# Sustainability
## Increasing the Likelihood of a Long-Term Impact by the ATE Program

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[2] Edited by the WMU Evaluation Project, January 2002.

# Executive Summary

Sustainability is the ability to prolong or to supply with sustenance. This straightforward definition takes on a much more complex character when considered in relation to the Advanced Technological Education (ATE) program because of the diverse nature of this program (i.e., operates under several drivers [e.g., collaboration, program improvement] and makes awards to projects and centers). Setting these complexities aside, in a simple sense, sustainability for the ATE program could mean continuation of whatever activities had been supported by the NSF grant, including institutionalization. This is consistent with the definition given for sustainability by the Community College Research Center (CCRC) in their study of the ATE program as well. They defined sustainability as "The state where the major activities involved in the ATE program continue even after the grant expires." Naturally, outcomes or processes that are not successful or of high quality should not be sustained. This places a burden on the ATE *projects* (i.e., projects and centers) and NSF to determine where efforts for sustainability should be focused.

This leads us to consider what NSF's perception of sustainability is and why NSF considers sustainability important. NSF is interested in obtaining the most leverage it can with the money it has. It has been careful to not lead its grantees into expecting long-term NSF support. Most grants have been short term (i.e., 1-3 years), and only recently have longer time frames been considered. The expectation is still that once whatever was proposed is accomplished, NSF will no longer be involved and the continuation of quality outcomes will be the role of others. However, NSF wants to be able to show that its funding produces long term, continuing effects.

The notion of sustainability of *projects* or their effects is not extensively described in NSF documents. There is no single definition of sustainability and those that do appear are subject to change. In other words, what is expected from ATE *projects* in terms of sustainability is evolving. Additionally, ATE *projects* funded earlier are learning about the need for sustainability retroactively.

Because there is no official definition of sustainability, we turned to the published literature, which offered a fairly comprehensive set of elements necessary for successful sustainability. These elements were consolidated into a seven-point sustainability checklist.

Although this literature-based checklist is helpful in defining sustainability in more concrete terms, it may underemphasize the richness of the entities it is intended to represent. Therefore, we constructed a description of an imaginary, successfully sustained project that participates in all the drivers to illustrate what might be reasonable expectations for such a project. To help highlight how this description relates to the checklist, we referenced specific elements within this scenario.

In addition to providing a portrayal of a successfully sustained ATE project, we believe it is useful to determine how the different sustainability checklist elements are manifesting themselves in the ATE *projects.* As a shorthand technique, a rating of the degree to which

the survey and site visit data from the Western Michigan University (WMU) evaluation project show that the ATE program is engaged in each element is suggested below. Each element was rated on a 1-4 basis: (1=seldom evident, 2=sometimes evident, 3=often evident, 4=almost always evident). Additional detail and support for these ratings are provided in the body of the paper.

1. Wide Participation and Clear, Shared Purpose—3 (Often evident)

2. Abundant Information Available and Used to Improve the Program and Reward Effort—2 (Sometimes evident)

3. Abundant and Needed Resources, Resource Mobilization—4 (Almost always evident)

4. Knowledge and Skills/Training—3 (Often evident)

5. Decision Making/Distributed Power—4 (Almost always evident)

6. Coordination with Current Initiatives, Administrative Support—4 (Almost always evident)

7. Use of Promotion and Marketing/Husbanded Resources—2 (Sometimes evident)

***Conclusions and Recommendations***

As can be seen from the above ratings, overall, the ATE *projects* appear to be making progress toward sustaining themselves in some form after the NSF monies are no longer available. Embedded in these findings is the importance of achieving and documenting concrete steps toward accountability.

Based on data from the site visits and surveys, there is strong evidence indicating that the ATE program manifests 5 of the 7 elements necessary for successful sustainability from our literature-based sustainability checklist. Two elements that we believe need monitoring and improvement are (1) the availability of abundant information and its use to improve the program and reward effort (checklist item 2) and (2) the use of promotion and marketing/husbanded resources (checklist item 7), since there is only some evidence indicating that these elements are present in ATE.

A specific set of recommendations we believe will assist the ATE program to optimize sustainability for its *projects* is provided below. These recommendations are intended to ensure sustainability, however it is defined, by increasing the likelihood that the 7 elements necessary for successful sustainability of any program will manifest themselves in each ATE *project*. These recommendations also address the areas of concern identified for the ATE *projects* under each sustainability checklist item, especially items 2 and 7.

1. NSF should clarify its position on sustainability for the ATE program.

2. If sustainability is to be a major goal of the ATE program, NSF should consider how best to help *projects* achieve it.

3. More attention should be given to data collection and use to identify *project* components that should be sustained, learn how to improve components, provide information upon which to base rewards, and convince others of the worth of the components.

4. ATE *projects* should consider integrating sustainability strategies into their work from the outset through the use of a sustainability plan. Elements of this plan, including implementation strategies and schedules of key milestones (e.g., written commitment from administration), could include the following:

- The ongoing vision and goals
- Methods and timetables for collecting data critical for determining quality, accountability, and decision making, and means for sharing and using this information with key stakeholders
- Identification of and strategies for obtaining additional funding, revenue sources, and other support outside of and/or beyond the time of the NSF grant
- Descriptions of collaborations/partnerships and what the contributions of these partnerships will be in concrete terms
- A depth chart (i.e., list of individuals who could step in when key personnel and partnership changes occur), including contingencies for critical personnel and partnership changes
- A description of the strategies for incorporating the *project* within the institution
- A promotion and marketing plan that outlines the various means to be used to raise awareness and acceptance of a *project* and to update and disseminate its products

5. Assessment of progress toward sustainability could occur at least annually.

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### *The Challenge of Defining Sustainability for the ATE Program*

According to the dictionary, sustainability is the ability to prolong or to supply with sustenance. This straightforward definition takes on a much more complex character when considered in relation to the Advanced Technological Education (ATE) program[3] because of the diverse nature of this program. The first complexity is that the ATE program operates through several mechanisms called "drivers." These include collaboration, materials development, recruitment and retention, program improvement, and professional development. Projects can be funded to work with one or all of these drivers. Therefore, what would "be prolonged or supplied with sustenance" and how it would be done varies dramatically project by project. As another element of complexity, awards are made in two categories—projects and centers. Although all *projects'* (i.e., projects and centers) ultimate goal is to support the development of well prepared technicians, projects tend to focus on only one or two of the ATE program drivers, while centers typically address most or all of the drivers. Additionally, centers tend to receive larger grants to match their expanded scopes of work, always receive funding for multiple years, serve as model programs for other institutions and organizations, and disseminate information to a region (e.g., several states or the nation as a whole).

