

## Executive Summary

This Report, developed from the Strategic Development Council's (SDC) Accelerating Technology Acceptance (ATA) Project summarizes many of the perceived obstacles to accelerating technology acceptance (Section A). Consistent with the *Vision 2030: A Vision for the U.S. Concrete Industry*, this Report provides specific recommendations that focus on significantly improving new technology acceptance.

This Report represents the concerns of a diverse group within the concrete industry who participated in the ATA Project (Section B). Participants expressed a wide range of opinions on the twenty-seven broad topic areas; the opinions covered the spectrum from maintaining the status quo to making fundamental process changes. However, the majority believed that proactive resolution of the issues presented within this Report (Section C) is necessary to accelerate technology acceptance and assure concrete remains the construction material of choice.

New technology acceptance is impacted by a "push-pull" dynamic. It is pushed by developers and champions, pulled by market demands, and affected by resistance factors across the various channels from inception through marketplace acceptance. Improvements can be made in all areas of this "push-pull" dynamic. The technology developer has to provide a well-written, technically supportable report as the first step in the standards development process. The concrete industry's Standards Developing Organizations (SDOs) need to analyze and facilitate improvements to the technical review, approval and acceptance process. (Since ACI is the dominant SDO in the concrete industry and since its process is familiar to most ATA Project participants, it is used in this Report to represent SDOs.) Collectively, we must reduce the negative impacts of market forces such as inconsistent application of codes, specifications, reports and guides by various governmental jurisdictions, competitive practices within the concrete industry, and liability issues.

To provide the greatest foreseeable positive impact to the industry, the SDO process needs production improvement. From initial document preparation through the inclusion into the codes, specifications, reports and guides, the key technologies of the industry require continuous management as they are processed through the SDO system. The proposed SDC Technology Mentoring Committee (TMC) could provide this management, mentoring and facilitation from beginning of a proposed solution through introduction of the document or process into the SDO system. Once it is in the SDO system, the TMC will monitor progress and provide any requested facilitation and mentoring.

The proposed TMC will identify and develop management plans for the critical technologies (Industry Critical Technologies) that have the greatest potential impact on the concrete industry. Once the plans are created and the consensus approach is developed, the TMC, working with the SDOs, will facilitate and mentor the technologies through the SDO system. Planning, communication and resourcing are the three main thrusts of the TMC. It is envisioned that the TMC will provide a framework for positive leadership of advancing technology acceptance within the SDO system.

## Recommendations

ITEM	RESPONSIBLE ENTITY	REPORT ITEM REF. (SECTION. C)
1. Advertise the pathfinder services the Standards Developing Organizations (SDOs) have available to technology developers.	SDOs	1.1
2. Technology developers must learn the systems of the various SDOs.	Technology Developers	1.1
3. Develop and/or improve programs to train and educate technology developers about SDO processes	SDO	1.2
4. A Technology Mentoring Committee (TMC) representative should be tasked to work with technical committee chairs concerning inquiries from technology developers.	SDC	1.3
5. Technology Activities Committee (TAC) should support the creation of a working relationship between technical committee chairs and the TMC representative concerning technology inquiries.	TAC	1.3
6. Continue facilitation and hosting of industry strategic planning sessions.	SDC	1.3
7. Create a Technology Mentoring Committee and a process to develop strategic plans for each "Industry Critical Technology."	SDC	2.1, 2.8
8. Create and maintain an annual list of the "Industry Critical Technologies" identified by respondents from a survey that uses the ACI database of over 40,000 industry members.	SDC	2.1
9. Maintain a real-time status of action items, objectives and goals from each plan associated with an "Industry Critical Technology."	TMC	2.1
10. Coordinate with SDC and other entities to provide the necessary resources to complete all plans associated with "Industry Critical Technology" items.	TMC	2.1
11. Work with other entities (including SDOs) to coordinate the development of items identified in the plans for "Industry Critical Technologies."	TMC	2.1
12. Facilitate the transfer of completed committee products, training tools, etc. to the EAC and certification committees for faster introduction into the marketplace.	TMC	2.1
13. Create Accelerating Technology Implementation (ATI) teams for each "Industry Critical Technology."	SDC, TMC	2.1
14. Review the American Concrete Institute (ACI) committee structure and reduce the number of actively engaged committees to an efficient minimum.	ACI Board, TAC	2.1
15. Provide the SDC a copy of the annual report from each technical committee that is involved with one of the "Industry Critical Technologies."	TAC, ACI staff	2.1, 2.8
16. Provide time on the TAC agenda for the SDC/TMC to update the TAC on the status of "Industry Critical Technology" plans during the two annual ACI conventions.	TAC	2.1

ITEM	RESPONSIBLE ENTITY	REPORT ITEM REF. (SECTION. C)
17. Require members of the TMC to sit in on open TAC sessions in order to better understand the process.	SDC	2.1
18. Place a TAC liaison to every ATI team.	TAC	2.1
19. Create an institutional mindset within ACI whereby documents or process changes associated with the strategic plans of the "Industry Critical Technologies" are managed in the same time-sensitive manner used for ACI 318 updates.	ACI Board, ACI staff	2.1
20. Rewrite Chapter 5 of the ACI Technical Committee Manual 2003 to change the procedures on TAC review of documents. One suggestion is to amend TAC's process so that only specific changes are under review unless there is a critical error impacting life/safety that requires immediate correction.	ACI Board, TAC	2.2, 2.10
21. Encourage the use of compensated consultants to assist committees with report development.	ACI Board	2.2
22. Expand the ACI technical staff to provide more technical editing services for committees.	ACI Executive Vice President, ACI Board	2.2
23. TAC should assume a "ways and means" or gatekeeper function to determine if a technology is ready to enter the ACI process.	TAC	2.3, 2.14
24. Improve internal committee and cross-committee communications such as using virtual meetings, creating a call center, continuing to educate and promote use of the web site, encouraging more meetings between conventions, and adopting processes used by ASTM that promote accelerated completion of documents.	ACI Board, ACI staff, TAC	2.4
25. Create and enforce standards for committee performance.	ACI Board, TAC	2.5
26. Provide training to all committee members and orient them on the critical nature of their work, to include the necessity for punctuality as defined by the market.	TAC, ACI staff	2.5
27. Committees should rely upon standardized tests (ASTM and others) to qualify products or, in the absence of testing, independent appraisals of client claims about product performance.	TAC, ACI Technical Committees, ASTM	2.5
28. Create incentive systems to motivate committee participation.	ACI Board, TAC	2.6
29. ACI should work with other organizations to develop procedures for committees to develop sources and controls for direct and indirect funding from members, technology developers, and others interested in facilitating the production of documents.	ACI Board, ACI staff, TAC, SDC	2.6
30. Increase the use of qualified staff assigned to key committees.	ACI Executive Vice-President, ACI Board, ACI staff	2.6
31. Criteria for selection and ratification of committee chairs should include validation of performance oriented leadership training along with continued training to develop this skill set.	TAC, EAC, CPC	2.7

ITEM	RESPONSIBLE ENTITY	REPORT ITEM REF. (SECTION. C)
32. A procedure needs to be developed pertaining to the selection/retention of Committee chairs based upon their demonstrated technical, communication, managerial and facilitation skills.	TAC	2.7
33. Committee chairs should attend the entire open portion of a TAC meeting in order to better understand the process.	TAC, Committee Chairs	2.7
34. Strengthen and enforce procedures that prevent or redress inappropriate blocking strategies related to new technologies.	ACI Board, TAC, ACI Committees	2.9
35. Committees need to release interim, mid-cycle approvals and reports as they are completed. TAC should support this process by providing corresponding timely reviews.	TAC, ACI Committees	2.10
36. Develop an operational roadmap and project plan to chart and manage each document handled by committees.	TAC, ACI Committees	2.11
37. Committees should be directed to allocate time in their schedule for technology users to relate market expectations pertaining to various technologies.	TAC, ACI Committees	2.11
38. Develop a forced consensus process for documents that would mandate a prescribed timeline for document completion and updates. This would include development of a process to allow for subsequent revisions/updates without a total committee rework.	ACI Board, TAC, ACI Committees	2.11
39. Realign ACI staff to provide greater support and resources for document preparation and updates.	ACI Executive Vice President, ACI Board	2.12
40. Adopt a system (patterned after Rilem or PCI) or enhance the Innovation Task Group (ITG) process to fast track technology items.	TAC	2.12
41. Provide ACI staff support to work with non-ACI entities to determine activities, trends, etc. in these other organizations that can be communicated to ACI committees.	ACI Executive Vice President, ACI Board, ACI staff	2.13
42. Include ASTM in document preparation to concurrently develop tests.	ASTM, TAC, ACI Committees	2.13
43. Encourage the use of qualified outside certifications, appraisals and endorsements for new technologies.	TAC, ACI Committees	2.13, 2.14
44. Support and lead efforts to develop consensus on a body of performance predictive criteria.	ACI Board, ACI staff, TAC	2.14
45. Adopt the use of European Standards Test Methods to meet US industry needs.	TAC, ACI Committees	2.14
46. Encourage efforts to develop standardized methods of test performance.	TAC	2.14
47. Establish educational programs and procedures to better assure the body of defining standards for technological advances keeps committee members current.	EAC, ACI Committees, all participants in the industry	2.15

