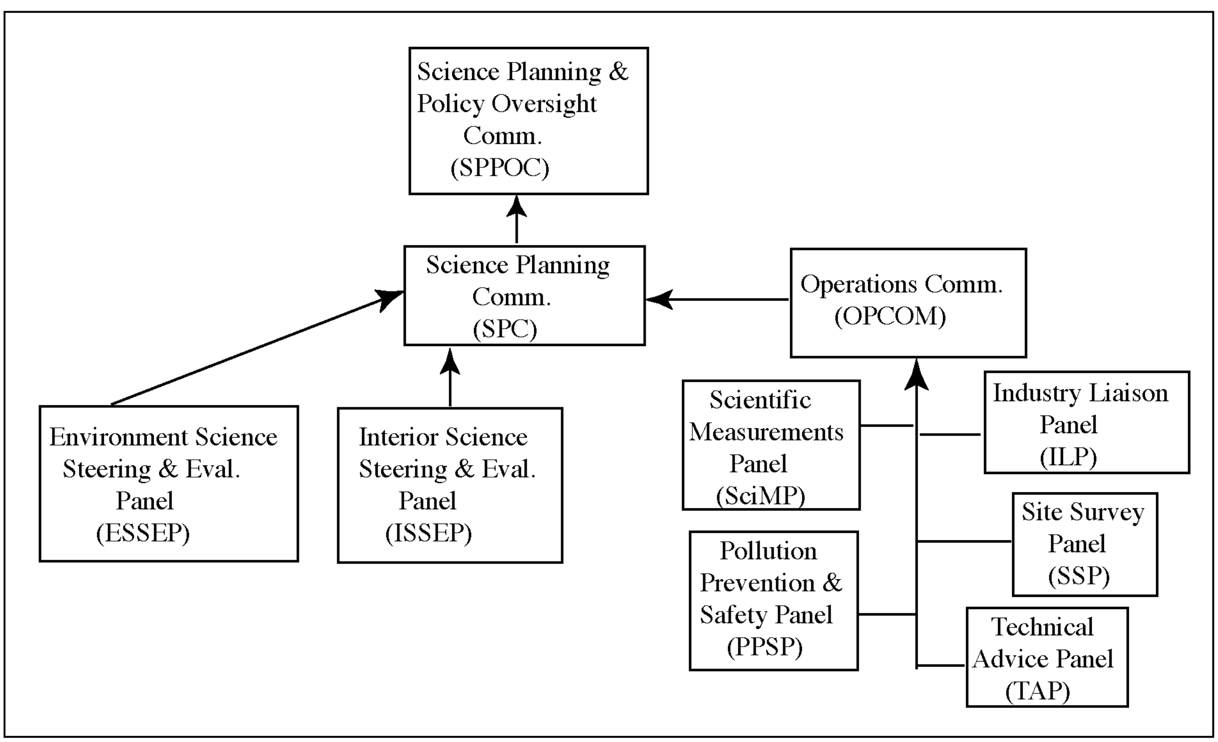


Organizational Structures of IODP

1. Management Structure



2. Science Advisory Structure



VII.4 SCICOM Responses on the Scientific Successes and Failures of ODP

How Well Did ODP Do?
(Input from SCICOM members to the July 2003 EXCOM meeting)

This Appendix contains contributions from SCICOM members, as presented to the July 2003 EXCOM meeting, regarding how well ODP had done in addressing its original scientific objectives. The responses are in different formats but are reproduced here with no editing. Two SCICOM members provided auxiliary material in terms of "grades" for ODP's accomplishments against the themes and objectives outlined in COSOD, COSOD II, and the 1990 or 1996 Long-Range Plans (LRP). Some SCICOM members contributed updated views of the most important scientific contributions of ODP, and those are summarized in this document as well. But for the most part, SCICOM stands by MASOD and A&O as the best current representation of the scientific impact of ODP.

Jamie Austin

What important scientific objectives has ODP addressed well? How has scientific progress within ODP set the stage for IODP?

• COSOD-I: 8. Global mass balancing of sediments; 9. History of ocean circulation; 10. Response of atmosphere and oceans to variations of planetary orbits.
• COSOD-II: Global array of full Neogene sections/orbitally driven oscillations.
• 1996 LRP: Earth's changing climate – spatial and depth transects.

- **Paleoceanographic transects (latitudinal, water mass): e.g, 138 (Eastern Eq. Pacific Neogene), 145 (N. Pacific), 167 (CA Current), 175 (Benguela Current), 199 (Pacific Paleogene), 202 (SE Pacific)**
- **Gateways: e.g., 151/162 (N. Atlantic Arctic), 181 (SW Pacific), 189 (Tasmania)**
- **IODP: continue "continuous [non-riser] coring" globally.**

• COSOD-I: 4. Dynamics of forearc evolution.
• COSOD-II: Fluids in subduction settings (experiment: fluid flow and the cycle of deformation and seismicity in a subduction zone).
• 1996 LRP: Convergent margin fault processes; in situ monitoring of geological processes.

- **Barbados: e.g., 110, 156, 171A**
- **Costa Rica: e.g., 170, 205,…(IODP: Subduction Factory)**
- **Nankai Trough: e.g., 131, 190, 196, …(IODP: Seismogenic Zone).**

• COSOD-I: 11. Patterns of evolution of microorganisms.
• COSOD-II: Evolutionary processes in oceanic communities.
• 1996 LRP: Pilot project: Earth's deep biosphere.

- **Sampling the subsurface biosphere: e.g., 112/201 (Peru margin),…(IODP: Deep Biosphere).**

• COSOD-I: 2. Circulation, chemistry and dynamics of hydrothermal systems.
• COSODII: Hydrothermal circulation.
• 1996 LRP: Hydrothermal processes and sulfide mineralization.

- **Hydrothermal circulation at/near ridge crests: e.g., 139/169 (SRI and II), 158 (TAG), 193 (Pac-Manus)**
- **IODP: a prime example of observatory-based, process-oriented science, one possible IODP focus.**

• COSOD-I: 2. "natural laboratories".
• COSOD-II: global seismic observatories.
• 1996 LRP: Mantle dynamics – LIPs, global seismic observatories.

- **ION activities: e.g., 136 (OSN-1), 179 (NERO), 186 (W. Pacific), 191 (NW Pacific), 195 (W. Pacific/Mariana), 200 (H2O), 203 (E Eq. Pacific)**
- **IODP: more of the same; increase integration with such liaison programs.**

In what areas of scientific endeavor could ODP have done a better job? How will IODP make our (drilling and coring) lives better?

• COSOD-I: 6. Reponse of marine sedimentation to fluctuations in sea level.
• COSOD-II: Changes in the global environment (experiment: Amplitude and Timing of Changes in Cenozoic Sea Level).
• 1996 LRP: Causes and effects of sea level change.

