Technology Transfer Innovation and Successful Diffusion in the Construction Industry

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Introduction

New technologies face a series of unique hurdles and barriers in each of the stages of their development and commercialization. These hurdles and barriers can potentially cripple a technology's ability to enter and/or succeed in the marketplace.

The following review of recent technology transfer literature explores some of the most prominent hurdles and barriers to successful technology transfer during the research, manufacturing, and industry and end user adoption stages of development and commercialization. It focuses particularly on technology transfer in the realm of the construction industry, with specific attention to technologies that aim to improve worker safety and health.

It also introduces some of the strategies players at each of the development and commercialization stages have employed in attempts to overcome the challenges of introducing new worker safety and health-related technologies into the construction industry marketplace successfully.

The literature suggests that among the most prominent hurdles and barriers are intellectual property and licensing issues during the research stage; market demand uncertainties in the manufacturing stage; and cost-effectiveness, incentive structures, and usability issues in the industry and end user adoption stage(s).

The literature illustrates a need to establish and facilitate ongoing and closer coordination of various actors at all stages of the development and commercialization of new technologies designed to address worker safety and health issues in the construction industry; the early involvement of the end user is of particular importance.

Secondly, there is a need to acknowledge characteristic variation among the institutions at each of the stages of development and commercialization when attempting to identify mechanisms and strategies to address challenges at each stage to ensure that the mechanisms and strategies are equally accessible, and do not cause adverse effects on smaller institutions.

Lastly, government has played an important role in incentivizing the development and commercialization of new technologies that aim to address worker safety and health issues in the construction industry. These incentives have certainly emerged through government regulation and standardization, but have also surfaced through other research grants and subsidized technology evaluation programs by increasing the scientific information available to manufacturers and industry about new technologies and the benefits of adoption.

Universities & Research Institutions

Professional Expectations for Academics beyond Research

In recent years, the expectation of academics and other research experts to adopt a greater role in bringing new knowledge gained through their research into practice in relevant professional settings has increased (Debackere & Veugelers, 2005).

To a degree, academics have willingly adopted this more active role in technology transfer (Renault, 2006). However, pressure from employers in academic institutions has also been an influential factor.

Leslie, Oaxaca, and Rhodes (2000) revealed that the pressure on academics to increase their role in technology transfer comes from the increasing engagement of institutions of higher education (IHEs) in competitive "academic capitalism"; where IHEs seek to utilize the human capital of their faculty to enhance the institution's reputation and revenue streams. In addition, Renault (2006) found that some institutional policies incentivize increased technology transfer activities by offering significant revenue splitting opportunities with inventors.

Intellectual Property & Licensing Issues

The complexity of legal processes related to attaining intellectual property (IP) rights can slow technology transfer efforts of IHEs and other research institutions.

The growing emphasis of universities on technology transfer has led to the increasing establishment of technology transfer offices on many campuses to assist academics in attaining IP rights over patentable components of their research. However, the review processes of these offices often involve a series of stages where researchers can be restricted from communicating their newfound knowledge until review processes have concluded, and the office has made a decision on whether or not to act on patentable technology. In addition, university technology transfer offices oftentimes determine that new technologies proposed in research are not sound economic investments, and chose not to move forward. *Foresight Science & Technology* points out, "the majority of technologies just end up sitting in a file not benefiting anyone" (Casola, 2011).

Universities and other research institutions utilize a variety of transfer strategies to facilitate the commercialization of new technologies. Perhaps the most common practice involves the "licensing intellectual property rights to established firms." Other viable options include granting provisional IP rights and technical assistance to support the establishment of new start-up enterprises, or spin-off ventures. (Carayannis and Alexander, 1998). While licensing IP rights can provide opportunities for more technologies to be introduced to the market, some noteworthy challenges arise in the licensing environment. Speser (2011) notes, "deals between research institutions and companies or venture capitalists involve transactions between people who live within different cultural frameworks." Universities, he states, "have a culture primarily focused on the creation and transfer of knowledge through research, teaching, and publication. Corporate culture is primarily focused on generating profits.” As a result, complications can arise during licensing negotiations that may slow the introduction of new technologies into the market.