ITEM	RESPONSIBLE ENTITY	REPORT ITEM REF. (SECTION. C)
48. SDC and the trade associations need to increase educational efforts to reduce the negative impacts of industry infighting	SDC, industry trade associations	3.1
49. Support collaborative research efforts, strategic development and common initiatives.	SDC, industry organizations, industry participants	3.1
50. Participate in responsible unified political action models (such as the "Political Partners for Concrete Progress").	SDC, industry organizations, industry participants	3.1
51. Work with industry members to equitably spread warranty exposure and to improve the impact of warranties for concrete.	SDC, industry organizations, industry participants	3.2
52. Develop and incorporate performance based criteria into industry standards and specifications.	SDC, TAC, ACI Committees, industry SDOs, industry participants	3.2
53. Develop guidelines for risk management with respect to various project delivery systems.	ACI Board, SDC, industry trade associations	3.2
54. Assist in the development of acceptable durability test methods.	TAC, ACI Committees, ASTM, industry participants	3.2
55. Create a performance division within ACI to construct a body of specifications for performance specifiers.	ACI Board, TAC	3.2
56. Formalize reciprocity programs with non-US research and testing entities.	Industry SDOs, ACI	3.3
57. Encourage initiatives that promote standardized acceptance of codes, specifications, regulations, etc. throughout all municipalities and states.	Industry SDOs, industry trade associations, industry participants	3.4, 3.5
58. Create and market continuing education initiatives that increase civil engineers' understanding of chemical processes. Coordinate with professional engineer licensing entities in each state to encourage adoption of this education.	EAC, ACI staff	3.7
59. Support efforts advocating fair comprehensive Federal legislation to provide greater liability protection for concrete designers, producers, contractors, owners, SDOs and other entities subjected to liability laws.	ACI Board, SDC, industry trade associations, industry participants	3.8

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The following members of the concrete industry participated in the development of this document:

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## Focus

The Advancing Technology Acceptance (ATA) Project was commissioned by the Strategic Development Council (SDC) in May 2002 to address the fifth goal of *Vision 2030: A Vision for the U.S. Concrete Industry*: "By 2030, the industry will reduce the time required for new technology acceptance to two years."

During the process, many of the industry's frustrations created a boil due to the various opposing effects and views. To those industry members that participate in the creation and maintenance of technical standards and codes, the idea of accelerating the flow of new technology has opposing effects. On one hand, a responsive system knows that keeping pace with competing materials groups is the only way to ensure concrete's position as the construction material of choice. On the other, it is the nature of an established consensus-based system to move cautiously, which has a decelerating effect. Likewise, to the concrete industry's innovators, the thought of navigating an SDO's system also has opposing effects. On the one hand, innovators take comfort and gain confidence from peer review, even though some may view the system skeptically and as a barrier to expediency. On the other, innovators sometimes do all they can to avoid delay in getting their technologies to market, even though shortcuts can hurt them. Fortunately, the process also enabled some venting to occur.

The intent of the ATA Project is multi-faceted. The first two facets have been accomplished with the publication of this Report. The other three facets require future events. The facets are: 1) the SDC facilitated meetings and workshops that identified the current processes and dominant issues that appeared to serve as unnecessary impediments to advanced technology acceptance; 2) the SDC developed suggested approaches to remove these impediments; 3) the SDC approaches need to be discussed and refined by the industry's SDOs and industry participants; 4) support for these approaches must be gained; and 5) an implementation plan for each approach must be developed and implemented.

This Report focuses on the first two facets of the intent. It presents the concrete industry's primary current technology acceptance process. It identifies many factors that hinder advanced technology acceptance and it offers general recommendations designed to reduce the technology acceptance cycle.

The third, fourth and fifth components of the ATA Project's intent will remain a continuing SDC-led industry focus and priority. Publication and dissemination of this Report, along with a continuing emphasis by the SDC, will help refine the approaches and gain industry support. The implementation plan will be developed, led and managed using the SDC as the catalyst for change. The guiding principle is to create and implement potentially better, less expensive and faster technology acceptance practices for the concrete industry that do not diminish the quality of the end process.

## Definitions

In order to understand the focus of this project, it is necessary to define "technology" and "accelerating technology acceptance."

*Technology is knowledge manifested in the process, product, system, design practice, or construction practice in one of the following seven stages of development:*

1. Existing technology no longer used, i.e., obsolete.
2. Existing technology successfully used, i.e., currently satisfactorily applied.
3. Existing technology in use but with limitations requiring improvement.
4. Existing technology developed but not yet in practice, i.e., emerging.

5. *Conceptual technology undeveloped.*
6. *Recognized technology need, no solutions established yet.*
7. *Unrecognized need, undiscovered technology, i.e., unknown unknowns.*

ATA mainly focuses on Stage 3 and Stage 4 technologies due to the economic benefits for the industry in terms of efficiency and quality improvements. Accordingly, ATA's first two workshops considered examples of technologies from these two categories. The ATA Modeling Workshop focused on technologies that took a long time to move through the technical review process. The ATA Roadmap Workshop did the same for present examples. The Roadmap Workshop honed in on technologies currently used but needing improvement, developed technologies still becoming generally accepted, and technologies that are under consideration by ACI or technologies that should be under consideration by ACI technical committees.

A few of the technologies identified in these workshops were:

