Report of the
2nd Triennium Review Committee

of the
Integrated Ocean Drilling Program,
Management International (IODP-MI)

Keir Becker, University of Miami, FL, USA
Elisabetta Erba, Università degli Studi di Milano, Italy
Toshitsugu Fujii, University of Tokyo, Japan
Geoff Garrett, The Australian National University, Australia
Hodaka Kawahata, University of Tokyo, Japan
Dennis Kent, Rutgers University, USA
Joanna Morgan, Imperial College London, UK
Clive Neal (ex officio), University of Notre Dame, USA
Ian MacGregor (Chair), University of California, USA

July 2010
IODP Management International
Tokyo, Japan

Table of Contents

A. Preface

In October 2009, the 2nd Triennium Integrated Ocean Drilling Program Management International Review Committee was asked by the Board of Governors to examine the effectiveness of the IODP science planning process. The Committee consisted of eight members from a range of scientific disciplines, with significant experience in the evolution of the ocean drilling programs and in offering expert advice on science program management. During the review it was apparent that we could benefit from additional expertise on the integration of service and operational panels and added an expert in this area, as an *ex officio* participant. In order to accomplish our task, the Committee held two meetings and supplemented our deliberations with the distribution of a questionnaire to solicit advice from the different interest groups involved in scientific ocean drilling. Some of our members also participated as observers in a meeting of the Science Steering and Evaluation Panel and Science Planning Committee, and opportunistically sought opinions from participating science groups and funding agencies while attending relevant national and international conferences.

The report is structured to include a comprehensive Executive Summary backed up by supportive Appendices. The intent is to provide a succinct report, while ensuring that its main substance is adequately communicated.

The report and the process have benefited by the advice and data provided by IODP-MI liaisons, Hans Christian Larsen and Hiroshi Kawamura, and logistical management by Hiroko Osawa for our meeting in Sydney (March 2009) and in Vienna (May, 2010). We must thank the University of Sydney, our Australian hosts, who generously helped in the logistical planning and Paula Brown who served as a scribe and expertly captured the essence of our deliberations during the Sydney meeting.

B. Executive Summary

1. **Review purpose and mandate** (Appendix 1)

(a) The Integrated Ocean Drilling Program (IODP) Lead Agencies (NSF/MEXT) have specified the scope for the contractually-required Second Triennium Review of Integrated Ocean Drilling Program Management International (IODP-MI) (FY2007−FY2009).

(b) Review guidelines are detailed in Appendix 1.The prime focus of review was *"(an) examination of the effectiveness of the IODP science planning process, including a thorough examination of the Science Advisory Structure (SAS), its functionality, and examining the relationships between the SAS, IODP-MI and the Implementing Organizations (IOs). Additionally, the Review should examine the effectiveness of the evaluation and ranking of IODP proposals in terms of addressing IODP scientific goals, especially those stated within the IODP Initial Science Plan (ISP)."*

2. **Our review process** (Appendix 1)

(a) In order to understand the context of the Review, the Panel considered both the historical evolution of the SAS, previous and current review reports, inputs received from a diverse set of stakeholders (through a questionnaire process) and interactions with practitioners and stakeholders. The contextual review provides insights to shortcomings with the current system.

(b) The Panel had access to early drafts of the New Ventures in Exploring Scientific Targets (INVEST) report and the major themes currently identified for the new Science Plan. It is critical that our recommendations help to achieve the goals of the next phase of scientific ocean drilling.

(c) The Panel also undertook an independent 'green field' (*ab initio*) examination of the essential generic elements needed by a SAS and in the context of a collective vision for the future of the IODP.

3. **Our positive findings**

(a) The IODP is at the frontier of science challenges and opportunity. Ocean drilling is the best method of directly sampling the two-thirds of our world that is covered by the world's oceans. The US$200 M *per annum* IODP funding comes from 24 contributing nations interested in using ocean records to understand global science problems. The outcomes of its expeditions provide excellent science, often of cutting edge scientific impact. For example, one IODP expedition alone resulted in 6 papers published in Nature.

(b) Some remarkable technological innovations − *e.g.* riser drilling, drilling in the high Arctic, and emplacement of in-bore hole observatories for continuous monitoring − have been developed in support of the scientific expeditions.

(c) With the variety of platforms available to IODP, nearly all locations, water depths and geological sequences can be drilled. The Program drilling vessels, *JOIDES Resolution* and *Chikyu*, are of high quality, with very good coring capabilities, and excellent laboratory facilities. Mission Specific Platforms (MSPs) have added a new dimension to the program that allows drilling in previously inaccessible locations.

(d) Bringing together a large, ‘captive’ group of scientists and technicians from around the world, in both the SAS discussions and IODP expeditions, leads to very productive networking and scientific outputs of merit; indeed a ‘collaborative crucible’ par excellence, which is a key comparative − and competitive − advantage for the IODP.

(e) Considerable mentoring (including ‘nurturing’ of proposals) occurs in IODP − from graduate students to senior scientists − helping to educate the next generation of scientists on how to develop science programs that make effective use of the wide range of available drilling capabilities.

(f) Since its inception in 1968 Scientific Ocean Drilling has undergone major changes in program scope and the way the science has been planned, gradually evolving from describing and documenting the sedimentary record, to a more quantitative and process-oriented analysis of the record. The Science Advisory process and structure have evolved positively in response to the changing nature of the Program.

(g) The current development of proposals is largely ‘bottom up’, with groups of scientists building proposals that generally aim to address problems of global significance with carefully selected ocean drilling records. The proposal driven process mechanism, well supported by the IODP-MI Central Management Office (CMO), has been successful as indicated by the fact that seven out of eight objectives set out in the 2004 ISP have been significantly advanced.

(h) The process of evaluation of proposals is considered to be generally fair, with the best science getting to the top and the most important expeditions being scheduled.

4. Current key challenges for IODP and the new Program (Appendix 3a)

Notwithstanding the significant advancement of the goals outlined in the ISP, and indeed the major achievements over the previous 40+ years, the Review Committee have identified a number of important challenges for the future, as follows:

(a) The current proposal evaluation, selection and implementation process and structure can be overly complex, with corresponding inefficiencies, delays and duplication of effort. An additional perceived problem area is a lack of clarity around respective functionalities, roles and responsibilities and inter-relationships. Furthermore, the prevailing ranking system of proposals is potentially flawed − the priorities and criteria for evaluation and approval/activation are not clearly defined, nor perceived to be uniform and consistent over time. This leads to some perceptions of random (or biased) ranking, and a corresponding reluctance to make the tough choices in screening and selection/prioritization.

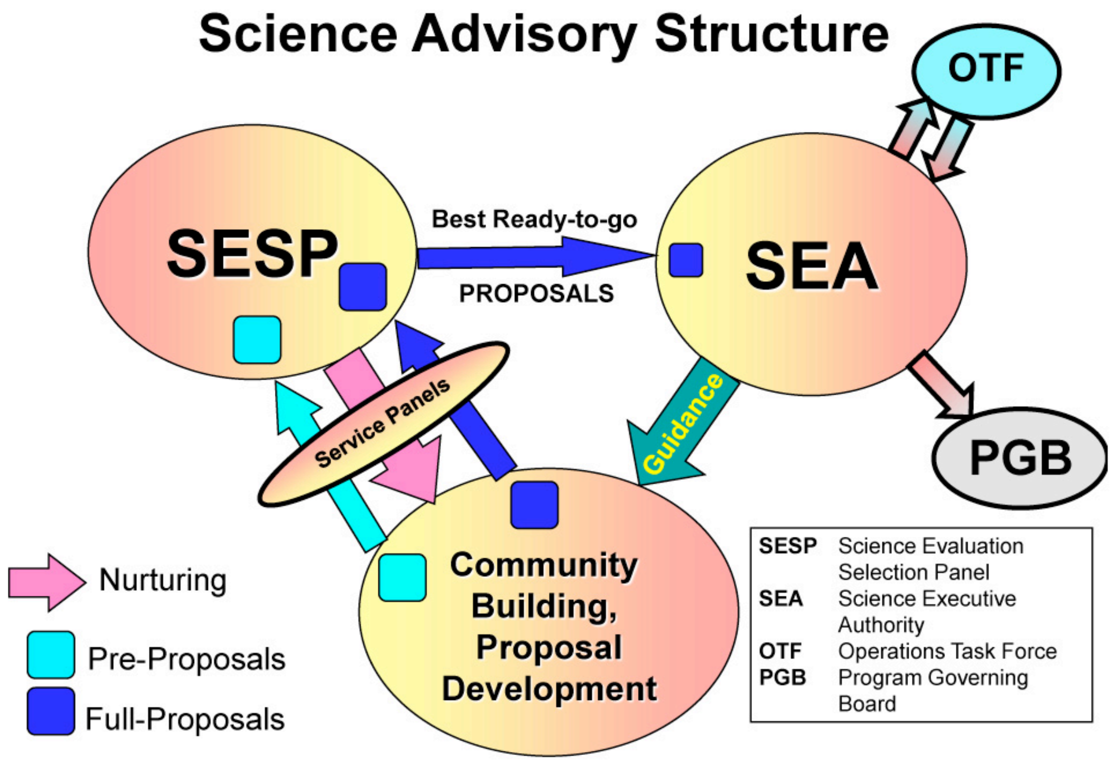
(b) Non-optimal integration and interfacing between the prevailing SAS and the operations/implementing structures (including site surveys, engineering development, environmental protection and safety, feasibility analysis and cost estimates).

(c) There is a tension, requiring resolution, between the prevailing ‘proposal responsive’ approach and a more ‘strategically planned and prioritized’ set of programs. Thus, the (current) weak integration of strategic planning with the proposal selection − implementation pipeline, and performance review, is such that the inter-relationship between science plans and expeditions is not always clear.

(d) Non-clarity (and overly convoluted) governance and decision-making processes for IODP as a whole: a quality and streamlined SAS will not produce effective outcomes in the absence of an effective and transparent system of governance. Lack of identifiable 'Executive Authority', *i.e.* the role(s) and mandate(s) of the Funding Agencies, Council and Board of Governors, and their respective interface(s) with the CMO (IODP-MI) and the SAS, needs urgent attention.

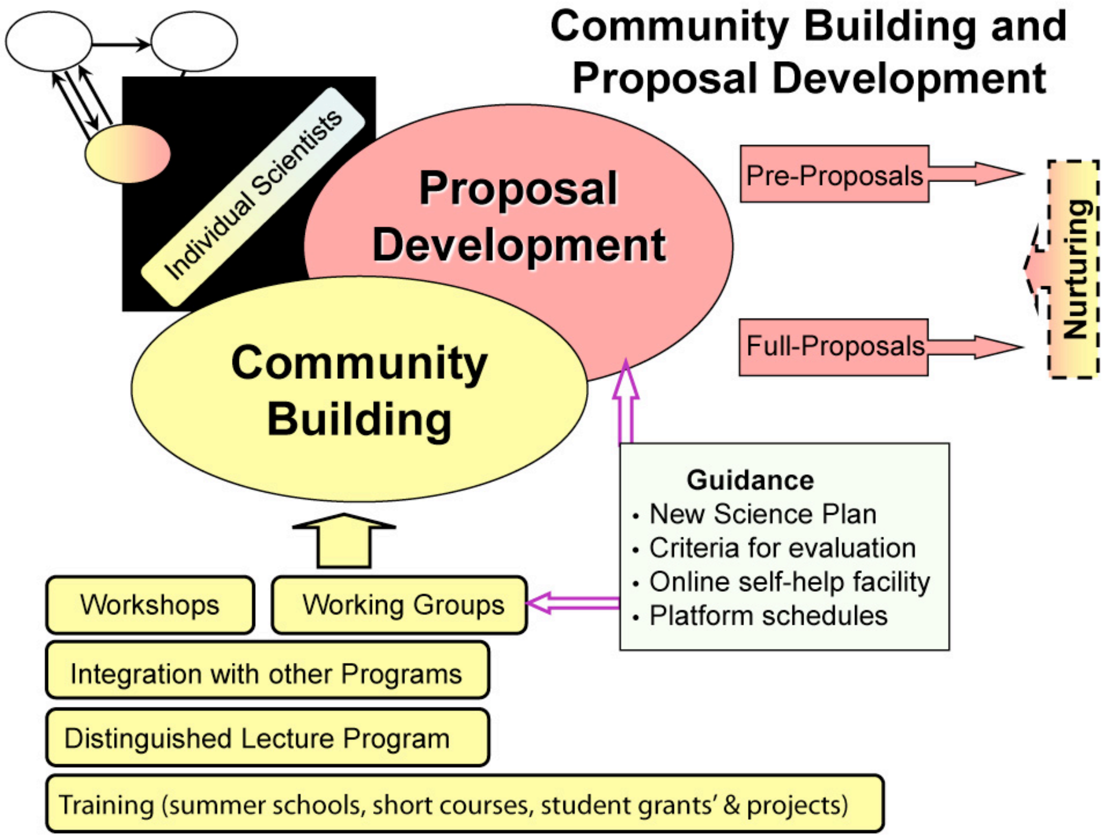
5. Key recommendations (Appendix 3b)

In the Panel's view simplification of the idea-through-to-implementation 'pipeline' is necessary, with a corresponding increased speed of throughput and communication clarity. In overview, the following diagram summarizes and provides an overview of the proposed SAS:

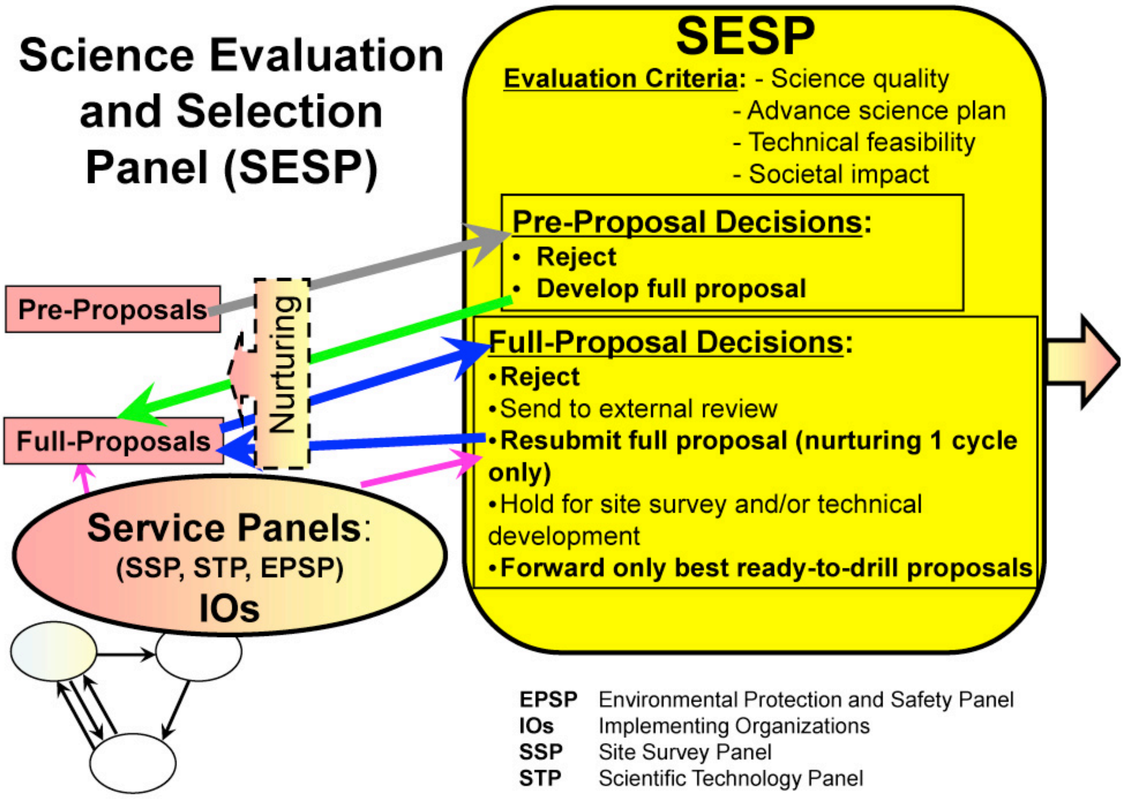


The key elements here, which are detailed in the relevant Appendices, are as follows:

(a) Promote community-building activities such as workshops and working groups (both unprompted and solicited), distinguished lecture programs and training opportunities, with the aim of producing high-quality, inclusive and well-debated proposals that address the new Science Plan. A self-help online facility should provide clear guidelines on how to develop proposals, as well as outline the evaluation criteria that will be used to assess proposals. Pre-proposals should be the preferred method of application; successful pre-proposals should be nurtured by the Science Evaluation and Selection Panel (SESP) through feedback on how to further develop proposals and integrate with other programs (if appropriate), and through the early identification of any safety, technological and site survey issues. The process should be straightforward to allow the best proposals to progress rapidly through the new system, and enable such proposals to acquire the necessary support data and technology in a timely fashion.