Setting these complexities aside, in a simple sense, sustainability for the ATE program could mean continuation of whatever activities (drivers) had been supported by the NSF grant, including institutionalization. This is consistent with the definition given for sustainability by the Community College Research Center (CCRC) in their study of the ATE program as well. They defined sustainability as "The state where the major activities involved in the ATE program continue even after the grant expires." This continuation could take on several forms, including those listed below:

- Retaining all grant activities for a *project* but lowering work scopes for these activities
- Moving forward with a subset of a *project's* activities
- Supporting the former grant activities by the organization(s) that received the NSF grant
- Receiving funding from other sources external to the institution via commercializing materials or processes (e.g., professional development), obtaining other grants, or obtaining support from collaborators
- Disseminating a *project's* activities or products through their continuation or use at different institution(s)

[3] Please see the attached overview document (*The ATE Program: Issues for Consideration)* accompanying this paper for a detailed description of this program and its evaluation.

The CCRC provides a similar list of examples and groups them into two approaches: to become self-sufficient and to integrate ATE into the college organization. Naturally, outcomes or processes that are not successful or of high quality should not be sustained. This places a burden on the ATE *projects* and NSF to determine where efforts for sustainability should be focused.

This leads us to consider what NSF's perception of sustainability is and why NSF considers sustainability important. NSF is less entrenched than other federal agencies, but it also has somewhat lower and less consistent levels of funding. It has capitalized on its flexibility to move quickly in funding innovative, cutting-edge programs. It is also interested in obtaining the most leverage it can with the money it has. In the Education Directorate in particular, NSF has a history of funding novel/creative approaches or model demonstration programs. It has been careful to not lead its grantees into expecting long-term NSF support. Most grants have been short term (i.e., 1-3 years), and only recently have longer time frames been considered. Even within these longer periods, however, the expectation is that once whatever was proposed is accomplished, demonstrated, or implemented, NSF will no longer be involved, and the continuation of quality outcomes is the role of other agencies or the states.

Because of this history of "in and out" funding, the notion of NSF supporting sustainability of projects or their effects is an evolving issue at NSF. It is becoming increasingly important because of the Government Performance and Results Act's (GPRA) focus on outcomes, even though the Fiscal Year 2001 Final Revised Performance Plan does not formally address sustainability. NSF wants to be able to show that its funding produces long-term, continuing effects. This is particularly true in the Education Directorate where sustained improvement is desired for the nation's approaches to science and mathematics education.

Although NSF staff members talk about sustainability, it is not a theme commonly written about by the Foundation. For example, a search for "sustainability" using the general search function on the NSF home page (http://www.nsf.gov) produced 193 hits. However, many of the hits were duplicates, and only 10 were related to sustainability in education. One of these was in the summary of the meeting on the Science and Technology Center (STC) directors' workshop. This report, *Building Bridges,* states among other issues, "Plan for sustainability of the STC from the beginning; Build a transition team that focuses mainly on sustainability issues." The October 2000 Grant Proposal Guide and the document *A Guide for Proposal Writing* do not mention sustainability. Furthermore, sustainability was only mentioned in 9 of the current 73 education program announcements located at http://www.nsf.gov/home/programs/ehr.htm.

The ATE program is housed in the Division of Undergraduate Education (DUE) of the NSF Education Directorate. The DUE Annual Report for Fiscal Year 2000 contains only two references to sustainability—one under the Evaluation of the Institution Wide Reform Initiative with the Course and Curriculum Development (CCD) Program (p. 44) and the other under the publication description for DUE 0085870: Columbia Pubscape—

A Core Integration System for a National Science Digital Library Publishing Center (p. 60). In 1998 and 1999, sustainability is mentioned in the program announcement for DUE under the Collaboratives for Excellence in Teacher Preparation (CETP) project.

The program solicitations for ATE mention sustainability only briefly and only in the more recent solicitations. Sustainability is not mentioned in any of the ATE program announcements through the year 2000. In the 2001 ATE Solicitation, "sustainability" appears only once, under "V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS, A. Proposal Preparation Instructions, Full Proposal, Project Description". It states, "The Project Description should explain the project's motivating rationale, goals, objectives, deliverables, and activities; the timetable; the management plan; the roles and responsibilities of the PI, co-PI(s), and other senior personnel; *the prospects for sustainability after the period of NSF funding*; the evaluation plan; the dissemination plan; and results from prior NSF support" [italics added].

The information provided above shows that NSF's interest in sustainability in relation to the ATE program is evolving. There is not single definition of sustainability, and those that do appear are subject to change. In other words, what is expected from ATE *projects* in terms of sustainability is evolving. Additionally, ATE *projects* funded earlier are learning about the need for sustainability retroactively.

### *A Literature-Based Sustainability Checklist*

Because there is no official definition of sustainability, we turned to the published literature. In order to review it, we searched a variety of databases and used several terms. We obtained several hundred references, but only a limited number were relevant to the ATE program[4], which were the references on the sustainability of organizational change. Copies of these books or articles were obtained and read. The following is a brief summary of articles providing advice or models on how to sustain change. Generally, these articles were advocacy statements based on the authors' experiences with sustaining change rather than empirical studies.

Howard and Howard (2000) presented the Self-Determination/Reliance Model (SDR). This is based on psychosocial development and associated with the monitoring and assessing of the processes and outcomes of community groups. Critical movement on the identified dimensions indicates progress toward sustainability. These dimensions are accountability; decision making; information; knowledge and skills; and resource mobilization. Flower (1996) described five fundamentals for organizational change: husbanded resources, abundant relationships, abundant information, distributed power, and a clear sense of purpose. Schwartz (1994) listed several guidelines for managing and sustaining change. He stated that successful change requires employee participation, training, provision of continuous feedback, a reward system, and development of group norms. Gabelnick, MacGregor, Matthews, and Smith (1990) offered a checklist for

[4] A large portion of the discussion about sustainability in the literature focuses on the sustainability of the environment or maintaining our society within environmental limits. Another segment addresses economic sustainability.

sustainable learning communities in colleges. The list includes determining focus and design; using faculty resources; coordinating with current institutional initiatives; obtaining and maintaining administrative support; having needed resources; using promotion and marketing; having institutionalization of the concept; and using program improvement mechanisms.

