Evergreening Peer Review
Business Process Modeling (BPM)

On behalf of the Peer Review Subject Matter Experts, this report is submitted to document the process, findings, and recommendations of the BPM process undertaken to model the current business process of peer review from the perspective of the Scientific Review Officer. Existing extension systems, areas for improvement, and sample metrics are provided.

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EXECUTIVE SUMMARY

- The NIH peer review system is the foundation of the NIH extramural research enterprise. Its continued excellence depends on maintaining the core values of peer review to provide fair, equitable, and objective examinations of applications by experts (peer reviewers) in the field of endeavor for which support is requested[1].
- The peer review community has experienced the evolution of many business challenges to their work over the last 10 years; major changes have included an increase in the volume of grant applications; complexities that result from the nature of collaborative science, and aggressive implementation of major process changes, including electronic submission of most grant applications and major policy changes through the Enhancing Peer Review initiative (e.g., templates for reviewer critiques; new scoring system).
- As Peer Review policies and practice change, the support information systems must be appropriately responsive.

This report describes the strategic approach to develop a comprehensive business model of the peer review process and to identify opportunities to improve the supporting information technology infrastructure so that high quality reviews continue to be produced with optimized efficiency.

APPROACH AND DELIVERABLES

The NIH Electronic Research Administration (eRA) provides the electronic information systems that NIH and its eRA partners, Administration for Healthcare Research and Quality (AHRQ), Centers for Disease Control (CDC), Food and Drug Administration (FDA), Substance Abuse and Mental Health Services Administration (SAMHSA), and the Veterans Administration (VA), use in support the grant lifecycle. NIH has adopted a long-term strategy that couples ongoing maintenance of the various eRA modules with a periodic, in depth re-engineering of each module. The business process model is developed by users and includes their input on prioritization of the needs and opportunities for improvement.

The user group (n = 56) for the peer review BPM included primarily SROs with representation from the extramural support and Committee Management staffs. A minimum of twice-weekly meetings were held February through July 2010, contributing in total well over 4,000 hours of experience and expertise. The model comprehensively represents the current review processes, including supporting technologies at an NIH enterprise level and IC-level extension systems. To improve efficiency and data quality and reduce cost in the peer review process, general areas for improvement, specific pain points, and missed opportunities are identified.

The team produced two models; one encompasses the purposes of the peer review activities and one that depicts the peer review activities workflow.

[1] NIH Policy Manual, 4204-204B, 7/12/06, http://oma.od.nih.gov/manualchapters/grants/4204-204B/

Purpose Model: The highest level purpose (activity) is to obtain an objective and fair scientific and technical merit (peer review process). The team decomposed this high level activity into five major, purpose-based activities that span the review process and comprise its core values:

- Establish the peer review meeting
- Manage the applications assigned to the meeting
- Manage participants (reviewers, applicants, and NIH staff)
- Obtain the reviewers' scientific and technical merit evaluations
- Manage integrity of the review process

Workflow Model: Represents the temporal sequence of activities (what actions must be done sequentially and what can be done in parallel). This model captures the inputs and outputs to each activity as well as personnel, roles, resources and technologies.

In addition, a dependency matrix of activities vs. inputs/outputs and a glossary are ancillary products as aids in using the model.

FINDINGS AND RECOMMENDATIONS HIGHIGHTS

The analysis found no basis for eliminating specific review activities or altering the general sequence of review activities. In some cases policy changes could be introduced but these were not considered to be the highest impact opportunities. Thus, the workflow model was updated to provide more detail and to incorporate new review modes (multistage, virtual, etc.). This model was then analyzed for "pain points". The major opportunities for improvement within the workflow that were identified for highest potential impact included:

- Analyzing the content of applications (both scientific content as well as involved individuals/institutions)
- Scheduling meetings (calendaring software)
- General IMPAC operations (downtime, slow performance, and lack of documentation and training)
- Identifying qualified reviewer pool and facilitating best match of reviewers to applications
- Critique templates that are more user friendly for both reviewers in composing and submitting their critiques and for staff in assembling and finalizing summary statements

The project team also analyzed a variety of extension systems and tools developed and supported by individual ICs. These systems have features and functionalities that could be leveraged to inform development of enterprise-level improvements. A major additional benefit of BPM is the facilitation of enterprise strategic planning since improvements have been identified by a cross-section of users and quantified with metrics to aid eRA in prioritizing the business case[2] and providing an objective approach to assessing areas of highest impact for users.

[2] Business decisions to be developed by eRA are approved through the NIH governance processes.

The recommendations herein represent opportunities for NIH to increase the efficiency of peer review and support the continued scientific credibility of the process using improved approaches to information management.

The specific goals of BPM are to identify opportunities for improvement in quality, consistency, transparency, and reproducibility of peer review processes and staff effort. The project team identified various core technologies to address the pain points above:

- Text mining and content analysis
- Scheduling software
- Secure communications
- FOA-configured templates

These are high- impact improvements expected to result in increased efficiency in the management of the peer review process, maximizing scientific credibility, speeding processes, and lowering the risk of flawed reviews.

I. OVERVIEW OF PEER REVIEW BPM PROCESS

INTRODUCTION AND BACKGROUND

Integrating and leveraging the knowledge of experts in the NIH extramural community, eRA has embarked on a major initiative to modernize the eRA grants processing technology, specifically, the IMPAC (Information for Management, Planning, Analysis, and Coordination) modules. The BPM effort started with a pilot in 2007 - 2008 led by Dr. Paul Sheehy, eRA, and OCITA (Office of the Chief IT Architect) working with small team comprised of expert users in the Division of Receipt and Referral (DRR), Center for Scientific Review (CSR), to determine if the current Receipt and Referral IMPAC module was optimal and if changes could be identified to improve the processes. This initiative has identified and prioritized changes and currently (2010) it is in the design/requirements phases for implementation of these changes.

Extending this approach beyond Receipt and Referral, it was decided to next focus on the Peer Review module. In terms of grants processing workflow, peer review is the next logical step after the receipt and referral of grant applications. The flow diagram illustrates a simplified path of an application from receipt of an application to its assignment to CSR or an Institute/Center (IC) for review. The DRR assignment process utilizes the Receipt and Referral (RR) IMPAC module. Once assigned, the application or application-related information is available in the Peer Review (REV) module and Committee Management (CM) modules. The availability of the application in the REV/CM modules marks the start of the business process model of peer review.

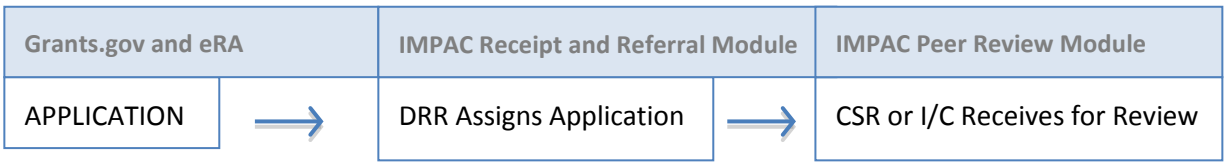


Figure 1: Simplified path from receipt of a grant application to its assignment to an NIH IC for review.

Compared to R&R BPM, Peer Review involves an order of magnitude larger scale in terms of users (<20 professional staff for R&R vs. >>500 for Review) and functionality and with a greater degree of acceptable variation in practices. “This approach is an exciting one, since it is not a temporary patch but a long-term strategy to ensure the extramural program and IT support remain effective and efficient,” said Mr. Oliver ‘Pete’ Morton, Acting Director of the Office of Research Information Systems (ORIS) that oversees eRA operations and programs. “It is important to note that this effort was not led by IT people, but the extramural community.”

In addition to the BPM process described in this document, the overall modernizing effort has included a major hardware infrastructure upgrade that eRA completed in May 2010. Another major focus is to evaluate the design of the software infrastructure with the goal of making it more flexible, reliable, and easier to maintain. These major projects are coupled with rebuilding the specific modules, which is expected to establish a solid systems foundation that should well serve the extramural community into

the future. “The goal is to deeply embed the concept of continuous improvement in information technology (IT) systems that support the business process. The approach is to take a fresh look, one area at a time, of the end-to-end extramural business processes to identify beneficial improvement. Then, after each area is examined, refresh the supporting IT systems, incorporating changes needed for the business process improvements.” This report has three major sections:

I. OVERVIEW OF PEER REVIEW BPM PROCESS

II. RECOMMENDATIONS AND FINDINGS

III. APPENDICES

The first section details changes to the Rev BPM process in order to accommodate the greater scope of stakeholders and associated activities. As Evergreening progresses to other eRA modules of comparable scope, this may serve as a reference for subsequent Evergreening efforts. The second section describes the actual finings from the BPM process, identifies priorities, and surveys IC extension systems for lessons that should be considered by the Enterprise system. The appendices present data used in the BPM analysis.

DELIVERABLES

This white paper describes the approach used to comprehensively document the current peer review business processes and collect metrics to aid in prioritizing areas for improvement in the development of the future-state business processes. In addition, detail is presented to describe the management of the process, including incorporation of input from the large, representative group of subject matter experts (SMEs) who were essential to optimizing the deliverables. The increased scope of the Peer Review evergreening effort necessitated many changes to the process piloted for RR because of the much larger user community and variety of policy and practice. Accordingly, this paper describes the approach taken to ensure representative input from the peer review community and how to manage the input from a large group. This report details the BPM effort for the Review IMPAC module, including process, findings, recommendations, and supporting material[3]. The deliverables of the evergreening peer review effort will be discussed in this document and include:

- **Models**, user-developed and verified: the models constructed in such a way as to stand the test of time (e.g., as jargon-free as possible; capturing all formats currently being used such as typical meetings, editorial board review, applicant interview, site visits, etc.). Models 1) better define the BP for eRA Systems Architects; and 2) support and direct fine-grained needs analysis by developers. There are two types of models:
    - WHAT model: captures the activities that, if accomplished, support the identified purpose.
    - HOW model: captures the purpose-based activities into an activity-dependent work flow in an “as-is” model that is then modified to include “to be” ideas contributed by the user community.

[3] Although examples of the model are provided in this report, not all deliverables can be included in the report; the models, the glossary, and the dependencies matrices formats are not amenable to the constraints of a Word document, but are available for viewing on the Sharepoint site, http://enterprisearchitecture.nih.gov/ArchLib/AT/BA/GrantsPeerReview.htm.

- **Areas needing improvement as identified and prioritized by the user community**
    - Prioritization based on business case of general areas that would have high impact if addressed (e.g., text mining an application to identify needed expertise)
    - Identification of specific “pain points” in the business process
    - Identification of missed opportunities such as IC-specific extension systems and how to interface those that are especially useful at an NIH enterprise level
- **Dependency Matrices**
    - Level 4 activities on the “y” axis
    - Inputs/Outputs on the “x” axis
    - Easy cross reference to find which inputs/outputs are associated with each activity; or, looking at it another way, the inputs/outputs across activities.
- **Glossary**
    - Defines all terms in the model, introduces standardized usage across the model (e.g., “Review Chief” to indicate the review unit supervisory position)
    - Includes terms that may not be in the model per se, but are directly relevant to understanding the model
    - Provides authoritative URL-linked references that can be used to obtain more information

OVERVIEW OF PEER REVIEW

NIH policy is intended to ensure that grant applications submitted to the NIH are evaluated on the basis of a process that is fair, equitable, timely, and free of bias to yield research results with the highest value to the American people. The NIH dual peer review system is mandated by statute in accordance with section 492 of the Public Health Service Act and federal regulations governing "Scientific Peer Review of Research Grant Applications and Research and Development Contract Projects" (42 CFR Part 52h). In addition, the Federal Advisory Committee Act (FACA) also applies to Peer Review.

A Scientific Review Group (SRG) composed primarily of non-federal scientists who have expertise in relevant scientific disciplines and current research areas carries out the first level of review. IC National Advisory Councils or Boards perform the second level of review. Councils are composed of both scientific and lay members chosen for their expertise, interest, or activity in matters related to health and disease. With some exceptions, only applications that are favorably recommended by both the SRG and the Advisory Council may be considered for funding. The two levels of NIH peer review have different emphases and groups of consultants[4]. The first level recommends applications based on evaluation of scientific and technical merit and second-level recommendations are based on scientific merit (as judged by the peer review group) and the relevance of the proposed study to an institute's programs and priorities. This BPM focuses only on the first level of peer review.

BUSINESS CHALLENGES

The peer review community has seen the evolution of many business challenges to their work over the last 10 years, including

[4] For more information and details, see http://grants.nih.gov/grants/peer_review_process.htm.

- Increase in volume of grant applications, which together with funding constraints has progressively reduced the success rate of applicants. This has resulted in increased pressure on applicants and created a need for a faster process while maintaining expectations that reviews continue to be thorough, fair, and objective and that the scientific mission of the NIH and associated OP/DIVs is advanced.
- Numerous consortia, multiple principal investigator applications, roadmap and other trans-NIH initiatives emphasizing translational, transformative, and multidisciplinary science characterize the highly collaborative nature of science, which adds complexities to the review work flow in identifying conflicts of interest, obtaining appropriate expertise, and producing high-quality summary statements.
- Re-organization of extramural support staff into a centralized structure resulting in a smaller overall workforce, loss of trained personnel, and problems related to re-establishing lines of communication and optimal workflow.
- Under specified conditions, continuous submission of applications is allowed (i.e., no receipt date deadlines).
- Peer review also has accommodated an aggressive implementation schedule of major changes, including
    - Transition to electronic submission of >95% of grant applications; however, the most complex applications continue to be submitted on paper.
    - Migration of IMPAC II modules from client/server to web based technologies, which brought about improvements, but was not without some challenges in implementation
    - Application and process changes mandated by the enhancing peer review (EPR) initiatives, which included enhanced review criteria; shortened applications with strict page limitations; mandated use of templates for reviewer critiques; new scoring system; criterion scoring; limiting re-submission of applications; changes in post-submission materials rules and error-correction windows; order of review and clustering considerations; and shortened review cycle for new investigators.