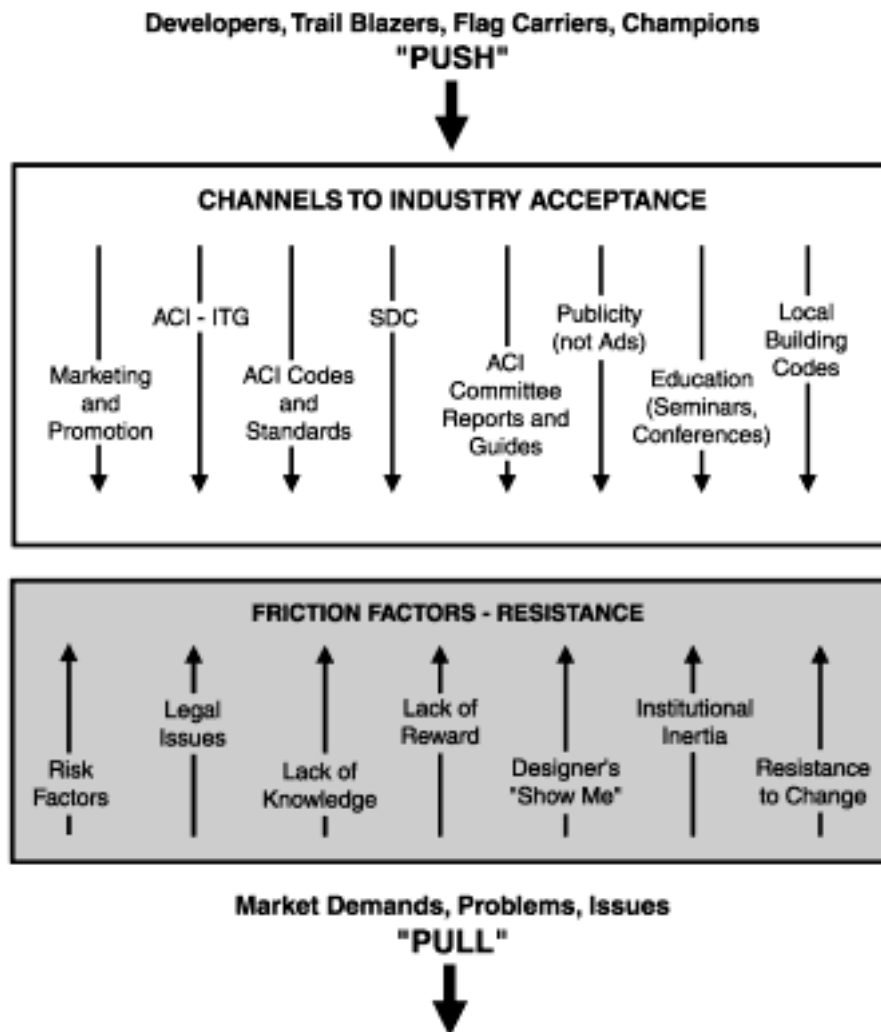
1. Self Consolidating Concrete (SCC) Guide from ACI Committee 237. The SCC committee was formed in 2002, and the initial document is still in committee.
2. Life 365 is a software product. This is not an ACI committee product, but the parties involved have used "365" as a marketing descriptor for this life cycle calculation. There is concern about a possible proprietary nature for this approach.
3. Insulated Concrete Forms (ICF) from ACI Committee 332. ICF technology was around for twenty-plus years but not mentioned in ACI committee documents. The Committee 332 draft code included design provisions for ICF, but TAC removed them from its review due to a TAC perception that the document lacked a rational design approach. An ACI ICF committee will be officially created in the summer of 2004.
4. Corrosion-Resistant Reinforcement. Committee 439 has considered the claims and has not come to consensus on them.
5. Flooring System Issues are primarily addressed through ACI Committees 302 and 360. Specifically, the issues involve floor moisture and flatness, both of which impact floor covering performance. These problems have persisted for years. Only in the last few years, due to the leadership of a few concerned individuals, has the industry as a whole tried to resolve the issues.
6. Fiber Reinforcement in ACI Committee 544. Committee documents have been published for twenty years, but other committees (e.g., 332, 302, 360, 318, 550, and 553) have not incorporated this technology. Fiber reinforced concrete technology is not recognized in ACI 318 Building Code because there is a belief that this technology does not readily lend itself to structural applications.
7. Practice for Proportioning Concrete in ACI Committee 211. The revisions to this document are currently stalled; this has been a ten-year effort with no completed deliverable.
8. Performance-Based Specifications. ACI Committee 301 is responsible for writing the main reference specification for the industry; it is not actively drafting a performance based specification. The rest of the industry started performance-based specifications in the early 1980's, whereas the concrete industry is just now getting this initiative underway.
9. Pervious Concrete. ACI Committee 522 was formed in 2001, and the initial document for pervious concrete is still in the committee.
10. Management of Returned Concrete and Wash Water. No committee is addressing this important environmental issue, though there are indications that ACI would entertain creation of a committee to examine this issue.

11. Sustainable Concrete Construction. As an industry, we did not see the impact of the "green building" movement. Nor did we understand how misperceptions or deliberate attempts by other industries negatively impacted the use of concrete as a sustainable material (even though the argument can be made it is the best material from a life cycle cost and performance perspective).
12. Performance-based cement specification. This is primarily an issue within the purview of the American Society of Testing and Materials (ASTM). ASTM C595 has performance specifications, but it is not widely used.
13. Bonded post-tensioning systems. ACI 318-05 has provided more regulation of the use of the system.

ATA is defined as: *a systematic approach to overcoming the friction factors inherent in the current industry acceptance process that resist the proper advancement of technology from those who develop it to those who need it in the construction marketplace.* Figure 1 depicts the flow of technology and illustrates the most common channels and friction factors.

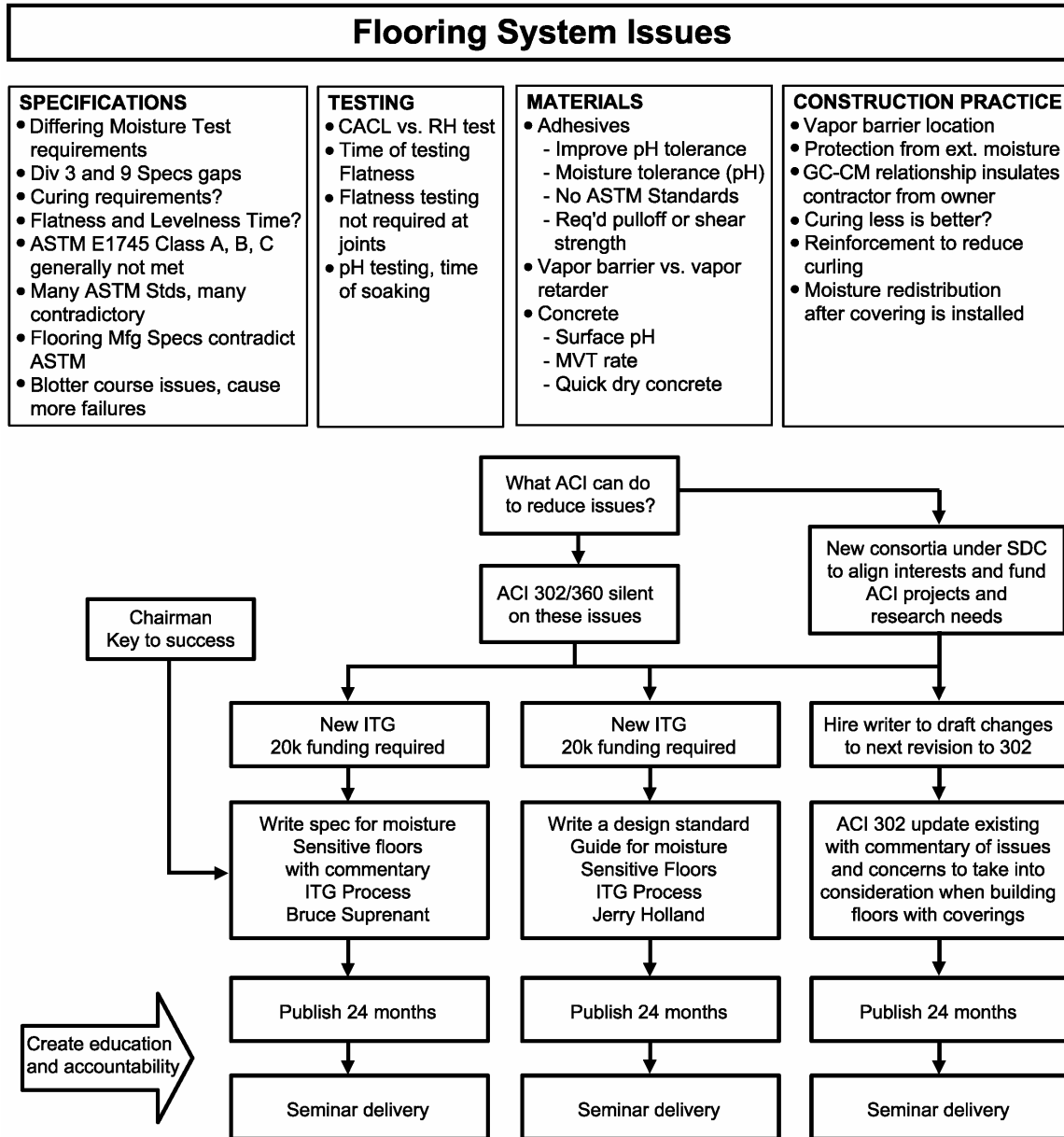
### TECHNOLOGY ACCEPTANCE IN THE CONCRETE INDUSTRY

(Figure 1)



The concrete flooring industry represents a contemporary example of the need to improve presently accepted design and construction practice. At a broadly attended April 2003 inter-industry meeting of concrete and floor covering organizations, concerned representatives from those industries identified critical improvements needed in the current practice of specifying, testing, constructing, and manufacturing floor systems. Accelerating technology solutions through the SDOs is critical because of the enormous impact these improvements have to a huge user base—fewer failures, less litigation, and happier owners. Figure 2 outlines a process for speeding up the acceptance of new flooring system technologies just within ACI.

**Activity Flow Chart for ACI Involvement to Resolve Some of the Flooring Issues (Figure 2)**



During the inter-industry working group meeting, one topic of discussion was the annual financial impact to industry/society of unresolved issues relating to flooring procedures, materials and education; the conservative estimate was over \$1,000,000 per week.