- **Atolls and guyots – the "dipstick" approach: e.g., 143/144. Science hampered by poor pre-drilling seismic imaging, poor core recovery, diagenetic overprinting of recovered samples.**
- **IODP needs: better geophysical surveys, tools to recover interbedded hard/soft lithologies, MSP's?**
-

• COSOD-I: 3. Early rifting history of passive continental margins.
• COSOD-II: Conjugate passive margin drilling.
• 1996 LRP: Extensional margin drilling.

- **Conjugate margin transects: Old N. Atlantic – 103/149/173 (Iberia) + 210 (Newfoundland); young W. Pacific – 180 (Woodlark Basin). Long-term community interest evident, but inability to drill deeply (and safely) and unwillingness to commit adequate drilling time has hurt the scientific goal of accessing early rift deposits and geologic history.**
- **IODP: riser capability, MSP's (?), community commitment! Also need to address other younger basins for processes – e.g., Gulf of CA, Red Sea, Adriatic.**
-

• COSOD-I: 1. Processes of magma generation and crustal construction at mid-ocean ridges. 2. "Natural laboratories" – arrays of holes, at least one deep.
• COSOD-II: Mantle-crust interactions (total crustal sections), stress and deformation of the lithosphere – world stress map (oceanic sites).
• 1996 LRP: Drilling in zero-age crust, complete crustal sections.

- **Zero-age ocean crust drilling: 106/109 (MAR), 118/176 (SW IndianRidge), 142 (EPR), 153 (MARK) has been for the most part unsuccessful.**
- **Hole 504B deep penetration a serendipitous result, but a good example of community resolve.**
- **One example of designed full-penetration hole – 206 (E. Pacific)**
- **A combination of imperfect engineering (hard-rock spud-in, hard-rock guide base/reentry system, DCS system [!], hammer drill-in casing) and loss of community resolve over time has hurt this science.**
- **IODP: Will we do better?**

Selected ODP achievements that are near and dear to my heart, and how we can capitalize on ODP progress made within those themes in IODP

• COSOD-I: 6. Reponse of marine sedimentation to fluctuations in sea level.
• COSOD-II: Changes in the global environment (experiment: Amplitude and Timing of Changes in Cenozoic Sea Level).
• 1996 LRP: Causes and effects of sea level change. Continental margin transects/global coverage/variety of sediment types.
  - **"Mid-Atlantic" U.S. (siliciclastic), e.g., 150 (slope), 174A (shelf), 174AX (coastal plain),…(IODP: NJ inner shelf MSP?)**
  - **Bahamas/Australia (carbonates), e.g., 166 (tropical bank flank), 182 (cool-water temperate), 133/194 (tropical platform),…(IODP: Tahiti/Great Barrier Reef MSP?)**
  - **We proved we could drill and core in these shelfal/platform environments safely. We showed that both local and eustatic base-level indicators exist and can be tracked. We learned how complicated the experimental plan must be.**
  - **IODP: use MSP's when appropriate, develop coring tools that can recover sands better (VPC?), maintain the global focus.**
  -

• COSOD-I: 3. Early rifting history of passive continental margins.
• COSOD-II: Conjugate passive margin drilling.
• 1996 LRP: Extensional margin drilling.
  - **Volcanic passive margins – e.g., 104 (Voring Plateau), 152/163 (E. Greenland)**
  - **We dated these volcanic accumulations (basalts and intercalated sediments) and assessed their paleoenvironments. In the process, we shifted the entire dialog about how continents rift and drift.**

<u>**Keir Becker**</u>

For many goals of COSOD, COSOD II, and the Long-Range Plan, the program has done quite well, both in following the scientific plan and delivering results! A few good examples include:
• Paleoceanography and paleoclimate
  - High-resolution Neogene

- Cretaceous/Paleogene "extreme climates"

- Subduction zone concerted drilling in 5 example settings
- Atlantic conjugate margin studies
- In situ monitoring of geological processes
  - ION global seismic observatories – 7 sites
  - CORK hydrogeological observatories – 18 sites

For what goals might the program have done better and why?

Global stress mapping – lack of proposals independent of ION sites
Deep penetration - lack of JOIDES (and community?) resolve for multi-leg commitment??
- Full crustal penetration a high priority since COSOD I
- Phase III drilling to 2-4 km at several sites promised in LRP (504B was a DSDP/Phase I/II fortuitous accomplishment)
- Special call for proposals issued, but first concerted steps being taken only during final year of Phase III

Zero-age drilling – realities of technological development
Mission-specific platform drilling, primarily for climate and sea-level studies – budgetary realities.

While ODP has not fulfilled these expectations, the entire ODP community has made an important contribution – laying the groundwork for addressing most of them in IODP!

Subseafloor observatory science: Where would it be without ODP?
- Almost nowhere, except for a few initial seismic efforts during DSDP or the potential of utilizing existing DSDP reentry holes for observatories
- Establishing borehole observatories is an important ODP contribution, both in hydrogeological studies and future global seismic studies
- ODP borehole observatory contribution has also been important factor within initiative for seafloor observatories

Submarine hydrogeology: Where would it be without ODP?
DSDP contributions include:
- Initial drilling in important crustal hydrogeological reference sites (504B, 395A, 417D/418A)
- Establishing basic crustal permeability/porosity model from 504B and 395A
- Important initial hydrogeological models on ridge flanks

ODP contributions include:
- Deep drilling in 504B, establishing other important sites for expanded global coverage in both ocean crust and subduction settings
- Significantly expanded global permeability dataset, indicating age variation and scale effects in highly permeable ocean crust
- Significantly expanded global dataset of alteration results, leading to better understanding of global fluxes
- Renewed modeling efforts based on realistic permeability structure

- Focus on subduction hydrogeology with indications of episodic fluid flow related to tectonics
- Important initial demonstrations of other fluid flow regimes: continental margins (NJ shelf), carbonate banks
- CORK observatories: time-series determinations of in-situ state and hydrogeological processes

Much work remains to be done, and ODP has set the stage for more sophisticated submarine hydrogeology studies in IODP.

Sherm Bloomer

How well did we do on fundamental scientific advances?

Area: Heat and Mass Transfer
Fundamental contributions:

- The program moved to provide **time** and **geologic** constraints on oceanic studies (FMS, magnetics, 3rd dimension)
- Provided the best constrained modern analogs for interpretation of the geologic record

Hits:

- Architecture of the ocean crust
- Chemical mass balance consequences of ocean crust formation and alteration
- Mantle dynamics – particularly the stability of the Hawaiian hotspot study (197)
- Dynamics and complexity of convergent margins – probably the most important contribution to land geology and geologic history interpretation
- The recognition of links…extinctions, volcanism, climate, circulation

Misses:

- Didn't take enough advantage of the ability to orient core and do structural and paleomag – plate reconstruction constraints
- Never really figured out how the drill could be used in complex active tectonic areas – transforms, detachments
- Didn't always attack the problems with the right tool
- The failure to do deep penetration and zero-age drilling was not, in my opinion, a major scientific failure in our studies of the oceanic crust

How well did we do in our operational goals in COSOD I and II and the LRP?