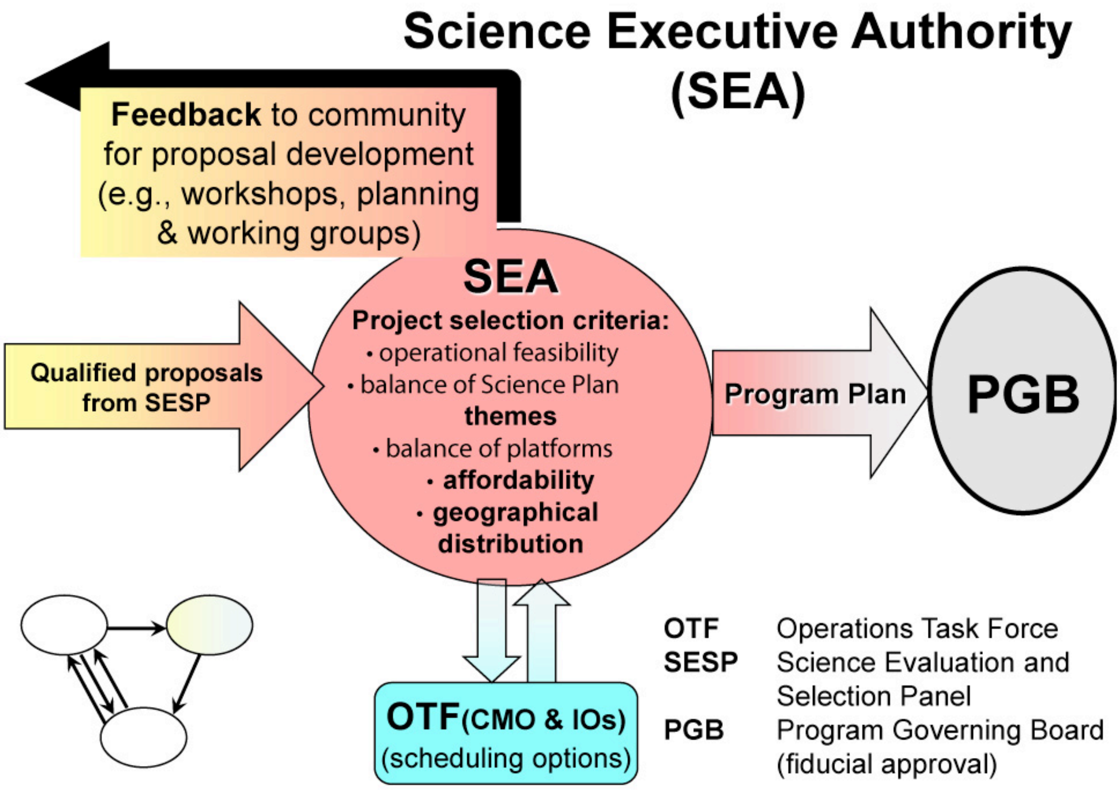
(b) A single SESP should be established, with the following characteristics and functions: (a) chaired by a broadly-respected individual engaged approximately 50% time, and with IODP-MI administrative and logistical support; (b) having a membership with appropriate and broad disciplinary coverage, and with sub-Panels covering the four Science Plan themes; (c) tasked with evaluation and prioritization of both pre-proposals and full-proposals. This Panel would be guided in its deliberations by (weighted) criteria covering science quality, Science Plan theme linkages, technical feasibility and potential societal impact.



(c) The streamlined pre-proposals (5-10 pages) would receive feedback appropriate to a rating from 1 (excellent concept, proceed rapidly to full proposal development) to 3 (proposal rejected, with reasons provided). Full proposals would require obligatory external review and provisional technical feasibility assessments from IOs and relevant service panels. Proposals will either be declined or accepted; if necessary, accepted proposals could proceed through one cycle of revision. All platforms should be treated together. The best of the ready-to-drill proposals would be identified for forwarding to Science Executive Authority (SEA) (see section 5d to follow) for feasibility assessment and implementation. Science evaluation of individual proposals ends with the SESP.

(d) Thereafter, successful proposals − of reduced number and of highest priority − are considered by a single Panel, the SEA, with a different chairperson, and tasked with delivering both long-range and annual implementation schedules as well as identifying gaps/new areas in the overall Program. This Panel will receive strong advisory support and options for annual schedules, for their consideration and approval, from the Operations Task Force (OTF) (which includes appropriate representation from the IOs, the IODP-MI and the Service Panels). In its decision making, the SEA considers criteria such as operations feasibility and efficiency, thematic and geographic balance, and affordability. The final Program plan is forwarded for Program governance approval (see point 5f below). The SEA will also conduct regular reviews of Program scientific achievement in the context of the Science Plan. Where there are important shortfalls or new or emerging scientific fields, the SEA will use a variety of mechanisms to stimulate program development, for example working groups, workshops, special calls for proposals, projecting long-term ship tracks, *etc.*

Greater clarity and emphasis should be placed upon effective communication and transparency of process, both within and outside the IODP community. This should include well-defined proposal evaluation criteria and timely feedback to proponents, as well as communication of the achievements of the Program to our stakeholders. These include targeted scientific communities such as atmospheric scientists, oceanographers, biologists and the continental scientific drilling community, and the general public represented by political legislators who control funding of large projects, school children who are the seed for the next generation of scientists and the interested lay public. This is critical in an ever-increasing competitive funding environment.



(e) A straightforward, transparent ‘chain of command’ is a prerequisite for good governance. While the SEA will provide programmatic science priorities, long-term planning and other scientific and technical priorities, and the CMO (IODP-MI) supports and facilitates implementation of a technically and fiscally feasible Program plan, clearly articulated strategic and financial oversight and formal approval/sign off is required. As such, the responsible delegates from the Funding Agencies should develop, specify and communicate a more unified, and ultimately accountable, peak body (Program Board? Council?), with clearly-defined responsibilities (including overall Program performance monitoring), representation and reporting responsibilities.

6. **Other issues of relevance and concern** (Appendix 4)

(a) Issue: Funding difficulties mean that the *Chikyu* and, to a lesser extent, the *JOIDES Resolution*, are not fully deployed (the exposure − and sensitivity − to fuel cost variability is also a cause of considerable anxiety).

Recommendation: Maximize science by rethinking drilling strategies and scheduling, *e.g.* drill targets of opportunity during long transits, minimize transit time (well cognizant of carbon footprint − see also point h to follow), provide well-in-advance information on ship tracks to help proponents develop a timely stream of competitive proposals.

(b) Issue: There is a notable absence of quantifiable metrics of success, to facilitate performance evaluation.

Recommendation: With their oversight responsibility, the SEA will develop appropriate measures of success, *e.g.* advancement of the Science Plan, journal publications, young scientist engagement, societal impact, *etc.*

(c) Issue: While the current Conflict of Interest Policy (COI) is satisfactory, the prevailing implementation may be ‘too draconian’. The net result is to deprive panels of essential scientific and technical expertise in the evaluation process.

Recommendation: Current IODP COI policies should be uniformly applied to all SAS panels. Critical to the application is the transparent declaration and recording of any conflicts and how they are addressed. Panel chairs should be given authority to evaluate and manage conflicts in the context of IODP policies and panel needs. Strict limits should be placed on any conflicted panelist from participating in any discussion relating to proposals where they are a proponent.

(d) Issue: Better integration with related science organizations is required, *e.g.* International Continental Scientific Drilling Program (ICDP), Antarctic Drilling Program, Ocean Observatories and others.

Recommendation: Encourage scientists from other Programs to participate in workshops and join as proponents on proposals. The goal is to identify collaborative opportunities early in the developmental stage of projects so that shared roles and responsibilities of different programs may be coordinated. As appropriate, proposals should be shared with other Programs so that opportunities for collaboration can be identified early. IODP-MI should provide facilitating support to this process, in conjunction with the proponents. An appropriate balance of science and technical experts from other Programs should be invited to serve on SESP and SEA panels.

(i) Issue: Improved integration of the required Site Surveys − with their prioritization, approval and funding by IODP supporting funding agencies − is essential.

Recommendation: High quality proposals should be identified early by the SESP to increase the likelihood of obtaining timely site survey funding. Work with funding agencies to develop policies that improve coordination.

(f) Issue: Need for better use of electronic communication, to reduce the carbon footprint of the Program (see also point h to follow).

Recommendation: Electronic distribution and discussion of proposals, reports and issues prior to face-to-face SAS meetings can increase the efficiency, and potentially reduce the time − and in some cases the frequency − of such meetings. Continue to take advantage of changing communication technologies to minimize travel and meeting frequency. All panels should adapt to the changing electronic environment.

(g) Issue: Can the carbon emission 'footprint' of the program be reduced by simplifying and reducing the number of SAS meetings without significant loss of SAS functionality?

Recommendation: There needs to be a balanced sense of perspective concerning the management of SAS committee meetings. It is important to realize that the greatest efficiencies would be achieved by a SAS that can minimize wasteful ship transit times. Avoiding just a few days of *JOIDES Resolution* transit per year more than compensates for the carbon footprint of practically the entire SAS meeting structure.

(h) Issue: Limited IODP budgets threaten the development of new technologies and engineering for application to scientific ocean drilling.

Recommendation: Under IODP guidance, revitalization of engineering and technological developments should be a goal of the new Program, with such developments leading to enhanced science return from expeditions.

(i) Issue: An analysis of proposals-in-the-pipeline (Appendix 2a ii) indicates a regional shortfall of ready proposals for efficient use of platforms.

Recommendation: SEA Panel's programmatic planning process will need to ensure efficient, long term, geographic deployment of drilling platforms that optimizes their use.

7. What will success look like?

The soon-to-be-published Science Plan will detail the main four themes of science endeavor that will be the focus of the next phase of ocean drilling, specifically (note this is still an early draft and subject to wording change): Climate and Ocean Change: Reading the Past, Informing the Future; Deep Life: Exploration of the marine intraterrestrials; Renewing the Lithosphere: Consequences for our planet; Earth in Motion: Deforming plate boundaries, fluid flow, and active experimentation.

The Review Committee anticipates a highly successful future for the IODP Program, and one that is likely to be enhanced by the implementation of their principal recommendations. Looking back from a decade's time (2020), a successful new Program is envisaged to be characterized by:

(a) Outstanding scientific outputs that advance the new Science Plan, and lead to fundamental breakthroughs in rapidly evolving understanding of our planet, its oceans and climate.

(b) New kinds of science, and ways of doing science, for example: the discovery of new proxies for quantifying past processes, the use of real-time observations, and the development of better methods for prediction.

(c) Impressive technological innovations, that enhance core quality and core recovery in challenging environments, stimulate science return and facilitate effective and efficient ocean drilling across the globe.

An efficient and effective SAS is central to these ongoing achievements, in order to generate a strong and wide set of excellent and readily-implementable proposals, and continue the move from a 'Facilities Program' to a truly integrated Science Program.

Fundamental to the ongoing success of the Program will be a broadening of the collaboration with other drilling programs, major global research programs and deployment of ocean observatories, but also reflected in the increased diversity of contributing scientific disciplines, and participating nations. Coupled with this, the Program should continue to be at the forefront in its hands-on training of the next-generation of researchers.

Meaningful outcomes of societal relevance and impact will become the order of the day, with effective education and outreach a priority. Excellent communications of IODP results will positively impact the life and health of the Program; substantially improved communication of such results to the broader scientific, political and business communities, and the general public, will enhance the longevity and effectiveness of the IODP. Furthermore, this will help to ensure the establishment of a sound and comprehensive knowledge base that will underpin future environmentally responsible resource utilization in this century.

8. In conclusion, we wish to indicate that −

(a) We are encouraged by the broad scope of the new Science Plan. The vision of goals that expands the program to link studies of the evolution of the oceans with direct monitoring of the active processes that link and control the interactive lithospheric, oceanic, atmospheric and biologic systems promises a new understanding of the global challenges that now confront mankind. The previous accomplishments of successive ocean drilling programs over past decades points positively towards future success in achieving the goals of the new Science Plan.

(b) From a wide variety of inputs, including recent reviews and responses to questionnaires submitted by different constituencies within the community at large, we see a specific congruence of 'red flags', which we have sought to address in the report, and have summarized in preceding paragraphs. Instructively, we have observed close alignment between our 'clean sheet' deliberations and other current 'experiential' perspectives. The convergent recommendations augur well for their accuracy and implementability.

(c) We believe three sentiments should frame the Science Advisory process, the key goal of which is to ensure the development, selection and implementation of quality, science-led ocean drilling proposals; these are: SIMPLIFICATION, ENHANCED COMMUNICATION and TRANSPARENCY.

C. Appendices

C. Appendix 1a: Mandate for 2nd Triennium IODP-MI Review Committee

The mandate set for the Second Triennium Review of Integrated Ocean Drilling Program Management International (IODP-MI) (FY2007−FY2009) by the Integrated Ocean Drilling Program (IODP) Lead Agencies (National Science Foundation (NSF)/ Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT)) is as follows:

1. This Review should focus on examination of the effectiveness of the IODP science planning process:
    a. Include a thorough examination of Science Advisory Structure (SAS) functionality, examining the relationships between the SAS, IODP-MI and the Implementing Organizations (IOs).
    b. Specifically, the Review should examine the effectiveness of the evaluation and ranking of IODP proposals in terms of addressing IODP scientific goals, especially those stated within the IODP Initial Science Plan (ISP).
2. The Review should also examine the effectiveness of the SAS service panels in aiding the technical capabilities and functionalities of the IOs.
3. The Review should further place the analysis of SAS activities within the context of current financial, legal, logistical, technical, and operational realities, and should help focus discussion for post-2013 scientific drilling.
4. Specific questions that should be addressed by the Review include:
    a. Does 'nurturing' of all submitted proposals improve the science outcome of the Program?
    b. Does scientific evaluation of the proposals adequately assess and weigh the quality of the underlying data and the technical feasibility of proposed operations?
    c. Does ranking of the proposals in the current manner promote advancing IODP ISP scientific goals in an efficient and cost-effective manner?
    d. Does the current conflict of interest policy, which effectively eliminates participation in the ranking process through co-authorship of a drilling proposal, promote effective selection of the highest priority drilling proposals?
    e. Do the Scientific Technology Panels (STP) and Engineering Development Panel (EDP) have an appropriate relationship with the IOs and IODP-MI that facilitates Programmatic science and drilling operations and technical development in an era of constrained finances? Is their advice effectively sought, and are their recommendations effectively implemented?
    f. In light of significant budget limitations and the desirability to reduce the carbon emission 'footprint' associated with IODP, can the SAS structure be simplified and the number of meetings reduced without significant loss of SAS functionality?

The Committee addressed all the items in the mandate. The process of the review included three main sections. We first set the context for the review by examining the past history of the program, the evolution of the science advisory mechanisms as the ocean drilling program expanded, and previous and current reviews of SAS. We prepared and analyzed the responses to a questionnaire to evaluate stakeholder concerns, and participated in Science Steering and Evaluation Panel (SSEP) and Science Planning Committee (SPC) meetings and focused discussions with constituent groups. Our report is also set in the context of the New Ventures in Exploring Scientific Targets (INVEST) report and the preliminary scientific themes, identified in the emerging Science Plan, that are likely to set the agenda for the next phase of ocean drilling. The contextual review helped highlight shortcomings of the current SAS. We also reviewed the essential functions of a SAS from an *ab initio* perspective. Our recommendations for a revised SAS derive from combining the contextual and *ab initio* perspectives. In addition to recommendations for the restructuring of SAS, we make a number of other recommendations that bear on an efficiently managed and operating SAS.