## Obstacles and Solutions

The challenge for all developers, reviewers, or users is to bring innovations to market as rapidly as possible without bypassing or compromising due process of technical review. However, if the review process itself stands in the way of progress, it cannot be above evaluation and change. A large constituency believes that unless the concrete industry streamlines its process for technical review, concrete risks the erosion of its position as the world's construction material of choice. This theme is presented with the following twenty-seven areas categorized within the three main forces of technology developers, SDOs and market forces.

### 1. TECHNOLOGY DEVELOPER OBSTACLES AND SOLUTIONS

- 1.1 **Technology developers fail to understand that any SDO system does not exist to promote their product or process.** This is the number one problem regarding technology developers. The technology purveyors fail to understand it is their responsibility to be the champion for the product or process and provide the necessary leadership to make this successful.

*Virtually all disputes between technology developers and SDOs come from unreasonable expectations by developers arising from an incomplete understanding of the process and the role each entity has in the process. The SDO's system is not a champion for any technology developer's innovations; that role must be taken by the technology developer. It is imperative that the technology developer create a plan that works within the SDO system to push the technology through the system. The SDC through the proposed Technology Mentoring Committee (TMC) will be able to assist the technology developer with this plan.*

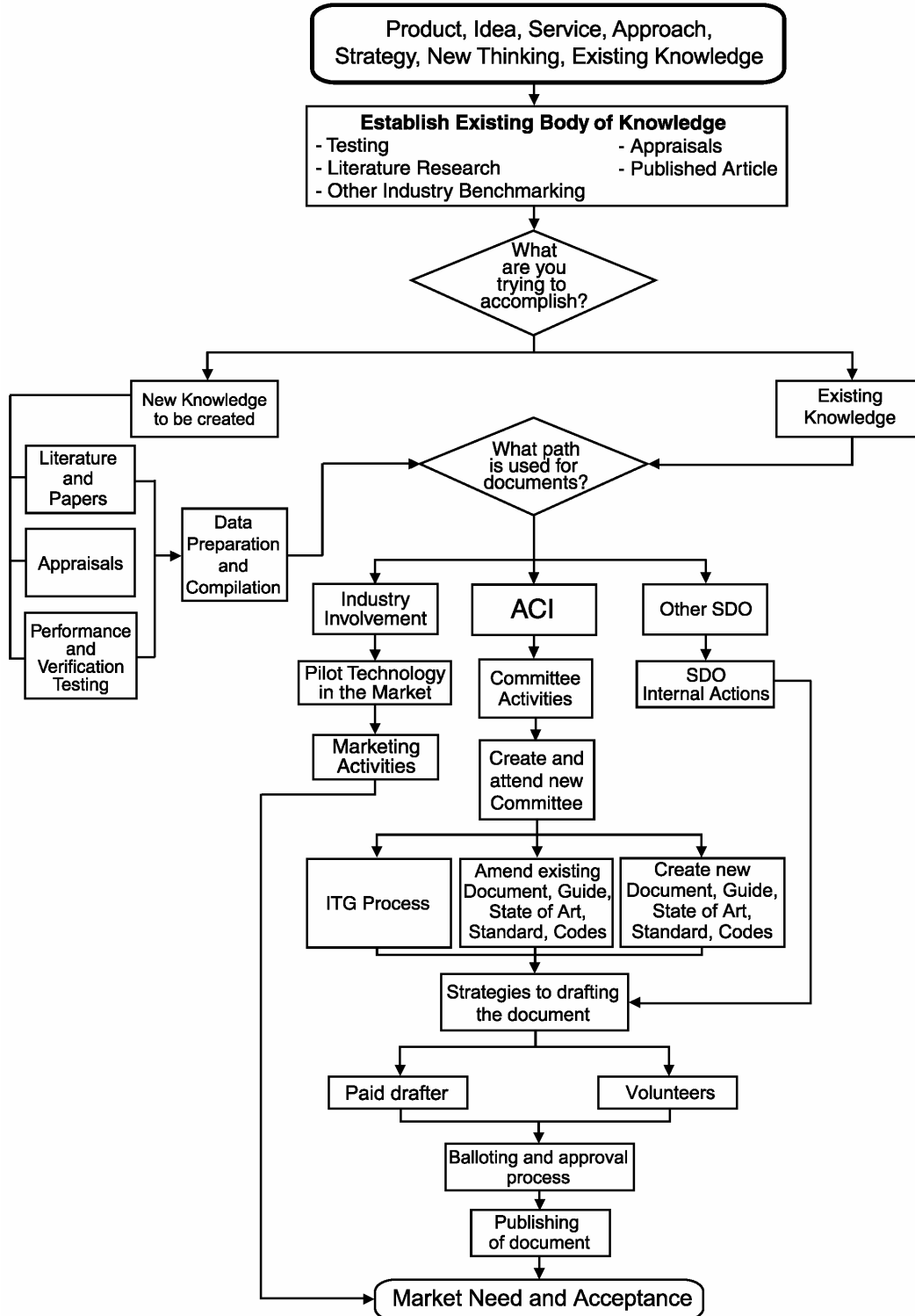
*Understanding the SDO's system is the first step. There are many existing resources within SDOs to provide assistance; most SDOs have a technical department that will explain how their process functions (such as the ACI Engineering Department Staff). Additionally, the technical community has a plethora of qualified, ethical and knowledgeable private consultants who can assist the developers with the technical review system. It is the purveyor's responsibility to learn the process, chart a responsible course, and take steps to properly advocate for its technology.*

- 1.2 **Technology developers fail to understand the SDO's process for technical review.** Not all innovations require technical review for code approval on the path to market use, yet many new technologies (particularly those that present radical change rather than mere improvement) involve review by ACI and other SDO's technical committees. These committees are either not known or not respected by technology purveyors; the developer's lack of knowledge about the committee consensus process leads to many misunderstandings and misperceptions. When the realities of delay set in for the developers, unjustified frustrations with committees often turn into disputes that spill over into public view, polarizing the technical community and accomplishing nothing. In general, technology "pushers" are more locked onto the "pull" of the market than the realities of the channels to the market.

*For technologies that must move through the system in order to gain the market's acceptance, Figure 3 shows the current process for ordered flow into the pool of existing knowledge in current and emerging documents. ATA seeks ways to work within this system*

*and improve it where needed to accelerate the flow of technology acceptance.*

**Current Process Flow Chart for New Technology Acceptance and Existing Knowledge into Current Documents (Figure 3)**



*The SDOs should develop better programs to educate technology developers about the technical committee review process and should strongly support committees and councils dedicated to this task. Specifically within ACI, developers should know that many ACI functions, such as the SDC, exist to help legitimate developers of concrete technology. Technology purveyors need to know there are entities that exist for the purpose of accelerating technologies that can prove themselves viable.*

*The SDOs should teach developers of new technologies that, although SDO action of one sort or another may be desirable for moving technologies along, SDO references are not always needed to allow their innovations to be tested and used. The technology developers must remember that the SDO committees are interested in the science behind innovations, not the innovations themselves.*

- 1.3 Technology producers fail to understand the market for their innovations and the market forces in play.** Technology developers often have unrealistic market expectations for their innovations, and when their offerings fail to “catch on” quickly in the industry, they take their frustrations out on the SDOs. In contrast to Item 1.1 where the review process is misunderstood, these developers significantly understand the process but fail to grasp why the market is reluctant to adopt their innovations and/or fail to have business and financial plans in effect to sustain them for the time needed for market acceptance. They often lash out at competitors on committees to whom they have disclosed their innovations during normal reviews and accuse them of poisoning the market or rushing the introductions of their own competing technologies. In short, their enthusiasm overshadows a rational view of how the market will receive their technologies, the forces that affect market receptivity, and any fair sense about the commitment required for the long haul.