Area: Heat and Mass Transfer
With a couple exceptions, the goals of COSOD I and II can be mapped in the themes of the LRP.
Hits:

- Ocean ridge construction, even without zero-age or deep penetration
- Subduction system dynamics and evolution: arc, forearc, backarc

• Mantle dynamics – LIPs (though we struggled), seismic observatories, Hawaiian hotspot drilling
• Subduction zone fluid dynamics and balance: accretionary prisms and forearcs
• Hydrothermal circulation: particularly sediment-buried, offaxis, and even bare-rock, given the tremendous technical difficulties

Misses:

• Deep crustal penetration to total crustal penetration – 504B our best effort; also deep holes in hydrothermal areas and continental margins
• Zero age drilling – though we may ask what the essential goals are now
• World stress map
• Magnetic field history (COSOD I) – incremental additions
• Translational margin studies and active tectonic processes: simple not amenable to drilling strategies.

Steven D'Hondt

Scientific Achievements of ODP

1. ODP has delivered tremendous understanding of natural climate and ocean variability.

ODP has greatly advanced understanding of:
- natural climate variability,
- the interplay between ocean and climate,
- the interplay between climate and planetary orbits,
- high-resolution (Mikankovitch-based) geologic timescales,
  - and rapid climate change.
  -

2. ODP has greatly helped to pave the way for a real understanding of subsurface life.

Without ODP, we would have little recognition of life beneath the seafloor.

What has the program done well?

It has greatly improved understanding of Changes in the Global Environment

Categories of success:

Response of atmosphere and oceans to variations of planetary orbits (COSOD / COSOD II)

Understanding natural climate variability and the causes of rapid climate change (1996 LRP Initiative)

Amplitude and Timing of Changes in Cenozoic Global Sealevel
  - passive margin stratigraphy (COSOD II "Illustrative" Experiment)
  - isotopic global ice volume estimates (COSOD II "Illustrative" Experiment)
  -

It has improved understanding of Sediments, fluids, and bacteria as agents of change

An example of success:

Pilot Project: Earth's deep biosphere (1996 LRP Initiative)

What goals might the program have met better?

ODP could have better improved our understanding of the biological history of the ocean, and its relationship to Earth's environmental history:

<u>Examples of success</u>:
Understanding of Paleocene/Eocene boundary event
Improved understanding of biological response to K/T impact

<u>Examples of under-achieved objectives</u>:
1. *Patterns of evolution of microorganisms* (COSOD)
2. *Long-term records in Jurassic/Cretaceous sections* (COSOD II)

Why? Lack of proposal pressure (1, 2)? Lack of integration with related proposals (1)? Lack of commitment to deep penetration (2)?

<u>Andy Fisher</u>

What ODP has done well…
- documentation of variations in Earth's past climate, identification of possible "causes"
- evaluation of structures and links to hydrogeology, lithology, tectonics, magmatism at active margins
- elucidation of sediment, climate response to changes in sea level, occurrence of gas hydrates
- investigation of tectonics, composition, history of rifted margins (volcanic, nonvolcanic)
- quantification of shallow hydrogeologic crustal conditions, initial development of borehole laboratories

What could have been done better…
- focus more on *process* rather than *product*
- follow through *after* drilling to evaluate whether individual programs were successful, problem was solvable, etc.

Achievements in Marine Hydrogeology…
- Ridge crests: Middle Valley, TAG
- Ridge flanks: Costa Rica Rift, Mid-Atlantic Ridge, Juan de Fuca Ridge, EPR flank
- Passive margins: New Jersey, Bahamas, Australia
- Active margins: Barbados, Nankai, Peru, Mariana Forearc, Costa Rica
- Overall: direct testing of properties, installation of observatories to monitor related processes, documentation of scales (spatial, temporal) of fluid flow and related processes

But for the Ocean Drilling Program…
- we might still think that fluids circulate to depths of several kilometers throughout most of the crust,
- we would not know how transient many hydrogeologic processes are within the seafloor,

• we would have much less understanding of development and evolution of ore deposits, and
• we would not know the magnitude of hydrogeologic driving forces, the enormous scales of flow, or relations between flow and tides or earthquakes.

Patricia Fryer

What we have done well?

- Drilling variety of environments
- Deep Earth Biosphere –archea in seep mud volcanoes
- Exploring transfer of heat and materials from interior of earth in subduction zones to the sea
- Reference centers
- Innovations in seafloor observatories

What we could have done better?

- Riser drilling - never did it
- Legacy data still will need to be transitioned (esp. paleontology)
- JANUS database – costly cumbersome, might better have been kept in academia
- Could have drilled into active subduction zone of a nonaccretionary convergent margin for investigating earthquake processes and cycling of constituents during subduction (would have utilized the stated max capability of ODP drilling)
- Establishing more observatories (ALL "Futures" documents state thatmonitoring will be key)
- Reorganization of the program was a major hiccup (change is good in and of itself)
- Abolishing of publication was a bold step, but has led to a loss of continuity and readership.

Scientific Achievements

Initiative II: In situ monitoring of geologic processes: fluid flow in the lithosphere, geochemical fluxes:

- Recycling of slab constituents at convergent plate margins is accomplished in large part via fluid flux. Drilling on numerous accretionary convergent margins showed that both diffuse and channelized flow is a major factor in the recycling. Leg125 demonstrated active fluid egress at serpentine seamounts on the Mariana system.
- Drilling on Leg 195 placed a perforated casing in a hole in the conduit region of a serpentine mud volcano and instrumented (thermistor string, pressure sensor and osmo-sampler) and CORKed the hole. Recovery will take place in Spring 2003.

Initiative III: Exploring the deep crustal structure of Continental margins and oceanic crust: to penetrate hitherto inaccessible regions beneath the seafloor
- to explore the underlying processes that form continents, rifts, oceanic crust, and economic sources, and to test models of active processes occurring at convergent margins.

- 103, 147, 173: (Iberia) transition from continent to ocean lithosphere and th serpentinization and emplacement of serpentine serpentinization process and exposure by faulting.

- amagmatic ridge segments: 37, 45, 82, 109, 153 mantle character and serpentinization process and exposure by faulting.
- Hess Deep: mantle near fast spreading ridges: nature of diking serpentinization process and exposure by faulting.
- Non-accretionary convergent margins drilling.
- First evidence of blueschist in situ and first evidence of direct transport of slab-derived fluids to seafloor (cycling of constituents in subduction factory).