The report is structured so that its main conclusions and recommendations are identified in the Executive Summary. Narratives that amplify the support for the recommendations are included in associated Appendices, and references and materials used by the Committee in its deliberations included under Resources.

C. Appendix 1b: History and change of program and its advisory structure

Since its inception in 1968, the scientific Ocean Drilling Program (ODP) has undergone major changes, both in the content of the program and in the way the science has been planned.

The predecessor program, the Deep Sea Drilling Program (DSDP), used the drilling vessel *Glomar Challenger* and was largely exploratory in nature. To a large extent its science program was planned through 'internal' advisory groups and leading scientists from within US-based scientific oceanographic institutions participating in the program.

ODP (1984) took steps to create a fully international program and established a truly competitive proposal process. The submission of unsolicited proposals allowed the broader community to compete for time on the new drilling vessel, the *JOIDES Resolution*. The ODP science program deemphasized regional, exploratory studies, focused on themes and processes, and modified the SAS accordingly. This SAS determined the relative science priority of proposals, and carried the *de facto* executive power to define the drilling schedule and the ship track for future expeditions.

The Integrated ODP (IODP), formed in 2003, became significantly more complex than ODP by operating up to three different platforms. However, it largely copied the ODP SAS, while its science plan took a step further towards declaring specific programmatic goals − the eight 'Initiatives' of the ISP. However, no implementation mechanism was formulated to ensure satisfactory achievement of the initiatives, and ODP largely remained a 'drilling facility' program, with the science executive (non-fiscal) authority remaining within SAS. Over time, by various mechanisms, including the Central Management Office (CMO) working closely with SAS, seven of the eight initiatives have, or will soon be, largely addressed, despite the fact that only less than half of the expected IODP drilling capacity has been made available because of fiscal shortfalls and other factors.

Preliminary indications from the INVEST report and new themes advocated by the emerging Science Plan indicate that important shifts in the scope of science are recommended by the scientific community. The emerging focus for research is to identify science goals that improve understanding of active processes that govern the behavior of the ocean biosphere, examine the climate consequences of ocean-atmosphere interactions, and include deep earth observations to monitor the dynamic evolution of the ocean crust. These changes will require closer cooperation with scientists from other programs such as Continental and Antarctic drilling and major ocean observatory programs. From the perspective of the 2nd Triennium Review Panel, this challenge requires a revised SAS tailored to capture, review, and prioritize proposals from an expanded scientific constituency, and capable of recommending operationally feasible scientific advice to a CMO responsible for final overall approval and program implementation.

C. Appendix 2a: Context: Background

i. SAS Background Summary

The SAS has been central to the development of the annual IODP science plans and has strong roots in the ODP Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES) advisory structure, as well as in the predecessor DSDP and ODP programs. The form of the SAS has evolved significantly since DSDP, partly in response to periodic reviews such as the contractually required ODP Performance Evaluation Committees and the IODP Triennial Review Committees. At the end of DSDP, proposals and leg plans were developed largely within the JOIDES SAS. A big change was instituted at the beginning of ODP with a commitment to a proposal-responsive program in which proposals would largely be submitted from proponents outside of SAS and evaluated within SAS. Since then, the program development framework centered within the ODP/IODP. The SAS can conveniently be broken down into four main functional elements: proposal development, proposal evaluation, final selection for an annual science plan, and then formal approval of an annual program plan by both an executive committee within SAS and a corporate Board of Governors for the contractual implementing entity. Through ODP, various committee structures were used to evaluate proposals and develop annual program plans. The final ODP JOIDES structure formed the basic model for the IODP SAS, which has continued to evolve gradually. Like the JOIDES SAS, it is recognized to have produced strong science plans and results, but several common shortcomings emerged in the periodic reviews. Some of the more important themes that emerged during the past SAS reviews include:

1. the balance and/or tension between the proposal-responsive ideal and a need for more directed planning in order to optimize achievement of primary objectives set out in the various science plans;
2. long residence times of proposals and multiple evaluation levels within SAS before final decisions are reached, sometimes allowing for inconsistent reviews as panel memberships rotated and proposals cycled between committees; and
3. shortcomings in incorporating practical realities (*e.g.*, site survey readiness, funding limits, technological capabilities, operator and platform capabilities) within the SAS proposal review and program development process, which traditionally have been dominated by pure science considerations.

These real and perceived shortcomings have been magnified in recent years given the realities imposed by:

1. construction delays, and
2. IODP funding limits that have precluded full-time operation of the two main IODP drill ships, *Chikyu* and *JOIDES Resolution*.

The solutions – as proposed by three different review groups this year, including this one – lie in simplifying and streamlining the future IODP SAS by aligning it more closely with the functional elements described above in the efficient development of annual and long-term science plans.

ii. Proposal statistics

In order to get a sense of scale of the number of proposals processed by SAS, the Committee reviewed the recent status and disposition of proposals in the SAS system. Details are provided in the **Resources** section.

IODP is a proposal-driven program and receipt of healthy numbers of high-quality proposals is essential for its success. IODP-MI solicits proposals from the scientific community biannually on 1 April and 1 October and forwards the proposals to the SAS for evaluation and nurturing. After successful nurturing, highly-ranked and technically-ready proposals are forwarded to the Operational Task Force (OTF) for possible scheduling.

IODP currently has a total of 105 'active' proposals, and 1,055 proponents from different member and non-member countries. During 2004−2010, IODP received a total of 250 proposals (71 of these 250 were carried-over from ODP and 179 have been submitted to IODP as new proposals). The SAS has deactivated 132 proposals for various reasons, and a total of 19 proposals resulted in 24 drilling expeditions. Time intervals between initial proposal submission and expeditions vary from 59 to 168 months with an average of 87.5 months (note that those numbers are strongly biased by 39-month operational hiatus of *JOIDES Resolution*). Average residence time in SAS is approximately 60 months (note that OTF is not part of SAS).

Total number of proposals in IODP 2003-2010*	250 (71 proposals were carried over from ODP, 179 proposals were submitted as 'new' proposal)
Total number of active proposals*	105 (including pre-, full-, APL, CDP- proposals, and 6 partially drilled proposals)
Total number of deactivated proposals*	132 (52.8 %)
Drilled proposals*	19 (including 6 partially drilled proposals)

Table 1. Summary of IODP proposals (* as of May, 2010)

While there is a significant flow of proposals through the system there are a number of areas for concern. These include the following:

- The long time it takes to move proposals through the current SAS. The delays result from delays in SAS (average of three years), and the lack of control in scheduling site surveys.
- Although there are 105 active proposals, there are not enough implemental proposals, which results in inefficient use of the drilling platforms, particularly the *JOIDES Resolution*, which currently spends up to 20% of its time in dead heading rather being utilized for drilling expeditions, and
- The inefficient use of the *JOIDES Resolution* is alarming, particularly, because funding constraints limits its use to only 8 months in a year. This failure appears to

arise from inadequate communication among the different elements of SAS and the OTF, and delays from poor integration of site surveys in the science and operational planning processes. The long delays in the construction of the *Chikyu* and *JOIDES Resolution* refurbishment, and the budget-controlled reduction in expeditions added to the current institutional difficulties.

iii. IODP Technological Innovations

Since the start of IODP new innovations in drilling, logging and core analysis have been brought to bear on scientific ocean drilling. This has had a major impact on the quality of IODP science and on our understanding of how our planet has evolved. Such innovations include:

- Routine microbiological sampling to build up a sample base for investigating the sub-oceanic biosphere;
- Riser drilling;
- Drilling in the high Arctic (with ice breakers);
- 3-D imaging of whole-round cores;
- Drilling in shallow waters;
- Development of new downhole measurement tools;

IODP Future Innovations:

The current EDP and STP have independently developed roadmaps for engineering/technology development. While there are distinct differences between these roadmaps, there are also commonalities. By the end of the next program, progress on increasing core quality and core recovery should have been made. Focusing on these fundamental aspects of drilling for the new program will lead to an increased impact of IODP science. New innovations would have been in the areas of:

- Minimizing core disturbance
- Recovery of hard/soft intervals (chert-chalk; lava flow boundaries; fault zones, *etc*.)
- Oriented Cores
- Aseptic sampling of cores

Technological innovations would include:

- Enhanced core recovery:
  - Thin-walled, short-stroke Shelby tube samplers;
  - Sea bed frames;
  - Riserless mud recovery system;
  - Sidewall coring;
  - Motor driven core barrel;
  - Pressurized coring with temperature control (*e.g.*, gas hydrates, carbon capture, marine microbiology);
  - Anti-contamination coring for microbiological sampling;
  - Thin walled geotechnical sampler.
- Minimize core disturbance:
  - Extended Punching Coring System and the Extended Vibration Coring System;
  - Ultrasonic coring techniques.

- Oriented Cores using:
  - o Secondary magnetization;
  - o Characteristic remnant magnetization (ChRM);
  - o Tensor Tool;
  - o Automated matching of bore hole patterns with core surface images;
  - o Combining core scribing with the Tensor Tool.

C. Appendix 2b: Context: Previous reviews, stakeholder input and science goals

i. Introduction

In order to better understand the context of this review, the Committee:

1. Examined the conclusions and recommendations of previous reviews. These earlier reviews also interrogated the ocean drilling community through questionnaires which provided insights into community concerns.
2. Prepared a questionnaire related to our specific mandate, to seek the opinion of the different functional groups that play a role in ensuring the quality of the science achievements of the IODP. The different functional groups included representatives from the funding agencies, IOs, Program Member Offices (PMOs), science community (proponents) and other major Earth science programs. There were 32 responses to the 63 questionnaires.
3. Received reports from two parallel reviews of the SAS that are currently being considered by IODP management groups: a report by the committee chaired by Keir Becker to Science Advisory Structure Executive Committee (SASEC), and a report to International Working Group (IWG+) by Chris Yeats.
4. Participated as observer, in the November 2009 SSEP and March 2010 SPC meetings.
5. Participated in a short discussion with representatives from the different funding agencies who provided helpful guidelines for our deliberations.
6. Reported our preliminary conclusions to SPC and the ANZIC Governing Council for their review.
7. Reviewed a preliminary draft of the INVEST science plan for 2013−2018, and were provided with the preliminary list of themes that will make up the new Science Plan.

The range of opinions and recommendations served as a context for our review of the current state of the SAS structure and provided the platform to consider recommendations for the future.

ii. Review of previous reports

Report to SAS/SPC, 2004

A 2004 SAS/SPC review of opinions of the J-DESC, USAC and ESSAC indicated general satisfaction with the panel mandates, but recommended better definition of the role of the technical panels. The number of panel members had grown significantly in the transition from ODP to IODP and mechanisms are needed to reduce the total number of members. A formula for national representation on the panels was accepted, but a clear recognition of priorities is necessary to ensure adequate expertise. Although co-chair leadership of panels was effective, the dispersed leadership can lead to inefficiencies and a single chair may be preferred, although there was strong support for the educational value of the co-chair process.

Communication among and within panels was deemed satisfactory and misunderstandings resulting from language and cultural differences have decreased. Nurturing is working although it introduces considerable delay and sometimes results in contradictory advice to the proponents. The matching of the review process to the goals of the ISP needs improvement. There was strong support for working cooperatively with other earth science research programs. Flexibility is needed to address these issues.

First Triennium Review Committee (US FY2004-FY2006)

The 1st Triennium Review (FY 2004-2006) concentrated primarily on IODP-MI management issues but provided the following comments on the SAS: "*Given the complicated, non-linear proposal nurturing and evaluation process involving many scientists, the potential for increased efficiency and effectiveness, as well as for improved cost-benefit, of the SAS appears to be high. However, the First Triennium Review Committee believes that it is vital for IODP that both the major tangible and intangible benefits of the SAS, such as community education and building, are sustained to the greatest extent possible*." They recommended that: "*A dedicated review committee that includes a significant number of external members should comprehensively evaluate the efficiency, effectiveness, and cost-benefit of the IODP SAS*". The 2nd Triennium Review Committee is dedicated to that task. The flowcharts describing the SAS structure and proposal review extant at the time of the 1st Triennium Review is shown in Figures 1 and 2.

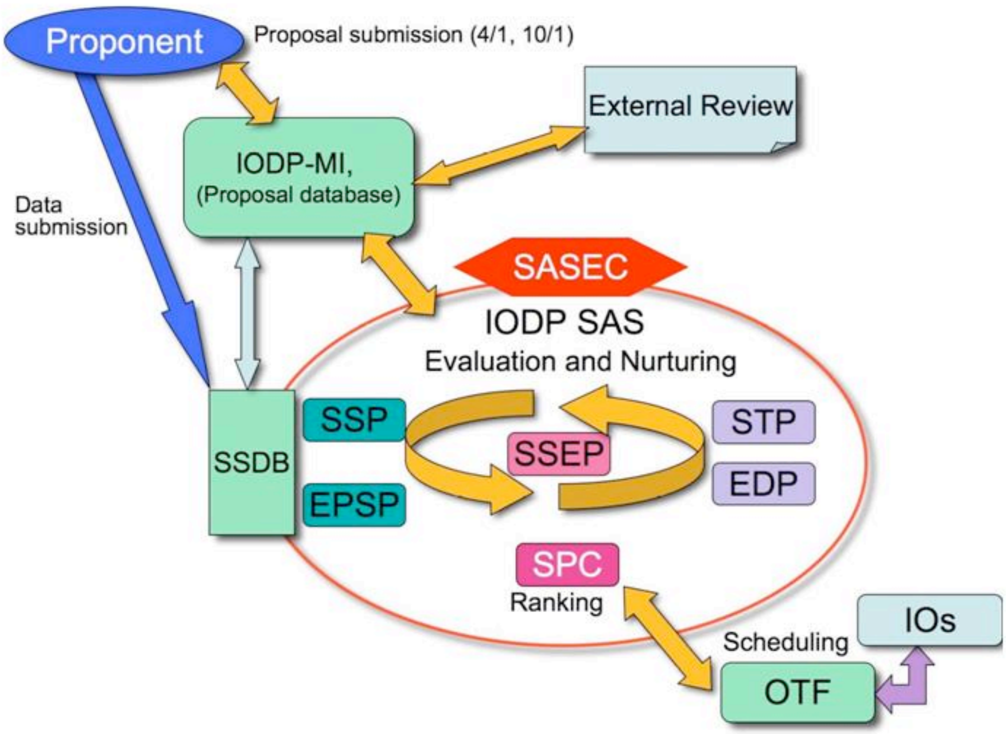


Figure 1. Current IODP/SAS proposal review and science program implementation process.