*ACI, which sits on many technology developer’s critical paths, cannot be expected to work to a developer’s schedule. Still, there are many things ACI can do to help developers mitigate their schedule risks. One is to provide support that helps developers plan for the long haul. A representative from the proposed SDC Technology Mentoring Committee should be assigned to each technical committee involved with an “Industry Critical Technology” and work with committee chair on inquiries from technology producers. At times, technologies turned down for committee consideration needlessly languish. A proactive approach would schedule the technology for consideration at a later date or refer it to a more appropriate committee for action.*

*In a broader sense, strategic planning exercises that led to the SDC’s research-oriented strategic Vision-2030 and operational Roadmap-2030 are invaluable for industry planning. Several concrete industry trade associations have adopted parts of these documents in their strategic plans. The result has been a more unified industry with a greater sense of purpose. This, in turn, has resulted in less squabbling among interest groups within the industry and less uncertainty on the part of developers. One Federal agency actually justified its budget request for concrete research with the coordinated R&D plan, Roadmap-2030. This approach encourages technology developers who depend upon outside funding (government or other) to focus on programs that the industry has already prioritized. This*

*should increase the likelihood that technical committees will give prompt consideration to the technology.*

- 1.4 Developers, producers, and suppliers fail to understand their innovations.** Developers often lack the product/market understanding and expertise to promote their new technologies. Consequently, these innovations fail to reach waiting markets or are misapplied. The resulting lackluster performance of truly viable technologies causes senior managers and investors to back away from further innovation; this is detrimental to the concrete industry.

*Many products in general use today started slowly because their science and application were not fully understood by the companies that originally took them to market. For example, polypropylene fiber, originally promoted as a replacement for continuous steel reinforcement, did not do well until its primary application was recognized to minimize plastic shrinkage cracking. This is a product and market development problem that can only be corrected by proper understanding of products and applications by developers, producers, specifiers, designers, and users.*

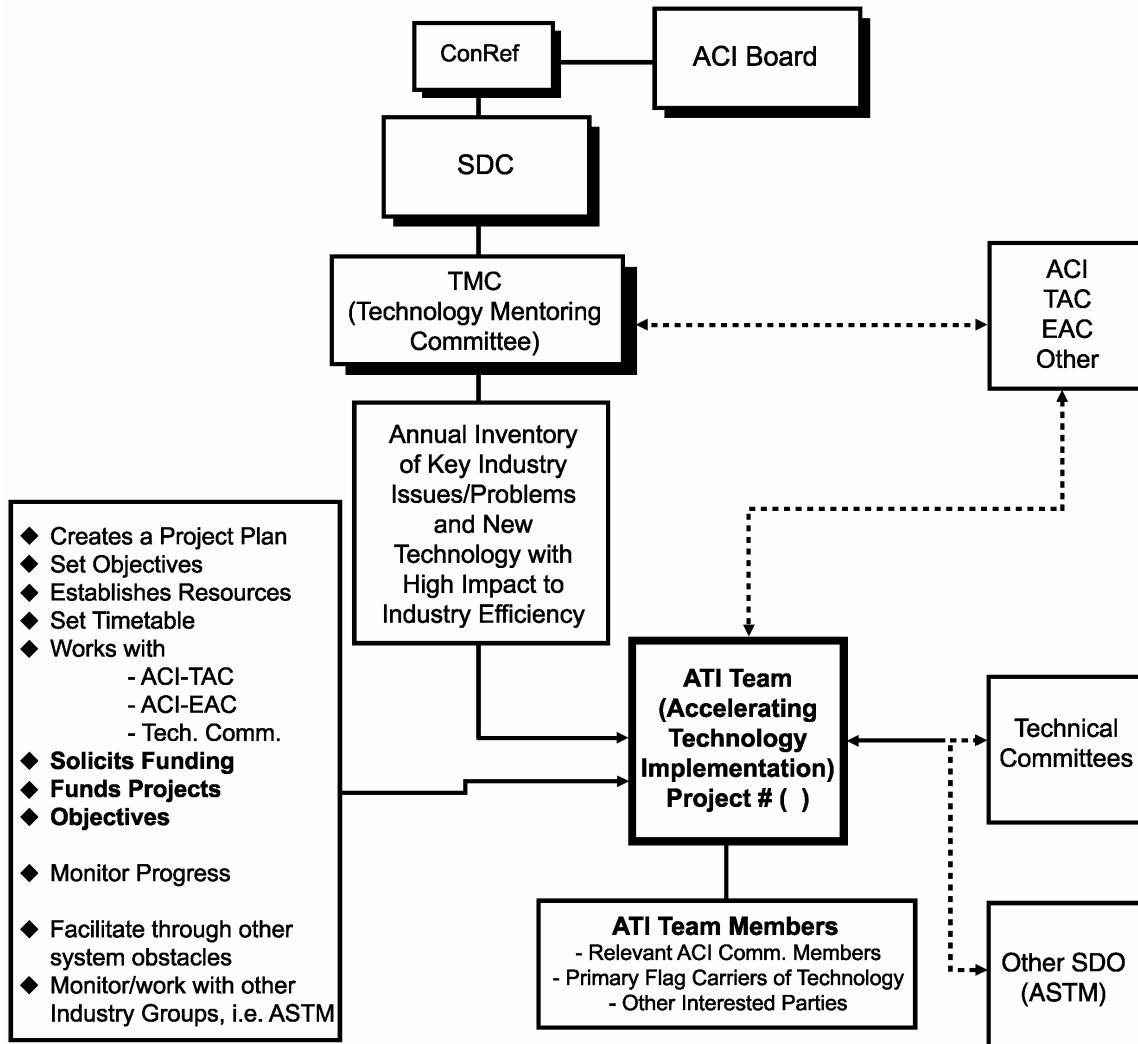
## **2. ACI COMMITTEE AND ACI SYSTEM OBSTACLES AND SOLUTIONS**

The concept of accelerating the flow of new technology creates a conflict between the SDO's caution versus market impacts on technology proponents. While this section focuses on issues within ACI, one could argue that the same issues are evident in many SDOs. If the ATA initiative can support the improvement of processes internal to ACI, the dominant standards development organization within the concrete industry, then the next logical step is to provide the same support to other SDOs.

- 2.1 TAC is not staffed to provide continuous up-front management for key technology acceptance.** TAC is comprised of thirteen talented individuals who collectively do a superb job controlling the output of ACI's core products. They oversee, yet essentially control, the quality and release of the work of 2,775 people presently serving on ACI's 112 numbered technical committees. This is a huge concentration of responsibility wherein TAC exerts a tremendous influence upon the output of technologies that have moved through the technical committee process. Unfortunately, there is no similar body to manage the movement of technologies through the process. Though the management of the committee's activities resides in each committee, the individual committee can only control items within certain parameters and at certain stages of the process. This is a significant deficiency. A committee is needed that can mentor the committee about a given technology, and when requested, assist with the elimination of barriers to the technology.

*The SDC will create the Technology Mentoring Committee (TMC). It will be charged with the management of technology acceptance prior to a technology entering the ACI (or another applicable SDOs') system and then mentoring the process as needed. Its three main leadership functions will be to plan, communicate and resource initiatives. The goal is to reduce the time of incorporation into ACI/SDO documents. Internal to the ACI process, the TMC will provide both relief and balance to the working system as TAC focuses on the quality of final output. TMC will provide the initial planning, and then mentor the process; TAC will review the output and provide quality assurance.*

## Technology Mentoring Process (Figure 4)



*TMC will be responsible for:*

*Coordinating with SDC for selecting, maintaining and publishing a current list of the Industry Critical Technologies that impact the concrete industry*

*Working with technology developers to identify pathways for proper introduction of their technologies into ACI's technical committee system.*

*Creating a conceptual and strategic plan for each identified technology. These plans would include setting specific goals, objectives, and timetables; finding appropriate funding or other resources to support the plans; and communicating with TAC, EAC, CPC, the ACI staff, and the staff and/or committees from other SDOs. The TMC will work to get consensus on the plan from any stakeholder associated with the technology. The TMC will create a team specifically focused on each critical technology. This team, identified*

*as an Accelerating Technology Implementation (ATI) team in Figure 4 will have the responsibility to provide the necessary support to bring the plan for that technology to completion. At the macro level, the TMC will maintain a real-time inventory of all technology items working their way through technical review or program development.. Coordinating with SDC and other organizations for sources of funding as may be necessary to accelerate committee activities. Working with other industry organizations to coordinate supporting parallel documents and their acceptance. Facilitating the transfer of completed committee products to EAC, CPC, certification committees, and ultimately, to the marketplace.*

*TMC will not function merely in an advisory role but as an active mentor assisting with resource issues and providing requested support to overcome any impediments to the plans.*