Cooperative Research and Development Agreements (CRADAs) are one mechanism Federal research institutions have successfully utilized to promote technology transfer, and mitigate some of the hurdles that arise in partnering with private firms. However, Carayannis and Alexander (1998) found that CRADAs still involve highly complicated procedures that can detour research institutions and private firms from utilizing them as tool to enhance partnership.

DeSimone and Mitchell (2010) argue that traditional licensing agreements present unnecessary barriers for new start-up companies. Among these hurdles are “demanding excessive equity for intellectual property, in some cases exceeding 15 percent; requiring royalties to exceed total cash flows; expecting external financing; and imposing unpredictable or unreasonable financing terms.” Other barriers in startup arrangements include “demanding that cash-strapped startups make cash payments upfront or early on; triggering buy-back provisions that pull technologies back when given milestones are missed; and issuing non-exclusive licenses to startups.”

Consequently, some universities such as North Carolina University, University of Hawaii and the University of Glasgow are exploring alternatives to traditional licensing negotiations with enterprises seeking license rights to a specific technology. Among these alternative licensing methods are “express licensing”, and “Easy Access IP” approaches.

Express licensing seeks to “expedite the commercialization of technology and give value, if only for the benefit of society, to technology that might otherwise go nowhere” (Casola, 2011). For example, the Carolina Express License offers a “standard licensing agreement for new firm formation” that aims to streamline the licensing process and provide greater support to startup ventures.

The University of Glasgow also provides an alternative approach for encouraging the commercialization of new technologies. Easy Access IP and licensing “literally gives away any technology that is not likely to be a big hit, including fundamental science breakthroughs too immature to license” (Speser, 2011a). The University’s approach is “expected to be particularly attractive to small and medium-sized businesses” (Speser, 2011a). The University advocates that this approach will lead to increased technology transfer, economic activity, and overall improved communities.

America Invents Act of 2011 & Reduced Patent Application Waiting Periods

Traditionally, it has not been unusual for patent processes to take approximately two to four years to complete. While provisional patents have helped to protect IP during review periods, the length of this process has resulted in some additional impediments to technology transfer efforts (Stevens, 2011). However, the recent passage of the *America Invents Act* on September 16, 2011 is expected to provide the US Patent and Trademark Office (USPTO) with increased resources to effectively address backlogged patent applications, and reduce new application waiting times (Wixon, 2011).

Technology Transfer and Commercialization in the Construction Industry

Manufacturers & Market Demand Concerns

The primary concerns of manufacturers are that a new technology has adequate market demand, and that production of the new technology will translate into profit upon introduction into the market.

Manufacturers become hesitant where market demand for a new technology appears to be weak or uncertain. While market demand analyses are a common practice among manufacturers, the level of analysis that is conducted is dependent upon the manufacturers' available resources.

Partnerships with IHEs or other public research institutions have increasingly provided manufacturers with valuable multi-discipline analysis to help manufacturers gain a more holistic view of the potential market demand for new technologies (Branstetter, 2003; and Verbeek et al., 2002).

Government programs that provide subsidized technology evaluation services have also provided a persuasive incentive to manufacturers to produce technologies that they may otherwise sideline due to the high costs of performance testing. For example, the National Institute for Occupational Safety and Health's (NIOSH) *Research to Practice (r2p)* supported research and evaluation for the development and commercialization of the Personal Dust Monitor (PDM) for coal miners. The PDM "provides real-time exposure data during a work shift and warns of potential overexposures" that can lead to black lung disease (Stout & Hull, 2007). The Federal Highway Administration's (FHWA) *Technology Partnerships Program* provided funding to support testing for a new "automated system for safer installation of pavement markers" (Zirlin, 2009). The system prevents workers from having to apply the markers manually in dangerously close proximity to the street and traffic. FHWA is also supporting the development of a road-marking paint that maintains its reflectivity in all weather conditions. The paint is expected to improve road safety for highway construction workers, as well drivers. The Environmental Protection Agency's (EPA) *Environmental Technology Verification (ETV) Program* and the Department of Energy's (DOE) *Technology Transfer Program* have also contributed to the emergence of technologies that have had a less direct, but still positive impact on worker safety and health.

Technology transfer and diffusion of worker safety and health-related technologies can be improved through partnerships with research institutions as well as government programs that help manufacturers gain additional information and analysis to better gauge the potential market for a technology, and can subsidize costly evaluation processes of technologies.