How the field would be different if there had been no drilling:

- No idea of magnitude of the serpentinization process (back to Hess hypothesis of serpentinized mantle throughout the oceans (not so)).
- No stratigraphic control over the relationships among peridotite bodies in the continent-ocean transition zone, along amagmatic sections of mid-ocean ridges, and at the crust - mantle boundary region of fast-spreading ridges.
- Would still be a controversy over diapiric vs fault emplacement of serpentinite at the edges of continents, in amagmatic spreading segments and fracture zones - the stratigraphy provides the answer.
- No way to prove the serpentine mud volcanoes of convergent margins are just that and that the associated pore fluids are slab-derived.
- No proof that blueschist does form in convergent margins.

<u>Teruaki Ishii</u>

Scientific Achievements of ODP

- Comparative studies on the geological cross-section of the oceanic crust down to mantle peridotite.
  ---ophiolite problem---
- In-situ and semi-in-situ geological cross sections on the seafloor.
  - preserved clear exposure of outcrop
  - stratification
  - geological background
- Petrogenesis of ophiolites (associated effusive rocks), mantle peridotites
  Combination of:
    - dredge hauls, ODP cores, submersible observations
    -

A. Serpentinite seamounts in the Izu-Ogasawara-Mariana forearc (dismembered ophiolites) (modern view of the Cyprus ophiolite)
B. Tonga forearc, Yap Trench inner wall
   (modern analogue of the Oman Semail ophiolite)
C. Southern Mariana Trench inner wall
D. Parece Vela Basin mega-mullion
E. Tectonic window
F. Mariana Trough cliff

Chris MacLeod

What we have done well (or what could not have been done without ODP)

- **palaeoclimate/palaeoceanography**
  primary tool in the field, directly responsible for progression in methodologies and hence stimulating massive progress in studying ocean history
- **deep biosphere**
  serendipitous discovery of deep biosphere one of major achievements of ODP;
  N.B. broad implications not only for science but also for biotechnology industry
- **gas hydrates**
  ODP has been a prime tool with which to investigate gas hydrates, not only for scientific aspects but also in the potential as a natural resource and societal relevance
- **convergent margin processes**
  insights into origin and dynamics of intra-oceanic forearcs and (early) arc volcanism
  subduction factory : consideration of fluxes and quantification of processes
- **mid-ocean ridge processes**
  providing the direct evidence that challenges the Penrose layer-cake paradigm starting to demonstrate the profound control spreading rate plays in processes of crustal generation
- **methodologies**
  training of young/non-U.S. scientists and exposure to the cutting edge;
  establishment of consistent and methodical procedures for dealing with core etc.
  rigour of publication procedures and schedules to maximise scientific returns (N.B. high rate of output compared to publications arising from many conventional cruises)
- **keeping all sections of the community happy**
  one of the principal successes of ODP has been to maintain the adaptability of a single platform so as to be able to do a huge range of scientific experiments, (for the most part) uniting a highly diverse marine geological community
  maintaining this breadth is key to the success of IODP and any *other future programme*.

What we could have done better

- **mid-ocean ridge processes**
  not enough legs scheduled to address even basic first-order questions posed in the Long Range Plan etc.
  little attempt to start natural laboratory experiments
- **technology development**
  lots of money spent by ODP/TAMU on schemes that never delivered, or else were axed or capped, e.g. diamond coring, hard-rock core orientation etc
  insufficient notice taken by ODP engineers of developments outside Gulf of Mexico???

Achievements of ODP

Mid-Ocean Ridge Processes

- challenging the consensus paradigm for ocean crust formation of the 1970s—80s(—90s): the regular layer cake (Penrose) crustal structure independent of spreading rate

- direct equation of seismic layering with (ophiolite-based) lithostratigraphy
- fundamental differences in crustal construction between slow- andfast-spreading ridges
- small-scale heterogeneity of magmatic processes in lower crust at slow-spreading ridge (Hole 735B) — completely unlike ophiolite layered plutonic sections
- complexity of hydrogeology
- critical inter-relationships between tectonic, magmatic & hydrothermal (& biological) processes at all stages

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Larry Mayer

How Well Have the Drilling Programs Done?

Crustal Objectives: We have failed (technology and spirit)

Magma Generation and Crustal Construction
Total Crustal Sections (Deep Crustal Sections)
Zero Age Crust

Hydrated Mantle: some success (blessing of soft rocks)
LIPs

Hydrothermal Systems: Very successful (technology-enabled: CORKs)

Tectonic Objectives

Failed – lack of interest
World Stress Map

Very Successful – combination of technology (need more), strong community and commmitment
Dynamics of Forearc Evolution
Fluids and Deformation in Subduction Settings
Circulation in Continental Margins
Seismicity and Fault Processes

Gas hydrates: Very Successful

Convergence of technology, commitment, and willingness to take risks

Conjugate Margin Studies and Early Rifting History: Moderately Successful

Limited by need for deeper drilling and commitment to longer time at hole

Paleoceanographic Processes : Very Successful

Have established global linkages, lead and lags that provide direct insight into working climate systems

History of Ocean Circulation
Response to Orbital Forcing
Patterns of Evolution

Natural Climate Variability at a Range of Scales and Biogeochemical Cycles
Linkages to Tectonic Events

Older Sections and Events (K/T, anoxic, impact, etc): M**oderately Successful** -- getting better as recovery improves…still lacking proper tools and commitment

Global Sea Level History: Barely Successful – lack of appropriate tools (and perhaps testable models) – need for mission specific platforms

Unexpected Surprises – Very Successful
Deep biosphere, global correlations, dessication of Med, etc.

A day-to- day demonstration that a well-run international collaborative scientific program can be a remarkable success.

Scientific Achievement in My Field

What is my field??? Geophysical Paleoceanography???
Paleoceanography would be a very different field without the drilling programs (if it would exist at all). Our view of Earth history would be constrained to small high-resolution snippets of very recent history or very low-resolution records of the long-term history of ocean and climate conditions. The drilling program has allowed us to obtain a global picture of oceanographic and climatic changes at scales ranging from decadal to 100's of thousands of years. The program has fostered the development of a number of new tools that allow for the global correlation of a range of paleoceanographic proxies and in doing so has established new approaches to refining very high-resolution stratigraphic control that has produced new, global time-scales that have revolutionized our ability to understand the spatial and temporal linkages between components of the earth/ocean system. The continuous recovery offered by the drilling programs has also revolutionized our ability to use seismic data to extrapolate beyond and interpolate between drill holes. Given that industry holes tend to sample only a small percentage of the drilled section, the ODP approach, in combination with detailed laboratory logging and sampling, has provided unprecedented insight into the relationship between the seismic and the geologic record – particularly with respect to paleoceanographic change.