*For technologies identified as an "Industry Critical Technology," the TMC would set up small, dedicated ATI teams assigned to specific tasks for defined periods with the responsibility of writing a report and getting it reviewed by TAC. The High Performance Concrete Committee, formed by TAC under the system being replaced, is a successful precedent for this concept.*

*As one of its first tasks in this process, TAC and the ACI Board should critically review the committee structure and reduce the number of actively engaged committees to an efficient minimum. Those less actively engaged committees (including committees not creating documents), should continue to meet at conventions, if desired, for mutual communication but should not be as thoroughly administered or tracked.*

*TAC should require all Technical Committees involved with a designated "Industry Critical Technology" to provide the TMC their annual reports.*

*TAC should provide time at its convention meetings for the TMC to update it on the status of the "Industry Critical Technologies."*

*The SDC should require members of the TMC to sit in on the open sessions of the TAC meetings in order to gain a more thorough understanding of the TAC process.*

*TAC should place a liaison to every ATI team working on components of a plan for the "Industry Critical Technologies."*

*ACI should create an institutional mindset, with the corresponding procedures, whereby the documents associated with the "Industry Critical Technologies" are managed in the same time-sensitive manner used for ACI 318.*

- 2.2 Committees are unnecessarily overburdened with technical editing** at the expense of technical analysis. TAC's expectations are partly the cause. Instead of proactively reaching out to technical committees, TAC has bored in on detailed technical review. Although TAC comments are often made to spur committees to greater levels of detail, these committees might have been better helped had TAC been involved as their reviews were underway.

*Committees need to get back to the business of technical analysis. TAC, TMC, and the entire ACI support system should be oriented to relieving committees of burdens that interfere with their mission of technical review.*

*TAC, for its part, should maintain its high degree of review for code work but should establish a lower level of scrutiny for non-code documents such as reports and guides. Change the procedures on TAC review of documents; TAC's process should be amended so that only changes are under review unless there is a critical error impacting life/safety that requires immediate correction.*

*The ACI system should allow and encourage the responsible use of qualified, compensated independent consultants to assist committees with report development. Retirees or specialized consultants are excellent resources for providing this type of assistance.*

*ACI's technical staff should be expanded to assist with document editing efforts. This service should be better marketed to the committees.*

- 2.3 Some Committees are overwhelmed with premature technologies** that are not fully developed, unsupported by testing (see Item 2.14), reconstituted from previously rejected material, pet projects of certain committee members, or simply inferior to other technologies. These jam committee dockets and limit the resources for other initiatives.

*The TAC should assume a "ways and means" (gatekeeper) role and require proof-of-concept before a technology is assigned to a technical committee, i.e., the developer or owner must provide proof that the technology is worthy of consideration and beyond the idea stage. Perhaps TAC's Technology Transfer Committee (TTTC) should take an active part in this, as its role is to facilitate technology transfer. Regardless of the agency assigned by TAC, its mission would be to act on all requests within a defined period shorter than the interval between conventions in order to keep the gatekeeper function from itself becoming a progress retardant. If TAC and the technology purveyor cannot agree about the worthiness of an innovation, either could call upon an independent appraisal service for a neutral appraisal.*

*Example (for a standard development): Several companies, working together in an open SDC consortium, would develop and then submit to TAC a proposed change to a standard to facilitate inclusion of a promising new technology. TAC and the technology developer cannot agree on the worthiness of the technology. The developer is referred to an independent appraisal service which then prepares an appraisal with report on the technology. The client then submits this appraisal report to TAC, which, after deeming the report sufficient, looks for a relevant technical committee to develop an appropriate standard. TAC finds that no appropriate committee exists or finds one but learns from the TAC representative to that committee that problems exist that would preclude rapid or objective consideration. TAC then refers the action to TTTC, which creates an ITG to develop a provisional standard.*

*Actual examples: (1) Vector's embedded anode repair technology is currently being incorporated into an ACI 364 document after a Concrete Innovations Appraisal Service (CIAS) appraisal of that technology gave the committee comfort about the new technology. (2) A CIAS appraisal of Structural Preservation System's rapid load testing technology has been incorporated into an ACI 437 Document.*

- 2.4 Committees need to meet more frequently to ensure steady progress.** Many committees have developed a convention-to-convention mindset; i.e., nearly six-months of relative inactivity punctuated with flurries of effort twice a year at convention time. Document preparation has thereby become a discontinuous batch process.

*Committees need more resolve and better means to facilitate cross-committee communication. Recommendations: (1) ACI should continue to encourage and facilitate the use of virtual meetings to allow active committee participation between conventions, thereby ensuring a steady, continuous process for document creation. (2) ACI should consider creating a call center through which free conference calls could be conducted by any committee official. (3) Continuing and measurable efforts focused on getting committee members to learn about ACI's website capabilities for password-protected electronic document development would accelerate the process of document processing and updates. (4) ACI should endorse/encourage official between-the-conventions committee meetings. (5) Adopt processes and tools used by ASTM such as draft templates, standards development forums, and technical editor support for committees.*

- 2.5 Committees do not cover all technical areas uniformly.** Committees do not provide uniform quality in the preparation or review of technical documents. The quality is impacted due to some of the following causes: a focus on distractive technical minutia, professional pride, commercial prejudice, system politics, and other issues not uncommon to large volunteer technical organizations. ACI's oversight committees (particularly TAC and EAC), and the ACI staff recognize this problem as endemic to a 110-committee organization. This Report recognizes the important contributions that ACI, EAC, and TAC have made in developing remedies and training programs but notes that there is a long way to go.

*ACI needs to establish standards for committee performance and create the means to enforce them no matter what the political/institutional cost. Unless this is done decisively and soon, technology areas in which ACI committees are deficient will be targeted by outside organizations, weakening ACI's impact and potentially contributing to its downfall as the unique technical society of the concrete industry.*

*ACI needs to train and orient committees for their roles, starting with the basics in mission and management. Committees need to rediscover that they are primarily tasked with reporting on the science behind products and that they are entrusted with an important, and in some cases crucial, place on the critical path for technology insertion. Committees need to see themselves as relevant to the total process and should not be allowed to operate autonomously. They need to learn to cooperate with and accept the work of other committees, and*

*they need to understand how to take advantage of what outside organizations have done.*

*For example, direct product evaluations are not an ACI committee's role, though they may be necessary to committee consideration. When necessary, committees should rely upon standardized tests (ASTM and others) to qualify products or, in the absence of testing, independent appraisals of client product performance claims.*

*To combat the general lack of understanding of technical committee documents by committee members (many are unaware of what is available now on TAC's web site, such as the Technical Committee Manual in .pdf form) the education of committee chairs should go down one more level to the committee membership.*

- 2.6 Committee volunteers need greater incentive.** ACI has yet to develop effective solutions for the problem that volunteers on committees routinely assign lower priorities to committee duties than to their "day jobs." The system offers little, if any, incentive to reviewers for moving technologies through committee reviews in a timely manner.

*Incentive systems should be created to motivate committee participation, including ones based on financial compensation, as a means for keeping committee progress on schedule. Compensation could come in many forms, such as paying the primary document authors and key expert reviewers drawn from a cadre of volunteer experts, an attractive role for retirees ("Golden Group").*

*ACI should work with other organizations to develop procedures for committees to develop sources and controls for direct and indirect funding from members, technology developers, and others interested in facilitating the production of documents. This is not to say that committees should look to technology developers to underwrite committee action as a condition of their review. Direct funding should be "soft," i.e., contributed funds totally out of the control of the contributor and possibly even blind-sourced to beneficiary committees. Indirect funding could be "hard," but only by means of ACI-approved programs where the developer pays for an appraisal report but has no control of the results and no guarantee that technical review committees will consider it as an evaluative tool.*

*ACI should increase use of qualified staff assigned to key committees considering innovations (see Item 2.2).*

- 2.7 Committee chairs need more training.** ACI's procedural and operational training to help committee chairs effectively run their committees is good in content but needs to become more performance oriented. Chairs have a clearly defined job description in the Technical Committee Manual.