A common theme across these challenges is that the resources supporting the peer review process needs to be robust, flexible, and responsive. Staff is not increasing at an appreciable rate to accommodate increased workloads; therefore, SROs (Scientific Review Officers) and ESAs (Extramural Support Assistant; Division of Extramural Support Activities, (DEAS)) need to work more efficiently. The increasing sophistication of resources has been in evidence in CSR and some of the larger ICs, but most ICs are not in a position to develop the needed resources. It is clear that the IT systems supporting the peer review processes require a fresh approach to align them with the needs of the community. This approach for significantly improving the efficiency of the peer review processes can best be done via IT and is needed at an enterprise level. This is a primary driver for the evergreening/business process modeling approach.

ANTICIPATED BENEFITS OF THE EVERGREENING STRATEGIC APPROACH

WHAT IS EVERGREENING?

The strategy is continuous improvement, module by module. Any software refresh is preceded by the user definition of the business process; thus the users drive development of the improvements. The business process to be modeled is defined by IMPAC modules, such as Receipt and Referral, Peer

Review, or Committee Management. Rather than a patchwork type of approach, the users will examine the workflow as organized in a model that they have created. Organization across models is captured by having the user groups from the different business areas included in the modeling effort. The model provides a detailed framework for a comprehensive evaluation of an entire business process; this refreshment is planned to occur approximately every 7 – 8 years. This overall strategy has been approved by NIH governance entities, including EAWG (Extramural Activities Working Group) and ITWG (Information Technology Working Group) as well as the Office of Extramural Research.

The evergreening initiative is being applied to the IMPAC software modules that encompass the grants cycle from application receipt to award closeout and associated records and reporting activities. Operationally in the past, eRA directly responds to high priority issues concerning the functionality of all modules. In addition to these areas of high priority, there are other operational/maintenance issues to be addressed over a given fiscal year; however, these issues may not necessarily be low cost or have high impact. As such, a number of issues languish without improvement over an extended period of time until and unless they become high priority, within budget, and doable by available technology/human resources. While these more routine issues may not be mission critical on an individual basis, collectively they can be a large drain on overall enterprise performance. The evergreening cycle complements the continual fixes and enhancements that take place on more immediate time frames and facilitates the introduction new technologies or architectures on a basis that is not disruptive to the wholesale enterprise-level system.

The continual refreshment, evergreening strategy represents a long-term commitment to having the most current and efficient support available to users not only on the basis of individual activities, which are continually addressed, but with regard to ensuring the overall systems are appropriate and serving the user community in both the short and long terms. The evergreening strategy relies on BPM by the stakeholders, which then will drive the needs-analysis done by eRA in implementing approved changes. An essential feature defining the success of the evergreening approach is that it is based on direct input from and verification by the users of a comprehensive workflow business model.

BENEFITS TO STAKEHOLDERS

Overall, stakeholders include the NIH ICs and HHS OP/DIVs that use IMPAC modules; current users of the peer review module include NIH and AHRQ. The value of the modeling approach lies in its support of a variety of stakeholders. Specifically, the users (SROs and ESAs) benefit because the model was designed by them and represents the way they do their work, providing for the first time a thorough picture of the workflow, which will be a good teaching tool. Since the models are generated through a global effort by the user community, it is an opportunity to identify opportunities to standardize and implement best practice. The eRA staff benefits because the model provides a context for the particular piece they may be working on. For example, in the WHAT model, which depicts the purposes, the system architects can more easily see how a particular activity relates to other, similar activities. Requirements analysts can use the How model to better visualize the context for the workflow, how that activity may impact other activities, resulting in more efficient (and maybe prescient) designs, and more readily identifying critical interdependencies or single points of failure. Another direct benefit is the evergreening of peer review initiative will establish this as part of the strategic approach for eRA in updating and maintaining all IMPAC modules and should result in greater stability, less disruption, and more flexibility in response to future requirements. Leadership and management will benefit from the thorough description of the business workflow, which can help in prioritizing competing demands.

There is indispensible value added in a process that incorporates the users from the beginning, ensuring not only buy-in for the results, but a common understanding of the methodology. This latter point is important because evergreening, by definition, is a cyclical process. In the future, this same methodology can be used more efficiently because a core group of users have learned the process and understand how to develop the models so that these skills can be applied to refining this model or working at more detailed levels of the model in implementing requirements. A major benefit that has emerged relates to how to maximize and manage input from a large group of SMEs. It is potentially a daunting task to manage up to 60 staff so that the project stays focused and on schedule and the planned deliverables come to fruition. The SMEs are vested in the process and will be valuable resources in the future. More detail on the SMEs can be found in Appendix 1.

Because of the grass-roots approach and commitment to improved module design to be re-engineered on a regular basis, the benefits to the extramural community are expected to include more responsive technological support, improved efficiencies in not only peer review workflows, but in actual implementation of the corresponding technology and design changes.

WHAT ARE THE SPECIFIC BENEFITS TO eRA PROCESSES?

In developing the model of peer review, the entire process was examined and although it was determined that fundamental changes to the workflow process were not needed, there are new modes of review, such as an editorial board process (two tiers of peer reviewers) or the three-tiered process for the transformative R01s, which are captured in the model. When initially designed, the current eRA system was based on face-to-face meetings, teleconferences were an exception, and there were no "virtual meetings". Having a thorough model of the business process makes it easier to understand where new processes, such as editorial board and virtual reviews, impact the workflow. The model has been designed to accommodate changes to specific peer review workflows. Another example pertains to data quality, which is a pervasive concern across various activities. The model is a tool to locate the affected activities to ensure thorough and uniform fixes and enhancements. Thus, a major benefit is that, in general, fixes and enhancements can be better defined and places in the process that are affected both upstream and downstream can be identified in a more comprehensive way. In addition, how enhancements and changes affect related modules, particularly Committee Management, and other NIH business systems (e.g., RCDC, NBS) supporting the grants management enterprise can be considered more efficiently because of the comprehensive scope of the model. If shorter development times can be realized, this will benefit all stakeholders. This user-defined approach is expected to result in a more robust product that is representative of user needs and more efficient to implement by eRA.

HOW WILL NIH AS A WHOLE BENEFIT?

The identified high impact improvements should result in better management of the peer review administration and bring tools to augment scientific credibility, speed processes, and lower the systemic risk of flawed reviews. While these are largely intangible, they are nonetheless high impact for NIH. Furthermore, tangible benefits will accrue through increased efficiency reducing the need for overtime for support staff and strain on professional staff time. A major added benefit includes facilitation of priority planning since needs have been identified by a cross-section of users and these needs are then quantified with metrics to establish the business case, providing an objective approach to assessing areas of highest impact for users. From an enterprise management perspective, the variables that can be evaluated in peer review include staffing, numbers of applications, peer review meetings, and reviewers, and streamlining the workflow. Since everything that is recommended or desired cannot be done given budget and other constraints, the goal is to maximize impact on staff effort for maximum benefit across the NIH peer review process.

PROJECT GOALS AND SCOPE

WHY TAKE THIS APPROACH?

Given the evolving extramural policies, the electronic systems that support implementation of those policies are in a constant mode of "catch-up"; the 'evergreening' approach is intended to improve this situation. The EPR initiative goals include engaging the best reviewers; improving the quality and transparency of peer review; ensuring balanced and fair reviews; and continuous evaluation of peer review. These high level goals of peer review will continue to be the guiding framework in defining future implementation needs. Since EPR commits NIH to continuous improvement, the supporting systems must be similarly committed to supporting and enabling the changes necessary. Furthermore, the EPR experience well highlighted the need for NIH to be as responsive as possible to the changing needs of the many stakeholders.

WHAT ARE THE OVERALL GOALS?

A major overall goal of the evergreening initiative is to integrate existing business processes with the supporting electronic resources in a way that results in more efficiency in current workflows. In addition, the design of the resources is intended to more flexibly accommodate change with less disruption to the users and to the system design itself. Implementing enhancements and changes to systems are intended to provide a more streamlined and enterprise-wide solution to existing peer review business activities. The resulting technology solutions will better align with peer review business processes because, for the first time, a complete "picture" of peer review will be available to system architects, requirements analysts, business use case developers, user community, and the NIH Help Desk, among others who have a need to know the work flow of the peer review process. Furthermore, subsequent enhancements are expected to be more straightforward and efficient, which will be essential when major policy changes require rapid solutions.

WHAT ARE THE PHASES OF THE BUSINESS MODELING APPROACH?

The first major phase of the process[5], which is the primary focus of this document, is a purpose-based approach that is accomplished by working with SMEs drawn from extramural, peer review staff. The outcomes of this approach include

- Models of how peer review currently is conducted
- Identification of high impact areas for improvement, pain points, and missed opportunities as exemplified by innovative solutions piloted in individual ICs but not available or well interfaced at the NIH enterprise level.
- Business case metrics for identified areas of improvement
- Reports: Dependency matrix; Glossary[6]

The next major phase, not yet begun, is to reengineer the peer review IMPAC module to support the identified improvements and meet the efficiency/responsiveness goals of the evergreening approach so

[5] An introductory description of the business process modeling methodology used in the current effort can be found in the book "Understanding 21st Century Corporations Using xBML", published by John Wiley & Sons, Ltd.; publication date: 2007; authors are Cedric Tyler and Stephen Baker (Business Genetics founders).

[6] The glossary is not part of the format BPM process, but is an ancillary product developed in conjunction with creation of the model.

that IMPAC is more flexible, reliable, and easier to maintain. The first changes could be implemented as early as FY 2011. Based on the outcomes provided in the initial phase and focused on the projects to be supported for development, this phase will include

- In-depth analysis of the current architectural structure of IMPAC of eRA
- Selection for implementation of high priority projects from those recommended and prioritized in the initial phase
- Specific business use cases
- Systems architects, requirements analysts, and user SMEs will design for implementation the projects supported for development

WHICH SYSTEMS ARE INCLUDED IN THE MODEL?

IMPAC modules and other systems include the Peer Review module (REV), Internet Assisted Review (IAR), IC-specific extension systems, and aspects of the Committee Management (CM) module that directly relate to peer review.

WHO IS INVOLVED IN THE EVERGREENING EFFORTS?

NIH and other DHHS OP/DIVs and agency partners that use or have interest in using IMPAC peer review module were included in meetings and provided regular updates on the evergreening initiative. The specific user base included SROs, ESAs, and relevant Committee Management staff.

Evergreening SMEs ($n \approx 56$) were volunteers nominated by Review Policy Committee principals. Representation was from across the NIH ICs as well as from one other OP/DIV, AHRQ, who accepted the invitation to participate. The majority of the group was SROs with representation from 15 ICs; DEAS and committee management staff also contributed substantially. A subset of the SME group (including SROs, DEAS, and Committee Management; $n = 10$) served as a steering committee for the effort. The SMEs met as separate groups; each group met in two-hour weekly meetings that extended from March through August 2010. Although the composition of the group varied at each meeting, there was a core of SMEs who attended all meetings with an average of 15 attendees per meeting. The SME person hours is estimated to have exceeded 4,000 hours of effort to create the models. For a list and more details on the participants see Appendix 1.

The leadership of the effort was spearheaded by Pete Morton, Acting Director, ORIS; co-chairs included two NIH persons on detail to eRA: Paul Sheehy, Ph.D., NIGMS Division of Extramural Activities, and Sheryl Brining, Ph.D., Director, Office of Review, NCRR. Business analyst, Michael Rennolds of ICF, International, led the modeling effort. Dr. Sheehy along with one of the SMEs (varied across meetings) led the SME group meetings; Mr. Rennolds edited the model and guided the group on the model methodology during the meetings; Dr. Brining captured the terms for the glossary from the discussion and helped define issues that arose concerning policy and process. Valerie Prenger served as the liaison from RPC to the evergreening SMEs, also serving on the Peer Review BPM Steering Committee. Among the SMEs, the review users group co-chairs, past and present, Drs. Ernie Lyons, NINDS; Weijia Ni, CSR; and Michael Small, NCI; and Dr. Jonathan Horsford, NIDCR, assisted as discussion chairs for individual SME meetings. Sally Amero, NIH Review Policy Officer, initiated the recruitment of SMEs and scheduled regular updates to be given by the Peer Review BPM leadership to the Review Policy Committee. eRA staff provided logistical support.

Additional input and communication channels included Angela Thomas, OCITA, who provided consultative advice, attended evergreening meetings, and supplied past models that served as the initial starting point for the current effort[7]. The peer review model does not include R & D contract review processes, but it was deemed important to closely interact with the relevant contracts working groups to help leverage and potentially either incorporate contract review in the current peer review model or establish a separate model for this contract reviews. Paul Sheehy is the liaison to NIH Contracts R & D Working Group chaired by Robin Wagner, Chief, Data Analysis branch in eRA; and Sheryl Brining is the liaison to the EPMC Contracts working group co-chaired by Hortencia Hornbeak and Diane Frasier. Along with Paul Sheehy, one of the SMEs, Dr. Xiang Ning Li, CSR, eRA has initiated an ongoing working group to identify IC extension systems and how they might interface or be integrated with eRA systems at an enterprise level. Special thanks are due to Dr. Carol Lambert who derived the data used to calculate potential savings (Table 2).