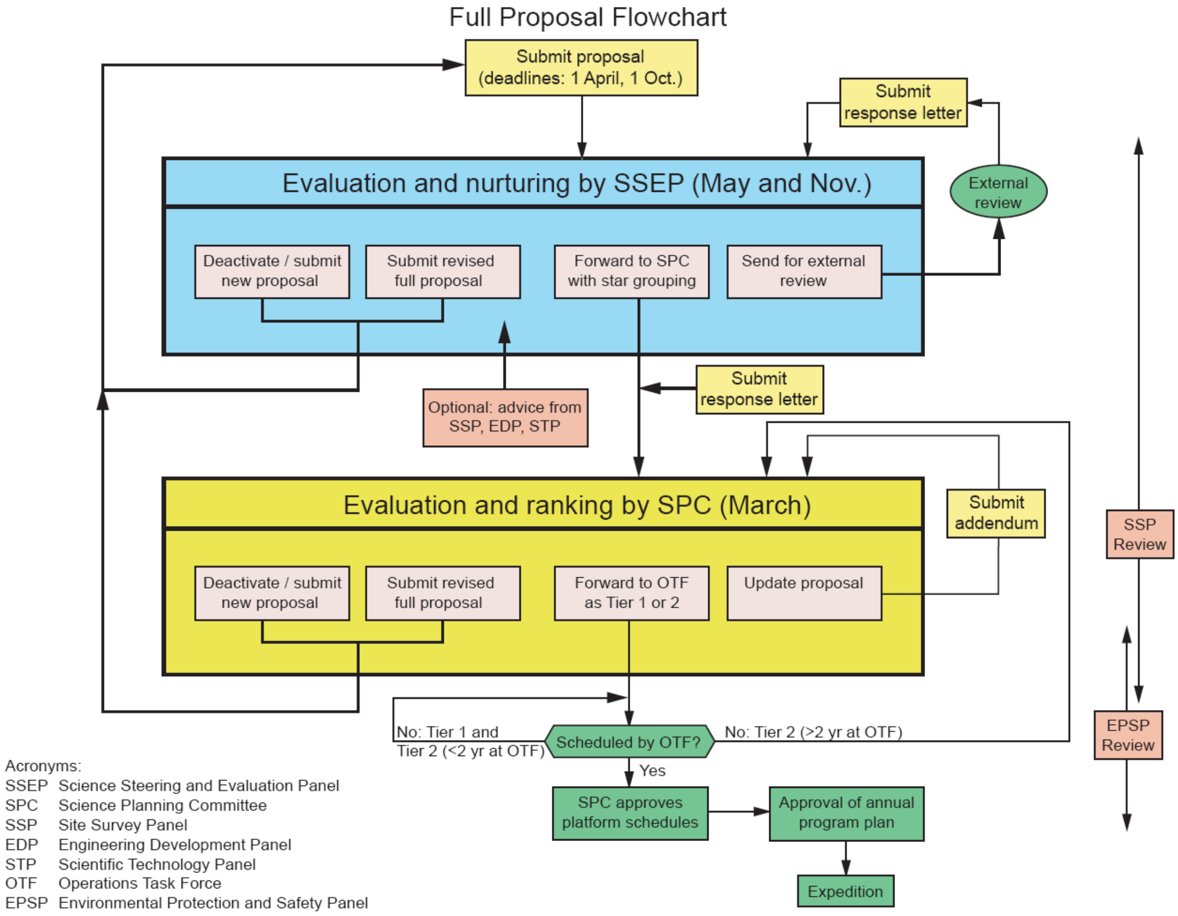


Figure 2. Current IODP review process for full proposals.

Report of the IODP-MI *ad hoc* Committee (2008)

The Report of the IODP-MI *ad hoc* Committee (October 2008) emphasized that: "*The proposal handling process for the next phase of scientific ocean drilling needs to be revolutionized. We need more straightforward mechanisms for promoting excellent proposals and for rejecting proposals with little chance (scientific or operational) of ever being drilled. The proposal system should more effectively incorporate larger scientific themes that are responsive to the ISP. Be they named missions or some other term, we need to start using the platforms more as floating experimental beds that sail with missions of exploration, rather than as two-month earmarks for individual one-off scientific ideas. This science review and implementation process needs to have mechanisms for identifying missions, provide adequate support for inclusion of operational imperatives, E/O activities, and funding mechanisms early in the scientific planning process. We note that 'missions' as defined earlier did not find favor with a segment of the scientific community and therefore the mission concept will have to be carefully redefined in concert with the scientific community*".

SASEC Working Group on SAS – Summary Report, June 2007

SASEC formed a small working group (SAS WG) to review the IODP SAS and recommend any changes to optimally configure its activities as IODP enters Phase II. The full report is included with the Resources section. Items that relate specifically to our review include:

- earlier SSEP rejection of proposals deemed unlikely to succeed, *e.g.*, unlikely to ever reach SSEP status of 3 stars or higher,
- more careful SPC assessment of proposals that repeatedly rank too low to forward to OTF for potential scheduling, and
- periodic SPC review of any backlogs of approved proposals forwarded to OTF but remaining unscheduled.

The SAS WG reaffirmed the need for separate Site Survey Panel (SSP) and Environmental Protection and Safety Panel (EPSP).

iii. Other reviews currently being prepared

The 2nd Triennium Committee also had access to other reviews of SAS that are now underway. The one is a report by the committee chaired by Keir Becker to SASEC, and the other a report to IWG+ by Chris Yeats.

SASEC report (2010): Keir Becker (Chair)

In 2009, SASEC formed a subcommittee "to assess models for the proposal evaluation process for the post-renewal phase of IODP." The subcommittee report (Resources) was accepted at the January 2010 SASEC meeting and forwarded to IWG+ for use in designing the post-2013 SAS. The subcommittee made the following four main recommendations with graphical representation for the new SAS structure/process.

1. The post-2013 SAS should be simpler, with two committees for proposal evaluation and program plan development where there are now three (SSEP/SPC/SASEC).
2. More effort should be placed into early proposal development and nurturing in program-funded workshops and potential SAS working groups prior to main submission and evaluation within SAS. That should maintain community involvement even with simpler SAS, allow earlier scoping by IOs, and produce fewer but more competitive proposals with shorter residence times in the proposal evaluation process.
3. Single-expedition *JOIDES Resolution* and MSP proposals can probably be evaluated using a common process/pathway, but planning for riser projects and long-term multi-expedition non-riser projects needs a separate pathway through SAS with strong similarities to the mission concept developed in 2005−2007.
4. The transition should begin within the next year.

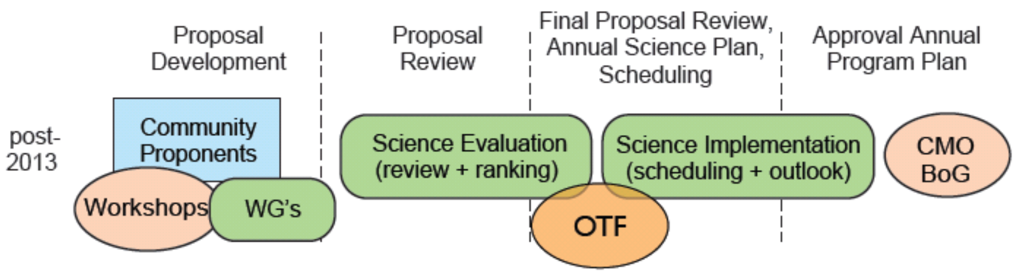


Figure 3. Summary diagram of SAS recommended in SASEC report (Jan., 2010).

Chris Yeats report to IWG$^+$

Chris Yeats presented a preliminary version of his report to IWG$^+$ to the committee. We were in agreement with his guiding principles and feel that our concerns and recommendations parallel those expresses by him. A copy of Yeats' preliminary guidelines and recommendations is included in the Resources section.

iv. Community opinion: Summary of responses to the 2nd Triennium Committee's Questionnaire

Positive comments

The value of the SAS lies principally in the general role of allowing a grass roots and science driven program to flourish. Access is open to international scientists from many disciplines, including those external to the IODP system. The panel members are typically competent, experienced, selfless volunteers lead by capable leaders. The system was successful in remaining open to young scientists who often matured into the next generation of leaders.

SSEP and SPC roles

There was a sense that the SAS was too complicated and that there was ineffective communication within and among the different panels and committees. As a result there has been considerable duplication of effort and a lack of continuity in reviewing proposals, leading to a lack of consistency in the disposition of proposals. Institutional memory is weak and the watchdog presentations variable, suggesting that the fate of a proposal may be overly dependent on the watchdog. In summary, the doubling up, or overlap, of SSEP and SPC roles can lead to duplication, confusing signals to proponents and delays.

Ranking

The ranking mechanism used by SSEP was not well designed to help with the rejection and selection of proposals. The inefficiencies result in a clumsy and slow review and selection process. It is common knowledge among social scientists that the ranking procedures, currently used by SSEP and SPC is the one system, among all known and tested systems, that results in more bias and strategic voting than any other system. This is particularly the case, in a group that is strongly polarized, which is potentially the case when people come from different scientific cultures and represent their country/consortium, or their scientific discipline. Another problem is that the current ranking mechanism focuses on tactical as opposed to strategic goals, *i.e.* the goals of the ISP are not advanced. Further, the current ranking mechanism focuses on tactical as opposed to strategic goals, and the goals of the ISP are not advanced through this process.

Panel membership

There was a concern that few people on the present SSEP really understand any single issue well enough to make useful comments. Consequently, the view of the panel is weighted to the few people who understand, or think they understand, the proposal. The views of a panel can swing wildly from year to year (due to the one-third rotation) as advocates for a particular proposal are no longer present (or become present) to sway their co-panelists. The problem is particularly exacerbated in the case of substitutes often selected on short notice and lacking the necessary technical skills to participate in the review process. There is a danger of creating a system where 'majority rules' instead of a system of careful evaluation of individual proposals by appropriate thematic experts. Scientific and/or technical expertise, rather than national representation, should be the main criteria for the selection of members on the different scientific review panels. The issue of representation is best addressed at the Executive levels and through participation in workshops.

Role of service and operational panels

There is a poor integration between the science content and goals of the proposals and the technical and operational constraints which often come too late in the review cycle. IOs and technical service panels should be brought in very early in the proposal preparation, review, and final selection process. Special attention needs to be paid to the drilling platform being used. The underlying site survey and technical data need to be assessed by specialists who do not participate in the scientific evaluation. It is important, in this respect, that the SSP not function as a science evaluation panel and does not participate in ranking proposals. Rather they are a technical panel who provide advice on feasibility and ensure that adequate data are available to insure a successful drilling program. Insofar as possible, the site surveys should be integrated into the proposal before it reaches the science program implementation stage. Further, it is difficult to understand whether the science can be accomplished or effectively reviewed without the site survey information in-hand.

The evaluations adequately assess underlying scientific data, but not the feasibility of proposed operations. It appears that operational considerations are not taken into consideration during the scientific review and ranking process. Many people have pointed out that the technical feasibility and operational constraints should be considered earlier in the process, and are best assessed by the platform operators. One reviewer emphasizes that the next program should have a group of paid professionals (engineering and managerial roles) within the CMO who have the responsibility of performing technical evaluations of incoming proposals for all the drilling platforms up to and including formulating the operational plan.

Nurturing

Contrasting opinions relative to 'nurturing' are illuminated by the following quotes. First: "*I favor eliminating the 'nurturing' function of the SAS and putting the onus on the proponents to seek nurturing, if they so desire, from expert colleagues before they submit a proposal to the IODP*." Second: "*I have long regarded one of the key strengths of the drilling program as the 'nurturing' of drilling proposals. Nurturing has allowed proponents unfamiliar with the ODP advisory structure and the complexities and requirements of an ocean drilling proposal, as well as the technical requirements for drilling, to develop excellent scientific and achievable drillable proposals*." However, the current system is not working. Nurturing should be much more limited. Not all proposals are nurturable and the universal application has led to a bottleneck. We need more 'up/down decisions'. Only those proposals with fundamentally exciting objectives and a chance of making it should be nurtured.

Cooperation with other programs

There was strong support for working with other programs. In order to effectively tackle the science goals for IODP it is often beneficial to place the problem in a more conceptually holistic context. In such circumstances, it is critical to encourage scientists used to working in different program modes to work cooperatively. Currently, no adequate mechanisms are built into the IODP SAS structure to ensure collaboration. Workshops need to be co-funded, proposals better coordinated, and panelists chosen that have the scientific and technical skills to represent other major programs and the range of skills needed to comprehend the broader perspectives.

Drill ship schedule and operation

The two-month cycle for each drilling leg tends to shape the content of the proposals and to discourage more innovative use of the drilling platforms. The widespread support for Ancillary Project Letters (APLs) indicates the desire to keep the program open to new science. These could be a valuable mechanism to help restore a healthy balance between programmatic versus independent science. In the past, advanced knowledge of out-year ship tracks was a very effective planning tool for minimizing transit times and fuel costs, providing sufficient advance time for funding and timely completion of site surveys, and allowed rational planning for the development and management of proposals. A geographic schedule would also help greatly in the review and management of proposals. Riser and non-riser proposals should be evaluated and ranked in separate review systems.

Conflict of Interest

Responders to the questionnaire felt that the current application of COI rules is too restrictive, particularly at the SPC level. The result is to deprive the panels of critical expertise. A common sentiment is expressed by one reviewer: "*We should take a broader view about COI. Dismissing all proponents from any form of discussion of a proposal removes a level of expertise that sometimes is critical to balanced and informed evaluation*." Although available for consultation, the proponents should not vote on the disposition of their proposals that directly compete in the same competitive grouping. The overly strict application of the COI rules is particularly problematic for national partners with smaller scientific communities. A significant fraction of their scientists are often listed as PIs or co-PIs on proposals. Correspondingly, there is great difficulty in finding scientists without a COI to serve on SAS panels. One consideration was to allow proponents, instead of watchdogs, to present their own proposals to whatever group ranks them. One thought was that application of COI rules is exacerbated when too many proposals are being ranked at the same time. One mitigating option is to find mechanisms to allow group proposals, *e.g.* by region. A major step forward occurred when Planning Committee (PCOM), during ODP, passed a motion that no panel member could have their name forwarded as a candidate for chief scientist unless they were a named proponent on the proposal.

Responses from different functional groups

The questionnaire was selectively sent to the different functional groups that play different roles in the development of the science program. These include funding agencies, IOs, PMOs, SAS, proponents and other major programs. Overall the answers to the questions from the different functional groups were convergent and presented comparable opinions. Strongly opposing opinions are identified in the summary.

v. Opportunistic visits to SSEP and SPC

The committee had limited opportunities to directly review SSEP and SPC. Committee Chair, Ian MacGegor attended one SSEP meeting in Melbourne (November, 2009), and the full committee, parts of the SPC meeting in Sydney (March, 2010).

During the SSEP meeting, there was a useful discussion with the co-chairs where a number of points were made. These include the following:

1. There is strong support for formalizing different paths for PRE- .and FULL-proposals. Prioritizing the PRE-proposals may be a mechanism to help secure funds for the necessary site surveys.

2. In order to minimize meetings and costs, it would be effective to hold SSEP meetings in conjunction with meetings of the service and operational panels. This would make it easier for technical and operational constraints to be integrated with the review process.
3. There was strong support for continuing the use of APLs to encourage the injection of new and innovative science into the program.
4. They encouraged flexibility to allow FULL-proposals access to the system without going through a preliminary PRE-proposal stage.
5. There needs to be better guidelines delineating the expected responsibilities for chairs and members.
6. In order to ensure good communication it is important that all members be fluent in English.
7. There is considerable concern about the quality of SSEP members. Currently, members are appointed on a national representational basis and selected from pools provided by their respective science advisory groups. It was felt that at the SSEP, *i.e.* proposal review level, considerations of scientific and technical expertise should be paramount in the selection of members.
8. The selection of substitutes and alternates gave greater cause for concern. The process is too *ad hoc* and often proceeds on such short time lines that individuals with inadequate expertise are selected.
9. One suggestion is to change the current co-chair structure and assign a Science Program Manager(s) who could maintain corporate memory and scientific and technical discipline (quality of members and alternates) by being involved in selection of SSEP members.

The take away message from the SPC meeting was that there is duplication of effort in the proposal review process, which should be the primary role of SSEP, along with unwillingness to make firm decisions on the disposition of proposals.

vi. Reports and responses to SPC and ANZIC Governing Council comments

The Committee had the opportunity to report our preliminary recommendations to the ANZIC Governing Council and SPC. ANZIC provided a detailed review which indicated that there is considerable overlap between their perspective regarding problems with the old SAS and the Committee's recommended solutions for a new structure. The ANZIC Governing Council's review and our responses are included in the Resources Section.

vii. Discussions at European Geoscience Meeting (May, 2010)

European scientists who participate in IODP and ICDP programs who were consulted at the European Geoscience Union (EGU) meeting in May 2010 strongly supported a simpler and more comprehensible SAS. Ideas for change were broadly convergent with those of 2nd Triennium Committee. There was a sense that the nurturing process has overreached its usefulness and that community development through workshops, and other mechanisms, was a better way to proceed. Many scientists emphasized that priority should be given to the appointment of panel members on the basis of their scientific and technical expertise rather than on achieving national representation. Any new panels that are formed should have new memberships.