*TAC criteria for selection of chairs and criteria for ratification by committee members should include performance-oriented leadership training similar to the process training that they are already getting. Because of its educational and technical nature, EAC and TAC could jointly manage this training function.*

*Chairs should be selected and/or retained based upon their facilitating, communication, and management skills in addition to technical expertise. TAC should develop and use a procedure for measuring performance of chairs and for removing ineffective, biased, and unfair ones.*

*Committee Chairs should attend part of the TAC meetings (beyond the sections devoted to their Committee's documents) in order to better educate themselves on the TAC process.*

- 2.8 Committees need more oversight to facilitate their progress.** They need this additional guidance to keep them on mission, accountable for their actions, and in step with related and crosscutting developments. Without oversight, Committees tend to drift out of the mainstream and become irrelevant. They do not intentionally do so, and may not even realize it. The system management that exists in ACI today is applied mostly at the end of the process, thereby making it insufficient and less effective.

*The system's ability to manage itself should be refined and should exert the greatest influence while committees are actively making their reviews, i.e., in real time. The TMC concept (Item 2.1) is the answer. Charged with the management of technology acceptance prior to entering the ACI Committee process, the TMC would define critical technologies to be included in ACI documents, prepare solutions to assist with overcoming system obstacles, mentor the technical committees as requested, and assist as needed with intra-committee and ACI-other SDO coordination.*

*ACI Committees involved with an "Industry Critical Technology" would provide the TMC a copy of their annual Committee Report as one method to share information.*

- 2.9 The committee process is open to abuse for personal and commercial gain.** Human nature and commercial interests too often work against professionalism and objectivity, weakening the committee system as an instrument of innovation. Companies have been known to place employees on strategic committees to retard or block the acceptance of better, competing technologies. Such actions discourage new product development in the concrete industry and are perceived as a significant reason for the low industry return on investment. These personal and commercial biases drive away qualified committee volunteers who choose to invest their limited time elsewhere.

*The committee system should not tolerate obvious and commercial biases that affect the free and open discussion of issues and the production of fair consensus output. ACI must address the use of inappropriate blocking strategies, such as not putting items on agendas or being intentionally tardy with assignments. This does not exclude fairly convincing the majority of the committee members in open discussion. Neither does it mean that the system should discourage champions working ethically and systematically to advocate for promising technologies. Notwithstanding competition and patents, means are needed to include competitors as advocates, possibly through licensing arrangements. Any legitimate and open means to include more organizations as beneficiaries of an emerging technology is a benefit to the industry.*

*The ACI Board should direct the development of committee operating procedures that reduce the effect of individual biases and other unnecessary roadblocks. Committees need guidelines and the authority to deal with stalling and other abuses. For example, voting rules should be changed to enable a committee to override obvious blocking actions, overrule obtrusive or non-performing committee chairs and provide procedures for the removal of those who permit the practice. Existing appeals procedures should be strengthened and promoted.*

**2.10 Fixed cycle reporting restricts timely publication of completed work.**

Committees of ACI and related organizations tend to report in fixed cycles for codes and seemingly randomly for non-code items. An approved new technology that misses a committee publishing date often has to wait years for inclusion in the next report, often with the penalty of being delayed to a waiting public.

*Where practical, committees need to release interim, mid-cycle approvals and reports as they are completed. These can be picked up in the full documents later in their regular publishing cycles. Committees should process documents by chapter, with TAC reviewing that chapter alone. In addition to timely output, committees would be able to make revisions sequentially and continually.*

**2.11 Committees are not cognizant of the detrimental economic impact that slow deliberations bestow upon the concrete industry.**

Often claiming the need for diligence, committees tend to exhibit little concern about the importance of innovations as evidenced by market need. In fact, committees may dig in when someone is pushing a technology, calling it crass commercialism. They do not seem to comprehend how a technology developer's enthusiasm might also be linked to a legitimate public need. This ambiguity is a source of much irritation to developers and users, especially when committee approvals are on the critical path to market. Further it drives away technology developers from the technical review process, and this is bad for the industry and the public.

*ACI should adopt an operational roadmap to chart and manage the progress of the committee documents. ACI needs to determine a methodology for expediting guides, standards and reports. Committees should create a project plan for each document, and the chairman, aided by training and overseen by TAC, should assume the role as active manager. A simple, easy to use means of tracking committee progress, such as a Gantt Chart program, updated at a minimum every six months, should be adapted for committee use and be posted on the ACI website for all to see.*

*Committees should be required to allocate time for users of technologies under their purview to relate market expectations. In other words, committees should understand the pulse of the market they serve. This is particularly important in ACI's system where academics and researchers, who comprise seven percent of membership and tend to be isolated from the concrete construction market, enjoy a much higher percentage of committee representation, especially at chair levels. Ideally, committees should reach out to users in their fields of interest themselves, although they could also rely upon user-involved councils in ACI, such as SDC.*

*Committee tasks should be as calendar-driven as possible. A “forced consensus” process should be established that would require a prescribed timeline to finish a document or an update. Committees should not be expected to report perfect documents. The pace of knowledge and technology is too rapid for that. Committees should report what they have developed in reasonable time periods. ACI should develop a process to allow for subsequent updates/revisions without a total committee rework.*

*The bigger issue at play here is the fact that some of the perceived unconcern is from a misapplication of resources in the technical review system. Case in point is TAC, whose thirteen members control virtually all of ACI’s technical output, while large numbers of people do other things; e.g., more people organize an ACI convention than manage ACI’s chief end product, the Manual of Concrete Practice. The solution is simple: reorient ACI’s structure for people and resources so that much more of the Institute’s time and talent is dedicated to its chief products.*

**2.12 System capability to fast-track technologies needs to be broadly expanded.**

The committee system generally does not work to the concept that some technologies are more important for delivery into public use than others. Committees are generally unmoved by public need. TAC’s Technology Transfer Committee (TTTC) is a start, but in ten years of existence TTTC has created provisional standards for no more than a few innovations.

*TTTC’s important role will be greatly broadened with TMC feeding it work (see example in Item 2.3). Technology transfer needs to be overseen as technologies are being considered, not after the fact.*

*Additionally, TAC should adopt a system (possibly patterned after Rilem or PCI) or enhance the ITG process to fast-track technology items by special task committees organized for specific purposes. Chartered with broad access to ACI’s system and given a defined set of objectives and a schedule, these special committees would investigate, report, and then disband. The new system should allow for compensation of members working on issues for which time is undisputedly of the essence.*

**2.13 Committees are sometimes unaware of resources available from inside and outside ACI.**

When this is the case, ACI committees fail to benefit from potentially useful information and resource tools from nontraditional sources. Often, committees are simply unaware of what others are doing in parallel activities within ACI and outside (such as from PCA, AASHTO, and ASTM). For whatever reason, not knowing, lack of coordination, “not invented here,” etc., the situation, when it occurs, alienates technology developers and encourages them to look beyond ACI for solutions (like participating in ASTM to try to get ASTM to specify how to use materials). This erodes ACI’s influence

*Committees need to be educated about all resources available to them, knowing what is available within ACI and knowing what other organizations are doing. Committees cannot be expected to do this themselves. This is a staff function. By staying on top of this issue, ACI will protect its position as premier technical society for the concrete industry.*

*For example, ASTM often takes ten years to develop a test. Committees have been known to take the same time to review a technology. It is therefore important that ACI committees include ASTM in document preparation so that test methods can be developed concurrently. Otherwise, committees will report standards that cannot be tested against, adding years of delay in getting innovations into use.*

*ACI should encourage more committee use of qualified outside certifications, appraisals and endorsements. This will result in more timely assessments of new and established technologies.*

**2.14 System's body of testing knowledge and testing requirements is incomplete.**

New technologies sometimes are brought into the committee process with inadequate testing. Subsequent technology demonstrations result in more questions and tests, making technical reviews a moving target. Spurious developer claims and competitor counterclaims played out on committee stages spoil the industry's trust. The body of testing knowledge, especially for performance, is not complete. For example, no one seems to agree on how tests for 30- to 40-year performance can be validated, leaving the industry open to wild performance claims that it can neither refute nor confirm.

*The TAC should require proof-of-concept from technology purveyors before the technology is assigned to a committee. Committees, for their part, should place a higher reliance upon credible, neutral, third party appraisals or endorsements or certifications by credible outside testing companies as tools to assist their review process.*

*ACI should facilitate the development of acceptance test standards for new concrete technologies. Adoption of European Standards Test methods to meet U.S. industry needs should be considered. ACI (and other SDOs) must develop consensus on a body of performance predictive criteria. Better performance models and standardized methods of testing performance need to be developed and validated before designers and code authorities will accept them.*

**2.15 Present ACI documents are not always optimized for defining future innovations.**

Committees lack knowledge about how to deal with new technologies when their nature and performance exceed the bounds of existing standards. Technical committees tend to resist innovative technologies because additional defining standards must be created before technical review. This mindset sometimes clouds the fact that reasonable solutions can often be reached.