In addition to these various lists, articles referenced the need for organizational cultural compatibility and the ability of programs to create and command value. Schneider, Brief, and Guzzo (1996) reported that the cultural aspect suggests that change is not sustained when (1) the change is inconsistent with existing climate and culture and (2) changers fail to build a climate and culture to support the change. They go on to state that changes are more likely to be sustained when the organization is ready and prepared for the change and when the change permeates all levels and functions of the organization. Cropper (1996) suggested that the creation of value falls into two domains—(1) consequential value such as legitimacy, security, and efficiency; and (2) constitutive value, which is based on efforts being valued (i.e., expressions of purpose and fit with institutional context, capacity, and conduct). For example, in the ATE program, consequential value could be provided in terms of legitimization from the business/industry collaborations or the use of standards. Security could be through the use of existing programs and professors and emphasis on how the new programs will increase the security of their jobs and the security of the institution in terms of new students.

Taken together, these offer a fairly comprehensive set of issues to be addressed or elements necessary for successful sustainability. These issues were consolidated into the following seven elements and form the basis for our comprehensive, literature-based sustainability checklist.

1. Wide Participation and Clear, Shared Purpose (i.e., abundant relationships, clear sense of purpose, employee participation, clear focus and design, development of group norms)
2. Abundant Information Available and Used to Improve Program and Reward Effort (i.e., abundant information, accountability, use of program improvement mechanisms, continuous feedback, reward system)
3. Abundant and Needed Resources, Resource Mobilization
4. Knowledge and Skills/Training
5. Decision Making/Distributed Power
6. Coordination with Current Initiatives, Administrative Support
7. Use of Promotion and Marketing/Husbanded Resources

### *A Successfully Sustained ATE Project*

Although this checklist drawn from the literature is helpful in defining sustainability in more concrete terms, it may underemphasize the richness of the entities it is intended to represent. Therefore, we constructed a description of an imaginary, successfully sustained project that participates in all the drivers to illustrate what might be reasonable

expectations for such a project. To help highlight how this description relates to the checklist, we have referenced specific elements within this scenario.

The XYZ technician education program is healthy. The new faculty member who was hired during the ATE grant has received a permanent appointment, and we have a firm commitment from industry partners for a continuing budget for upgrading our equipment on a rotating basis (3. Abundant Resources/Resource Mobilization; 6. Administrative Support). This is smaller than the budget we had under the ATE program, but we still can plan ahead.

We have solid enrollment. The recruitment procedures we put in place under the ATE grant are not as elaborate, but the contacts facilitated by the grant are still in place. We have an articulation agreement with several school districts. Through that agreement we interact with the local K-12 school districts, especially the counselors, and the science, mathematics, and technology teachers to help guide students to our program (1. Wide Participation; Shared, Clear Purpose). In some cases, students can take courses for simultaneous credit for high school graduation and college credit, and in other cases, the high school students can receive advanced standing at the college. We also have several mechanisms in place to support the students once they come to our institution. We have 5 years of external funding from a local business to support a summer mentoring placement where students from our college get paid to work at this business (3. Abundant Resources/Resource Mobilization). Additionally, the people providing the generalized support services are well informed about our program and its needs so that they can tailor the resources to our students (1. Wide Participation; Shared, Clear Purpose; 3. Abundant Resources/Resource Mobilization; 5. Decision Making/Distributed Power; 6. Coordination with Current Initiatives/Administrative Support; 7. Use of Promotion and Marketing/Husbanded Resources).

We are engaged in the development of materials to help improve our instruction. One of the pieces of curriculum we designed turned out very well, and we commercialized it (3. Abundant Resources/Resource Mobilization). Profits from the sale of these materials are used to keep it current and to support more local development work. We want our materials to incorporate more in-depth understandings of the science and mathematics principles behind the more technical concepts. We also want to help our students become more adept with workplace skills such as communication and group work. With the very small amount of money now available, materials development is more incremental. It generally involves trying to improve or update at least one section of a course every time it is taught. We all try to help each other by critiquing materials, and we routinely gather student outcome data against which we can ascertain the effects of any changes. The feedback from our advisory committee also highlights needed changes or effective elements of our instruction. Work on improving course instructional materials is considered in the merit pay schedule (1. Wide Participation; Clear, Shared Purpose; 2. Abundant Information Available and Used to Improve the Program and Reward Effort; 5. Decision Making/Distributed Power).

We have an advisory committee of representatives from the several employers of our students. This advisory committee meets only once a year now, but we communicate electronically at other times, especially when an important question comes up (1. Wide Participation; Clear, Shared Purpose). An important part of our meetings is when the business/industry people inform us about the on-the-job levels of performance of our graduates using evidence they have gathered throughout the year (2. Abundant Information Available and Used to Improve the Program). We then discuss what all of us can do to make the graduates even better prepared (1. Wide Participation and Clear, Shared Purpose; 3. Resource Mobilization; 5. Decision Making/Distributed Power).

As part of this discussion with business/industry, we arrange for short exchanges of faculty and business/industry people to promote understanding which are paid for by industry (3. Abundant Resources/Resource Mobilization; 4. Knowledge and Skills/Training). We discuss arrangements to attend the national meetings of the related businesses/industries (7. Use of Promotion and Marketing/Husbanded Resources). We also consider future directions of the businesses/ industries and make modifications in our program in anticipation of these changes (3. Resource Mobilization; 6. Coordination with Current Initiatives). We also have some members from our local K-12 school districts and the nearby 4-year college on our committee. These educational institution members also function as a subcommittee in which we work on guaranteeing the smooth entry of high school graduates into our program and the transfer or continuing education of those who wish to pursue education at a 4-year institution (1. Wide Participation; Clear, Shared Purpose; 6. Coordination with Current Initiatives). We have continued the development of the articulation agreements begun under the ATE grant, and several decisions have been made. These contacts also aid in the recruitment and retention of students.