Given that this evergreening of peer review approach is based on the user and relies on the user input to develop the models, eRA staff did attend the meetings, but only in the role of observers. To bridge the modeling efforts to eRA implementation, an implementation transition team was established that consisted of eRA leadership, team leaders, and members; the evergreening co-chairs and business analyst; and other contractor business analysts. The implementation/transition group was not put in place to decide on what changes would be implemented, which is a management issue decided by NIH and eRA leadership. The focus of this group was at a high level of planning so that eRA would be well positioned to utilize the model in implementing the IMPAC changes as approved by leadership. For details on the composition of this team, see Appendix 2.

HOW WERE THE SMEs ORGANIZED?

All 56 volunteers were SMEs and worked on creating and vetting the model. Subsets of SMEs attended at least one of up to three weekly, two-hour meetings from March to August. Of this group of 56, approximately one-third were designated Super SMEs (SSMEs); this group was responsible for looking at the model at various stages of development to ensure comprehensiveness, consistency, and accuracy. Of the SSMEs, approximately one-third were designated as steering committee (SC) members; this group was primarily the most experienced users and, as in all groups, was representative across ICs (large, medium, small; CSR and non-CSR) and business areas (SROs, ESAs, Committee Management). The SC provided guidance to the co-chairs on how to best structure the SME meetings in terms of schedule and organizational approach to maximize gathering of information and progress on the model. They also were responsible for final vetting of the models, prioritization of areas needed for improvement, and final recommendations. This group met approximately every six weeks.

This organizational structure with the SC embedded in the SME/SSME groups was established to ensure the results of the modeling effort were captured in an efficient manner, vetted with the user community, and that all persons were invested in and knowledgeable of the process and the model each step of the way. Continuity across meetings was facilitated by this “embedded” organizational approach.

In addition to this organization of the SMEs, the two co-chairs and the BPM modeler (business analyst), met for two-hours weekly on Monday mornings. The purposes of these meetings were to prepare materials and confirm the approach for the upcoming SME meetings. Specifically, the model would be reconciled to include the latest SME input; handouts prepared; progress goals established; and constant critical examination of the process resulted in adjustments to maximize the SME meetings. One change

[7] Models can be viewed at http://enterprisearchitecture.nih.gov/ArchLib/AT/BA/GrantsPeerReview.htm

that was made early on was to involve one of the SMEs to lead the SME meetings, which helped to ensure that sharing of views and input could be maximized without an appearance of dominance from the co-chairs. The success of the modeling effort depended on obtaining all views and a consensus across the group on how the model would be constructed so that the peer review activities and workflow would be representative of current user practices. The modeler was instrumental in being able to guide the group in the methodology, but, again, was not the "thought leader," the users were the "thought leaders". Given that the initiative stayed on schedule, resulted in a comprehensive, consensus model, and produced deliverables that are already in use, this organizational and managerial structure in working with such a large group of SMEs in an intensive meeting schedule was highly successful.

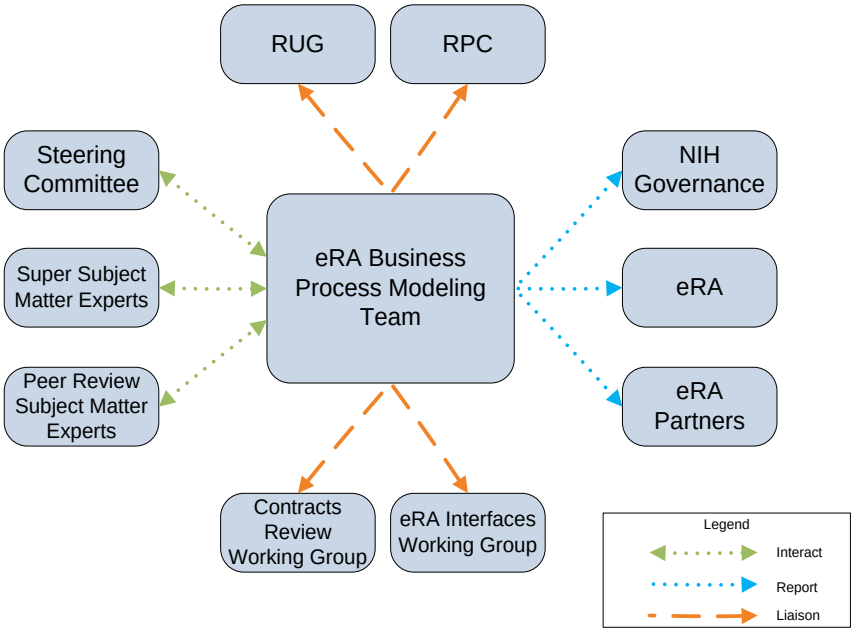


Figure 2: Organization of Peer Review BPM team and related communications/liaison activities with appropriate NIH governance and functional bodies.

BUSINESS PROCESS MODELING

WHAT METHODOLOGY IS USED TO DEVELOP THE MODELS?[8]

Based on a proprietary product provided via contract from ICF, International and supported by trained business analysts, the BPM approach has been used in the evergreening of Receipt and Referral and Peer Review IMPAC modules. This approach utilizes a proprietary software program to construct the model, which can be converted to an Excel or pdf format for viewing by others. Personnel who are specifically trained in the methodology and how to implement it with user communities are integral to the success of using this methodology. In addition to the contractor, an OCITA staff member experienced in developing models for peer review, among other business areas, provided her expertise as a consultant to the group and provided access to models that she and other OCITA staff had

[8] The methodology used is compliant with NIH RFC0027 - Business Process Modeling, which establishes a standard for current and future state business models. This governance standard states that a model should be purpose-based and represent the business processes, resources, and data; it also may contain temporal constraints and locality constraints. Any tool may be used as long as it describes the constraints, including WHAT, WHICH, WHO, WHEN and WHERE; see http://enterprisearchitecture.nih.gov/ArchLib/Guide/BusinessModelingMethodology.htm.

developed in the past. The two most recent models were used as a starting point for the current effort. In addition to these activities, the OCITA consultant attended many of the evergreening meetings and provided informal feedback on the modeling efforts; in this way, prior knowledge was not lost, but leveraged to launch the current approach.

HOW DOES BPM WORK AND WHAT IS THE VALUE OF THIS APPROACH?

Generally stated, BPM is a systematic (staged) approach to modeling the business process; the user community is involved in both stages described here. In the first stage, creation of the WHAT model, the activities that support a specific purpose are identified. The highest-level purpose, in the case of peer review, is to "obtain peer review recommendations of the scientific and technical merit of grant applications", which includes, at the next more detailed level, five purposes, such as "manage participants" (see Figure 3). These second-level activities are further broken down into increasingly more detailed levels (see Figure 4). For Peer Review, the result is a WHAT model with one "head", the highest level purpose, and five underlying "legs" (the models will be discussed more fully later in this document). This model is not workflow based, but is used to identify the major activities in a hierarchical representation that corresponds to the major purposes.

In the second stage of modeling, the HOW model is created. This process involves extracting the purpose-based activities identified in the WHAT model and organizing them into a time-based, activity-dependent workflow. Other dimensions are added to each activity core, including person roles, technologies, and other inputs as well as outputs of each activity. The final stages include identifying the areas of improvement, defining metrics that provide a basis of the business case, and prioritizing the users' "wish list". With a process as involved and extended over time as peer review, it is easy to get lost in the details. The value of this two-stage modeling approach is that starting with identifying the purposes results in a more thorough model as compared to attempts that jump right into a complex workflow.

The sequential phases of the methodology was conducted according to Lean Six Sigma principles[9] and include **defining** the existing process, **measuring** the activities in the process that contain significant defects or "pain points", and **analyzing** those processes that have the highest potential impact for improvement. The result of the process promotes understanding of the actions and dependencies of the activities that is useful to different stakeholders, including the user community and the technical staff. Ensuring a refreshed examination of business processes before reengineering the IT support for those processes should result in faster and more cost-effective software development and improved functionality and disruption for the user community.

HOW LONG DOES IT TAKE TO CREATE THE MODELS?

Planning for the peer review BPM effort started October 2009. Recruitment of SMEs took place in February 2010; the first meetings started in March 2010 and the SME effort concluded the end of August 2010. Over the subsequent few months, September – October, the BPM leadership team created, vetted with the SMEs, and finalized the deliverables. Well over 4,000 SME hours were devoted to creation of the WHAT and HOW models. The commitment to involve a broad cross-section of users is daunting and time consuming, but the pay-off results in models that are functional and representative of how peer review is done across the NIH; the models are thorough, useful to many stakeholders, and

[9] Formalized Lean Six Sigma approach was beyond the scope of this project; only used limited measurement approach to identify areas for improvement. Subsequent efforts focused on specific changes would benefit from a more formalized Lean Six Sigma approach.

should stand the test of time based on the purpose-based design approach in identifying the activities and naming the inputs and outputs. In addition, there is now a substantial group of SMEs who have in-depth experience with the modeling methodology, understand the models, and have further developed their own understanding of the peer review process; these attributes can be leveraged in future efforts, which is essential to making the evergreening approach work as a continual refreshment of IMPAC. For more details on the meeting schedule, see Appendix 1.

"WHAT" MODEL

To define the existing peer review process, a purpose-based activity model was created to ensure that all the activities related to the peer review process were captured and documented at a consistent level of complexity. The purpose-based activity model, the WHAT model in xBML (extended business modeling language) terminology, would be used as a foundation in producing the workflow model. The activities in the high level WHAT model were decomposed to a level at which the enterprise peer review process could be described to represent ~80 percent of activities commonly performed across NIH. In addition, activities that may occur at a less frequent basis but are of high value were included, particularly related to processing of complex grant applications. The WHAT model was decomposed to 'level 4' and can be viewed in Appendix 3.

The model workflow starts at the point when an application referred by the Division of Receipt and Referral is received by the IC for review and ends with the IC advisory council/board meeting. Activities are identified and arranged according to the purpose of the activity. The level 1 purpose of peer review is to "Obtain Recommendations on the Scientific and Technical Merit of Grant Applications".

Figure 3 shows the first- (top box) and second-level activities, the latter of which includes Establish Review Meeting; Manage Applications; Manage Participants; Obtain Evaluation of the Application; and Manage Integrity of the Review Process. The WHAT model is NOT temporal (workflow) based, but purpose based with activities arranged hierarchically. The logic of the WHAT model is that completion of all the second-level activities defines completion of the first level purpose. In the case of levels 1 and 2, completion of all the level 2 activities defines accomplishment of the level 1 purpose. This hierarchical arrangement of activities results in a purpose-based model of the peer review business process that is thorough and supportive of the next stage to create a temporal workflow of the identified activities.

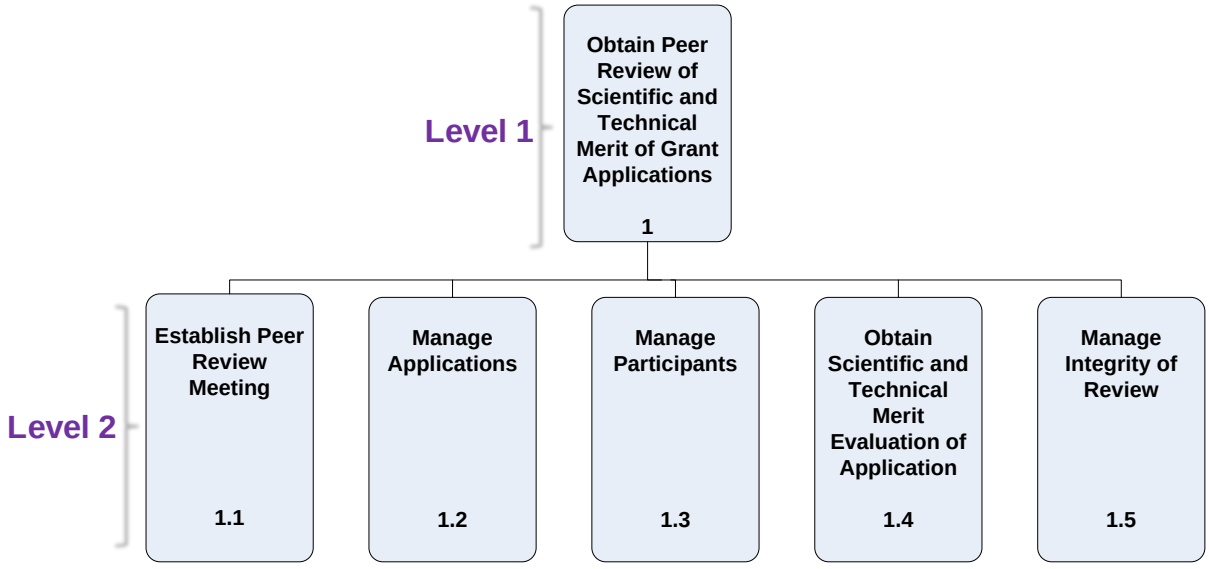


Figure 3: Levels 1 and 2 Activities of the NIH Peer Review "WHAT" Model

To be useful to most stakeholders, additional levels beyond level 2 need to be identified. A decision is made as to the appropriate level at which to model the workflow, which is the HOW model. In this case, it was decided that level 4 WHAT model activities would be optimal to capture sufficient detail to describe the peer review business process, but would not be at a level that is so detailed that relevance would be compromised across the different stakeholder groups. See Figure 4 for an example of an activity (e.g., 1.5, Manage Integrity of Review) modeled to a level 4.