Delia Oppo

How Well Have We Done?
High-resolution Neogene Paleoceanography and Paleoclimate:
Multiple offset holes and MST techniques have improved ability to acquire continuous sections. With 4 holes, continuous sections and sampling higher volume is possible (critical for high-resolution).

How could we have done better?
A minimum of 4 holes at each site should be routine, allowing high-volume sampling of

continuous sections.
More high-resolution (centennial-millenial) sites, better spatial coverage, especially in tropics/subtropics.
Longer well-resolved, multiple proxy records (also requires better funding to work on existing material).

Technical needs:
Improved MST/color scanner
Improved/standardized digital camera
Larger sediment lab, more lab facilities for shipboard analysis and sampling

Where would the science be without ODP?
No ODP:
-- no long cores
Either poorly resolved (low sed rate) long records or well resolved short records
-- no high-resolution studies spanning several years glacial cycles; aliasing
-- no knowledge of millennial-scale variability during previous interglacial, last glacial in some locations
-- poor documentation of 40k-100k yr transition
_ poor documentation of ocean-cryosphere interactions
-- poor understanding of climate variability during altered boundary conditions (e.g., tectonic and glacial)

Paleoceanographic Contributions that Required Scientific Drilling:
- Spatial and depth transects spanning continuously several Myr to address questions about evolution of Earth's climate with respect to changing boundary conditions. The roles of insolation, tectonics, deep ocean circulation, biogeochemical cycling. Evolution from 40kyr – 100 kyr cycles. High to low latitude linkages.

Legs 130 (OJP), 154 (Ceara Rise), 108 (E trop. Atl.), 114 (SubAA S. Atl.), 138 (ETP), 145 (N Pac.), 152/162* (N Atl.), 165* (Carib.), 167* (Calif. Margin), 172* (Bermuda Rise; BBOR), 175 (Benguela), 177* (S. Oc. Paleo.), 178 (AA), 181 (SW Pac.), 184* (SCS, 202* (SE Pac.).

- Has or will provide important insights on shorter time scales – characterize millennial variability during earlier time intervals.

- Mean ocean _18O change since the LGM was ~1‰ (Schrag et al., 1993, Leg 154, confirmed and refined on subsequent legs)

- Extending records from ultra-high-deposition-rate sites beyond that possible with piston cores, e.g., reaching the LGM, capturing a full glacial cycle (e.g., Leg 165 – 1002, Cariaco Basin, Leg 167 – 893, Santa Barbara Basin; Leg 178 – 1098, Palmer Deep)

- North Atlantic millennial scale climate variability during earlier peak interglacials (e.g., MIS 11), was persistently greater during glacial than interglacial times and occurred in the 40 kyr world (Leg 162)

For What Goals Might the Program Have Done Better and Why?

Understanding natural climate variability and the causes of rapid climate change (1996 ODP LRP Initiative):

Only a handful of ultra-high-resolution sites, records tend not to be very long (e.g., safety issues at SBB). Takes a long time to generate data at high resolution, funding is a problem. Few low latitude sites capture centennial-millennial resolution.

Dave Rea

Achievements in the Field of Sediments and Ocean History

Essentially the entire pre-Quaternary aspect of paleoceanography, and much of the Quaternary science as well, would not be possible without DSDP, ODP, and the HPC-APC-XCB technology. This ranks with the strikingly clear demonstration of plate tectonics as the two greatest successes of the entire program.

It’s hard to know where to start:

- Orbital control of pelagic and hemipelagic sedimentation, thus paleoproductivity, oceanic and atmospheric circulation, climate, etc.
- Millennial scale variability of ocean-wide, likely world-wide, climatic and oceanic processes
- Tectonic control of longer term climate and oceanic changes
    - Cenozoic climate, warm to cool – in steps
- Oceanic record of continental variability, the land-sea links
- Carbon cycles and paleo-CO_2
    - Ocean anoxic events and broader implications thereof
    - Sapropels
    - Gas hydrates
    - Estimates of past CO_2 concentrations
- The nature and rate of evolution of the major microfossil groups
- Geochronology in general
- Sea level, passive margin architecture, ice volume
- The reality of the deep biosphere
- Understanding what really happened at the K/T and P/E boundaries and other boundary “events” – E/O, Cen/Tur, etc.
- Resolving the atolls and guyots quandary

Scores

Objectives Outlined in 1990 Long Range Plan

Objective	Grade	MASOD#
• Structure and composition of the crust and upper		

mantle

1. Exploring the structure and composition of the lower oceanic crust and upper mantle	C	22,26
2. Magmatic processes associated with crustal accretion	C+	22
3. Intraplate volcanism	A-	21,25
4. Magmatism and geochemical fluxes at convergent margins	B+	24
• Dynamics, kinematics, and deformation of the lithosphere		18
1. Dynamics of the oceanic crust and upper mantle	C-	18
2. Plate kinematics	C	15.25
3. Deformation processes at divergent margins	A-	19,20
4. Deformation processes at convergent margins	A-	3,24
5. Intraplate deformation	C	
• Fluid circulation in the lithosphere		
1. Hydrothermal processes associated with crustal accretion	B	4,23
2. Fluid processes at plate margins	B	3,9
• Cause and effect of oceanic and climatic variability		5
1. Short period climate change	A	6,8
2. Longer period changes	B	12,15,16
3. History of sea level	B+	14
4. Carbon cycle and paleoproductivity	A/B	2,9,10
5. Evolutionary biology	A-	7,9,13

• Other MASOD not parsed:

Deep biosphere - #1
Methane hydrates - #2
Deep sea sands - #11
Carbonate platforms - # 17

Matt Salisbury

How Well Have We Done?

Success Stories

Ocean Crust

- Upper ocean crust revealed
- Porosity, fluid circulation in crust
- Massive sulphides (TAG, JdeF)

Paleoenvironment/Climate

- Orbital forcing
- Onset of glaciation

- Greenhouse / icehouse
- K/T

Margins

- Conjugate margins (eastern 1/2 N. Atl.)
- Convergent margin fluids
- Clathrate story

Special Bonus! - Connectivity

Technology

- Complete, undisturbed sediments
- Seismic observatories
- Packer technology
- Logging
-

Bummers

- Deep crustal penetration (technology)
- Zero-age crust (technology)

Jury's still out

- Seismic observatories (not much data yet)
- Conjugate margins (western 1/2 N. Atlantic undrilled)

Ocean Crust Achievements

- Upper 1/3 of ophiolite model confirmed
- Layer 2/3 ≠ petrologic boundary
- Porosity, permeability "gradient"
- Long-range hydraulic connectivity
- Massive sulphides in situ
-

Without ODP:

- we would still be debating the validity of the ophiolite model,
- we would have no quantitative models of the hydrologic regime of oceanic crust,
- and we would have no way of sampling massive sulphides in-situ for comparison with on-land deposits.