Although we meet less often than we did when the ATE grant was in operation, the faculty teaching the basic science and mathematics courses interact with us on a regular basis to ensure that what they are teaching meets our needs (1. Wide Participation; Clear, Shared Purpose; 6. Coordination with Current Initiatives). They share their student assessment results with us so we have input into what sort of knowledge should be assessed and what levels of accomplishment we require (2. Abundant Information Available and Used to Improve the Program; 3. Resource Mobilization).

We try to engage in professional development. There is very little money available for it without the ATE grant so we compensate by piggybacking on other opportunities (4. Knowledge and Skills/Training; 7. Husbanded Resources). As mentioned above, faculty members spend time in local businesses/industries while their counterparts do some instruction. When we hire adjunct instructors with cutting-edge expertise, we all try to attend their classes. As part of the hire, the adjuncts present a seminar to the rest of the faculty (1. Wide Participation; Clear, Shared Purpose; 3. Resource Mobilization; 7. Husbanded Resources). Contacts that we made while we had the ATE grant have been maintained through electronic connections, and we make use of an ATE-supported center's resources for our technical area (1. Wide Participation; 3. Resource Mobilization; 4. Knowledge and Skills/Training). When someone gets the opportunity to

use the small amount of money we do have to receive professional development, s/he provides a seminar for the rest of the faculty (7. Husbanded Resources).

### *A Comparison of the ATE Program to the Sustainability Checklist Based on Survey/Site Data*

In addition to providing the previous portrayal of a successfully sustained ATE project, we believe it is useful to determine how the different sustainability checklist elements are manifesting themselves in the ATE *projects.* As a shorthand technique, a rating of the degree to which the survey and site visit data from the Western Michigan University (WMU) evaluation project show that the ATE program is engaged in each element is suggested below. Each element was rated on a 1-4 basis: (1=seldom evident, 2=sometimes evident, 3=often evident, 4=almost always evident).

The WMU evaluation project has two major sources of data about the ATE program—a set of 13 site visit reports and 2 web-based surveys, all conducted in 2000 and 2001. Details of these studies are provided in the overview document (*The ATE Program: Issues for Consideration)* accompanying this paper. The data were not gathered in a way that allows for causal analyses, nor were data available on the quality of the activities except in relation to the site visitors' expert opinions. Furthermore, data were obtained only from presently funded *projects*, so no direct evidence is available of what was or was not sustained. Approximately 20 items on the survey relate to sustainability. Eight of these are items that rate *project* growth, and the rest pertain to the different *project* activities such as collaboration or materials development. During the site visits, the site visitors were asked to comment on the potential for sustainability of the *project* overall, and additional comments about sustainability were made in the individual sections related to the ATE program activities. Comments related to sustainability in the site visit reports were marked, reread, and considered in conjunction with the survey data.

#### 1. Wide Participation and Clear, Shared Purpose—3 (Often evident)

This first element relates mostly to the collaborations required by the ATE program and the development of a shared vision within these groups of what each *project* is to accomplish. The ATE program appears to have wide participation with a variety of groups that have personal interest in different elements of the *projects* being sustained.

In both years of the survey, a majority of the *projects* reported increasing or substantially increasing direct participation by other institutions and organizations. In each year of the survey, the median *project* lists at least 22 or more collaborative efforts, and each engages slightly more than 2 people per collaboration. The most prevalent collaborator reported by *projects* in both years of the survey is business/industry followed by educational institutions. When asked what factors affect the quality of the collaborative efforts, the PI responses in both years were categorized into 5 areas—(1) the quality and the enthusiasm of the people involved, (2) commitment/interest, (3) mutual benefit, (4) common purpose/vision, and (5) communication including clear expectations.

During the visits, all sites mentioned advisory committees of some sort comprised of business/industry representatives. The use of advisory committees for workforce programs is generally required at community colleges, often along with very structured program approval processes. These requirements contribute to the sustainability of the collaborations and therefore to the tie of educational programs to business/industry needs. Several *projects* are supported by business and industry because of their needs for employees and their lack of preparedness to provide introductory level training. The ATE *projects* are seen as providing good service at a favorable cost; as a result, these *projects* receive business/industry support and endorsement.

*Projects* also collaborate with professional organizations or work to build them up. These collaborations can provide sustainability of *project* activities in terms of prestige and name recognition. In one site visited, the ATE group became a quasi-national communication hub, and it is likely that the communication function will continue after funding ceases. Several of the professional organizations are business/industry related rather than education related. This contributes further to connections with business/industry. In two visited sites, the ATE *project* personnel had positions of national prominence in the business/industry professional organization. This clearly enhances awareness of the efforts of community colleges and their suitability for meeting business/industry needs. Connections with these professional organizations also provide additional venues for future funding as it becomes necessary. Having a national presence also helps local programs and their staff members believe what is being done is important and worth continued funding.

The survey and site visit data show some potential barriers to sustained collaboration in terms of wide participation and shared purpose. Many collaborations are based on the energy and commitment of one person—either from business/industry or from the *project*. Having these dynamic leaders is wonderful as long as the leaders stay at their institutions and remain interested in their programs; but if not, programs often disappear when their champions do. Additionally, because many of the businesses/industries are strictly local, they are reluctant to support efforts with a national focus. Interviews during the site visits reveal that the purposes of the ATE project activities are not always shared nor understood in the same way by all involved in the collaborations. On the survey, the projects reported communication and coordination as barriers.

**2. Abundant Information Available and Used to Improve the Program and Reward Effort—2 (Sometimes evident)**

This element is directly relevant to the management and evaluation of the *projects.* Many different types of information are necessary for something to be sustainable, and this information must be used effectively to provide accountability information and to reward effort. First and foremost, the information needs to be used to determine if the activity is worth sustaining. Also, if mechanisms are not in place to continuously provide the information necessary for incremental change and if that information is not acted upon, the *project* will remain in the past and will become obsolete. The notion of reward is a

subset of this element, since it is a special use of information that also provides incentives to continue a particular behavior.