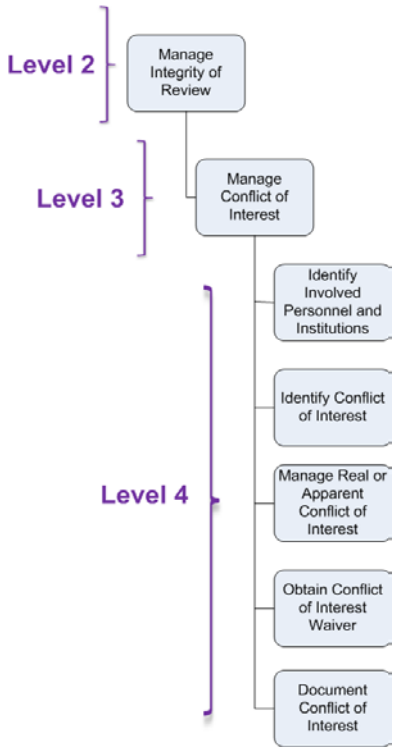


Figure 4: Shows a partial "leg" at levels 2 - 4; only one of the level 3 activities is shown here.

A powerful aspect of this modeling approach is that additional or fewer levels of detail can be considered as suitable to the perspective and needs of the stakeholder. For a requirements analysis purpose, for example, it is likely that at least a level 6 would be needed to adequately capture the relevant details. However, for purposes of understanding a system-level analysis, levels 3 or 4 may suffice. Regardless of the level of focus, the logic remains the same, namely, if all the activities under a given box are completed, then the activity defined in the "parent" box is accomplished. This approach results in a thorough description of the business process and the methodology of using a purpose-based approach results in a model that is a flexible and powerful tool suited to a variety of purposes.

"HOW" MODEL

The peer review HOW model was created using all the Level 4 WHAT model activities. These activities are sequenced in a temporal workflow model to illustrate activity dependencies. This model flexibly embraces changes and enhancements. For example, if a new review format is introduced, the system can accommodate the new activity and associated inputs/outputs, easily integrating the new process in relation to other activities in the model based on the purpose.

The SMEs identified the inputs and outputs for each activity. See Figure 5 for a diagrammatic representation of the HOW model elements. The input/output "dimensions" further define the activities, including

- Roles or organizations that have an active role in support of the activity were identified according to the "RACI" definitions: **responsible** (the person assigned to do the work), **accountable** (the person who makes the final decision and has the ultimate ownership), **consulted** (the person who must be consulted before a decision or action is taken) and/or **informed** (the person who must be informed that a decision or action has been taken).
- The technology used in support of each activity was identified, categorized by (1) eRA-supported systems modules, specifically, Receipt and Referral, Review, Committee Management, Internet Assisted Review (IAR), Query View Reporting (QVR), and Research, Condition, and Disease Categorization (RCDC) and (2) IC-level extension systems. An extension system is defined as an organizational tool, COTS (Commercial Off-the-Shelf) or in-house designed system, used to support a peer review activity that is not integrated into the IMPAC II or other enterprise-wide system. This definition excludes data sources used to extract information such as contact information, publication sources, and expertise.
- Relevant time dependencies were identified that either preclude an activity from being performed until a preceding activity has been completed or prevent an activity from being performed after a pre-determined amount of time. For example, the Federal Register Notice is required to be published no less than 15 days prior to the meeting.
- Inputs and outputs of each activity were defined and integrated into the workflow; each can be assigned a status descriptor (e.g., output "roster" may be an "updated" version of the input "roster").

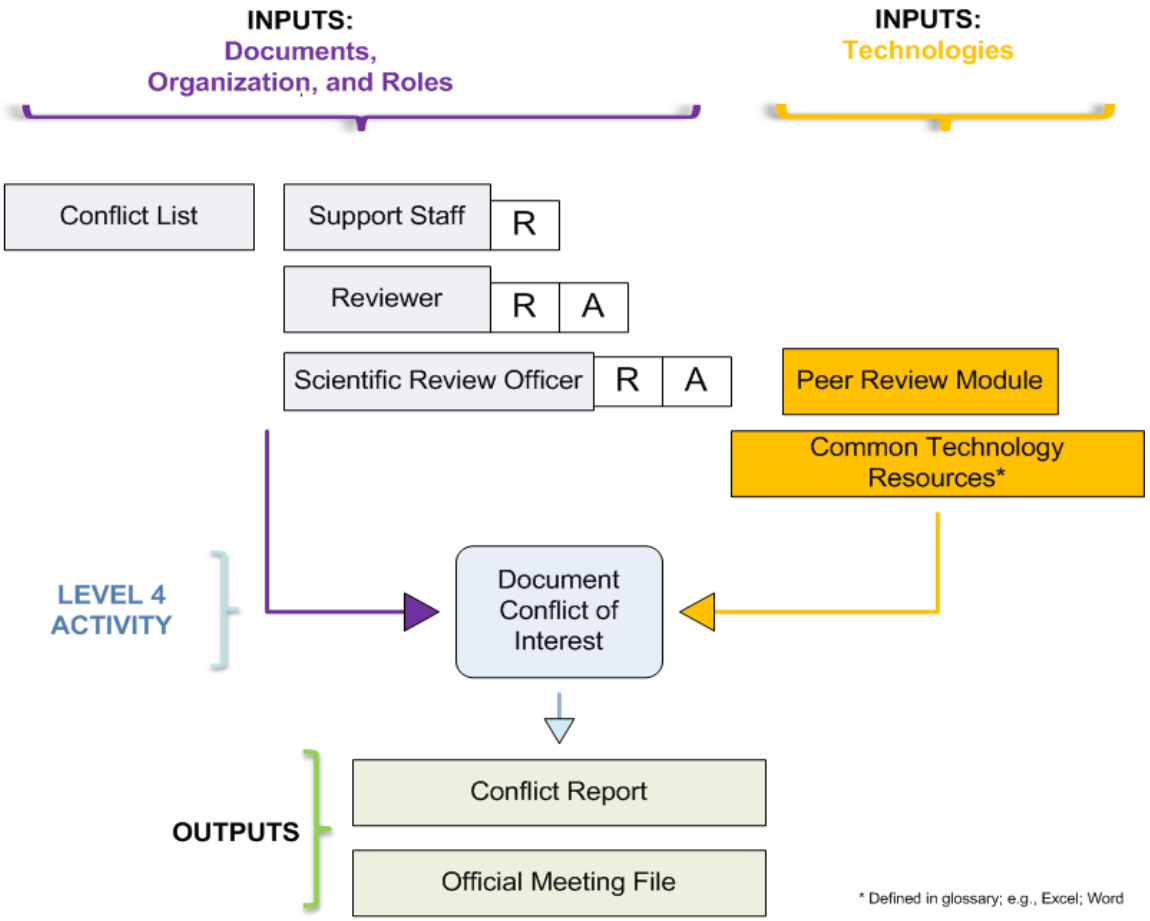


Figure 5: Diagrammatic representation of HOW model elements.

IDENTIFYING IMPROVEMENTS

Once the existing process is defined, common practice is to measure the process efficiency of *each activity* to pinpoint areas that may require improvement. Since the peer review process is well established and the fundamental activities/workflow are not changed (e.g., applications need to be peer reviewed), it was determined that in lieu of measuring each activity, specific areas for improvement would be identified and measured by the SMEs. General areas for improvement, specific pain points, and missed opportunities are defined as activities that could be improved or augmented in one or more of four major categories, including **quality** (e.g., duplicate profiles, outdated contact information, "goodness of fit" for an assignment), **process efficiency** (e.g., identifying conflicts of interest; balancing reviewer assignments), **cost** (e.g., increasing numbers of applications, steady-state staffing) and **risk** (e.g., lack of identification of conflict of interest). The improvements were identified and quantified (measured) by the users based on available data (e.g., as available in QVR numbers, applications, meetings; types of meetings and applications; staffing; etc.) and expert judgment of the users (primarily SROs and ESAs). Opportunities were identified to improve efficiency and data quality and reduce cost in the peer review process. A basic tenet of the process is to encourage "out of the box" thinking from the SMEs with ideas not bound by current systems and processes, but more based on identifying an efficient, ideal process.

II. RECOMMENDATIONS AND FINDINGS

RECOMMENDATIONS FOR IMPROVEMENT

GENERAL FUNCTIONALITIES – HIGH IMPACT

- Text mining and analysis
- Expand upload/download, integration, and/or interfaces with IMPAC and external data sources
- Integrated effort involving eRA staff and users to improve user interfaces
- Scheduling software
- Secure communications with reviewers[10]
- Better video conferencing software (Adobe Connect has insufficient voice capabilities)
- IMPAC system performance (e.g., page-refresh slows workflow), reliability, and downtime
- Expand browser compatibility
- Poor data quality in reviewer profiles; multiple entries for same reviewer
- Ability to customize IMPAC reports
- IMPAC error codes are not always sufficiently specific
- Cumbersome committee management functionality for creating meetings and rosters; CM not part of this BPM, but is intimately related to Peer Review functionality; improvement of this module would greatly facilitate peer review processes
- Lack of information indicating when all applications have been assigned from DRR (this is a communication issue between modules, RR and REV)
- IMPAC training for review staff
    - Virtual School and in-person training
    - Ensure up-to-date documentation and user manuals
    - Provide a training "sandbox"

ACTIVITY-SPECIFIC IMPROVEMENTS – HIGH IMPACT

- **Notify Public** (Publish Federal Register Notice; FRN): Need better system controls to ensure that FRN is published in a timely fashion so that peer review meetings are compliant with FACA requirements. The issue whether the policy that technical merit review committee meetings (that contain effectively no portion open to the public) should continue to publish FRNs was discussed. No specific recommendation is made, other than that the relevant NIH authorities might reconsider the risk/reward aspect of this procedure.
- **Conflict of Interest** (COI): Text mining tools would facilitate identifying COI and involved personnel and institutions, true for all applications, but particularly problematic for paper-submitted formats; transferring COI information from SRO records is cumbersome and subject to error.
- **Assignment matrix functionality**: efficiently display information relevant to making assignments, such as the application description, key personnel, involved organizations, links to the expertise, publications, conflict of interest information, assignment workload, and schedule of the reviewers on the roster; for all types of applications, assembling a draft assignment matrix is usually done in Excel spreadsheets or other software so the data elements are easy to work

[10] Current NIH policy precludes sharing potentially sensitive information with prospective reviewers. Whether and how such information can be shared that might be enabled by instruments such as standardized Non-Disclosure Agreements was discussed. No recommendation was made regarding the current NIH policy or adoption of NDAs as standard practice.

with, but then this information must be transferred to IMPAC, which is usually a manual process that is inefficient and subject to error.

- **Reviewer Recruitment and Expertise**: Determine expertise needed, identifying qualified reviewer pool, and matching reviewers to applications are activities that require better text mining tools with an ability to interface with or be integrated into IMPAC; improved recruitment tracking ability.
- **Templates**: Need templates that are easier to construct and customize when necessary; more user friendly for reviewers in preparing their critiques; increased compatibility with summary statement production.
- **Scoring**: Enable reviewers to more easily update their critiques and criterion scores; provide the ability to upload more than five criterion scores or scores that are non-numeric; improved electronic final scoring process; automatically populate FOA criteria into relevant Internet Assisted Review screens.
- **Summary Statement Preparation**: More efficient means of cleaning up, formatting, and finalizing drafts, particularly for complex summary statements; need macros that better align with the review criteria/application format; integrating late material; special character handling; quality check (text mining approach) to ensure right critiques are in summary statement; batch processing in uploading final drafts to IMPAC; improved feedback to staff on status of generating final summary statement in IMPAC. See Templates bullet in this list.

ACTIVITY-SPECIFIC IMPROVEMENTS – MODERATE IMPACT

- Goodness-of-fit metrics for SRG assignment
- Better hotel information (rating system for staff and reviewers)
- Provide the actual reviewer screen shots or access to the reviewer views so that review staff can better assist reviewers in using IAR, SPRS, Commons (with the latter related specifically to facilitating reviewers in updating their contact information, degrees, and positions)
- Checklists to help with confirming format and programmatic responsiveness requirements
- Increase the allowable files types for materials that review staff upload into IAR[11]
- Develop more efficient and consistent means to characterize reviewer expertise

IC EXTENSION SYSTEMS

CSR, NIAID, NHLBI, and NIGMS have developed extension systems to facilitate the review process. As far as possible, these products are shared with other ICs, but there is no formalized support, which can make it impractical as a long-term solution. As part of the evergreening/BPM process, the SMEs identified extension systems their respective ICs have in place that augment or add functionality to IMPAC Peer Review module resources. A descriptive inventory of the currently used systems is provided here.

In addition to these IC resources, several SROs across the NIH have developed their own, powerful tools that are based on customized functionality built in Filemaker Pro (Sam Edwards, CSR; Craig Hyde, NIGMS; Peter Kozel, NCCAM) or Microsoft Excel or Access (Weijia Ni, CSR); these are not separately listed, but should be considered as potential resources to leverage in any new design. For example, Dr. Ni's Access system pulls a great deal of information onto one screen so that SROs have in place much of the information needed to do administrative review and make assignments. Also, not included here, are

[11] This may be a moot point given current post-submission materials policies, see http://grants.nih.gov/grants/guide/notice-files/NOT-OD-10-091.html. A related issue is if new formats would be allowed in the future, such as movies, then current IAR allowable file sizes are not adequate.

NIH-enterprise systems that are integral tools for managing peer review, but not part of IMPAC (e.g., SREA, Scientific Review and Evaluation Activity, which has some integration with IMPAC and is used to process reviewer reimbursements and honoraria). Also not listed here are the many databases, freely available on the web, used to find reviewers (e.g., PubMed, Community- and Web of Science, Gene Cite, and SciFinder, to name a few). These are captured in the notes associated in the model, but there is no definitive list since these resources are constantly being developed, significantly modified, sold to other companies (name and/or content changed), or discontinued.