*ACI must keep its body of defining standards current for technological advances in order for committees to maintain a satisfactory pace for evaluating innovations. Innovations can be neither fully understood nor incorporated unless SDOs include criteria for new technologies to be measured against.*

*Designers, contractors, building officials, QA personnel, and others in the design/construct cycle cannot intelligently specify, use, or test innovations without a proper understanding of how innovations satisfy their requirements and how they meet existing design/construction standards. This educational issue is everyone's responsibility.*

### 3. BROADER OBSTACLES AND SOLUTIONS

- 3.1 **Industry infighting restricts innovation and the use of concrete.** Competition is healthy, but some “competitive” practices stifle innovation in this diverse industry. Instead of recognizing important technology advances and then developing state-of-the-art products and practices to use them, different industry factions will resist them. Consequently, users will turn to materials that do not use concrete to satisfy their needs; this results in lost market share for concrete.

*The SDC and the trade associations need to increase their roles in educating the concrete industry about how infighting reduces concrete’s competitiveness against other construction materials. Strategic organizations (like SDC) that are open to all elements of the industry and involve direct customer input are highly important in unifying the industry.*

*The concrete industry needs to support collaborative research, strategic development, and common initiatives that benefit all. The SDC model should be further supported and refined. Federal research programs that support specific materials groups should be pursued by the SDC and trade association; other materials groups are making significant inroads through these programs. Responsible unified political action models (e.g., “Political Partners for Concrete Progress” by NRMCA, PCA, and ACPA) should be adopted by more of the industry’s numerous trade associations to support the industry.*

- 3.2 **Market is not sold on performance-based specifications.** The construction industry’s established prescriptive-based specifications system generally does not embrace radical change as is often required for bold innovational leaps, particularly those oriented to durability and other long-term properties. The main barriers are: an institutional inertia against changing performance specs for prescriptive ones because it is almost always not a specification for specification proposition; a lack of confidence about how concrete will perform and can be tested; an entrenched low bid system that inhibits the use of performance-based standards; and a dug-in industry unwilling to accept risks and/or provide warranties.

*Contractors need to provide fair warranties to give comfort to customers about the life of the systems in which new technologies will be used. Warranty exposure needs to be spread equitably to all tiers that support contractors, e.g., suppliers and subcontractors. Warranties will do much to expand concrete’s market penetration; this is evident in the asphalt industry where their use of warranties is pushing some DOT entities to specify asphalt instead of concrete.*

*The market as a whole needs to develop and accept the use of performance-based standards. The concrete industry’s support for adding performance based specifications to support certain owner’s project delivery system requirements needs to be uniform from all corners. It should be oriented to overcoming specific objections and fostering contractor/customer relationships built upon trust. As a unified whole, the construction industry needs to provide guidelines on risk management with respect to the various project delivery systems.*

*Pragmatic case-by-case transitions may be necessary in which performance-based specifications coexist in a prescriptive environment; e.g., specification of water/cement ratio, total batch*

*weight, and other key mixture parameters without specifying the weights of each ingredient. The rationale: consistency in fresh concrete properties such as slump (desired by the specifier) and setting time (desired by the contractor) requires flexibility so the producer can change mixture proportions when material properties or ambient conditions change, as they inevitably do. Limiting the producer to prescribed, and thus fixed, proportions limits flexibility and ability to satisfy the contractor's needs. Once customers learn that the producer can meet performance specifications reliably without divulging mixture designs and other proprietary information it will be easier to provide product under a performance-based system.*

*ACI needs to work internally and externally (with other SDOs like ASTM) to develop acceptable durability test methods that have a higher level of construction industry trust. ACI committees need to drop the mindset that it is "easier to quantify than define." Externally, ACI needs to join with other organizations in the concrete industry promoting this approach.*

*ACI needs to develop acceptable standards for performance-based criteria. These should identify specific goals and objectives. Contractors, who incur the greatest level of responsibility under a performance-based system, should be courted by ACI and fully integrated into committee actions to produce documents that define/support the performance-based system.*

*ACI should create a Performance Division to construct a body of specifications for performance specifiers. If ACI does not address this need, some other organization will. The objectives of this division should include development of programs to certify producers.*

- 3.3 Duplicative research and testing wastes time and effort.** Efforts in North America tend to duplicate research and testing already completed or underway in Europe and Japan, wasting limited R&D dollars. Indifference, lack of communication, and institutional arrogance create this inefficient expenditure of limited R&D funds and use of time.

*America's SDOs and government agencies need to formalize reciprocity programs with the world's other successful research and testing systems.*

- 3.4 Local building authorities promote/enforce irregular and inconsistent regulations and practices.** New practices and technologies acceptable in one particular jurisdiction are often not allowed on a similar project in another jurisdiction. At the state level, reciprocity is insufficient for technology standards and approvals, resulting in differing criteria, tests, specifications, and regulations. This non-uniformity results in higher bid prices, particularly for DOT-controlled bridge and highway construction.

*The concrete industry must take an active part in the governing and political processes in local jurisdictions. Contractors and designers need to provide public officials with rational arguments and supporting details about how present methods are resulting in expensive outcomes if they expect to introduce 'equivalent' designs across jurisdictional boundaries.*

*The Federal government must step in. Increased Federal oversight and regulation is merited because the States' inability to coordinate the use of uniform construction standards and approvals affects public safety and interstate commerce. We need to replicate the cooperation between the Federal, State and local governments that resulted in the construction of the interstate highway system.*

- 3.5 Delay in adopting the International Building Code (IBC) by regulatory agencies inhibits advances in concrete design and practice.** The delay in adopting the current IBC by government agencies complicates and delays uniform application of contemporary criteria and standards (closely related to Item 3.4).

*Before government systems can be expected to change, specific improvements in concrete technology must come to them in the form of credible, expert documents from recognized and supporting uniform building code sources such as ACI-318.*

- 3.6 Construction industry's low return on investment (ROI) discourages innovation.** The historically low percentage of revenue reinvested in research by the construction industry sets the pattern for the concrete industry. Further, the obstacles detailed in this Report are a disincentive to research and technological growth in our industry.

*Until the climate for a better industry ROI improves, the concrete industry will continue to scramble for the investment it needs for technological growth and market competitiveness. Accelerating the pace of innovations to market will lead to better construction and business practices resulting in increased profitability and, in turn, more research leading to more innovations; an upward spiral.*

*A shortened acceptance cycle generally lowers production costs, resulting in lower market pricing, increased use, and greater returns. If new technologies can reach the market faster, satisfying customers ready to buy, the cost and risk of developing more new ones will become increasingly tolerable to those who decide where profits are reinvested; research will increase.*

- 3.7 Civil engineers are not well trained in the chemical engineering concepts necessary to support new designs and practices.** Civil engineers often lack understanding of chemical processes, discouraging the specification of chemistry-based technologies in their designs.

*Chemistry-based continuing education programs for civil engineers should be a requirement for maintaining Professional Engineer (PE) licenses. ACI should develop a continuing education course that presents the fundamental issues of chemistry related to concrete production and placement. ACI should take a major role in pioneering the development of relevant continuing education programs for professionals and should do so in close cooperation with state PE accreditation boards and professional societies like American Society of Civil Engineers (ASCE) and American Society of Chemical Engineers (ASChE).*

- 3.8 Liability issues discourage innovation.** Liability issues are a significant contributor to the general reluctance of the nation's model building codes. Most governmental agencies are reluctant to adopt change until standards, guides, and

specifications are clearly defined/tested/prove. While there is nothing wrong with caution, especially when public safety is involved, exhaustive testing is not always realistic, or even possible, for some innovations. This is especially true for innovations that are durability related and often cannot be defined/tested/proven in terms of the technologies they replace and/or by present evaluative systems.

*There are no quick remedies. The concrete and construction industries need to be actively involved in the political process at local, state, and national levels, specifically advocating for comprehensive and fair Federal legislation to provide greater liability protection for SDOs, designers, producers, contractors, owners, and others in the developer-to-market chain. This is an area where ACI, within its established bounds, should consider joining with the industry's many trade associations in attempting to bring about relief from liability issues. Product liability limitations are an important component of any solution.*