Concerns were raised about inadequate support to develop engineering technology for improved drilling and down hole experiments. One danger is that the science is driven by the limited drilling capability, leading to a focus on easy drilling targets, *e.g*. shallow sedimentary drilling targets

There is very effective cooperation between IODP and ICDP. A joint forum, open house, science sessions, and shared exhibits booth reflected the support of European scientists for close collaboration between the two programs.

viii. Conversation with members from funding agencies (Lead Agencies NSF and MEXT, and Contributing Member, European Consortium for Ocean Research Drilling (ECORD))

An opportunistic discussion at the Fall (2009) meeting of the American Geophysical Union (AGU) with representatives from the three main funding agencies for IODP (NSF, MEXT and ECORD) led to the following general guidelines for the Committee to consider:

1. We should think about our recommendations from an *ab initio* perspective and not get bogged down in the historical context of how the SAS changed over time. While the earlier process, with its strengths and weaknesses, is important to provide a sense of perspective, it should not dominate any forward looking recommendations. The parameters that will guide the post 2013 program should hold our major attention.
2. The review committees should consider designing a SAS that can respond more adroitly to the program planning needs of the different drilling platforms. Since the operational responsibilities of the IOs are different, any proposed SAS needs to be responsive to a range of different program implementation constraints. While acknowledging the different operational needs, we will need to think carefully about mechanisms to retain an integrated program. The science that is planned (see INVEST report and new Science Plan) is linked to the implementation strategies; in fact, the IODP science goals, which are universal, should also be linked with partner program groups such as ICDP.
3. An issue of special concern is the optimal balance between ensuring a rigorous review process versus the emphasis on member representation on SAS. While, over time, the balance must be addressed, recommendations could vary depending on different perspectives on how to resolve this dilemma.
4. Although SAS is now used both to review and prioritize proposals, as well as serving as an educational and nurturing resource for the IODP science community, these functions can clash and lead to conflicting outcomes. One alternative is to more clearly separate the review and nurturing functions and find other mechanisms to ensure member representation and education of an informed international IODP community.

ix. INVEST science report and new Science Plan for 2013−2018

The INVEST conference report identified four important topics and several cross-disciplinary research frontiers as important new ocean drilling themes. These are:

- Climate Change Impacts,
- The lithospheric membrane-key interface and processing zone,
- Co-evolution of life and the planet,
- Earth-human-earth interactions, and

- Cross-disciplinary research frontiers

The themes and the associated sets of research topics identified in the report comprise a significant change from themes identified in previous phases of ocean drilling programs. There is an expanded outreach to include researchers interested in a wide spectrum of research questions that cut across the atmospheric, ocean, solid earth, and anthropology communities. The databases essential to understand the different earth systems and their interactions no longer resides solely in ocean drill cores, but will need integrated access to data collected from the atmosphere, oceans, and adjacent continental land masses. The approach advocated by the INVEST report conceptually expands the research themes well beyond traditional ocean drilling perspectives. The importance of the expansion of the intellectual horizons is that the SAS infrastructure must adapt to this enhanced disciplinary diversity. Moreover, the introductory nurturing and workshop process will need to stress the overarching multidisciplinary focus of the guiding themes. Successful proposal will have to reflect the new thematic syntheses.

In terms of the management of science the report makes four main recommendations. These are summarized as follows:

- Scientific planning and execution in the new ocean drilling program should be driven from the ‘bottom up’, with scientists playing the key roles in proposing specific expeditions and drilling targets, in defining short and long term goals, and in advising and working directly with the management and ship operators to execute the drilling program.
- Transformative science is often born from and nourished by cross-disciplinary perspectives, and the drilling program must have multiple mechanisms to proactively engage scientists and students from other disciplines outside of the traditional drilling community; these include observationalists and theorists from academia and industry.
- There was general support for ‘mission-like’ multi-expedition, long-term projects to achieve the ambitious goals of the new drilling program. Many of the grand challenges that were defined, as described in this report, cannot be achieved by single two-month expeditions.
- At the same time, it was recognized that many of the highest impact ocean drilling projects in the past arose from unanticipated and/or concise and focused ideas. Thus, there must be mechanisms by which the new ocean drilling program can quickly respond to, nurture, and execute any brilliant new ideas that require ocean drilling.

The INVEST report emphasizes “that there should be serious consideration of designing a new SAS that would optimally support the important characteristics of a new program”. A new SAS will need to consider a structure that effectively responds to the overarching mission goals while respecting the potential and value of new ideas advanced by individual scientists. The main cross-disciplinary thrust will also require mechanisms that ensure the participation by science experts from a wide variety of disciplines. Locking up scientists from many disciplines for extended periods in the incubator of a drilling platform is an experiment that is likely to lead to the development of revolutionary insights of the behavior of earth systems.

Another outcome of the INVEST report that would impact proposal development and review is the associated site survey. They recommend that site survey data should be integrated into the science program of an expedition as fully and as early as possible, preferably with direct interaction between proponents and the SSP from initial proposal development stage through full site characterization. This would allow proponents to adequately plan for additional site surveys and highlight ways to optimize science goals of a given drilling project. These comments speak to the overall importance of integrating the advice from service and operational panels early and throughout the proposal development, review, and program implementation phases of the SAS process.

The new **Science Plan** establishes goals for four major themes. These are:

- Climate and Ocean Change: Reading the Past, Informing the Future,
- Deep Life: Exploration of the marine intraterrestrials,
- Renewing the Lithosphere: Consequences for our planet,
- Earth in Motion: Deforming plate boundaries, fluid flow, and active experimentation.

Comparable to the INVEST report, the four themes conceptually expand the research goals well beyond traditional ocean drilling perspectives. The debate on the balance between 'bottom up' and 'top down' science will continue into the next phase.

The recommendations from the 2nd Triennium report incorporate three mechanisms to encourage dialogue and help scientists negotiate the balance between 'tactically' and 'strategically' driven proposals.

1. Proposals will be prepared through a science community process driven by workshops and other collaborative opportunities. The process should allow open access to all scientists and stimulate a sense of balance and competition between the tactical science and strategically driven approaches at the earliest stages of proposal development. This approach will enable scientists to be well informed and engage in the responsibilities for managing the overall balance of the program.
2. The SESP will be structured around thematic panels. This review will retain sensitivity to the overarching thematic goals while respecting proposals for innovative science.
3. The SEA will provide continual feedback to the scientific community and SESP. Their goal is to identify thematic gaps, and alert the scientific community to new areas of research and imbalances in the program. If necessary, SEA can propose workshops, Working Groups within SAS, or other mechanisms to increase proposal pressure that address the imbalances amd new fields of research.

There should be no restriction between doing excellent innovative science and at the same time accomplishing the thematic goals or the program.

C. Appendix 3 a: *ab initio* review of a Science Advisory Structure

i. Introduction: The importance of clarity and well-defined responsibilities and evaluation/selection criteria

Notwithstanding the significant achievements outlined in the 2004 Science Plan, and indeed from the previous 30+ years, the Committee has identified a number of important challenges for the future. Thus, through its deliberations, the Committee developed the clear perspective that the current proposal evaluation, selection, and implementation process and structure is overly complex, with corresponding inefficiencies, delays and overlaps, confusion and ambiguity about respective functionalities, roles and responsibilities, and inter-relationships.

Furthermore, the prevailing ranking system of proposals is potentially flawed − the priorities and criteria for evaluation and approval/activation are not clear, nor perceived to be uniform. This leads to some perceptions of random (or biased) ranking, and a corresponding reluctance to make the tough choices in screening and selection/prioritization.

Illustrative comments from participants included, for example:

- *"....when the respective Committee mandates are not clear...the community doesn't really understand what the difference is..."*
- *"... unclear to me is the large overlap in tasks between SSP and EPSP...'*
- *"...the way forward is littered with potential for misunderstandings..."*
- *"...the pile up of proposals of mediocre quality greatly reduces the efficiency of the entire system, and gives false hope to the proposers..."*
- *"...The SAS structure is too complicated with overlapping functions of committees..."*

Furthermore, it was evident that there is non-optimal integration and interface between the prevailing SAS and the operations/implementing structures (*e.g.*, site surveys, engineering development, and environmental protection and safety).

- *"...it appears that operational considerations are not taken into consideration during the scientific review and ranking process..."*
- *"...the review process does very little to inform on the technical feasibility of proposed operations...efficiency would be gained by doing a better job early in evaluation process of linking science and operations..."*

Based on these comments and other investigations throughout its deliberations, the Review Panel determined that many perceived and actual problems −and associated conflicts − with the prevailing system could be laid at the door of 'non-clarity' around:

1. Goals: "*Where are we headed?*" − which are clearly-defined objectives that are well and widely communicated, and provide decision-making clarity in project evaluation and selection,
2. Roles: "*Who is responsible for what?*" − which removes unnecessary overlaps and duplication of effort, re-work and frustration, and
3. Processes: "*What needs to be achieved, how and by when?*" − based on fairness and transparency.

The Committee concluded that striving for *simplification* and improving *communication* will enhance performance.

In developing its recommendations, therefore, the Panel was mindful of these dimensions of effective organizational strategy implementation.

Finally, the Panel identified a tension, requiring resolution, between the prevailing proposal, responsive approach and a more strategically planned and prioritized set of programs. The current weak integration of strategic planning with the proposal selection and implementation pipeline and performance review prevents the inter-relationship between science plans and expeditions from being transparent and logical.

ii. Simplifying the SAS, to facilitate long-term performance

In order to independently calibrate the messages emerging from parallel reviews and reports − and in the context of the Committee's mandate − the Committee undertook a 'green field' (*ab initio*) perspective to the IODP, along the following lines:

1. Reviewing the history of the whole program, from its day 1, including its predecessor(s), and including major achievements,

2. Formulating and conceptualizing a 'vision': Placing ourselves 10 years in to the future: what will it look like, and what will we (IODP) have achieved in those intervening years?
3. Understanding and describing the current reality, *i.e.* what are the key prevailing challenges (and opportunities) and problem issues potentially impeding future progress and delivery? This was very usefully informed by the questionnaire process, tapping into the diversity of practitioners' and stakeholders' perspectives and experiences, and
4. Determining key focused initiatives (new, changed, *etc.*) that we would recommend to get from point 3 to point 2, *i.e.* from where we are to where we want to be. In this regard, the Committee focused attention on the goals, roles (responsibilities and accountabilities), and processes constituting the SAS, including its organizational design.

In simplifying the idea-to-implementation 'pipeline', with a corresponding increased speed of throughput and communication clarity, the following diagram (see Appendix 3b i) summarizes the conclusions the Committee reached around a simplified - and more readily understandable and communicable − process, from idea formulation through proposal evaluation, selection, and implementation, re-emphasizing, enhanced simplification and ease of communication with transparency, which we believe to be fundamentally important.

C. Appendix 3b: Science Advisory Structure

i. Introduction

An *ab initio* review of the needs of a SAS identifies three essential linked **functions**. These include the development of:

1. an informed scientific community that has the opportunity to develop competitive proposals that meet the science goals and operational parameters of the program,
2. a proposal review mechanism that selects those proposals that are of the highest scientific merit, best address the goals of the program and are operationally feasible, and
3. a science executive authority that deploys the highest quality proposals to develop a science program that responds to the management and funding constraints imposed by the technical capabilities of the drilling platforms, and funding limits imposed by national agencies

Critical to the success of SAS is the integration of site survey data, technical and operational constraints, and budget realities into all phases of the SAS process. Essential to the success of a SAS is that the responsibilities of the respective elements are clearly defined and the functions are linked as a **system** that effectively communicates its operation both internally and externally to the scientific community and senior management. The system must be adequately transparent so that it may be effectively monitored and adjusted as its constituents, program goals and constraints change.

In order to achieve these goals we recommend that a future SAS be made up of three functional groups that include a **Community Building and Proposal Development Function,** a **Science Evaluation and Selection Function,** and a **Science Executive Function.** The recommended roles and interrelationships of these groups are defined in the following appendices (Appendices 3b ii, 3b iii and 3b iv).

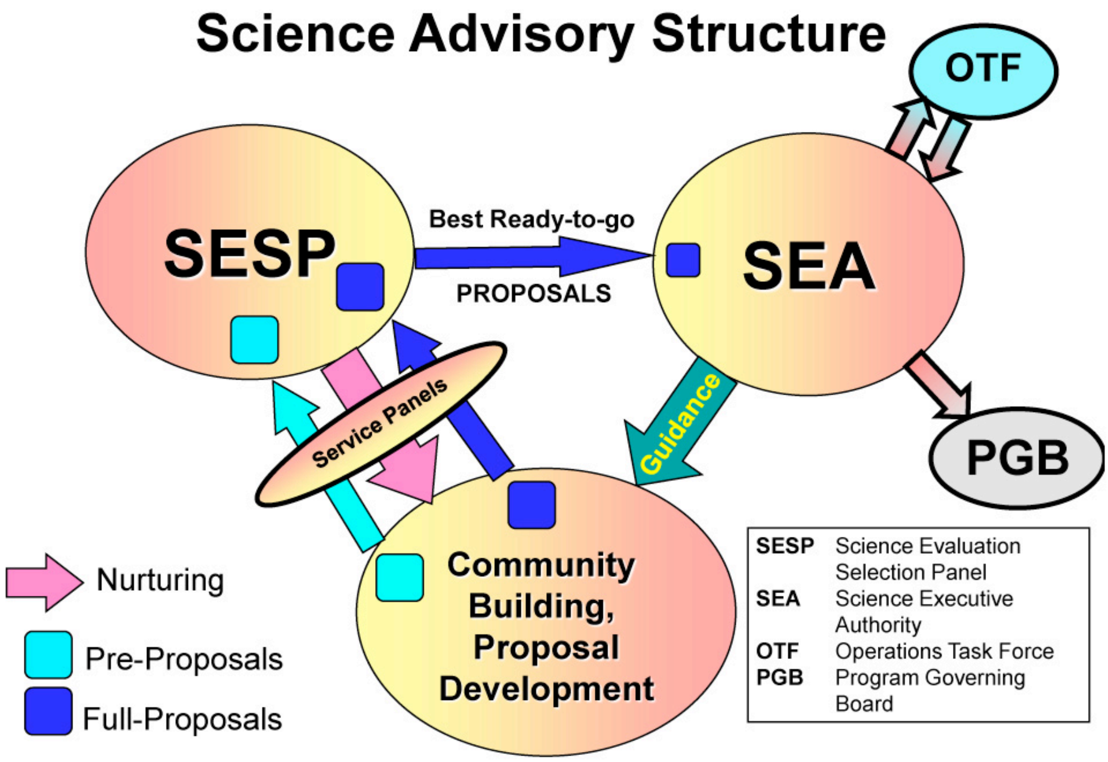


Figure 4. Recommended Science Advisory Structure.

ii. Community Building and Proposal Development Function

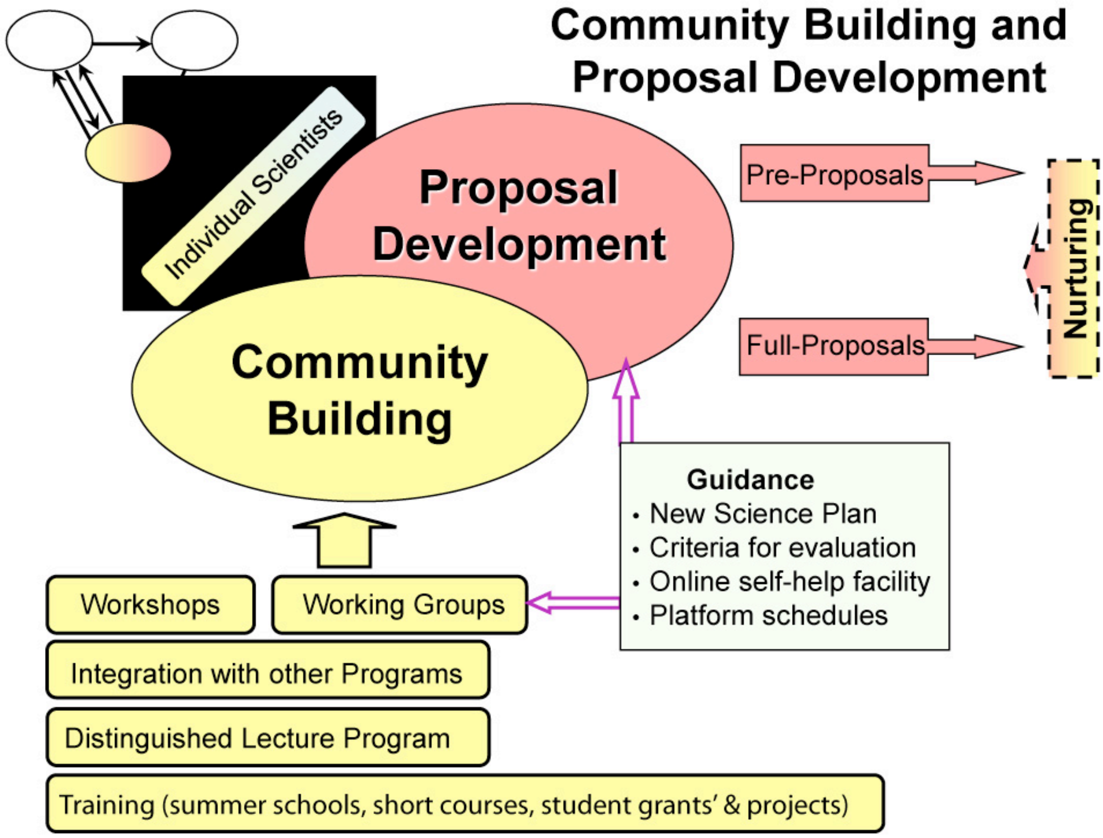


Figure 5. SAS: Community Building and Proposal Development.