The focus of BPM is on the Peer Review module of IMPAC. The purpose of this inventory is to provide information on potential resources that could either be integrated into IMPAC or improve existing interfaces with IMPAC. The route of assimilating these functionalities cannot be at the expense of performance of IMPAC. In many cases it would not be necessary to create enterprise versions of these tools, although in some cases doing so may be appropriate. This presentation is intended to capture the resources available to date, not to advocate for how or what would be implemented at an enterprise level. A general issues with all these systems is that data elements are collected in unique formats that are not cross compatible or in formats that are consistent with IMPAC data constraints. At minimum, extension systems have great value in identifying gaps in IMPAC functionality. These tools can be viewed as proofs of concept and could inform future enterprise efforts and lead to more efficient and successful outcomes.

CSR

- **Summary Statement Macro**: CSR summary statement macro that helps format the standardized headers and resume boilerplate language; works best on single project, R01 types of summary statements. Although this macro is readily available[12] and generally useful to all ICs, it does have limitations, primarily it is designed to work with R01-type of applications with standard headings.
- **Real Time Meeting**: A web-based tool used to inform program officers and others with a need to know about the order of review at a face-to-face review meeting. Available for CSR only.
- **Exit Ramp**: CSR extension system to help fingerprint application used to match application to study section (Scientific Review Group, SRG). This functionality was available for CSR only; currently being updated.
- **zApps:** an electronic solution that delivers applications and review information to reviewers. It evolved from the eCD Initiative and replaces the production and mailing of an individual CD to each review panel member.
- **OTM** (Out-of-town meeting): a means for CSR reviewers and staff to rate non-local hotels; used to judge whether to use that hotel again for a peer review meeting.
- **CSR Rosters --> WTS**: CSR has an automated procedure to send their study section meeting rosters to the World Travel Service, the contractor who arranges travel of non-federal reviewers to review meetings; the roster is required as verification of expected attendance and provides reviewer contact information. In non-CSR ICs, rosters are faxed, which is not as efficient and sometimes leads to updated entries on a roster not transmitted to the travel contractor, preventing reviewers from making travel arrangements for the peer review meeting.
- **IAM** (Internet Assisted Meeting): Many IC review units conduct virtual review meetings; CSR has an extension system that facilitates reviewer discussion of applications. IAM essentially operates as a chat room, but with an override that holds all comments until the SRO clears them for

[12] See http://www.csr.nih.gov/sumstate/default.htm

release to the review committee, which assures compliance with the FACA statutory requirement to have a Designated Federal Official (in this case, the SRO) monitoring the discussion. This extension system is available to ICs outside of CSR.

NIAID

- **RSS** (Reviewer Support Site): A comprehensive in-house NIAID system that facilitates reviewer communications and SRO management of review meetings. This system is used primarily for the review of contract proposals. The system has state-of-the-art security features to protect confidential information sent to reviewers. Available to any IC. Includes support for

  Reviewers

  - Indicate availability on calendar
  - Identify COI with persons/institutions
  - Certify pre- and post-meeting COI forms
  - View meeting related reports, such as rosters
  - Upload/view critiques before meeting

  SROs
  - Manage review documents (applications, reports, travel documents),
  - Lists of participants (reviewers and staff) and other information (expertise)
  - Communications (obtain current contact and title for reviewer; obtain COI information from reviewers; feedback from reviewers on process and FOA)
  - Solicit post review evaluation of solicitations

- **PubMed Macro**: Checks reviewer name against spreadsheet list of key personnel from all applications in a review meeting; identifies common publications between reviewer and key personnel to screen potential conflicts of interest. Available to all ICs.
- **Multi- and single-component Macros**: a concatenation macro: assembles critiques; separate macros for either single- or multi-project summary statements. Available to all ICs.
- **Electronic Scientific Portfolio Assistant (eSPA):** Electronic tool to analyze and manage portfolios of grants and contracts; extracts portfolio information from existing systems, cross-linking data for publications, grants, contracts, interventions, patents, clinical trials, and drugs. A data aggregation and visualization tool currently available at an NIH enterprise level.

NIGMS

- **SAM**: Used for unique grant programs, specifically, Pioneer Award and New Innovator; provides a centralized location where reviewer and application data are available to reviewers and SROs; contains a standard toolset to support the following:
  - Managing the reviewer invite list
  - Tracking reviewer status and number of received applications by science area
  - Administrative review of received applications
  - Comparison of the SAM meeting roster to the meeting roster in Peer Review
  - Assignment of reviewers to applications based on science area
  - Export of application-to-reviewer assignment data for upload to Peer Review

NHLBI

- **Reviewer Finder**: A COTS (Collexis) product customized by HL to
  - "fingerprint" grant applications
  - Identify involved personnel

- Identify reviewers with appropriate expertise
- Identify conflict of interest
- Produce draft assignment matrix

Table 1 is provided as a summary of the above bulleted information to more easily compare the advantages and limitations across systems.

Table 1: Comparison of opportunities and limitations of major, existing IC extension systems

System Name	Opportunities	Limitations
eSPA (NIAID product that is transitioning to NIH enterprise level)	- Accesses many different databases to identify reviewers, including patents, foundations, etc. - Data analysis is unstructured, which means terms are captured in a way that is ontology independent, which may be more comprehensive - Has access to NIH systems and can write to directly to IMPAC	- Set up to analyze existing awards; does not access pending applications under review
Reviewer Support Site (RSS; NIAID)	- Provides list of involved institutions and personnel for reviewers to check conflict of interest - Access to COI certification forms and other review materials - Updates reviewer contact and other pertinent information - Calendaring software to facilitate scheduling review meetings - Allows the posting of preliminary scores. - Allows the upload/view of critiques before meeting. - Contains state of the art security features to protect confidentiality. - Available to other ICs	- Does not interface directly with IMPAC - Uses NIH External Active Directory to control login and authentication for outside users in addition to that required for them to use eRA.
Reviewer Finder	- Text mining applications for required expertise and reviewer names (looks for term matches based on NIH RCDC ontology)	- Relies on NIH MeSH controlled vocabulary: applicants do not compose their applications according to this structure,

System Name	Opportunities	Limitations
	- COI detection - Draft assignment matrix generation - Allows reviewers to post reviews	potentially limiting accurate description of application expertise - Database uses different identification system of people that does not integrate with IMPAC - Lacks IMPAC interface
System Application Management (SAM; NIGMS)	- The same defined ontology is used by both applicants and reviewers - Boolean logic applicable to ontology - COI identification system - Recruitment tracking - Ability to make initial review assignments (need to be vetted and finalized by SRO) that follow defined business rules (e.g., reviewer who is in conflict is not assigned)	- Not used for common NIH mechanisms (applicable only to Pioneer and New Innovator awards) - Ontology is limited - Need to manually enter reviewer names - Output matrix not readily interfaced with IMPAC: uploaded comma-separated-value (csv) file must run overnight before appearing in IMPAC
CSR Summary Statement Macro	- Formats/standardizes headings, fonts, and removes template boxes, and other aspects of the draft summary statement - Readily available to all ICs	- Not applicable for complex applications with sub-projects - Not easily customizable by users
Internet Assisted Meeting (IAM; CSR)	- Allows for virtual meeting discussion via a "chat room" type of format but with the constraint that discussion does not proceed without SRO oversight. - Reviewer interface is robust - Program staff can be enabled to "listen" in by accessing the site - Available outside of CSR	- No support available for non-CSR ICs - Not easily customizable by users

EXAMPLES OF POTENTIAL SAVINGS

Peer review has two major constraints, time and workload, neither of which is under the control of staff, which means optimizing the available time and ways to handle the workload are the options available to

realize efficiencies. Peer review begins at the time of receipt of the applications and the finish is marked by the council date. Typically, counting backwards from the council date sets work schedules.

The "Mtg Phase" column indicates (1) Pre-meeting, (2) meeting, and (3) post-meeting phases that define the major peer review scheduling milestones; the Activity is from the BPM Peer Review model; existing IC extension systems that have implemented efficiencies to varying extents are noted; and the table is ordered according to savings calculation per activity.

Three sources of information[13] were used to calculate these estimates. In brief, the meeting/application/reviewer data were collected from QVR for meetings held FY2010, excluding ARRA. Metrics associated with calculated savings were based on SME estimates of time associated with an activity and what would be reasonable to expect in terms of percent improvement. Estimates used in the calculations are conservative. The overall peer review effort supported by the REV module is enormous. At NIH in FY2010, more than 75,000 applications (not including ARRA) were reviewed by nearly 50,000 reviewers in more than 2,600 separate review meetings. Savings are intended to demonstrate efficiencies to be gained and are not intended to replace the professional judgment required for each task.

Data quality provides an example of how the estimated savings likely are conservative. Estimate of time saved if entering of duplicate reviewer profiles were significantly reduced is~127,000/year (not included in table below). However, additional costs not included in this simple calculation includes the cost of the time to identify and eliminate the duplicate profile from the database, the cost in time to reviewers and NIH staff in dealing with inaccurate committee service records, and the time the NIH review staff spend in finding and entering information that may already exist in the database. Thus, calculations of savings overall are under-estimates and the benefits in terms of dollars saved are probably greater than what is calculated here.

Table 2: Potential savings estimates (illustration purposes only; calculations approximate)

Mtg Phase	Activity	Examples of Existing Extension System Capability	Estimated Savings Per Activity Per Year[14]
1	**Establish Physical Meeting Arrangements** (non-BPA hotels)	SREA Hotel BPA	$47,925
1	**Identify Involved Personnel and Institutions in Applications**	Reviewer Finder Reviewer Support Site (RSS)	$570,950

[13] All three sources of information are discussed in more detail in Appendix 4 in terms of how the data were collected and Appendix 5 for a discussion on reliability, sources of error, and savings calculations.

[14] Calculations use the formula: # of occurrences X time unit(s) to complete task X SRO or ESA hourly salary X percent desired improvement in time to complete. See Table 12 for metrics and formulas for these and other activities.

1	**Determine Expertise Required**	Reviewer Finder	$1,042,163
1	**Identify Reviewer Pool**	Reviewer Finder	$22,124,700
1	**Identify Conflict of Interest**	Reviewer Finder RSS PubMed Macro	$1,629,925
1	**Invite Reviewer** (calendaring)	RSS	$354,563
1	**Send rosters to travel contractor**	CSR	$30,250
3	**Create Draft of Summary Statement**	CSR and NIAID Macros	$732,975
3	**Collect Official File Documents**	None	$32,738

DISCUSSION OF POTENTIAL SAVINGS RELATED TO PEER REVIEW ACTIVITIES

In terms of potential savings, there is significant opportunity for improvement across all three meeting phases. Based on these phases, the following highlights a few examples:

1) Pre-meeting tasks typically consume the most time overall. These activities include determining the expertise needed, finding, scheduling, and communicating with reviewers and developing and assembling guidance documents. As might be expected given the time involved, the potential dollar savings for activities pre-meeting are substantial. The data analysis clearly supports high prioritization of effort put into tasks that occur pre-meeting, primarily improving text- and data-mining capabilities. It is a mission-critical task of SROs to obtain the right expertise and tools exist that can significantly improve the efficiency of the search for appropriate reviewers.

2) Review meeting efficiencies involve maximizing reviewer time by use of appropriate meeting formats (e.g., face-to-face, editorial board, teleconference, and virtual reviews, to name a few of the options) and optimal use of Internet Assisted Review types of interfaces between reviewers and staff. These activities primarily revolve around maximizing reviewer time, saving travel time as appropriate to the review parameters by using meeting formats that do not require travel or travel is required for a smaller number of reviewers (editorial board).

3) P**ost-meeting** activity is dominated by the timely production of high quality summary statements. Summary statements are the product of peer review that is relied on by subsequent users, including IC Advisory Councils, NIH staff, and the applicants. Areas for improved efficiencies include formatting and clean-up macros that are more customizable; a means to quality check the contents in terms of ensuring the right critiques are inserted; batch uploading of drafts into IMPAC.

The data analysis can be used to demonstrate reduction in the processing cost per application. Additional benefits could be evidenced by improvement in the quality of life for staff, particularly during peak times, reducing the need for overtime and, overall, increasing efficiency and thoroughness. Staff efforts could be spent more productively and be better aligned with their core talents. NIH would realize a peer review effort that is overall improved through optimal use of all resources as defined by the

supporting technology and involved personnel. BPM provides the common frame of reference for all stakeholders in these processes.

FUTURE SCENARIO: Unifying BPM Results with the Peer Review Process

TOPIC 1: INFORMATION MANAGEMENT

Major events in the peer review business cycle include

1. Recruiting Reviewers
2. Managing Conflicts of Interest
3. Making Review Assignments (e.g., matching reviewers to applications)
4. Produce Summary Statements

In each one of these steps, typically the SRO either keeps their own records (spreadsheets or Word document) or has an extension system that helps to manage the information. The challenge is to accurately and efficiently transmit this carefully constructed information into IMPAC as appropriate to document the meeting (roster, conflicts, assignments) and generate reports (summary statements). For #s 1 – 3, there currently is no enterprise-level functionality to upload information from a spreadsheet into IMPAC.

In the case of summary statements (#4), once the initial draft has been created, upload functionality currently exists, but it can be inefficient process to make corrections, requiring re-uploading the edited Word document rather than being able to work in the IMPAC document itself.

BPM-DERIVED RECOMMENDATIONS

- Text mining (recruiting reviewers)
- Adopt the best features from existing extension system functionalities (e.g., Reviewer Support Site, NIAID; Reviewer Finder, NHLBI; System Application Management, NIGMS) and create new functionality to allow for better interfacing of spreadsheet-type of information with IMPAC Peer Review module.
- Improve how draft summary statement edits are handled.