Will Sager

How ODP Has Advanced Research in My Fields

Paleomagnetism: History of Earth s Magnetic Field Focus

- Largest number of paleomagnetists working on single program
- But paleomag was prime focus of only one leg
- Has had large impact, mainly by providing high-resolution records
- ODP has not revolutionized field, but without ODP progress would be slower, especially in high-resolution records
- Note: Magnetic susceptibility (environmental magnetism) has become paleo-

oceanographic mainstay

Marine Geophysics
- ODP is the ground truth for many marine geophysics studies
- But very broad area, so impact diffuse
- Without ODP, we would know a lot less about marine geology

Gas Hydrate: LRP Theme
- ODP major impact on study of marine hydrate
- Without ODP, little progress on marine hydrates, BSRs
- Work mostly incomplete
- Blake Ridge done and disseminated
- Hydrate Ridge done summer 2002
- Petroleum basin - problems interfacing with industry

Plate Tectonics / Geodynamics
- Not a focus area — many aspects of PT/G investigated as processes
- Like MGG, ODP collects critical data for many studies, diffuse impact
- ION observatories — huge ODP investment, but payoff still unclear
- Hotspot motions — Leg 197 and potential future legs
- Plate motions — ODP data play important role
- Without ODP, progress much slower in many areas

Shelf/Continental Margin Sedimentary Structure & Stability
- ODP provides data from deep margins
- But not many projects focusing on margins
- ODP has not been able to drill shelves effectively

Scores

Theme

COSOD-I	**Score**	**Comment**
Environmental Changes — Tectonic Driver	2	Few attempts to address; tends to be local
Environmental Changes — Orbital Driver	8	One of best ODP efforts; many legs targeting; Neogene wiggles
Solid Earth Geochemical Cycles	4	Few done in much detail; W. Pac. Subduction factory
Total Crustal Sections	1	None complete; Hole 504B best effort
Hydrothermal Fluid Circulation	6	Sedimented ridges
Fluids in Subduction Settings	8	Costa Rica, Nankai, Peru, Barbados
Fluid Circulation in Continental Margins	5	Few attempts; New Jersey
World Stress Map — Ocean Sites	2	A few measurements here and there; little synthesis, no master plan
Neogene Evolutionary Processes	5	Follows Neogene paleoceanography, but impact not evident
Evolutionary Effects of Catastrophic Events	4	K/T only effort? Most of focus on K/T

		elsewhere
Evolutionary Records in Jurassic/Cretaceous	4	A few attempts; Atolls & Guyots
COSOD-II		
Amplitude & Timing of Eustatic Sea Level	7	A few notable studies: New Jersey, Atolls & Guyots; Bahamas; many lessor efforts; lacks systematic approach
Deep Crustal Penetration	5	Hole 504B; 735B, not much else
Fluid Flow & Deformation/Seismicity	1	Not well addressed; SEIZE (Nankai) will go there
K/T Boundary	3	Some successes: Legs 165; 198; no systematic approach
LRP-96		
High Resolution Climate Changes	6	Milankovitch cycles well studied; Piecemeal at shorter wavelength
Sediments, Fluids, Bacteria as Agents of Change	2	Only now beginning; Leg 201
Gas Hydrate	5	Getting there but approach still filling out; Blake Ridge (mature), other sites immature or not done
LIPs	5	Limited approach; OJP and Kerguelen only, one leg apiece (182,192)
Global Seismic Networks	8	Large investment in holes: Legs 136, 179, 186, 191, 195, 200, 203; not much data yet
Transect through Ocean Crust	1	Only a few attempts: Leg 147, 176, Hole 504B, 206, but no systematic approach
LRP-96 Big Themes		
Understanding Natural Climate Variability and Causes of Rapid Climate	7	Natural climate variability widely investigated one of big contributions of ODP; Causes less well understood
In Situ Monitoring of Geological	3	Many CORKS, ACORKS, but lack of Systematic approach; many CORK Installations piggy-back on other programs; problem with US infrastructure
Margins and Oceanic Crust	3	Some starts, but not much deep drilling; awaits riser ship

Appendix VII.5 Responsibilities of Phase-Out

Entities involved / Matters of Phase-out	NSF		JOI																					JOIDES									IPSC	IWG
				TAMRF											LDEO																			
							Core Repositories				Ship		Shore																					
	ODP	Council	JOI ODP Man.	TAMRF Adm. Services	Publicat. Services	Drilling Services	E' Coast	W' Coast	Gulf Coast	BCR	Marine Lab's	Electron. Lab's	ODP Lab's	Overseas Drilling Ltd. ODL	LDEO Adm.	Schlumberger	LMF France	Leicester UK	Aachen Germany	ORI	BRG Logging Serv.	Site Survey Data Bank	JOIDES Office	ISSEP	ESSEP	TEDCOM	SciMP	SSP	PPSP	OPCOM	SCICOM	EXCOM		
Drillship	x		x	x		x					x	x		x	x	x					x					A	A			A	A	A		
Equipment (Drillship, Shorelabs, Core Reposit., BRG)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	(x)	(x)	(x)	(x)	x	x	x			A	A				A	A	x	x
Data Base (Core data, Logging data, Site Surv. Data, Publications, IR, SR, others)	x	x	x	x	x	x	x	x	x	x					x	(x)	x	x	x	x	x	x		A	A		A	A			A	A	x	x
Core Rep's (Cores, Sub-Samples)	x	x	x	x			x	x	x	x														A	A		A				A	A	x	x
Intellectuall Prop's Rights	x	x	x	x											x						x			A	A	A	A				A	A		
Advisory Structure (Proposals, Minutes)	x	x																						x	x	x	x	x	x	x	x	x	x	x
Reference Ctrs.	x	x	x	x			x	x	x	x	x													(A)	(A)		A				A	A	x	x
Final Statement of Achievements	x	x	x	(x)	x	x	x	x	x	x	x	x	x	(x)	(x)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
IODP (Proposals, Assets)	x	x	x	x											x						x	x	x	x	x	x	x	x	x	x	x		x	x