Current situation:

- Pre-proposals and full proposals are developed by single scientists, spontaneous groups of scientists, and prompted groups of scientists (*via ad hoc* workshops).
- Pre-proposals and full-proposals are submitted with the same deadlines (twice a year: April 1 and October 1).
- Two science evaluation (SSEP) meetings are held every year; a selection of highly ranked proposals is forwarded on to SPC. SSEP provide evaluation and nurturing to proponents.
- Proposals are re-evaluated and ranked by SPC once a year. SPC provides feedback to proponents.
- 1-2 IODP Workshops have been organized per year; some are joint with other programs.
- Two IODP Summer Schools per year organized by ECORD.
- A distinguished lecture program has been in operation since 2007.

Successes of current system:

- The program has promoted workshops and working groups which, along with participation on drilling legs, have provided the community with opportunities for collaboration, networking and career development. This has led to the generation of high-quality proposals, an exciting diverse international program, and major scientific breakthroughs.
- The program has provided opportunities for training, through feedback from experts on panels (cost-effective), the distinguished lecture program (USA, Japan, Europe and others) and online materials. Of particular note is the training for next generation of scientists.

Criticisms and Perceived Shortcomings:

- Long length of time proposal spend in overly complex system
- Lack of clarity of roles between SSEP and SPC
- Reluctance to reject and remove proposals from system
- Lack of corporate memory on panels
- In current submissions, reference to the ISP can be limited in its scope.
- Difficulty for PIs to secure site surveys
- Limited integration with other programs
- Lack of technical advice in early stages
- Lack of regional strategic planning to address most pertinent science
- Training of young scientists could be improved.
- Limited technological development for some high priority targets

Recommendations

Community Building (Senior Scientists to Graduate Students)

- Workshops, at least one for each new Science Plan theme, should directly involve other geoscience programs (*e.g.* ICDP community), involve graduate students, postdocs, and young scientists
- Training, to include summer schools, short courses, text books, small grants for studying IODP material (through proposal evaluation)
- Working groups to be solicited by SEA
- Continue with distinguished lecture program
- Promote wider participation and integration with other programs

Proposal Development

- Proponents should be encouraged to use new Science Plan when writing proposals.
- Clarify criteria for proposal evaluation.
- Clarify roles of SESP and SEA.
- Provide an online self-help facility for writing pre-proposals and full-proposals.
- Solicit representatives from other bodies, *e.g.* ICDP, IRIS, Ocean Observatories Initiative (OOI), *etc*., to participate in development of pre-proposals (with permission of proponents), so that opportunities for integration with other programs can be picked up early in the process.

- Encourage diverse proposals, including short, single target sites (within a broader overarching drilling strategy).
- Nurture only promising pre-proposals. For those pre-proposals that are allowed to proceed to a full proposal, SESP should make recommendations on how to develop the proposal, identify safety and site survey issues, encourage integration with other programs where appropriate, encourage wider community involvement if appropriate, encourage a workshop or working group if appropriate (in particular for novice applicants).
- Promote and organize WORKSHOPS. These could be initiated by:
    - PIs (to encourage wider community involvement, and to identify the highest scientific priorities for drilling)
    - SESP (if the science is interesting, but a wider community could develop and improve proposals within a more strategic approach) or
    - SEA (if some themes in the Science Plan are not being advanced by the bottom up process).
- WORKING GROUPS could be initiated by SEA to address gaps in the program. Clear definition of Workshop and Working-group roles.
- For all full proposals with links to other programs, either have a member of the program at the SESP meeting, or have them review the full proposal (with comments available at the SESP meeting). For all proposals with an ICDP link, have a member of the ICDP science review committee present at the SESP (and *vice versa*).
- Regular review of the new Science Plan to address emerging science.

<u>Criteria that could be used to evaluate the success of community and proposal development</u>

- A clear, rapid and fair process (as judged by the users),
- Effective nurturing of those proposals selected for development (as judged by the scientific outcomes for those that are drilled),
- Number and quality of pre and full-proposals submitted,
- Number of training opportunities for young scientists.

iii. Science Evaluation and Selection Function (SESP)

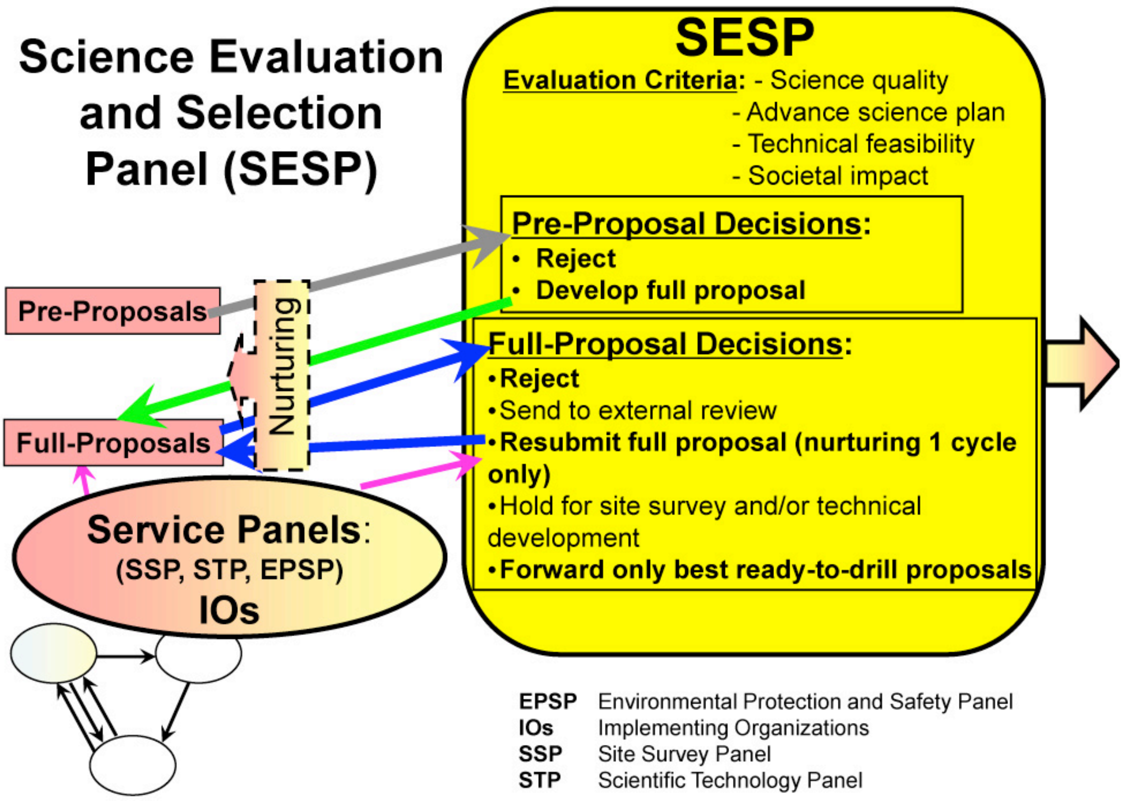


Figure 6. SAS: Science Evaluation and Selection Panel.

<u>Current Situation</u>

- Proposal evaluation occurs at two levels – SSEP and SPC. The same process is used regardless of platform to be used.
- SSEP evaluates and 'nurtures' pre-proposals and proposals, mainly on science grounds (*i.e.*, with little consideration for practical realities).
- When proposals become mature, SSEP identifies them for external review and then forwards them to SPC for final ranking and selection of science plan. When forwarding mature proposals to SPC, SSEP by consensus 'rates' them against an absolute scale of one to five stars defined mainly by potential scientific impact and relevance to the IODP ISP.
- SPC annually reviews all mature proposals forwarded in past years by SSEP, and then ranks the pool competitively by individual ballots. The individual ballots are averaged to produce a composite statistical ranking, and then SPC decides what subset of the highest-ranked proposals should be forwarded to the Operations Task Force for potential inclusion in schedule options for operations in the fiscal year that starts about 1-2 years later. Proposals not identified for forwarding to OTF are normally kept in the pool for the following year's ranking.

- OTF and SPC work together to select the best annual schedule option based on a combination of scientific criteria and practical realities. Proposals that were forwarded to OTF but not included in the selected schedule have normally been left at OTF for future consideration but may be returned to SPC for reevaluation.

Successes of Current System

- Despite criticisms and perceived shortcomings (below), the current (and past) SAS proposal evaluation processes have advanced excellent proposals to produce consistently strong IODP annual programs.
- Participating on SSEP provides invaluable experience for the younger generation of geoscientists across the full spectrum of IODP membership.

Criticisms and Perceived Shortcomings

- The two-stage review process normally requires at least two years even for the best proposals, and more commonly takes significantly longer.
- Nurturing at SSEP level may extend too many meeting cycles. This can lead to unreasonable time scales for decisions and may allow for inconsistent advice to proponents as SSEP membership rotates.
- For mature proposals, the second stage of review at SPC may be (or seems to be) inconsistent with the SSEP review. SPC has a smaller membership than SSEP and cannot match the expertise balance at SSEP. SSEP normally does not forward any proposals to SPC that are rated with fewer than three stars. Proponents of proposals that are not ranked highly by SPC do not always understand that the pool of proposals at SPC is all highly-rated by SSEP, so the SPC ranking is a highly competitive relative ranking.
- Proposals at SPC level that are not included in approved schedules sometimes get very different SPC rankings in future years.
- Even at SPC level, practical realities (funding limits, technological capabilities, and site survey readiness) are not thoroughly evaluated. These factors are brought in mainly during the SPC-OTF interaction to select the best schedule options, and for some proposals this is probably too late in the process.
- The process is well suited to evaluating most riser-less and MSP proposals, but may not be optimally suited for developing multi-expedition or riser programs given the long lead times and major commitments required.

General Recommendations

- Simplify the structure so that the proposal evaluation and selection function that now crosses SSEP/SPC is done at one primary evaluation panel, the SESP.
- Integrate evaluation of site survey and technological feasibility much more closely with the SESP evaluation process.
- Streamline the evaluation process to make decisions more quickly and avoid wasted effort and frustration through multiple proposal versions and meeting cycles.
- The program should invest in more community development early on (*e.g.*, workshops) for developing multi-expedition and riser proposals.

Specific Recommendations for SESP Function/Process

- SESP should be subdivided into thematic subgroups consistent with the main themes identified in the new Science Plan. It appears there will be four such main themes, and each subgroup should have a membership of 8-10. Members should be chosen for their strong scientific expertise, within or across these themes. Membership terms should be 2-3 years with an option for renewal. If the new program memoranda define panel membership allocations per member countries/consortia, they should be applied proportionally to each thematic subgroup. The subgroup chairs should be chosen for both expertise and leadership skills. The SESP chairperson should be selected by the SEA for known leadership skills and broad scientific expertise. The role will require at least a 50% dedicated time and should be provided with appropriate salary and logistical support. He/she should attend all SEA meetings as an *ex officio* member.

- For initial submissions, pre-proposals should be the preferred method. SESP should be selective in determining which pre-proposals should be developed into full-proposals, rejecting those that are clearly unlikely to succeed, but for others potentially providing for one round of nurturing/resubmission when appropriate to meet program objectives.
- SESP will evaluate full proposals to identify a select group of the very best proposals to forward to the SEA for scheduling. The 'select group' is initially envisioned to be order of 10 of the very best proposals per year, spanning all major themes of the new science plan if possible but without any strict quotas. The expected number and balance may be adjusted based on implementation and long-range science needs identified by SEA.
- The main proposal evaluations and decisions should be conducted within the thematic subgroups, followed by a plenary review by the whole SESP to identify the group for forwarding to SEA. (It is likely some proposals will span more than one subgroup, in which case the relevant subgroups could join for the review.) The plenary review for defining the 'select group' to be forwarded to SEA should not be a relative ranking by individual ballots as conducted in the current SPC, but should be based more on an absolute merit scale analogous to that used in the current SSEP rating.
- The primary evaluation criteria should include scientific, practical, and societal considerations, including the following:
    - Would the proposal advance the new Science Plan?
    - If not, does it contain cutting-edge new science that should be addressed by the new drilling program?
    - Does the proposal include appropriate multi-disciplinary science?
    - Would the proposal produce results of important societal relevance?
    - Would the proposal engage new communities or other geoscience programs into the new drilling program?
    - What site survey data are available, what new data are needed, and what is the plan for acquiring these new data?
    - Can all the measurements required to achieve the science goals be made?
    - Does achieving the goals require engineering/technology development?
    - Are there potential safety issues with the proposed sites?
    - Are there other operational constraints from IOs' perspectives?
- The practical aspects like site survey readiness, platform-specific issues, *etc*., should be brought into the evaluation process early. Specifically:
    - The SSP assessment of site survey readiness should be much more closely integrated with the SESP review, *e.g*., by shifting the SSP schedule for their meetings to be coordinated with SESP meetings.

    - Technological assessment by STP should be brought in at the stage of nurturing pre-proposals or developing full proposals.
    - Preview by EPSP should be invoked as needed.
    - Operator feasibility analyses should be provided for all full proposals under SESP consideration.
- The thematic subgroups and SESP, as a whole may also provide advice to the Science Executive Authority *via* the SESP chair about any shortcomings in the proposal pool in terms of advancing the new Science Plan objectives and suggested mechanisms for addressing these shortcomings.

iv. Science Executive Function/ Science Executive Authority

Current Situation

- SPC and OTF work iteratively to select drilling science plans on an annual basis, based on strong proposals as described in the previous section. These science plans are developed into annual program plans by IODP-MI, working with the IOs. Before annual program plans are forwarded to the IODP funding agencies, they are formally approved by SASEC, as the SAS Executive Committee, and then the IODP-MI Board of Governors.
- The responsibility for longer-range scientific planning was shifted to SASEC in 2006 when its predecessor, Science Planning and Policy Oversight Committee (SPPOC), was dissolved and SASEC formed in its place (before then, the mandates for both SPC and SPPOC included aspects of long-range planning).
- SASEC has used several techniques for long-range planning, including thematic reviews of performance to date, approving thematic workshops that are then implemented by IODP-MI, and suggesting thematic areas for special emphasis.
- During the 2006 reorganization of SPPOC to SASEC, oversight of policy was removed from SASEC's mandate.