TOPIC 2: SCHEDULING AND COMMUNICATING WITH REVIEWERS

Scheduling reviewers for meetings is handled in a few ways. For standing study sections, typically meeting dates are set a year ahead of time so that reviewers can reserve their schedules in advance. For Special Emphasis Panels, the review date may be set ahead of time with the schedule of the chair taken into account, but it is not possible to do this with all the reviewers who may serve and many times the date is set prior to recruiting the chair so that suitable space is reserved. Therefore, in the case of SEPs, the review meeting date is a constraint, which impacts recruitment if the reviewer's schedule precludes his/her attendance. Where this becomes particularly problematic is in setting a meeting date for a teleconference for which there can be an enormous time sink for both the SROs and the reviewers to mutually agree on not only the date, but also a time frame.

The second issue has to do with secure communications with reviewers. There currently is no efficient way to securely transmit review-related documents via email with reviewers (potential or recruited). The IMPAC Internet Assisted Review (IAR) system is widely used and appreciated functionality, but it has disadvantages of requiring the reviewer to be online to obtain information; reviewers not yet recruited cannot access the system; and there are limits to the size of files that can be uploaded. As a specific example, in recruiting a reviewer, it is important to screen for conflicts of interest, which means the application institutions and involved personnel are screened against the reviewer name and institution. To transmit this information, SROs have relied on email, which is not secure. Although communicating via unsecure channels is now recognized as not best practice, there are no good options at an enterprise-level to communicate securely with reviewers.

BPM-DERIVED RECOMMENDATIONS

- Calendaring software to more efficiently schedule review dates/times with a group of reviewers.
- In addition to IAR, secure communications with reviewers.
- The NIAID Reviewer Support Site extension system has calendaring functionality and secure means to communicate with and supply review documents to the reviewers. [15]

EXAMPLE OF INTEGRATING RECOMMENDATIONS

Ideally, the greatest value from incorporating these recommendations into the Peer Review module would be derived from seamlessly integrating them rather than implementing them as a collection of minimally interacting or independent components. The strength of tightly integrating the capabilities requested by the evergreening participants can be illustrated in terms of several of the highest priority issues – specifically, automated identification of conflicts of interest, text mining, enhanced reviewer profiles, easier generation of rosters, reviewer invitation and tracking tools, and algorithms to aid in assigning reviewers to applications. Taken as a whole, the vision that emerges is one in which cutting-edge technology is used in a well-integrated fashion to assist Scientific Review Officers in managing the review process. The intent is not to de-emphasize professional judgment, but rather to provide powerful tools for efficiently managing reviews with even greater quality than already exists.

Table 3: Workflow Example of Integrating Recommended New Tools: Finding and Assigning Reviewers

Review Activity	Tool	Result	SRO Professional Judgment
Determine Expertise	Text mining algorithms Semantic clustering algorithms	Groups of applications that require similar expertise are identified. Number of reviewers/cluster of expertise are estimated	Optimize expertise needed (delete or add to results of algorithms); adjust expertise identified. Specify reviewer workload

[15] eRA currently is developing a secure means to communicate with potential reviewers regarding conflicts of interest (scheduled for release in early 2011).

		Reviewer workload parameters are factored in.	parameters.
Identify Reviewers	Text mine multiple databases (publication, NIH, NSF, IMPAC) Filter, sort, weight results for strength of match related to specified factors	Profiles of a large number of scientists working in areas relevant to the NIH application are identified.	Specify databases and report parameters Specify weighting/filtering factors (e.g., expertise match, academic rank, funding history, geography, etc.)
Manage Conflict of Interest (COI)	Algorithm to match reviewers to key personnel and institutions in applications to find potential COI based on application information as well as collaborations evidenced by co-publications or grant activity that may not be listed in application.	Manage, reduce, or eliminate COI. Integrated information for more thorough COI vetting process.	List of COI vetted by SRO for accuracy and final documentation.
Invite Reviewers	Customizable, automated email invitations Current reviewer contact information Track invitation responses Add vetted reviewers who accept to roster	Realize greater efficiencies in contacting reviewers and in reviewer data quality.	Send automatic email invitations to potential reviewers from the vetted result set by clicking an invitation button Based on tracking information, send follow up email or set task to call reviewer
Match Reviewers to Application & Balance Workload	Identify reviewer expertise and match to expertise required for application, taking into consideration workload and COI issues. Track assignments to identify gaps in expertise required; identify additional reviewers from vetted list.	Composite of factors related to making review assignments in one interface.	Finalize assignments Balance workload/reviewer; # applications/reviewer; reviewer role

III. APPENDICES

APPENDIX 1: SMEs: PARTICIPANTS AND SCHEDULE

Table 4 lists all volunteers. A few participants attended only one meeting, but the majority of volunteers attended the meetings throughout the six-month schedule. Average attendance at any given SME meeting was ~20. Note, all participants were SMEs; ~1/3 of the group were SSMEs and ~1/3 of SSMEs were on the Steering Committee.

Table 5: number of SMEs organized by IC

Table 6: the BPM leadership and liaisons

Table 7: schedule of meetings and major milestones (all dates 2010)

Table 8: List of implementation team members

Table 4: Master List of Subject Matter Experts (SMEs)

Last Name	First Name	IC	SSME	Steering Committee
Amende	Lynn	NCI		
Amstad	Paul	NIAID		
Binder	Roberta	NIAID		
Birken	Steve	NCRR		
Birkle	Dale	NCCAM	SSME	SC
Buczko	Ellen	NIAID	SSME	
Buzas	Beata	NIAAA	SSME	
Chu	Serena	NIMH		
Connaughton	John	NIDDK		
Cooper	Jermain	DEAS		
David	Tracey	DEAS	SSME	SC
Ellis	Bonnie	DEAS	SSME	
Ferrell	Rebecca	NIA		
Flemming	Monica	DEAS		
Guthrie	Peter	CSR		
Hall	Kimblee	DEAS		
Harris	Claire	CM		
Horsford	Jonathan	NIDCR		
Huang	Zoe	NLM		
Hutko	Autumn	DEAS		
Hyde	Craig	NIGMS		
Johnson	William	NHLBI	SSME	

Last Name	First Name	IC	SSME	Steering Committee
Jones	Joshua	DEAS		
Kozel	Peter	NCCAM		
Li	Xiang-Ning	CSR		
Lopaczynski	Wlodek	NCI		
Lyons	Ernie	NINDS	SSME	SC
Moore-Hoon	Marilyn	NIDCR		
Nakamura	Ken	NHGRI	SSME	
Ni	Weijia	CSR	SSME	SC
Nuss	Mary	NIAID CM		
Petrosian	Art	NLM		
Ponce-Gonzalez	Ileana Maria	AHRQ		
Roman	Laura	CSR		
Schaffner	Annie	NEI	SSME	
Schmidt	Michael	CSR	SSME	
Shayiq	Rass	CSR		
Sinnett	Everett	CSR	SSME	SC
Slice	Lee	NCRR		
Small	Michael	NCI	SSME	SC
Snouffer	Anna	CM	SSME	SC
Srinivas	RV	NIAAA		
Srinivas	Shamala	NCI	SSME	
Stoica	Adriana	NCI		
Tatham	Thomas	NIDDK	SSME	SC
Temple-O'Connor	Meredith	NIGMS	SSME	
Thompson	Estina	CSR		
Thyagarajan	Chelvi	NINR		
Tian	Ying	AHRQ		
Trocki	Rebecca	AHRQ		
Walls	Carla	NICHD		
Washabaugh	Chuck	NIAMS		
Wedeen	Cathy	CSR	SSME	
Wilson	David	NHLBI		
Yang	Shiguang	NIDCD		
Zhou	Ruixia	NIBIB		

Table 5: IC SME Representation

IC	Total
AHRQ	3
Committee Mgmt	3
CSR	9
DEAS	7
NCCAM	2
NCI	5
NCRR	2
NEI	1
NHGRI	1
NHLBI	2
NIA	1
NIAAA	2
NIAID	3
NIAMS	1
NIBIB	1
NICHD	1
NIDCD	1
NIDCR	2
NIDDK	2
NIGMS	2
NIMH	1
NINDS	1
NINR	1
NLM	2
Grand Total	56

Table 6: Non-SME BPM Participants

Last Name	First Name	IC	Non-SME Role	Steering Committee
Brining	Sheryl	eRA	Co-chair	SC
Goodman	Mike	eRA	eRA	
Prenger	Valerie	NHLBI	RPC Liaison	SC
Rennolds	Michael	eRA	Modeler, Business Analyst	SC
Sheehy	Paul	eRA	Co-chair	SC
Shiuk	Eugenia	eRA	eRA	
Siegert	Mark	eRA	eRA	
Thomas	Angela	OCITA	Consultant	

Table 7: Schedule of Meetings and Major Milestones (all dates 2010)

Task	Time Frame	Deliverable
Assess/Evaluate existing peer review models	February	Preliminary draft of two peer review models from OCITA
Project kickoff, introduction to methodology	March	Introduction of the BPM methodology, strategy and goals to the SC, SSMEs, and SMEs (sequentially)
Identify comprehensive hierarchy of purpose-based peer review activities	March – April	Level 4 "WHAT" model development: categorize activities by purpose
Establish dependencies of level 4 activities in a sequential workflow model	April – May	Dimensionless "HOW" model at level 4 detail: put activities into a workflow
Identify inputs, outputs, roles and eRA-supported systems associated with level 4 activities	May – June	"HOW" model with dimensions: role, technology, and other inputs and outputs
Identify non-eRA supported systems associated with level 4 activities	June – July	"HOW" model with IC level extension systems added
Identify defects associated with level 4 activities	July - August	Prioritized list of areas of improvement associated with the peer review process (level 4 activities)
Summary of BPM findings	September	"evergreening Peer Review" white paper, glossary, metrics finalized

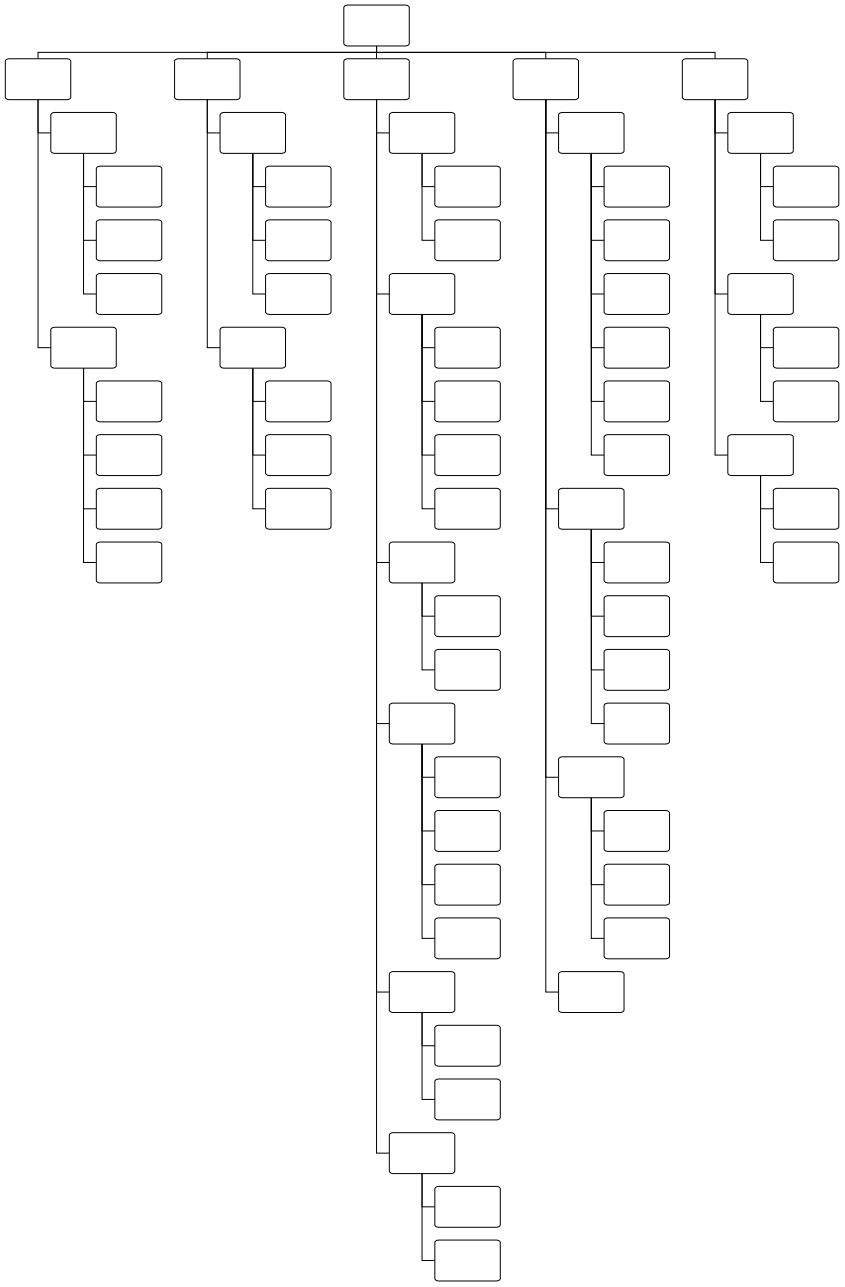
APPENDIX 2: TRANSITION IMPLEMENTATION TEAM