A = Advisory function significant
(A) = Advisory function marginal

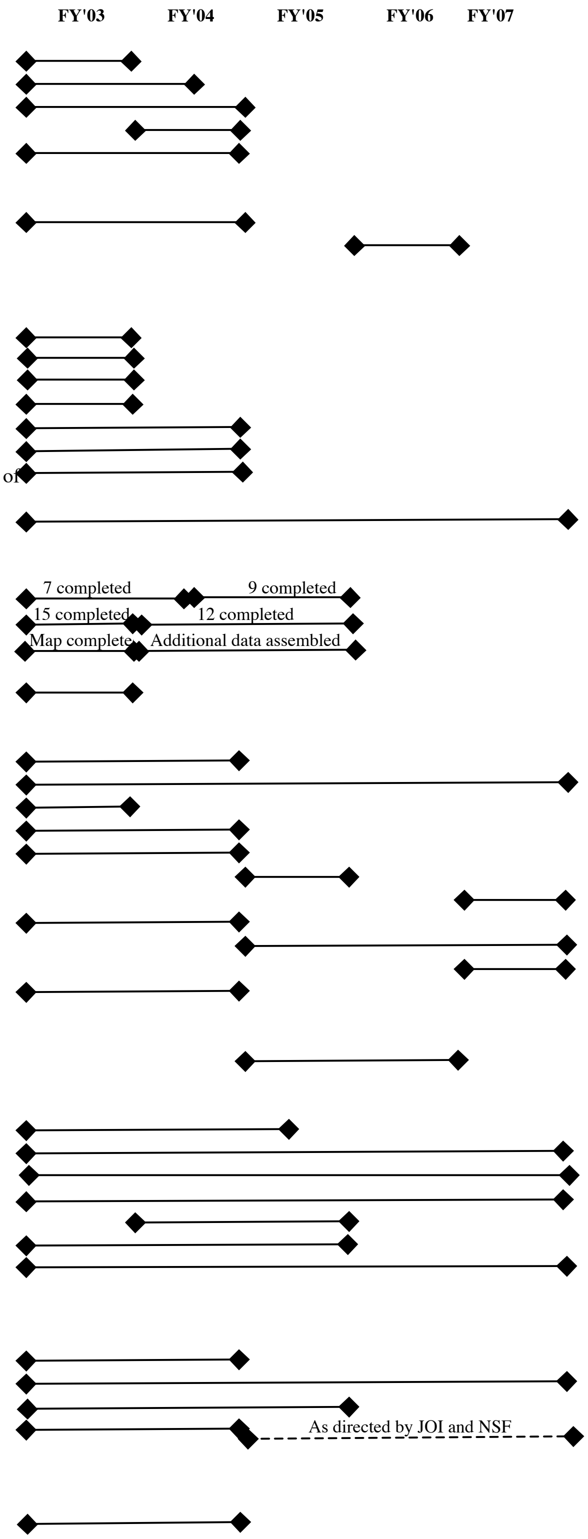
x = full phase-out involvement
(x) = marginal phase-out involvement

Still to define: General Phase-out structure (lead agencies, wiring diagram)

Note: list of Phase-out matter may not be complete

Needed: Schedule

Timeline of Phase-Out and Legacy Preservation Activities for ODP



JOI
Completion of JOIDES activities
Final issue of the JOIDES Journal
Finalize policy manuals
Co-Chief Scientist review meeting
Develoment of ODP legacy web site

****PEC VI Recommendations****
Historical record of all PR/education materials
Final review of legacy preservation

SCIENCE OPERATOR
Science Services
Cruise participant database
Safety documentation
Lab procedures/instrumentation manuals
Curation procedures & sample records
Documentation of components for each instrument
Additional technical notes
Analysis of historical costs of operation/maintenance of each system
Completion of SR editorial responsibilities

Drilling Services
Operations manuals
Science overviews
Legacy holes
Save Technical notes (either out of date or redundant with Operations Manuals)

Information Services
Migration of XRD data to Janus
Migration of paleontology to Janus
Migration of MST, Phys. Props., & Chemistry data
Migration of Paleomag, T, Splicer & MCD data
Paper prime data in digital format
Transfer of Janus data to NGDC
Transfer of paleontology database to NGDC
Scanning of ODP film core images
Scanning of DSDP core film images
Transfer of digital images to NGDC
Policies and procedures documentation

****PEC VI Recommendation****
Database of core close-up photographs[1]

Publication Services
Completion of all IR volumes
Completion of all SR volumes
Cumulative index project
Documentation of procedures
Microfiche/microfilm of ODP volumes
Digitize print volumes (joint with Texas A&M)
Support legacy documentation for other Depts.

LOGGING SERVICES
Completion of last IR Data CD
Maintenance of ODP Log Database
Processing and archiving of digital DSDP data
Maintenance of international log analysis centers

SITE SURVEY DATA BANK
Completion of legacy; transfer of small dataset to NGDC

[1] - May require additional resources

VII.6 Revised Drilling Services Legacy Documentation Plan

ODP DSD LEGACY DOCUMENTATION INFORMATION

Executive Summary

The revised plan for the documentation of the ODP engineering legacy is now broadly defined and balances the dual responsibilities of creating the ODP legacy of engineering tools and providing support for IODP engineering activities. There are four core elements. First, we intend to engage the services of a technical writing firm to develop a documentation template and directory structure for engineering operations manuals utilizing structured writing techniques (e.g., Information Mapping®) and Adobe FrameMaker software. This initiative will create a uniform and codified structure for each of our Operations Manuals to be produced during the ODP legacy documentation project. In addition, this template for the engineering manuals will be designed to be flexible so that during IODP these ODP legacy documents can be revised and added to in response to tool modifications. Moreover, this template will be used for new engineering tools that will be developed during IODP. We intend to use the technical writing firm to work with our staff to create several of our more complex engineering manuals. This exercise will definitively test the documentation template and directory structure and provide an opportunity for software modifications and enhancements, will provide an opportunity for our staff to become familiar with the process of building an Operations Manual, and we will have produced manuals for some of our more complex and highly variable equipment (i.e., BIH-CORK II/ACORK/CORK). Not only will our engineers be involved in this exercise, but appropriate Information and Publication Services staff will participate, so we are facile with the documentation package, will be in a position to manage the rest of the legacy project, and will be good stewards of the documentation package. Second, we plan to complete the remaining 12 science overviews of ODP drilling tools using ODP staff. The science overviews are designed to be a brief summary of each significant engineering tool used by ODP during FY2004. Third, a map of the ODP legacy sites, along with a summary of the engineering and scientific characteristics that define each site will be available on the web. Fourth, we are in process of sorting and inventorying technical files, notes, and documents that have been used during the life of ODP. These are historical documents that will be archived at IODP/TAMU. An index that identifies all the historical documents archived at IODP/TAMU will be available to interested parties upon request.

Background

The original FY04 Program Plan was based on phasing out ODP in FY04 using full time employees (FTEs) to perform the extensive documentation required, assuming no ongoing work for IODP. The revised FY04 Program Plan reflects the fact that ODP Legacy documentation will be completed in parallel with IODP phase-in work.

Revised Strategy

Given that the audience for legacy documentation has changed significantly (i.e., the information is being handed off to ourselves) and the same people working on legacy documentation will be working on IODP requirements, ODP has revised the legacy documentation plans. In this change, we were guided by two considerations. First, we want to focus our time and effort on those legacy products for which there is a documented need. Second, we want to create products that will serve as a model for how we create legacy documents in IODP. With this perspective in mind, we define the following legacy products in order of priority.