The site visits and survey data showed that there is only some carefully collected and targeted information available. What is available is not always used nor is it necessarily related to program improvement. It is often information for information's sake. At the end of this paper, specific recommendations for data to be collected to track progress toward sustainability are provided.

In each year of the survey, more than 80 percent reported use of a *project* evaluator. However, based on the site visits, it appears that only modest data collection for evaluative and accountability purposes is undertaken (e.g., collection of number of students enrolled, number of students completing programs, number of students that gain credit for articulated courses, number of students in mentoring programs, and number of students that go on to college and their majors). Without this critical information, *projects* are most likely "operating in the dark," not knowing how to improve activities and programs and/or reward effort, not knowing if the goals for their activities are being attained, or unable to track their progress toward sustainability.

Directly related to this is the information collected for materials development. Although business/industry people are consistently involved at the beginning of materials development, use of other subject and pedagogical experts is less common. Pilot testing and revising materials by the creators based on informal input from classrooms and students are also very common. There is much less collection and use of more formal data on the effect of materials on student outcomes or on effects in diverse settings.

In terms of reward, there appears to be very little acknowledgement of effort for community college faculty to improve themselves through the ATE program. The work on the ATE program often seems over and above regular job responsibilities. Although it is seen as valuable, work on the ATE program rarely fits into the usual reward structure. There is very little money available for professional development, and it is not rewarded in the standard system. For example, one community college visited doesn't allow release time for its faculty members, and another doesn't offer ATE professional development for credit, which means it doesn't count on the merit pay schedule. This is particularly disheartening because, as one *project* reported, it is difficult for the faculty to adjust to new project-based approaches to learning; and they need the type of assistance that professional development could provide. Furthermore, instructors at community colleges are often paid less than similarly qualified people in business/industry, making recruitment and retention of these instructors a major challenge, especially after they have participated in extensive professional development. Perhaps if the value of professional development was clearly demonstrated, the community colleges would find more money to support this activity.

**3. Abundant and Needed Resources, Resource Mobilization—4 (Almost always evident)**

This element highlights the need of any *project* to have the necessary fiscal, material, personnel, and emotional resources available. For ATE, this involves the support of business/industry partners, the home institutions, other collaborators, and peers. Necessary resources also include individuals to teach courses, develop materials, program computers, handle administrative details, etc., and materials required for individuals to carry out their tasks. A critical resource, of course, is the money to pay for the people, time, and materials.

The site visits and surveys show that the ATE *projects* are making quite good use of existing resources, bringing all available resources to bear on the activities, and using what they have to leverage more resources. However, this does not mean that the *projects* have all the resources they need. This seems to be particularly relevant in terms of faculty hires and salary and in the potential for continually upgrading high cost technical equipment.

The survey data show that for every dollar provided by NSF for the duration of projects'/ centers' grant periods, the *projects* reported increasing their working resources for the ATE program by 50 cents in 2000 and by 80 cents in 2001. *Projects* also reported receiving more than $12,000,000 each year in direct contributions of money and $16,000,000 of in-kind support in addition to the NSF funding. Connections across peer institutions also provide monetary support. The *projects* reported themselves as increasing their receipt of financial support from other organizations and income from and use of developed products. On the other hand, they reported lack of time, money, or other resources as barriers.

Several visited sites reported sister institutions adopting their programs, which would save them the developmental costs. At other visited sites, an institution is designated to provide a given type of educational program for the whole system. A variation of this at other sites has institutions sharing the cost and effort of a technical program by offering different modules at different sites. Either variation makes a program viable though a system that would not be so at a single institution. Barriers to system viability of programs do occur when there is competition between the institutions or varying quality of offerings or special student needs. Additionally, in order to obtain support across a network of peer institutions, a *project* might have to broaden its original work scope to something such as high tech education rather than its original focus on education for a specific technical skill.

Another element of resources is materials for quality programs. Materials are resources in and of themselves and also secondarily because they can be sold to produce revenue. In each year of the survey, more than 1,000 of these materials were reported in use at least locally. If one presumed all materials developed were used at least on a local basis, then in each year, at least 35 percent of this total was used at sites other than the *projects* and 11 percent were commercially published.

Sustainability of materials is less related to their development per se as to their continued updating and availability. Only some of the *projects* visited have plans for what will happen to their materials once the grant stops; most do not. Only one appears to have a very clear process in mind, although it is a project that is solely focused on materials development. Two sites visited have business plans that are designed to make them self-sufficient; and the materials provision is within those plans, since selling materials is one way to attain income. Difficult issues such as who will update the materials, Web listings, and links to materials if a project/ center is not sustained do not appear to have been considered by the visited sites.

Directly related to the issue of sustainability of materials development is the connection of materials to curricular program requirements. Materials that are required by programs of study or have some clearly defined marketability are more likely to be sustained. For example, one site shared its concern that its program could be negatively impacted as a result of the core tech area of its ATE program being dropped from its state's high-stakes high school proficiency test and most likely the high school curriculum. The site visits showed that the materials developed are not always linked to programmatic requirements or even market demand. In terms of market demand, most of the materials produced are community college instructional materials for teachers. Unfortunately, there is low market demand for these since few community colleges have the funds necessary to purchase them. Student materials are more likely to have a market.

**4. Knowledge and Skills/Training—3 (Often evident)**

Knowledge and skills training within the ATE program can be applied to at least four distinct groups—community college students, high school students, high school teachers, and community college instructors. This element, because of the last two groups, also directly relates to professional development and points out that specific knowledge and skills are necessary to achieve the goals of the *projects.*

For community college students, the numbers of students in a program are strong indicators of a program's sustainability. Because of the different emphases of the *projects*, these numbers varied substantially for the visited sites. Some had very high numbers of students (e.g., 700) while others had small numbers (e.g., 7-10). Generally, the numbers of students involved at the visited sites were modest (i.e., 10-30 students).