Table 8: List of Implementation Transition Team Members

Last Name	First Name	Area of Interest or Role on Team
Brining	Sheryl	BPM Evergreening Co-chair
D'Amico	Al	Architecture/SDLC Representative
Faenson	Inna	Co-Chair of BPM Transition Implementation Team
Goodman	Michael	Design/Development Representative
Howell	Donna	Business Analyst
Rennolds	Michael	BPM Business Analyst, Modeler
Seach	Jim	Architecture/SDLC Representative
Sheehy	Paul	BPM Evergreening Co-chair
Shiuk	Eugenia	Requirements Representative

Silver	Sara	Co-Chair of BPM Transition Implementation Team

APPENDIX 3: LEVEL 4 "WHAT" MODEL (best viewed at 200% zoom)



APPENDIX 4: QVR DATA COLLECTION PARAMETERS TO CALCULATE POTENTIAL SAVINGS

Data were drawn from QVR for review meetings held FY 2010, excluding ARRA. An assumption was made that all meetings would have been held for FY 2010 at the time of data collection. Data elements included:

- Numbers and types of meetings; numbers of applications; number of reviewers/meeting.
- CSR and non-CSR ICs
- Standing study sections and Special Emphasis Panels (SEPs)
- Activity codes include the following:

Table 9: Activity codes used in analysis of estimated savings

F	K	P	R	T	U	Other: D, G, I, L, S, X
F30	K01	P01	R01	T01	U01	D43
F31	K02	P20	R03	T02	U01	D71
F32	K05	P30	R13	T03	U10	DP1
F33	K07	P40	R15	T15	U10	DP2
	K08	P41	R18	T32	U13	G08
	K12	P50	R21	T32	U13	G11
	K18	P51	R24	T34	U18	G12
	K22	P60	R25	T34	U19	G13
	K23	PN2	R33	T35	U24	G20
	K24		R34	T35	U24	I01
	K25		R36	T36	U2R	L30
	K26		R37	T42	U34	L32
	K30		R41		U41	L40
	K99		R42		U42	L50
			R43		U42	L60
			R44		U44	S06
					U44	S10
					U45	S11
					U48	SC1
					U54	SC2
					U58	SC3
					U60	X01
					U90	X02
					UE2	
					UH2	

GATHERING the QVR DATA [16]

[16] This section provides a detailed explanation of how the data were collected and assembled (Carol Lambert, NCRR SRO, or Sheryl Brining, NCRR, can be contacted for more information).

QVR search (initial search):
To gather one fiscal year of data, we limited the QVR (Main) search to applications in Council Rounds 2010/01, 2010/05, 2010/08, and 2010/10. We then searched for applications by receipt date, based on the standard receipt dates for each Council Round as defined in NOT-OD-07-001, and included all applications received between May 1, 2009 and August 30, 2010. Searches were constructed to return fewer than 10,000 results each, as required by QVR. It is assumed that the vast majority of applications that will go to 2010/10 Council have been received by the end of August 2010.

A sample query included the following parameters:

Primary/Admin Projects Only
Councils = 201001, 201010, 201008, 201005
Competing Projects Only
Application Received
Application Received between 2009/05/01 and 2009/05/31
Application Types = 1, 2
Extramural Grants

Downloaded items included **Type, Actv, Project, IC, PI Name (Contact), Institution, Inst St, Mtg Classification, RevMtg Agenda, RevMtg Appls Cnt [this includes subprojects], Rev IC, ARRA Appl, Study Section, and SRG.**

Note: It would be preferable to exclude all ARRA apps in the initial search. We did the initial searches with ARRA apps included before we realized we would need to exclude them from the carts to get an accurate ROSSTATS report (see below).

ROSSTATS REPORT

A ROSSTATS report will give a reviewer count by meeting. We do not know any other way to obtain this information from QVR. To generate a ROSSTATS report, you will need to repeat the (Main) search as described above (excluding ARRA apps) and save the (Main) search results as Agenda Sequence Number carts. The Agenda Sequence Number uniquely identifies an instance of a peer review meeting on a specific date at a specific time and is the identifier we used to integrate the data from different searches and pivot tables for each individual meeting.

On the bottom of the (Person) search screen, select the Agenda Sequence Number carts saved in the previous step and run the search. This will retrieve a list of all the reviewers who served on the specified panels.

On the Download/Reports screen, select Review Meeting Roster Statistics (ROSSTATS). Select the download option for Roster Statistics by Council, IRG/SEP.

The information needed is on the ROSSTATS RawData sheet. Copy the RawData sheet to a new workbook. There are headers for **Council, Study Section,** SRO, SRO Email, **IC,** IRG Cluster, Cmte ID, Cmte/Panel Title, **Cmte Type, Mtg Agenda,** Mtg Start Dt, Mtg End Dt, Mtg Class, **Appl Cnt [this includes subprojects], Total Reviewers Cnt,** Appls Per Reviewer Cnt, REV link, ROS link, Reviewer Name,

Reviewer Title, Title Cat, Profile ID, ROS ID, Profile Inst, ROS Inst, ROS City, ROS Addr 1, ROS Addr 2, ROS Addr 3, ROS Addr 4, ROS Addr 5, Cmte Start, Cmte End, Cmte Mbr Type, Attendee Class, Attendee Role, Attendee Type, Reviewer Cnt, Rpt Header, Mtg Info, Country.

Make a copy of the RawData sheet in a new Excel file. Keep the columns listed here in blue and delete the rest. Remove duplicate meetings by clicking on Remove Duplicates in the Data tab; set the Agenda Sequence # as the item that should not be duplicated. This will give a list of unique meetings by institute, with the number of reviewers in each meeting and the number of applications (including subprojects). There is also a column for IRG or SEP. For our purposes, we converted all items listed as RG in the IC column to CSR, and all other items in this column (e.g., CA, DA, GM, RR) to IC.

PUTTING IT TOGETHER

To make the data a bit easier to handle, we separated the meetings from the initial search into chartered meetings and SEPS and copied the data into separate worksheets. We removed from each sheet the applications that were not affiliated with a Review Meeting Agenda # and did not have a meeting date.

The following were done separately with the data for the chartered meetings and SEPS:

To determine the distribution of grant mechanisms among the applications reviewed at each meeting as well as the total number of applications reviewed at each meeting (**not counting subprojects**), we constructed a pivot table that became the basis of the final results spreadsheet.

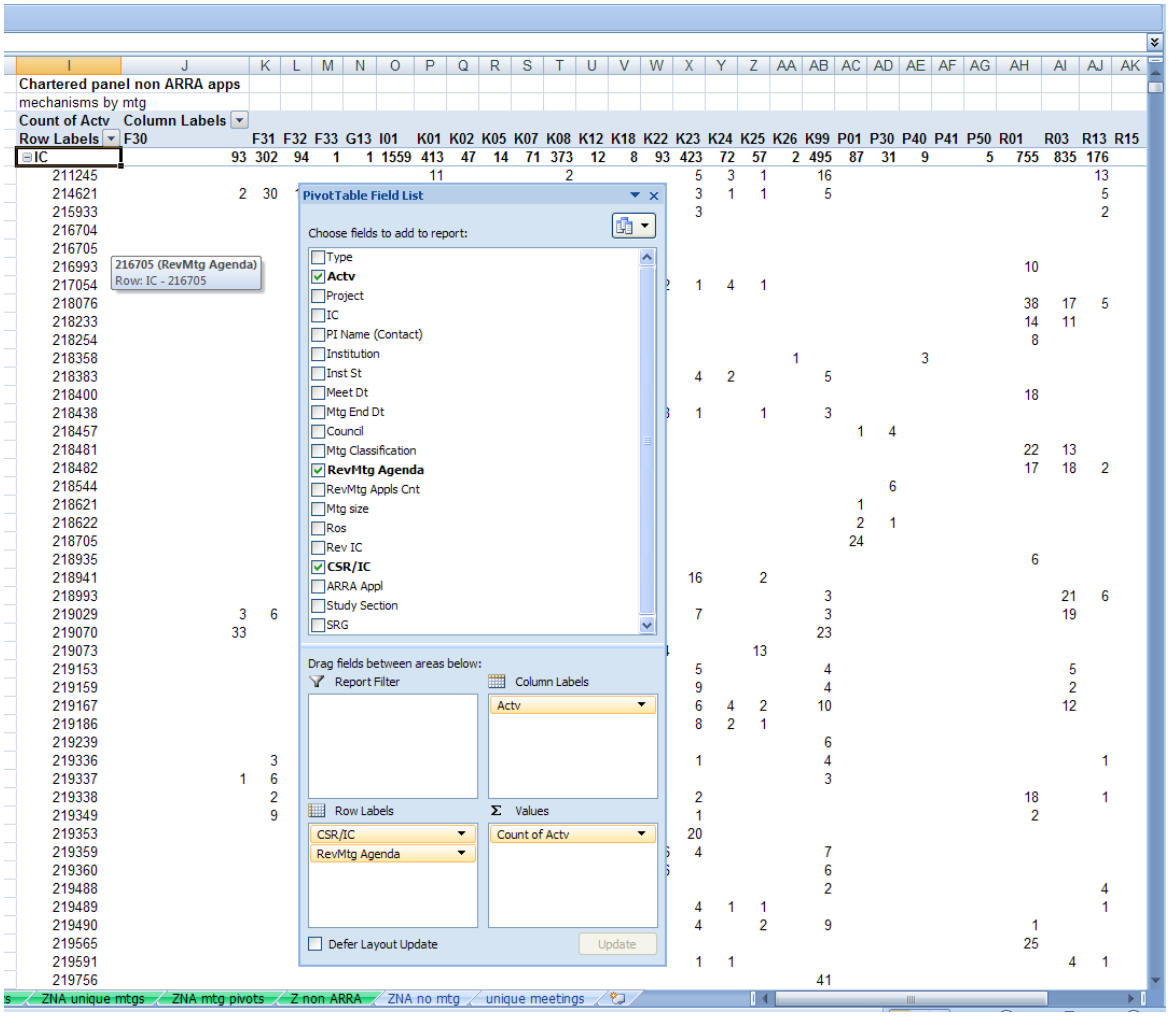


Figure 6: Example of pivot table menu and underlying data to determine the grant applications reviewed at a particular meeting (subprojects not included)

To determine the number of unique meetings by reviewing IC (IC or CSR), we removed all duplicates, based on Meeting Agenda #. We also removed the columns that identified the mechanism, the project #, the PI, and the institution. The rows that remained were the unique meetings, and each row included data about the Council, the Meeting Classification, the Agenda #, and the reviewing IC.

For the final combined data source, the data from all the searches were assembled in a single spreadsheet; here is an example of what this looks like:

Table 10: Final data sheet used to calculate estimated savings

IC or CSR	Agenda #	Council	Mtg class	App Total	App Cnt (incl subproj)	Reviewer Count	Mechanisms were entered in these and subsequent columns		
CSR	216086	201001	Regular	51	52	26			
CSR	216206	201001	Regular	8	9	8			
IC	217070	201001	Regular	1	20	44			
CSR	217575	201001	Regular	47	48	25			

IC	217717	201001	Regular	7	46	18			
IC	217718	201001	Regular	15	140	30			
CSR	217724	201001	Internet Assisted Meeting	13	13	7			
CSR	217853	201001	Regular	11	11	22			
CSR	217955	201001	Regular	8	8	14			
CSR	218062	201001	Regular	27	28	16			
IC	218180	201005	Telephone Assisted Meeting	1	1	4			
CSR	218195	201001	Telephone Assisted Meeting	4	4	9			
IC	218339	201001	Virtual Meeting	5	5	12			
IC	218340	201001	Regular	40	41	25			
IC	218345	201001	Regular	25	25	21			
IC	218346	201001	Regular	29	31	35			
IC	218371	201001	Regular	4	54	23			
IC	218372	201001	Regular	5	68	26			
CSR	218377	201001	Internet Assisted Meeting	27	28	58			
IC	218394	201001	Regular	1	1	31			
CSR	218398	201001	Regular	16	16	21			
IC	218422	201001	Regular	33	33	22			
CSR	218442	201001	Internet Assisted Meeting	11	11	9			
CSR	218443	201001	Site Visit	1	1	7			
IC	218540	201001	Telephone Assisted Meeting	1	7	6			
IC	218542	201001	Telephone Assisted Meeting	13	13	16			

APPENDIX 5: DATA QUALITY NOTES

QVR Data

- Reliable: numbers of applications; number of reviewers/meeting; separation by CSR and non-CSR ICs and by standing study sections and Special Emphasis Panels (SEPs); and activity codes
- Number of reviewers per meeting is probably mostly accurate; however, their classification as to type (regular, temporary, SEP member, etc.) may not be accurate since there is known variation in the data entered on this factor and categories of entry are not consistently interpreted.
- Types of meetings include regular, internet-, telephone-, or video-assisted, virtual, editorial board, hybrid, site visit, mail review. Numbers may not be accurate since there is known variation in the data entered on this factor and categories of entry are not consistently interpreted.
- Data on the number of components reviewed were collected as well, which likely has significant error because of the fundamental dependency on how the data are entered into IMPAC; most notably, not all ICs enter the sub-components in the peer review module even though each sub-component is separately assigned to one or more reviewers and represents a complex workload. Thus, it is highly likely any analysis containing this component is under-estimated.

SMEs Time/Activity Estimates

The other part of the savings calculations depends on how much time it takes to complete a certain task and the magnitude of the task. Metrics were collected from the SMEs (including SROs and ESA input and perspectives) on how long it currently takes to do certain tasks. The BPM Steering Committee members

reviewed these data to ensure realistic estimates; however, data collection relied on anecdotal estimates of the folks around the table and, although they are well experienced and representative of the peer review community, the data were not collected by a rigorous, systematic means.

Depending on the basis for the estimated savings, data were collected from the SMEs on how long it typically takes to process a certain task per application, per meeting, per type of application, as a few examples. As appropriate to represent differing views and practices, ranges of data were collected for some metrics.