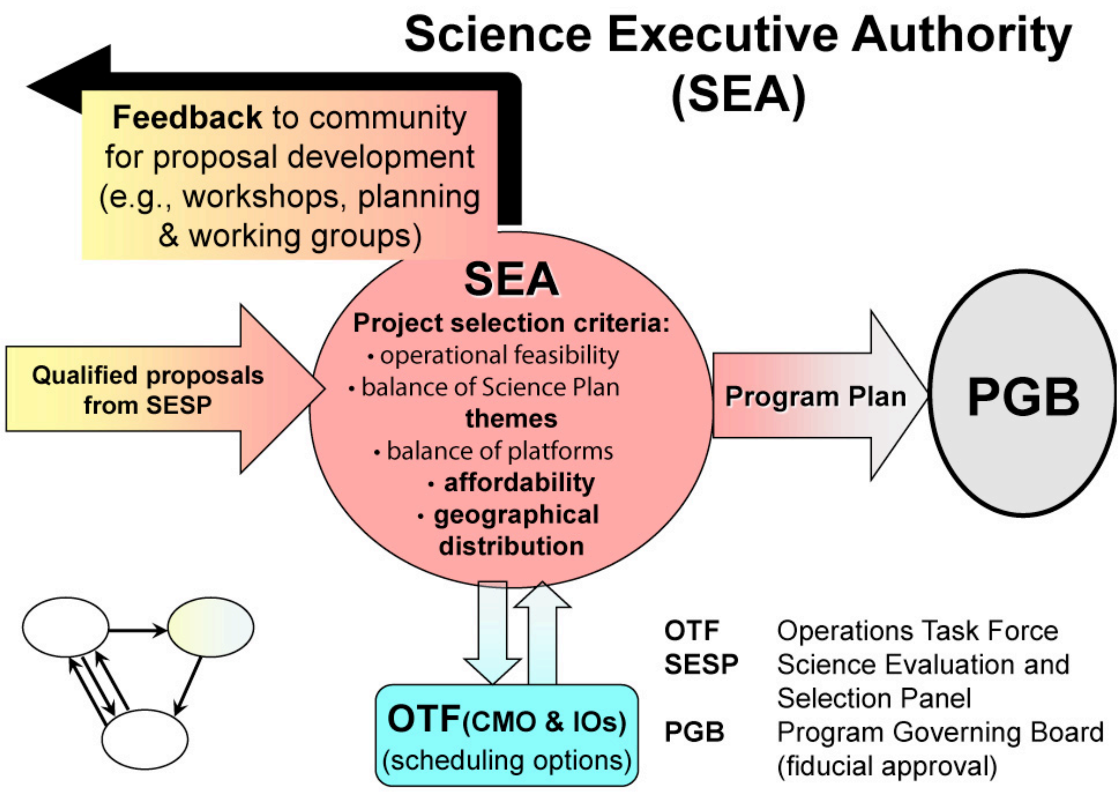


Figure 7. SAS: Science Executive Authority.

Successes of SASEC

- SAS and SPPOC/SASEC have encouraged the international community to develop and submit drilling proposals, and the response has been impressive – 179 IODP proposals to date since the initiation of IODP in 2003.
- Since 2003, SPPOC/SASEC have approved consistently strong annual plans developed *via* SAS, despite major platform operational hiatuses and funding limits.
- SASEC has overseen thematic reviews for the three main ISP themes and supported several important international workshops for IODP objectives.
- In preparation for renewal post-2013, SASEC has:
    - initiated and overseen the very successful INVEST international meeting in 2009
    - formed a strong Science Plan Writing Committee to distill the science plan for the post-2013 program, and
    - endorsed its own plan for a simplified proposal evaluation system for the post-2013 program (as noted elsewhere in this report, the SASEC plan is quite consistent with the plan arrived at independently by the Second Triennial Review Committee).

Criticisms and Perceived Shortcomings

- The overlap in SPC mandate for annual science planning and SASEC mandate for long-range planning has caused confusion and even misperception about the relative roles of SPC and SASEC.

- Despite the successes (above), the nature and effectiveness of SASEC's executive authority are not always clear, given that (a) the annual drilling science programs are developed by SPC and (b) the IODP-MI Board of Governors has fiducial responsibility for approval of the resulting annual program plan.
- Some aspects of strategic long-range planning elements endorsed by SPPOC/SASEC have been poorly received by the rest of SAS and the community, *e.g.*, (a) 2006 endorsement of the mission concept developed by the IODP-MI Management Forum or (b) 2007 identification of a subset of ISP themes for special emphasis through 2013.

Recommendations

- The annual and long-range science planning functions now parsed out between SPC and SASEC should be combined in a single Science Executive Authority (SEA) panel tasked with delivering both annual and long-range implementation schedules as well as identifying gaps in meeting the new science plans or new themes and developing appropriate proposal pressure.
- The membership of SEA should consist of broadly experienced scientific leaders who reflect member participation in both the new program and any corporate central management organization. The chair of SEA should be approved by the board of that central management organization. The chair of SESP should participate, as and *ex officio* member, in all SEA meetings.
- SEA will work closely with and receive strong advisory support from the OTF, the IOs, the central management organization, and the service panels.
- In its decision-making, the SEA will consider criteria such as thematic balance, operational feasibility, affordability, and cost-efficient schedulling, and geographic deployment of ship tracks.
- The annual schedule will be presented in the context of a rolling long-range plan based on existing proposals and pre-proposals to provide guidance for thematic and geographic distribution.
- SEA will provide continual feedback to the scientific community and SESP. The goal is to identify thematic gaps, and alert the scientific community to new areas of research and imbalances in the program. If necessary, SEA should propose workshops, working groups within SAS, or other mechanisms to increase proposal pressure that address the imbalances and new fields of research.
- Early involvement of the IOs, central management organization, and service panels will be required for technological developments that may be needed to support ambitious proposals that will advance the new science plan.

C. Appendix 3c: Role of Service and Operational Panels

The current SAS contains four Service Panels: EDP; SSP; EPSP; STP. Under examination, the following became clear:

- Service Panels provide discrete pools of community expertise that IODP can draw on for advice and analyses.
- The number of Service Panels could be contracted to three as there is currently a duplication of effort regarding engineering development, both as a service panel and as a task force. The foreseen limited budgets for engineering development led to the

conclusion that this could be conducted at the task force level with advice from STP on an as needed basis.

- The STP, with its broader mandate than EDP, should continue to give advice regarding science measurements and technologies on platforms, at repositories, as well as aiding in proposal evaluations. Part of STP's function is to monitor the quality of measurements coming from the IODP platforms and gives advice on how to remedy those measurements that are difficult and/or show spurious results.
- The SSP should coordinate its meetings with the SESP in order to contribute evaluations regarding site surveys in a timely manner, thus speeding up the proposal preparation process.
- The role of EPSP is in evaluating the implementation of proposals for drilling, whereas the SSP is involved at the initial stages of proposals moving through the IODP process. EPSP performs an independent role in ensuring that drilling that is safe both for the platform and the environment.

In the new SAS, the advice from Service Panels should occur at the earliest of stage of proposal preparation. Proponents preparing either pre- or full-proposals should be able to seek this advice. We envisage that the Service Panels would comprise SSP, EPSP and STP.

Service Panels will generally report to IODP-MI, although targeted items can be sent directly to the entities involved (*e.g.*, SESP, SEA, OTF, IOs, *etc*.). Involvement includes addressing the following questions:

- What site survey data are available, what are needed, and what is the plan to obtain these? (SSP)
- Can all the measurements needed to achieve the science goals to be made? (STP)
- Does achieving the goals require engineering/technology development? (STP)
- Are there safety issues involved in drilling the proposed sites? (EPSP)

In addition, there needs to be communication between the Service Panels and the IOs (through IO presence at Service Panel meetings) and the SESP and the IOs to highlight any operational issues or constraints at an early stage of full-proposal development. Such IO-Service Panel interactions are critical in order to bring relevant expertise to bear on giving advice regarding platform- or repository-related issues.

The Service Panels will interact on an as-needed basis with the SEA and the 'OTF Equivalent' over issues pertinent to the panels' relevant expertise. SEA will approve the Service Panel chairs using recommendations from the different panels as a guide.

Service Panel meeting schedules should be closely coordinated with the SESP meetings.

C. Appendix 4: Other issues of relevance and concern

a. On Governance

We conclude from our findings that the current model of a SAS, as formed, supported, and working closely with a CMO, has been viable and relatively successful in providing scientific program governance in the past.

The complexity of the new IDOP science program post-2013 is anticipated to escalate for a number of reasons, including: (a) the imperative to develop science agendas jointly with other research programs, (b) ensuring that specific research topics and milestones are achieved despite fiscally tight and changeable conditions, (c) increased program membership and diversity, and likely, multiple funding sources (*e.g.*, other programs, co-funded proposals), and (d) inevitable demand for improved efficiency in the use of fiscal, human, and material resources (*e.g.*, platforms, lab facilities). New approaches will be required to achieve truly effective overall program governance in the future.

The degree to which a SAS can help maximize scientific impact and achievement of milestones from the US $200 M+ annual cost of the new drilling program will depend strongly on an overall program governance structure that emphasizes excellence, transparency, and fiscal efficiency. This will not only help to maximize use of existing resources, but is a prerequisite for long term trust and support of the program by funding agencies and other funding entities and, eventually, to earn and retain the support of scientists to make it a career priority.

The Committee has concluded that presently there is a lack of clarity about governance and decision-making processes for IODP as a whole. Correspondingly, we would submit that a quality and streamlined SAS will not produce effective outcomes in the absence of an effective and transparent system of governance. Clarification of the roles and mandates of the Funding Agencies, Council, and Board of Governors, and their respective interfaces with the CMO (IODP-MI) and the SAS, needs urgent attention.

A straightforward, transparent 'chain of command' is a prerequisite to achieving these goals. The SEA establishes programmatic science priorities, long-term planning and other scientific and technical priorities; the CMO (IODP-MI) supports and facilitates implementation of a technically and fiscally feasible Program plan. What is required is a mechanism to provide clearly articulated strategic and financial oversight and formal approval and sign-off. As such, the responsible delegates from the funding agencies should develop, specify, and communicate a more unified, and ultimately accountable, overarching governance entity (Program Board? Council?) with clearly-defined responsibilities, including overall Program performance monitoring, international representation, and reporting responsibilities.

It is envisaged that this 'Program Board' would therefore have responsibility, *inter alia*, to:

- set the long-range budget goals, and provide annual, concrete budgets for the entire program;
- approve the overall scope, goal and structure of the program including its fundamental Science Plan;
- receive and approve annual plans that meet the budget guidance for the entire Program;
- require reviews of Program performance (at all levels/entities), as deemed necessary; and
- require updates of the Science Plan, if reviews find it out of date, or otherwise subject to change (for example, a five years review could be 'hard-wired' in from the beginning)

This governance entity will be accountable, in the first instance, to the funding agencies that entrust the program with their support, maintaining oversight to ensure science quality and efficiency and the most effective use of program funds, material, and intellectual assets.

This body would furthermore be accountable to both the scientific community that is the source of science proposals, scientific capability and capacity to do the science, and which additionally provides critical contributions of laboratory services and research time; and finally, to society-at-large and its tax payers, which underpin the support of the scientific enterprise.

b. Funding difficulties

The IODP ISP and its implementation sections were drafted when the vision was for full-time operation of both IODP drill ships and at least one major mission-specific platform expedition per year. Available funding has not been sufficient to fulfill that vision, and the situation was compounded by substantial delays in bringing *Chikyu* into IODP service and the refurbished *JOIDES Resolution* back into IODP service after dry-dock. The net result has been:

- limited availability of IODP platforms for about half to two thirds of the originally anticipated drilling time, and
- limited support for ambitious, innovative, yet expensive programs, such as those requiring observatories or major casing investments.

Despite this reality, IODP has succeeded in drilling exciting and truly excellent scientific programs, but with inevitable inefficiencies owing to partial operations and scheduling inefficiencies (*i.e*., long transits). Funding limits are expected to continue through 2013 and possibly into the new post-2013 program, so more effort will have to be done in planning IODP operations at the SAS/OTF level to minimize inefficiencies and maximize the scientific output of the new program. A longer-term scheduling view should be taken in order to minimize expensive transits and maximize use of the drill ships along any necessary transits. When appropriate, SEA should consider projecting long-term ship tracks (especially for *JOIDES Resolution* but potentially for *Chikyu*) well in advance so that the best possible proposals (and APLs) can be developed to maximize IODP scientific output along those ship tracks.

c. Metrics and publications

There are three sets of scientific products published and distributed by the current IODP and past scientific ocean drilling programs. These are as follows:

1. The first are the Scientific, Thematic and Operational Reviews prepared by IODP-MI in cooperation with the co-chief scientists, technical experts and review committees from each drilling expedition. These systematic reviews of expeditions and scientific achievements provide important management tools for ensuring the success of future expeditions and program goals set by IODP ISP. Although publicly available (http://www.iodp.org/spc/; http://www.iodp.org/trc/; http://www.iodp.org/ortf/;) these reports are not published in the reviewed literature. The reports include:
    a. SPC Expedition reviews: The SPC conducts an initial scientific review of each IODP expedition which is followed by the co-chiefs' report to the SPC 18 to 20 months post expedition and forms the basis of the second-phase of science review. Completed expedition reviews are available at http://www.iodp.org/spc/.
    b. IODP-MI Operation Review: IODP-MI Operations Review Task Force conducts operational reviews of IODP Expeditions. The Task Force review is based upon confidential reports submitted by the IO and expedition co-chief scientists. These operational reviews focus on 'lessons learned' and "*how do we do things better in the future?*" Areas of discussion include pre-expedition planning, expedition drilling operations, communications between scientists and operators, roles and

responsibilities of scientists and operators, general procedures and policies (*e.g.*, curation, communications), laboratory operations, *etc*. Each of these operational reviews results in recommendations that are compiled into a short summary report that is posted on the IODP website (http://www.iodp.org/ortf/).

c. IODP-MI Thematic Review: IODP-MI chairs thematic review committees with members from the scientific community (nominated by SASEC). The reviews evaluate progress achieved in relation to major scientific themes and goals stated in the ISP. Reviews are based on a number of expeditions that address a common theme, and normally emerge 2 to 3 years after the expeditions have been completed. Reviews also provide brief comments on planned activities in order to assess how certain themes and program goals eventually might be achieved. Completed thematic review reports are available under http://www.iodp.org/trc/.

2. Serial monographs published over the course of the successive scientific ocean drilling programs which incorporate the scientific and technical results of each expedition and capture the data resources collected and archived for each drill leg. Summary scientific reports (peer-reviewed) are published in the journal *Scientific Drilling* published by IODP-MI with ICDP.

3. The third are the formal contributions published in the reviewed literature:

   a. IODP-MI is currently working to improve the mechanisms whereby metrics of the publication record of the ocean drilling programs can be readily available in an easily accessible and timely fashion. Access to such a record is of critical importance for scientific research, informing the scientific community at large and advising funding agencies and those with political oversight of the value of the program. The publication record is also of critical concern when making arguments for renewal of the program and for reviews conducted by national funding partners. Information that is currently available indicates that IODP-MI has:

      i. registered for CrossRef 'Cited-by Linking Service' for tracking citations of IODP publications in the open literature. Until recently, 'Cited-by Linking' was only available for peer-reviewed journals and was therefore not available for IODP publications. With the inclusion of monographs to the CrossRef Cited-by Linking Service offerings, IODP hope to soon be able to fully analyze the ways in which IODP publications serve as citations in scientific literature, and

      ii. contracted with the American Geological Institute (AGI) to use the GeoRef Service to provide an Ocean Drilling Citations Database of articles related to DSDP, ODP and IODP. These articles include IODP publications and open literature publications in which DSP, ODP and IODP sites, samples or data are referenced in the reviewed literature.

      iii. The following data give a preliminary sense of scale for the IODP-related-publication record:

         - as of 2010, more than 25,000 ocean drilling-related publications have been published,
         - from 1 January, 2000 to 31 December, 2009, 7,390 of the 25,000 publications were published, and

- more than 1,500 articles that feature IODP research have been published in highly regarded journals like Nature and Science. A preliminary assessment indicates that at least 40 of these publications can be uniquely related to IODP expeditions. It almost exclusively represents efforts between 2003 and 2006.

With their oversight responsibility for the health of the science component of the program, SEA should quantify the data mix of publications that are needed to fully document and publicize the scientific record of the ocean drilling programs. These range from the development of science plans and workshop reports, to operational records, serial monographs of expedition results to formal publications in refereed journals.

Notwithstanding the importance of publication-related materials as a key indicator of scientific excellence and productivity, the Committee would also wish the SEA to reflect more broadly on key metrics, including those related to 'societal impact'. At present, we observe a notable absence of quantifiable metrics of success, to facilitate overall Program performance evaluation. In this context, we should note the future pressures on Funding Agencies to balance world-wide sensitivity towards greater emphasis on 'relevance' and 'impact', and not solely 'scientific excellence'. In an increasingly competitive environment for 'big ticket' funding, if we don't migrate this way, IODP may struggle financially. Meaningful outcomes of societal relevance and impact are likely to become increasingly critical, with effective education and outreach an important priority. Substantially improved communication of IODP results to the broader scientific, political and business communities, school children, and the general public, will enhance the longevity and effectiveness of the IODP.