Enrollment numbers reported on the surveys were more encouraging. For *projects* as a whole, average enrollments reported for the past 12 months more than doubled in the secondary and associate degree level courses (244 vs. 700 in 2001 for secondary; 915 vs. 2,300 in 2001 for associate). However, these increases appeared to be due largely to a few institutions rather than an across-the-board increase. For example, at the secondary level, two *projects* reporting for the first time in 2001 cited enrollments on the high end of the range (2,000 and 5,000). Similarly, one center reported enrollment in 2001 of around 70,000 in its associate level programs. The *projects* also reported themselves as increasing for numbers of students enrolled, students placed in technical jobs, and students graduating or completing programs.

When viewed from the perspective of a specified program conducted during the last 12 months, *projects* reported that their average enrollment rose substantially (94 to 160 students in 2001 at the associate degree level). In these specified programs, the average number of program completers also increased from 43 to 58 in 2001 at the same degree level. When examined from a per course perspective from the survey data, the average number of students enrolled in a course in a specified program increased from 7 to 11 in 2001 at the associate degree level. However, based on our site visits, at many colleges the break-even point for providing instruction is 15-20 students per course.

Despite these strong indicators of potential sustainability for programs overall, the sustainability of the new mentoring or internship opportunities funded by ATE is more questionable. These opportunities require additional resources and are likely to decrease or stop without continued external funding or explicit program requirements for these experiences.

Knowledge and skill training of high school students takes two forms: directly to high school students or indirectly through the education of their teachers. Several visited sites provide both types of educational opportunities. Students are often trained directly, although these approaches are generally more interest-generating opportunities such as science camps or opportunities to learn about exciting scientific advances. Two visited sites also report working with high schools to provide general upgrading of students' academic backgrounds. Another approach used at one visited site is working with high school counselors and parents to enhance the image of a two-year degree in comparison to a 4-year one. One project has both community college and high school students working at its partner institutions at the very jobs they are training to obtain—real on-the-job training. The service this provides to the participating institutions increases hope for sustaining the activity.

Presently, there is a great deal of professional development in the ATE program. The participants find these opportunities valuable, but little is known about the implementation of the education received. Also, although the training is rightfully focused on content upgrading, other types of knowledge (e.g., instructional materials development) are less apparent. A confounding issue is one also mentioned above under resources: it appears unlikely that the level of professional development presently supported will be sustained. In other words, there are few processes in place for providing the continuous upgrading and cutting-edge knowledge necessary to maintain excellence in technology. Despite this, it is likely that the upgrading already provided will improve instruction.

ATE-provided professional development opportunities are well attended and received. In both years of the survey, conferences, workshops, and in-service courses were the most popular formats. Course offerings were well attended with a median of around 20 individuals for projects and about 130 for centers. Most participants were from associate degree granting institutions. Regarding how full their professional development opportunities were in both years, more than 75 percent of the projects reported they were

at least at 75 percent capacity, and more than 90 percent of centers reported this level of capacity. On the 2001 survey, the *projects* reported themselves as increasing in the number of and participation in professional development opportunities.

High school teacher education programs are often associated with the development of articulation agreements between high schools and community colleges, and the formal agreements will help to sustain the associations. Regardless of the development of formal agreements, the teacher education programs update the high school teachers' technical knowledge and help guarantee that the high school courses will be consistent with the courses offered at the community colleges. The provision of educational opportunities for high school teachers and students is likely to be sustained only if these encourage enrollments and or enhance the public image of the sponsoring institution thereby increasing its chances for external support.

Despite these successes and as mentioned in item #2, there are few processes in place for providing continuous upgrading and cutting edge knowledge other than the ATE program. The *projects* also reported the ability to attract/keep faculty and other critical staff members as a barrier as well as faculty having difficulty adapting to the changes needed for the new programs.

An issue related to professional development of existing faculty is the use of adjunct faculty. Many of the visited sites reported very small numbers of regular faculty and large numbers of adjunct faculty. This is a positive development if the adjuncts are providing knowledge based on recent contact with cutting-edge business/industry techniques. On the other hand, this does not bode well for sustainability because, if money gets tight, adjuncts are most likely the first to go. Additionally, if a program is staffed almost completely by adjuncts, there is no ongoing supportive voice in the regular processes of the institution and hence little hope for institutionalization of the program (see item #6).

**5. Decision Making/Distributed Power—4 (Almost always evident)**

This element relates to the consideration of shared power because, in that way, more people are responsible for the success of the *project*, and more people feel ownership. This also allows a *project* to continue essentially undamaged in the event that key personnel leave the project. The ATE *projects* seem to operate fairly distinctly from their individual schools and from NSF. They also appear to share the decision making related to their *projects* through their collaborations. On the other hand, the success of many *projects* appears to be centered in one dynamic PI.

**6. Coordination with Current Initiatives, Administrative Support—4 (Almost always evident)**

This element presents the issue of institutionalization of a *project*. To be institutionalized, a *project* must become part of the fabric of the organization in which it is embedded. It must fit with and complement the other institutional initiatives and goals, and it must also meet its needs utilizing existing institutional processes. To guarantee that it can continue,

a program needs to be formally approved, have its own permanent faculty, and a continuing budget line. Even smaller components such as courses need approval and support.

Chances for institutionalization are highest if a similar type of program existed before the grant was ever obtained. In other words, sustaining improved programs is easier than sustaining newly created programs. A preexisting program is already institutionalized; therefore, only the new elements have to be incorporated into the system. Incorporation of new elements is much more likely if these elements can be provided by existing, full-time faculty or if new, but full-time, faculty lines have been authorized. This was actually the case at several of the site visit locations. The visited NSF *projects* expanded or improved on existing programs, and it seemed highly likely that these programs would continue after the grant expired. These improved programs were delivered by existing faculty or new, full-time faculty members permanently hired to deliver the program.

New programs can also become institutionalized. This is most likely to occur if there is strong external support for the program, such as industry demand. It is also helpful if the principal investigator promoting the program is a well-respected faculty member with institutional power, as is often the case in ATE *projects.* Administrative support is also crucial. The visited sites report high levels of administrative support for both new and improved programs. The administrators are creative in diverting resources, and they are often the driving forces behind the programs. The administrators report viewing the ATE programs as models of what could be done in other areas and see the ATE programs as showing other faculty that they could get funding as well. However, administrator support for programs is tempered. They are supportive only as long as the programs provide incentive or revenue. One administrator stated that he is supportive as long as there is a continued increase in enrollment. Another said he could only support the purchase of the high tech equipment for a few years and then it would have to stop because the prices were prohibitive even if enrollments were high. On the survey, the *projects* reported administrative support as a barrier.