Targeted Efficiencies

In addition to QVR data and activity metrics, the last part of the calculation included assumptions made about what would be a reasonable targeted percent decrease in the amount of effort to be realized given implementation of the improvement. In this calculation, SRO salary was represented by $100/hour and ESA salary as $50/hour; these figures are chosen for purposes of illustration and do not include total costs, including benefits, of an FTE position.

Table 11: Example from Table 2 that describes one of the estimated savings items

Activity	Existing Extension System Capability	Calculated Savings
Collect official file documents	None	$16,369

Activity: This activity occurs primarily in the final phases of the review process (Meeting Phase 3) and consists of completing the official committee management file and contains numerous documents gathered from the reviewers and IMPAC. Currently, this is a manual process, involving paper records, conducted by DEAS staff. Improvements could be realized with transition to electronic recordkeeping and storage.

Metrics:

- #s of meeting 2,619
- 30 minutes per meeting
- $50/hour DEAS salary
- targeted change: 50%

Formula: =2619*30/60*50*0.5, which works out to be a savings of $32,738

APPENDIX 6: AREAS OF IMPROVEMENT AND METRICS FOR SELECTED ACTIVITIES

OVERVIEW

The NIH Peer Review process has experienced considerable change from internal and external sources (EPR, eSubmission, increased volume and complexity of applications) since its supporting IT systems were designed. While changes have certainly been made over the years, the current system urgently

needs to be refreshed from top to bottom and this opportunity to introduce new functionalities should not be missed. Some measure of what improvements may be gained can be taken from the estimate of potential savings (Table 2). The thematic result of the savings analysis is the primacy of the need to develop new and more efficient means to find reviewers. Peer review is the foundation of the NIH extramural research enterprise and the expertise and management of conflict or bias is the foundation of the peer review process credibility. Numerous opportunities, some of which have been tested by individual ICs, exist to greatly facilitate the SRO's analysis of the application and search for relevant expertise. This analysis has identified many discrete opportunities to introduce specific features into the IMPAC Peer Review module. The greatest value of incorporating or interfacing these features into the Peer Review module would be the availability of these functionalities at an NIH enterprise level to facilitate more efficient data management. The following table lists all areas for improvement identified by the SMEs (partial list in Table 2).

Table 12: Detailed List of SME-Identified Areas for Improvements and Metrics Collected for Selected Activities[17]

ACTIVITY	IC EXTENSION SYSTEM or TOOL	DISCUSSION NOTES	METRICS	CALCULATED ANNUAL SAVINGS
Establish Physical Meeting Arrangements	SREA Hotel BPA	~15% meetings occur outside of BPA; should find out why and if the hotels could be enticed to participate in the BPA so review staff could avoid having to contact three hotels and go through purchase order process to secure hotel meeting/sleeping rooms	4 hours per meeting for non-BPA; minutes up to 1 hour for BPA 213 meetings (15% of 1,422 face-to-face and site visit meetings) $75/hour average of SRO/ESA salary since one or both may be involved 75% targeted reduction	$47,925

[17] Table continues to p. 54.

Identify Involved Personnel and Institutions	Reviewer Finder (NHLBI) Reviewer Support Site (RSS; NIAID)	Incomplete automated extraction of all involved personnel and institutions, particularly difficult for paper applications. Excel spreadsheet or other system used to add additional personnel, institutes lists from other sources. No systematic set of institutional relationships (e.g., CHOP/UPA vs. BWH/HMS). Getting information into IMPAC time consuming, duplicative effort in terms of record-keeping (SRO spreadsheet; IMPAC)	10 min per simple meeting; 30 minutes per P01 types; 3 hours for very complex 60,645 simple applications (80% of all) 841 P01/P20/P30/P50 297 U10/U54 $100/hour SRO salary 50% decrease targeted reduction for each time frame	$570,950
Determine Expertise Required	Reviewer Finder	Text mining would provide a "first pass" in characterizing the expertise from the application	15 min per component in complex applications 83,377 components (underestimated; not all ICs enter subprojects into IMPAC to do review) $100/hour SRO salary 50% decrease targeted reduction	$1,042,163

Identify Reviewer Pool	Reviewer Finder	IMPAC does not allow import from external sources; information management on potential reviewers inefficient in IMPAC	20,656 standing study section members, 1 hour each initially (not included in calculation) 28,365 non-standing study section members: 50% take 4 - 5 hr; 40% take 6 - 10 hr; and the last 10% can take 8 - 14 hr (lower estimates used in calculation) 3 invites/acceptance (broad generalization, could be many more or sometimes even less attempts per recruitment) $100/hour SRO salary 50% decrease targeted reduction	$22,124,700

Identify Conflict of Interest	Reviewer Finder RSS PubMed Macro (NIAID)	Time consuming and prone to missing information in identifying sources of conflict such as: institutional, co-publication, mentor/mentee, shared grants, commercial (consultation, contracts), network/consortium and other collaborations. Need better interface with IMPAC/IAR for reviewers at recruitment stage to help identify COI (recruitment screening tool is currently under development by eRA) Practices across ICs vary; policies hard to find.	30 min per simple application; 2 hours per complex application 60,645 simple applications (80% of all) 1,138 complex: P01/P20/P30/P50/U10 /U54 $100/hour SRO salary 50% decrease targeted reduction	$1,629,925
Invite Reviewers	RSS	Availability status in Commons; scheduling reviewer; finding contact information (data quality issue in IMPAC records); recruitment tracking; roster building (identify correct person and profile)	30 - 60 minutes per reviewer (calculated 30 minutes) 28,365 number of non-standing study section members (did not include standing study section members in calculation) $100/hour SRO salary 25% reduction targeted reduction	$354,563

Assign Reviewer to Application (add name to roster only)	SAM	The issue here is focused on creation of duplicate profiles, which occurs when review staff enter a reviewer profile in addition to a profile that already exists in the Peer Review module. This happens for a variety of reasons and is an ongoing problem.	10 minutes/reviewer profile 49,021 reviewers; ~40% are estimated to have duplicate profiles $50/hour ESA salary 80% reduction	$126,667
Establish Electronic Meeting Infrastructure **(e.g., send rosters to WTS)**	CSR has electronic system that automatically sends rosters to the travel contractor	Send original and updates when reviewers are added or deleted; if not done, results in reviewers unable to make their travel plans; phone calls and more effort to ensure updated roster is sent	1 hour per meeting 605 non-CSR, face-to-face meetings $50/hour ESA salary 100% targeted reduction (automate)	$30,250
Create Draft of Summary Statement	Summary Statement Macros (CSR and NIAID)	Macro not applicable across different activities, requiring additional template clean up; incorrect use of template by reviewers; missing reviews; adding late material amplifies issues; more than half the summary statements drafts are estimated to need special attention to formatting alone	10 min per simple application 2 - 8 hours per complex application (calculated 4 hours for complex) 60,645 simple applications (80% of all) 1,138 complex: P01/P20/P30/P50/U10 /U54 $100/hour SRO salary (did not factor in support staff time) 50% targeted reduction	$732,975

Collect Official File Documents		Extract existing information from IMPAC II into approved format, which may require collecting, printing, assembling documents	30 min per meeting 2,619 meetings (all meetings, FY2010) $50/hour ESA salary 50% targeted reduction	$32,738
Confirm Compliance with NIH Format Specifications		With shortened applications, checking page limits in paper applications and application content organization, fonts and margins (to ensure fairness) in all applications is taking a lot of time. The follow up can be problematic involving other staff as well, including program, referral liaison, and even IC leadership. Decisions hold up review processes such as checking conflicts of interest. Need better, automated checking systems.	Not calculated; likely there are highly variable processes across ICs	
Determine Scientific Compliance	Checklist (not application checklist, but a unique list created by the IC based on the FOA)	Text mining may help: search for "must" and "shall", exclude boilerplate, as appropriate	Not calculated	

Establish Electronic Meeting Infrastructure	CSR Internet Assisted Meeting (IAM) CSR Out-of-Town Meeting (OTM) tool	IAM transfers data from IMPAC to populate screens for SROs and reviewers in web-supported "chat" meetings OTM provides a way for SROs and reviewers to provide feedback on the hotel and other features of meeting out of town; would be desirable to do this for all hotels, local and non-local, with functionality available to all ICs	Not calculated	
Notify Public [FRN]		Late FRNs put NIH at risk for running meetings that are not FACA-compliant	Not calculated	
Screen Reviewer Pool		Includes identifying conflict of interest (metric calculated); additional screening factors include current service on other review committees or Advisory councils and balancing the SRG committee for institutional, geographic, minority, gender, and other elements.	Not calculated	

Match Review to Applications **Assign Reviewer to Application** **Balance Reviewer Workload**	Reviewer Finder RSS	Inconsistent, incomplete, or inaccurate definition of reviewer expertise SRO draft assignment matrix should include/balance expertise, workload, conflict, reviewer schedule and other factors Workload/scheduling issues	Not calculated (too many variables to estimate)	
Provide Guidance to Reviewers	RSS	Multiplicity of information sources Reviewer communication tools needed Reviewer training: standardize communication plans and find efficient approaches to orient	Not calculated	
Ensure Reviewers Present Critiques	Internet Assisted Review (IAM) Real Time Meeting (CSR)	Part of this is to keep on schedule and keep program staff informed (CSR tool to do this but not used in other ICs) The other part is to ensure reviewers submit critiques and partake in deliberations, particularly in virtual meetings; IAM helps with this, but is not customizable or with support available to non-CSR ICs who may adopt it	Not calculated	

Obtain Critique		Missing critiques: how to ensure timely submission and complete critiques are obtained from reviewers In preparing template shells, difficult to add/delete appropriate/inappropriate sections; insert custom or boilerplate language	Not calculated	
Obtain Reviewer's Score	PRS Interwrite Peer Review System	Enter/update criterion scores is not efficient for reviewers, particularly during meeting Only five criteria slots available, so IAR scoring does not work well if there are >five criteria to be scored. Non-numeric scores not accepted. Lack of back-up or verification for reviewers for online scoring during the meeting FOA-configurable score sheets that reflects specific criteria	Not calculated	

Produce Summary Statement (upload into IMPAC)		Lack of fidelity for special characters between what is uploaded (Word document) and IMPAC draft Cannot make corrections directly in IMPAC, necessitating multiple uploads of edited drafts During peak times, period to upload may be lengthy to generate a draft summary statement in IMPAC and there is poor monitoring/reporting status available to the SRO ESAs would like ability to do batch upload of Word summary statement drafts	Not calculated	

APPENDIX 7: Peer Review BPM Glossary Notes

The glossary contains ~250 definitions and can be found on the Sharepoint[18] site.

DEFINITIONS

Definitions are specific to the model. Whenever possible, definitions were quoted from official sources, but only the portion of the definition that applied to peer review generally was used. These model definitions are not sanctioned or vetted at an NIH enterprise level. Rely on these definitions to understand the BPM model, not as an official NIH resource. The Resource Links attached to the definition reference official sources.

INPUT/OUTPUT DIMENSIONS

WHO: Roles (many) and Organizations (only one, Advisory Council)

WHAT/WHICH: All other entries that are not WHO or WHEN; includes Technology Resources; artifacts (tangible things that are created, such as reports); entities (tangible things that already exist such as)

WHEN: Although the entire peer review process is constrained by time boundaries (defined as a council round) that begins with the receipt of applications on a due date and ending with the advisory council meeting, only two time constraints are built into the model: (1) the Federal Register Notice must be published no later than 15 days prior to the peer review meeting and (2) appeals of the initial peer review must be received no later than 30 days after the council meeting. No other time constraints are indicated in the model because the activities within the defined council round boundaries can happen on varying time scales.

ACTIVITIES THAT SPAN LARGE PORTIONS OF THE MODEL AND CAN ARISE ACROSS A BROAD TIME SPAN

Establish Fiscal Obligations: path starts at time services are contracted (e.g., hotel, shred, teleconference) and ends after the meeting when expenses related to the meeting are concluded; see Process Fiscal Obligations for final step in this activity.

Notify Public (FRN): The path begins at time of setting up the SRG meeting once the required information is known, e.g., time, date, place of meeting. The Federal Register notice must be published no later than 15 days prior to the start of the meeting, so the path ends prior to start of the SRG meeting.

Conflict of Interest: Identify, Manage, Obtain Waiver, and Document Activities: These activities may be executed at any time after an application assignment to the IC/IRG has been confirmed and, by definition in the model, end at release of the summary statement. Activities broadly include management of reviewer, NIH staff, and SRO/DFO potential conflicts, which are completed by the end of

[18] http://enterprisearchitecture.nih.gov/ArchLib/AT/BA/GrantsPeerReview.htm

the meeting. Manage Allegations of Conflict of Interest are not on this path, but are defined in the model as part of the appeal process after release of the summary statement.

Coordinate with Chair: Coordination with and instructions specific for the SRG Chair path starts at time of recruitment of the chair and may continue until the completion of the meeting. In the model, the path starts after assignment of reviewers, but it is recognized that interactions with the chair may begin well prior, at the time the meeting date is being established.

Guide Review Participants: The path formally begins once review materials are transmitted to the review participants and continues until the application scores have been published and all critiques have been received. Informally, SROs provide guidance to applicants, NIH staff, and reviewers at any time as part of their position duties.

Report Allegations: Research misconduct allegations may be reported at any time after review materials are transmitted to the review participants, usually arising from reviewer communications to the SRO/DFO. The path ends at time summary statement is released since, with the exception of possible appeal/council issues, the SRO duties generally are over in terms of who should be communicating with the extramural community; any research misconduct issues that arise at that time would fall under the purview of program staff.