- Operations Manuals are documents for engineers to describe the coring/drilling tools and how to operate them.
- Science Overviews are documents designed as a resource for the science customer and interested public. These summaries provide an overview of the engineering tools that ODP used and the scientific application.
- Summary of Legacy Holes is a list of data related to Legacy Holes (i.e., holes we can reenter because a reentry cone, casing, or some other equipment was emplaced).
- Technical Notes are historical in nature and provide a record of engineering activities over the life of ODP. Almost all of this material is out of date or, if tools are still used, redundant with the Operations Manuals.

Operations Manuals

The most challenging legacy contribution is the Operations Manuals for the drilling/coring tools used by Drilling Services. There are 16 Operations Manuals to be completed***:*** ACORK, ADCB (in process), APC, APCT, APCM, CORK, BIH/CORK II, DIC, DSS, DVTP, HRRS (in process), IWS, PCS (in process), RCB, RECC, XCB. No manuals are completed. Seven of these manuals need to be completed for IODP Phase I Expeditions: BIH/CORK II (Exp. #1), RECC (Exp. #3), HRRS (Exp. #3), CORK (Exp. #5), and new tools (APCT, APCM, IWS).

Five technical writing companies were interviewed to collect information on constructing a document strategy as well as information on the cost and time required to create 16 Operations Manuals. Ideally, the technical writers will be familiar with structured writing (e.g., Information Mapping®) methodology, which has been used in industry since 1972 to produce training, procedural, and reference manuals. The method allows the writer to integrate the reader's uses for the material with the writer's purposes for writing it by focusing on sequencing information in an easily scanned modular format. Modular formats will assist DSD in moving to a "single sourcing" process (i.e., producing multiple outputs from a single source of material). Single sourcing also allows the writer to update the source material so that updates are consistent and timely, which will ultimately reduce the time and effort required for legacy documentation at the end of IODP. A technical writer's professional expertise is required at the beginning of the documentation project to plan and create the modules, create document and directory structures, and tag text. Structured writing is also compatible with ISO 9000 standards.

Adobe FrameMaker software provides the technical writer with the capability to tag text so it can be used in different media (print, html, pdf, etc.) without major reformatting/rewriting each time. It also easily supports the structured writing methodology. Modular or "chunked" units of text can be pulled quickly and easily to create custom manuals (a plug and play concept). In the past, the same information has been in multiple places, which led to increased maintenance time and costs, and resulted in variances where none should exist. A directory structure can be created in Framemaker that will allow a single source of material to be updated (both text and figures) quickly and reduce maintenance time and cost. DSD does not currently have personnel who are experienced enough in FrameMaker or structured writing to create this kind of documentation strategy.

Our goal is twofold: (1) use technical writers to develop a legacy documentation plan for ODP engineering tools that that will last through the life of IODP and (2) use technical writers to complete three Operations Manuals by June 2004. ODP may hire the technical writing firm to do more of the seven priority manuals, depending on the process and the timeline; however, the goal is to use in house resources as much as possible. The remaining nine Operations Manuals, will be completed in FY05.

In an effort to streamline the Operations Manuals and make them more user friendly for both core technicians and field engineers, the following considerations were taken into account pertaining to graphics content (drawings, schematics, and photographs).

1) Only those graphics that are essential for portraying critical assembly, deployment, operation, and maintenance will be included. Minimally, an assembly drawing with a Bill of Materials will exist with space-out drawings, detail schematics, and captioned photos, as required.

2) Most graphics (drawings, schematics, and photographs) will be presented in black and white format. Color will only be used if it is essential.

3) AutoCad (.dwg) drawings of the tools will be made into pdfs for inclusion in the final document. Likewise, photographic images existing in a jpeg format, will also be converted and imported into the final document. Depending on the file sizes and number of images and drawings included in a given operations manual, provisions will be made for indexing and accessing such files on a compact disk (CD) included in the manual's binder sleeve.

Science Overviews
The Science Overviews will be completed in house by ODP staff. There are 27 total Overviews and 15 are finished and on the web (bold). Four are in process (underlined). Science Overviews include: **ACORK**, **ADCB**, **APC**, **APCT**, APCM, BHA, BIH, Core Bits, **CORK**, **DIC**, Drill String, DSS, **DVTP**, **FFF**, **HRRS**, IWS, LFV/MBR, MDCB, Packers & Flowmeters, **PCS**, **AHC**, **RCB**, **RECC**, RIS & load pins, **Ship**, UR/Bi-Center Reamer/Mud Motor, and **XCB**. The remaining Science Overviews will be completed over the course of FY04-FY05.

Legacy Holes
A map was generated showing the sites where reentry cones, casing strings, and/or instrument packages have been set in place. Work continues on organizing additional data for placement on the web for reference and this information will summarize the

essential engineering and scientific characteristics of each hole. Detailed engineering schematics for each hole will be available upon request. If, as time goes by, a need arises to populate the legacy hole reference material on the web with detailed data (e.g., engineering drawings) time and resources will be devoted to this task.

Technical Notes (86 Total,) Miscellaneous Archiving (Obsolete/Inactive Tools, Existing DSDP/ODP Documents)

Almost all of these materials are either out of date or, if tools are still used, redundant with the Operations Manuals. Our plan is to archive the records and create an index of the material, which will be available upon request. Technical Notes are documents that describe the historical development of a tool as well as other documentation that does not fit in the Operations Manuals. Technical Note materials are being sorted, inventoried, and boxed. A document list will be created for data referencing and this explanatory list will be on our legacy web page.

Miscellaneous files not required for Legacy document preparation are being sealed inside plastic bags in file storage boxes and inventoried. A list of contents for each storage box is placed on the box front, inside the box, and in reference binders. The list of contents for each box is also maintained in an electronic record to assist in searching for documents. The storage boxes are being placed on pallets on steel shelving in the locked cage in the ODP shipping and handling area.

Operations Manuals Cost

We estimate there are 350 pages of new documentation that need to be created and 705 pages of existing documentation that need formatting and editing. The final product will be in pdf format in both electronic and hard copy. Reformatting AutoCAD drawings to eps format is not included in this cost estimate, but will be done in house.

The plan that we intend to implement is to hire a technical writing firm with the expertise to create the document strategy, templates, and new manuals utilizing structured writing, and FrameMaker software. The technical writing firm will create a few initial manuals to familiarize staff with the process. Once this is accomplished (June 2004), the ODP staff will use the established templates to finish the rest of the Operations Manuals. If necessary, a technical writer will be employed if problems arise or there is a need for them to review drafts and ensure consistency. Funds of $125,000 were allocated in the FY04 Program Plan to support this endeavor.