Another condition that enhances sustainability is the development of spin-off programs or other opportunities that feed on and nurture the first effort. At one visited site, a second program was spun off from the one supported by NSF. In three other cases, large development projects, such as technology centers or industrial parks, provided impetus to guarantee the sustainability of the programs.

Capitalizing on other funding also enhances the potential for sustainability. Several *projects* are working with other grant programs such as tech prep (a program to help students move from school into technical jobs) to help support efforts related to their ATE *projects.* Tech prep is particularly relevant, since it may enhance the image of technology overall and provide technological literacy to all students. Sometimes, specific grant funds were made available for the training programs of technology education teachers. As mentioned under item #1, direct ties with businesses/industries that need to hire students are also supportive of sustainability. This is a complex issue, however, because many technical businesses are small and do not need large numbers of

employees (e.g., biotech) or they need workers in different parts of the country, and students at community colleges often do not want to move.

**7. Use of Promotion and Marketing/Husbanded Resources—2 (Sometimes evident)**

This seventh element relates to sustainability in terms of the *project* as a business. In order to continue, a *project* must be believed to be necessary, and marketing is one of the best ways to accomplish this. To be sustained, the ATE *projects* need to convince their various constituencies that they are worth continuing. This approach also assumes some sort of outcome, process, or product that is to be marketed or provide value. For ATE, these are generally related to instructional materials or professional development opportunities. Additionally, the husbanding or targeting of resources allows a *project* to be more flexible, hold out in lean times, and take advantage of unexpected opportunities, all contributing to sustainability.

In keeping with NSF's evolving interest in sustainability, the centers and newer projects show more evidence of meeting business goals than the earlier funded *projects.* Many projects have Web sites, and some are quite complex and entrepreneurial. The PI meetings also promote this business goals attainment approach. However, it is a relatively new approach for NSF, and many of the *projects* do not see it as a reasonable goal.

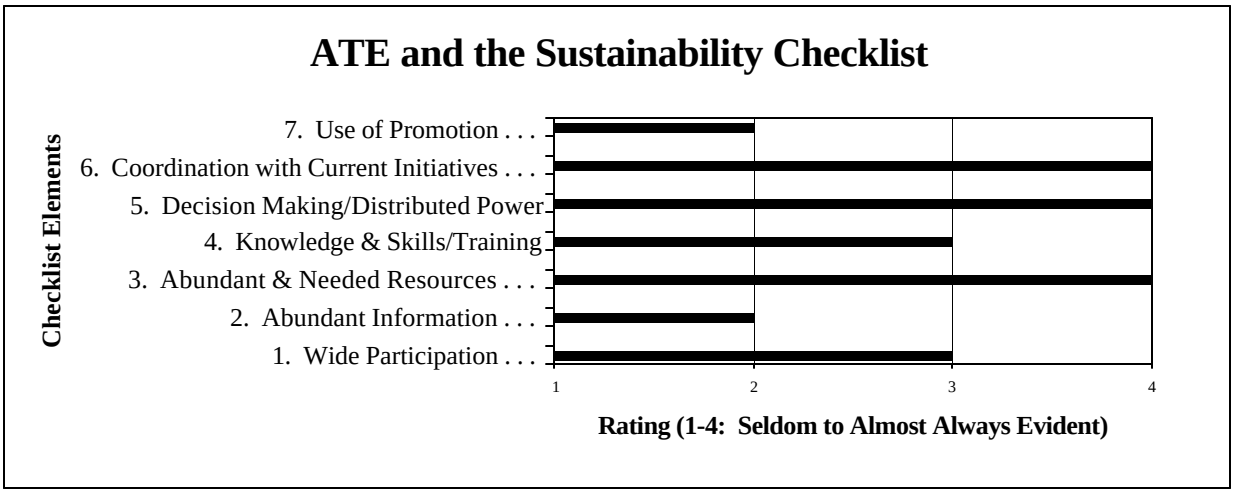
The commercial textbook and instructional materials companies are often more highly funded than the ATE projects and are therefore more competitive. Furthermore, the locally developed ATE materials are often specifically designed to fit with a particular site and designed for teacher and not student use. People at other sites are reluctant to put in the effort involved to adapt or modify the materials for their use.

A thorny issue is related to marketing materials or professional development in order to provide sustainability. ATE *projects* need to reconcile the fact that they are supposed to be providing the best materials and education available to their fields with the reality that they may have to sell materials or professional development if they are to sustain themselves. Just how entrepreneurial should *projects* be? Should they employ marketing experts? Should they withhold valuable materials or education from colleagues because they can't afford them? One visited site has grappled with this issue by marketing its services at different rates based on ability to pay, but this solution presents difficulties as well. These issues are inextricably intertwined with dissemination issues.

Another aspect of marketing and husbanding resources that affects the sustainability of a program is its ability to train people for a variety of situations. This approach tends to increase numbers of students in courses because the courses offer material that is valuable for students pursuing different areas of expertise. It can enhance employability of the graduates in the face of changing job markets and thereby increase enrollment because more students see the program as a pathway to employment. It also allows the educational institution the flexibility to change direction. Several visited sites mentioned that they are providing a broad-based set of experiences for their students, they "were not putting all their eggs in one basket" (e.g., all into network administration training), they

are involving instructors from a whole division, and/or they are using several different platforms (e.g., several types of network software).

***Conclusions and Recommendations***




As can be seen from the above figure, overall, the ATE *projects* appear to be making progress toward sustaining themselves in some form after the NSF monies are no longer available. Embedded in these findings is the importance of achieving and documenting concrete steps toward accountability. Formal certification or approval of these steps from advisory committees, administrators, professional organizations, and others is important. Examples of approvals include creation of new permanent positions, official course or program authorization, or a state's determination to include technician-based content in its curriculum standards or assessments.

Based on data from the site visits and surveys, there is strong evidence indicating that the ATE program manifests 5 of the 7 elements necessary for successful sustainability from our literature-based sustainability checklist. Two elements that we believe need monitoring and improvement are (1) the availability of abundant information and its use to improve the program and reward effort (checklist item 2) and (2) the use of promotion and marketing/husbanded resources (checklist item 7), since there is only some evidence indicating that these elements are present in ATE.