We recommend that, with their oversight responsibility, the SEA should develop appropriate measures of success, e.g. advancement of the Science Plan, journal publications, young scientist engagement, measures of societal impact, etc. What is needed are quantifiable metrics that will help IODP evaluate success in communicating its science and relevance to the broader constituency. In cooperation with the PGB, CMO and IOs, SEA must help define the measures that ensure the engagement and support of these constituencies. SEA's critical role is to encourage scientists to be an integral part of explaining their discoveries in the context of relevance to, and educating an interested public.

d. Conflict of Interest Policy

The current COI guidelines identify the overarching goal as:

"*The objective of the COI policy for the SAS of the IODP is to minimize both real and perceived conflicts of interest while maintaining the fullest possible involvement of knowledgeable scientists in providing scientific and technical advice to the program*."

Responders to the questionnaire and the 2nd Triennium Committee agree that the current application of COI rules is too restrictive, particularly at the SPC level. The result is to deprive the panels of critical expertise. The overly strict application of the COI rules is particularly problematic for national partners with smaller scientific communities.

We endorse the support for application of the following guidelines for all SAS panels:

- At the outset of each meeting, all possible types of conflicts should be openly declared and recorded.

- Using the IODP COI guidelines as a basis, the chair(s) should evaluate the conflict and set a policy on how to manage the conflict on a case-by-case basis. The basis for each decision should be recorded in the minutes of the meeting.
- Proponents with a COI may not be present when any aspect of their own proposal is being discussed.
- Proponents with a COI may be present for the discussion of other proposals; comments should be restricted to the scientific and technical merit of the proposal.
- Proponents with a COI may not vote on any decision where his/her proposal is in the group of proposals being considered.
- The same guidelines should be uniformly applied for all SAS committees.

Our recommendations are very much in line with current IODP COI policies. The one area where the current policies are more restrictive is treatment of watchdogs in SPC – "*No proponent with a COI may be a watchdog on any proposal*". This contrasts with the policy set for SSEP.

Current IODP COI policies should be uniformly applied to all SAS panels. Critical to the application is the transparent declaration and recording of any conflicts and how conflicts are managed. Panel chairs should be given authority to evaluate and manage conflicts in the context of IODP policies and panel needs. Strict limits should be placed on any conflicted panelist from participating on any discussion relating to proposals where they are a proponent.

e. Other science programs

Integration and cooperation with other science programs has always been a mantra of the ocean drilling programs. Reports such as those from COSOD, COMPLEX, IODP ISP and INVEST endorse this perspective. It is apparent that the science needed to understand the interacting Earth systems is contributed by many disciplinary and organizational communities. Illustratively, in order to fully understand a number of the different research foci identified in the INVEST Report, such topics as: the Extent of Life on Earth, Geo-hazards-Exploring the Future, Anticipating the Transition to a high pCO_2 World, Extreme Events, African Climate and Human Evolutions, and Climate-Tectonic Linkages and Feedbacks, all need the participation of science communities from other disciplines and programs. The ocean drilling programs have been particularly successful in making the oceanic record a critical part of earth systems research, both in terms of understanding history and processes. However, the interests of the new science constituency IODP will serve have evolved and expanded significantly from the initial focus on using ocean cores to study the history and evolution of the oceans. This changing emphasis is more indelibly outlined in the new Science Plan which selects two and possibly three themes: (1) Limits of Life: Deep Life, Extreme Environments and External Forcing, (2) Earth in Motion: Sub-seafloor observatories and (3) Earth's Climate System[s]: Gradients, Linkages and Sensitivity, that deal with active processes that govern the behavior of complex interacting earth systems; an intellectual expansion beyond the more traditional scope of the ocean drilling community. Corresponding to the conceptual change there will be a parallel expansion of participating scientists from other disciplines who have traditionally worked with other programs.

Previous cooperation with other programs has been on an 'as need' basis where science goals have overlapped into other shared interests. The new science plans now call for a more formal integration of the new population of scientists whose interests and skills extend beyond those that currently support IODP. Importantly, the SAS structure needs to ensure that the new research community is appropriately represented in all stages of the SAS process. IODP needs to be more inclusive and solicit their support and help.

f. Site Survey concern

The IODP Initial Science Plan envisioned a strong supporting program of pre- and post-drilling site surveys. However, the limits on overall available funding have resulted in a situation in which acquisition of the necessary site surveys is often a critical limiting factor in actually scheduling proposals that have been vetted by SAS as high in scientific and programmatic priority. As in ODP, it generally remains the responsibility of proponents and national funding agencies to implement necessary site surveys, and often a high rating by SAS of a drilling proposal is a necessary prerequisite for justifying funding of site surveys. This has been recognized by SAS, IOs, CMO and agencies as an issue, and all have worked to overcome it. An important aspect of the recommended proposal evaluation process in SESP is identification of a fairly selective set of high priority proposals earlier in the process, and this should help in early identification to the funding agencies of the most important site surveys for financial support.

g. Electronic communication

Use of electronic media (e-mail, teleconferences, and video-conferences) should be encouraged in order to:

- Facilitate efficient use of face-to-face meeting time;
- Disseminate reports, minutes and background information between meetings;
- Construct meaningful agendas;
- Provide rapid feedback to IODP-MI, IOs, SESP, etc.

It is important to note that electronic media cannot replace face-to-face meetings. For example, meaningful debate on a subject is not efficiently undertaken via e-mail between groups of people. E-mail can lead to misunderstandings and require lengthy correspondence in order to obtain clarifications, especially when several time zones are involved. It is the recommendation of this review panel that electronic media be used to enhance face-to-face meetings rather than replace them. IODP-MI should also have the ability to facilitate teleconferences and video conferences on an as needed basis by the SAS.

h. CO_2 emissions: Carbon footprints

The carbon impact of the SAS meeting schedule is a legitimate concern for responsible management of IODP. The SAS provides guidance for the most effective scientific use and implicitly the carbon footprints of the drilling platforms. A simple analysis suggests that the largest gains can be achieved by an active SAS that can minimize hugely wasteful transit times, especially those associated with the peripatetic nature of expeditions on the *JOIDES Resolution*. Indeed, avoiding just a few days of *JOIDES Resolution* transit per year more than compensates for the carbon footprint of practically the entire SAS meeting structure.

What is the carbon footprint of the JOIDES Resolution?

The carbon footprint of the *JOIDES Resolution* depends strongly on whether it is in transit when it consumes ~40 metric tonnes (mt) of fuel per day or when on station at ~ 15 mt fuel per day (see attached JR fact sheet). Daily consumption of 40 mt (*i.e.* 40,000 kg) of diesel fuel (density 0.85 kg/L) is equivalent to 47,000 l/day whereas daily consumption of 15 mt is equivalent to 17,650 L/day.

Parenthetically, at a nominal transit speed of 10.5 knots (1 knot=1.852 km/hr), the *JOIDES Resolution* would cover a distance of 466 km in a 24-hour day with an average fuel consumption of ~10000 L/100 km (or nearly 2000 liters per hour). (For comparison, a big car like a Hummer consumes fuel at something like 15 L/100 km.)

Assume that diesel fuel produces 2.68 kg CO_2/L (*e.g.* see attached table from an Exeter University (UK) website); thus, the carbon footprint of the *JOIDES Resolution* in transit mode is ~126,000 kg CO_2/day, nearly 3 times higher than ~47,000 kg CO_2/day while producing science in station mode. Long transits clearly should be minimized.

What is the carbon footprint of travel for SAS meetings?

According to various carbon footprint calculators, round-trip air flights produce CO_2 at rates that range from 100 kg CO_2 to ~2,000 kg CO_2 per person; let's assume an average 1000 kg CO_2 per person per round-trip. If the SAS has ~150 members, the carbon footprint for all to attend one meeting would then be 150 mt CO_2. This is roughly equivalent to the carbon footprint of a little over 1 day of JR transit. Avoiding just a few days of JR transit per year should be a high priority for the SAS.

i. Technological Developments and Innovations

IODP Future Technological Developments and Innovations (3c of the Executive Summary)

The current EDP and STP have independently developed roadmaps for engineering/technology development. While there are distinct differences between these roadmaps, there are also commonalities. By the end of the next program, progress on increasing core quality and core recovery should have been made. Focusing on these fundamental aspects of drilling for the new program will lead to an increased impact of IODP science. New innovations would have been in the areas of:

- Minimizing core disturbance.
- Recovery of hard/soft intervals (chert-chalk; lava flow boundaries; fault zones, etc.)
- Oriented Cores
- Aseptic sampling of cores

Technological innovations would include:

- Enhanced core recovery:
    - Thin-walled, short-stroke Shelby tube samplers;
    - Sea bed frames;
    - Riser-less mud recovery system;
    - Sidewall coring;
    - Motor driven core barrel;
    - Pressurized coring with temperature control (*e.g.*, gas hydrates, carbon capture, marine microbiology);
    - Anti-contamination coring for microbiological sampling;
    - Thin walled geotechnical sampler.

- Minimize core disturbance:
  - Extended Punching Coring System and the Extended Vibration Coring System;
  - Ultrasonic coring techniques.
- Oriented Cores using:
  - Secondary magnetization;
  - Characteristic remnant magnetization;
  - Tensor Tool;
  - Automated matching of bore hole patterns with core surface images;
  - Combining core scribing with the Tensor Tool.

In order for this vision to occur in light of constrained budgets, targeted developments need to be defined at the outset of the new program. It is suggested that technological developments have a goal (*e.g.*, improving core quality and recovery on all platforms) and have a small number of significant technologies that limited funds could target for implementation. Such development could be overseen by an Engineering Task Force and/or STP.

D. Figures and Tables

E. Resources

1. Transition Summary: ODP to IODP, and IODP to new ODP
2. Proposal Statistics
3. Technological Innovations
4. SASEC: report to SAS/SPC, 2004
5. First Triennium Review (US FY2004-FY2006)
6. Report of the Integrated Ocean Drilling Program Management International *ad hoc* Committee (December 2008) (*ad hoc* Report)
7. SASEC/SAS-Working Group (2007)
8. Other reviews currently being prepared
9. Questionnaire
10. Responses to Questionnaires
11. INVEST preliminary report
12. ANZIC Governing Council Review and 2nd Triennium Committee response
13. IODP Conflict of Interest Policy

All resources are available at http://campanian.iodp-mi-sapporo.org/Meetings/2ndTRC/

login: SAS

password: iodpSAS

F. Acronyms and Abbreviations

AGI	American Geological Institute
AGU	American Geophysical Union
ANZIC	Australia-New Zealand IODP Consortium
APLs	Ancillary Project Letters
CDP	Complex Drilling Proposal
CDEX	Center for Deep Earth Exploration
CMO	Central Management Office
COI	Conflict of Interest Policy
COMPLEX	Conference on Multiple Platform Exploration of the Ocean
COSOD	Conference on Scientific Ocean Drilling
CrossRef	http://www.crossref.org/
DSDP	Deep Sea Drilling Program
ECORD	European Consortium for Ocean Research Drilling
EDP	Engineering Development Panel
EGU	European Geoscience Union
EPSP	Environmental Protection and Safety Panel
ESSAC	ECORD Science Support and Advisory Committee
GeoRef	comprehensive database in the geosciences
ICDP	International Continental Scientific Drilling Program
INVEST	New Ventures in Exploring Scientific Targets
IODP	Integrated Ocean Drilling Program
IODP-MI	Integrated Ocean Drilling Program Management International
IOs	Implementing Organizations
IRIS	Incorporated Research Institutions for Seismology
ISP	Initial Science Plan
IWG	International Working Group
J-DESC	Japan Drilling Earth Science Consortium
JOIDES	Joint Oceanographic Institutions for Deep Earth Sampling
MEXT	Japan's Ministry of Education, Culture, Sports, Science and Technology
MSPs	Mission Specific Platforms
NSF	National Science Foundation
ODP	Ocean Drilling Program
OOI	Ocean Observatories Initiative
OTF	Operations Task Force
PCOM	ODP Planning Committee
PGB	Program Governing Board
PIs	Principal Investigators
PMOs	Program Member Offices
SAS	Science Advisory Structure
SASEC	Science Advisory Structure Executive Committee
SEA	Science Executive Authority
SESP	Science Evaluation and Selection Panel
SPC	Science Planning Committee
SPPOC	Science Planning and Policy Oversight Committee
SSEP	Science Steering and Evaluation Panel
SSP	Site Survey Panel
STP	Scientific Technology Panel
TSP	Technical Service Panels
USAC	U.S. Advisory Committee

Integrated Ocean Drilling Program Management International (IODP-MI)

Response to the Second Triennium Review (US FY2007-FY2009)

To: Jamie Allan and Takashi Nakagawa
RE: Report of the Second Triennium Review Committee of the IODP-MI

The Second Triennium Review (FY2007-2009) focused on examination of the effectiveness of 1) the IODP science planning process and 2) the SAS service panels in aiding the technical capabilities and functionalities of the IOs. The Review was to be made within the context of current financial, legal, logistical, technical, and operational realities and help focus discussion for post-2013 scientific drilling.

We are pleased with the positive findings of IODP by the Committee and will further endeavor to strengthen these merits. The Committee identified 4 key challenges for IODP and the new Program. We are encouraged by the conclusions of the Committee and we totally agree with the "three sentiments" to prevail in the proposal to drilling process of SIMPLIFICATION, ENHANCED COMMUNICATION and TRANSPARENCY.

We appreciate all the penetrating comments and recommendations to improve ourselves for better efficiency and more science with focus and ambition. We refrain from commenting on Appendix 4: other issues of relevance and concern. These are indeed critical issues that we must face and we will cooperate with appropriate mechanisms to resolve these issues such as at IWG+ and Board meetings of IODP-MI.

Key Recommendations (full descriptions are in the original Report Appendix 3)

Three functional groups of SAS: (1) Community building and proposal development function; (2) Science evaluation and selection function; and (3) Science executive function.

We agree the three identified functions to be vital for present and future SAS.

(1-a) Community building (Senior scientists to graduate students) i) Workshops, ii) training, iii) working groups, iv) distinguished lecture program, v) link with other programs.

We believe i) and v) are the particular items that IODP-MI should be leading the efforts, while IODP-MI will be encouraging and supporting other items to be conducted by individual IODP Members. Workshops to directly involve other geoscience programs is not an unexplored arena and we are confident to expand the scope in this direction as well as engaging younger generations.

(1-b) Proposal development function i) Reference to New Science Plan, ii) proposal evaluation criteria, iii) roles of SESP and SEA, iv) on-line help, v) integration with other programs early in the process, vi) encourage diverse proposals, vii) nurture promising pre-proposals, viii) promote and organize workshops, ix) working groups, x) joint evaluation with other relevant programs, xi) address emerging science

(iv) We recognize the importance of lowering the barrier for first-comers to be able to easily dive into IODP. (v) We will work with PMO to engage national and international programs to participate in development of pre-proposals. (viii) This is the new focus to generate crosscutting proposals and conduct best science possible. (ix) We think this concept is similar to the concept of the PPG (program planning group) in ODP to identify and advice on emerging science and technology. Together with (xi), this should function as a good stimulus to the science community.

(2) Science evaluation and selection (SES) function.
(i) Simplify the structure, (ii) integrate evaluation of site survey and technological feasibility with SES process, (iii) streamline evaluation process to make decisions more quickly, (iv) invest in more community development for multi-expedition and riser proposals.

Most of these recommendations are being implemented by the present SAS and IODP-MI, which encompasses all the specific recommendations. (iv) We cannot agree more with the importance of this point.

(3) Science executive function.
(i) SPC and SASEC to be combined, (ii) membership of broadly experienced scientific leaders, (iii) support from OTF, IOs, CMO and service panels, (iv) decision-making criteria, (v) rolling long-range plan, (vi) propose workshops and working groups, (vii) technological developments for ambitious proposals

The present SAS with IODP-MI is already in the process to respond to these recommendations. New Terms of Reference are being developed by SAS with IODP-MI and we set timelines for transitioning into the new SAS scheme agreed by the SAS. (iv) The recommended criteria including geographic ship tracks have not been explicit in the present SAS. Implementing these will help IODP-MI support the planning process in optimal and efficient manner.