A specific set of recommendations we believe will assist the ATE program to optimize sustainability for its *projects* is detailed below. These recommendations are intended to ensure sustainability, however it is defined, by increasing the likelihood that the 7 elements necessary for successful sustainability of any program will manifest themselves in each ATE *project*. These recommendations also address the areas of concern identified for the ATE *projects* under each sustainability checklist item, especially items 2 and 7.

**1. NSF should clarify its position on sustainability for the ATE program.**

As stated at the beginning of this paper, there is very little information in NSF publications pertaining to sustainability. It appears to be an evolving issue. As a result, ATE *projects* may not be aware of NSF's interests in this area. Even if *projects* are aware of NSF's interest in sustainability, they are unlikely to have clear ideas for operationalizing it or for determining what should be sustained. NSF may want to include the PIs in developing a definition of sustainability as it applies to the ATE program.

**2. If sustainability is to be a major goal of the ATE program, NSF should consider how best to help *projects* achieve it.**

From our work on the evaluation project, we have observed the increased synergy that occurs when *projects* share programmatic information and strategies. There are already two vehicles for creating this synergy for sustainability—NSF's Web site (http://nsf.gov) (or the evaluation project Web site [http://www.ate.wmich.edu]) and the PI annual meeting. NSF may want to include sessions on sustainability at the PI meetings. NSF may also want to provide advice on how to consider and achieve sustainability to *project* national visiting committee members. Having a Web seminar for the PIs and/or creating an electronic mailing list (or chat room) are other options. NSF may also want to consider providing technical assistance (e.g., dollars for a consultant for marketing/promotion, technical assistance for data collection methods) and other interventions. Ultimately, NSF may want to add explicit consideration of sustainability to the program announcement and a rating system to help reviewers assess a potential grantee's sustainability plan.

Detailed suggestions for a sustainability plan are included in recommendation #4.

**3. More attention should be given to data collection and use to identify *project* components that should be sustained, learn how to improve components, provide information upon which to base rewards, and convince others of the worth of the components.**

As pointed out under item 2 of the sustainability checklist (Abundant Information Available and Used to Improve the Program and Reward Effort), many *projects* are struggling with measuring their progress toward goals and providing data to inform key stakeholders (e.g., NSF, administrators, business/industry partners) because they do not have effective strategies and methods in place to collect critical indicators of progress. As a result, these *projects*, because they do not really know how they're performing now, can't really improve or reward performance nor effectively plan for the future. Data should be gathered to help determine what should be sustained and how. The list of issues discussed in this report might help identify types of data to include (e.g., items on the sustainability checklist).

The NSF FastLane report and the annual evaluation survey are two existing mechanisms for assisting with the collection of key indicator data. The old adage in many

business/industry settings is that "what gets measured, gets attention." We have observed that because of these two mechanisms, *projects* are now starting to attend to specific kinds of data (e.g., number of collaborations and materials developed; enrollment and completion figures). The collection and use of critical information for *project* accountability and decision making could be further expanded by developing and disseminating a set of key indicators for meeting ATE program goals and accompanying means to collect data for these indicators. Assessment of progress toward sustainability could also be an indicator (How this assessment would be accomplished is described in Recommendation 5 below). These key indicators would also need to be emphasized on the FastLane report and the annual evaluation survey.

**4. ATE *projects* should consider integrating sustainability strategies into their work from the outset.**

We believe that the detail we are suggesting for inclusion in the sustainability plan described below ensures that the critical elements necessary for sustainability are given attention from the beginning of a *project*, thus strengthening the probability of achieving this goal. The recommendation assumes that the *project* is worth sustaining. This recommendation is also aimed at the concerns raised in regard to the varying degrees of administrative support, promotion/marketing, and institutionalization.

We suggest the development of a multiyear plan, perhaps six years to mirror two NSF grant cycles, that is based on an "exit strategy" for NSF's funding (i.e., what are the strategies for replacing NSF monies and other support over time). Elements of this plan, including implementation strategies and schedules of key milestones (e.g., written commitment from administration), could include the following:

- The ongoing vision and goals (i.e., where a *project* sees itself and its partners in six years)
- Methods and timetables for collecting data critical for determining quality, accountability, and decision making and means for sharing and using this information with key stakeholders
- Identification of and strategies for obtaining additional funding, revenue sources (e.g., product income), and other support (e.g., dollars for training, release time for faculty) outside of and/or beyond the time of the NSF grant
- Descriptions of collaborations/partnerships and what the contributions of these partnerships will be in concrete terms (e.g., specific goals, in-kind services, dollars, dissemination of materials—written commitments and for what time period)
- A depth chart (i.e., list of individuals who could step in when key personnel and partnership changes occur), including contingencies for critical personnel and partnership changes (e.g., PI change, key business/industry partner struggling through an economic downturn, loss of another key funder)

- A description of the strategies for incorporating the *project* within the institution (e.g., approval of a tech program by a specified date, plan for written commitments from administration over time)
- A promotion and marketing plan that outlines the various means (e.g., Web, conferences, publications, professional organizations, trade shows) to be used to raise awareness and acceptance of a *project* and to update and disseminate its products (e.g., materials)

**5. Assessment of progress toward sustainability could occur at least annually.**

As the *projects* are implementing their sustainability plans, they could assess their progress toward sustainability at least annually as a reality check. This self-assessment would involve using the sustainability checklist described in this paper with key stakeholders and collecting artifacts as described in Recommendation 4 that provide evidence that progress toward sustainability is occurring (e.g., agreements with administration for providing a permanent faculty member once the ATE funding is done). We also suggest that NSF add a question to the FastLane report asking for the general results of this self-assessment. This not only ensures that this self-assessment will be done, but also informs NSF on an annual basis. Adding a question or two to the annual evaluation survey so that results would be aggregated across *projects* is also another suggested method. As many *projects* have indicated they focus on the National Site Visiting Committees' recommendations, NSF may also want to have these committees use the sustainability checklist and collect artifacts as part of its evaluative process or at least review and comment on the site's self-assessment.

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