Industry Consumer Concerns

Johnson, Gatz, and Hicks (1997) argue that barriers to technology transfer can arise in social, political, economic, personal, and cultural contexts. The authors suggest that the adoption of new technologies by industry consumers is dependent upon five important characteristics. These characteristics include the following: (1) *Relative Change*, or "the degree to which an innovation is perceived as better than the idea it supersedes as measured in economic terms, social prestige, convenience, and satisfaction"; (2) *Compatibility*, or "the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters”; (3) *Complexity*, or “the degree to which an innovation is perceived as difficult to understand and use”; (4) *Trialability*, or “the degree to which an innovation may be experimented with on a limited basis”; and (5) *Observability*, or “the degree to which the results of an innovation are more visible to others.”

Johnson et al. (1997) also discusses *timing* and *change agents* as having considerable influence over successful industry adoption of new technologies. The authors recommend the early inclusion of end users in the development of new technologies to ensure that the new tool being developed adequately suits the needs of the worker.

Johnson et al. support Pursell (1993) in the idea that the technologies that are likely to experience the highest rates of adoption are those that are “inexpensive, easily maintained, suitable for small scale application, compatible with one’s need for creativity, and are relatively easy to learn.”

In exploring musculoskeletal disorders among masons, Entzel, Albers, and Welch (2007), reveal that “business considerations, quality concerns, design issues, supply problems, jobsite conditions, and management practices” can influence the process of diffusion. The authors point out that most industry consumers were quickest to adopt new technologies that clearly demonstrated “financial savings in the form of increased productivity, decreased labor costs, or reduced workers’ compensation costs.”

According to the authors, mason employers had a tendency to avoid new technologies that require large capital investments, and “expressed a strong resistance to interventions that may decrease worker productivity, reduce job quality, require frequent and/or costly maintenance, introduce new health and safety hazards, or change the nature of a job so dramatically that it is assumed by another trade or requires added supervision.” Stakeholders also cited a general lack of awareness and understanding about work-related musculoskeletal disorders (WRMDs) as an additional barrier to technology adoption (Entzel, Albers, & Welch, 2007).

The authors illustrate a need for increased effectiveness evaluation research, as well as “cost-benefit and return-on-investment analysis to highlight productivity and financial gains that may be achieved by implementing seemingly cost-prohibitive interventions” (Entzel, Albers, & Welch, 2007).

Stout & Linn (2002) hones in on injury prevention practices in the mining industry. They find some of the barriers to the adoption of safer technologies and practices in the mason industry also apply to the mining industry. They state there is a “lack of evaluation of the effectiveness of prevention strategies and technologies, including cost effectiveness; lack of widespread implementation of known, effective prevention; and lack of efficient transfer and implementation of prevention knowledge and products to the workplace.” The authors conclude that “evaluation and implementation of prevention efforts are most successfully achieved in partnership between researchers and the industry at risk, which requires outreach efforts on the part of the occupational research community.” Furthermore, they find that “multidisciplinary collaboration among injury prevention researchers, and collaboration and cooperation among multiple sectors, have improved the relevance and application of injury prevention research and development.”

Characteristic variation between industry consumers can influence the issues they face, and their willingness and/or ability to adopt new technologies related to worker safety and health. For example, Hasle and Limborg (2006) explore the behavior of small business enterprises as it relates to worker safety and health issues in Denmark. The authors find “sufficiently strong evidence to conclude that employers of small enterprises are subject to higher risks than employees of larger ones, and that small enterprises have difficulties in controlling risk.” This risk, the authors argue, often emerges from “limited human and economic resources.”

It can also arise from the influence of an owner’s personal values and priorities. The authors point out that many small business owners “consider health and safety to be the responsibility of the employees.”

Hasle and Limborg suggest that small business owners tend to harbor a deep suspicion towards “state regulation and external consultants.” They reveal that the most effective strategies for improving worker safety and health in small construction companies include “low-cost solutions, disseminated through personal contact.”

Hasle and Limborg also point out that “formal structures such as safety committees are difficult to establish and sustain because of the informal culture of the small business.” Instead, the authors suggest the utilization of regional safety representatives for collective groups of small businesses in the related industry (Hasle & Limborg, 2006). Peppard (2007) provides additional evidence to support the effectiveness of this approach in its examination of Britain, Australia, and New Zealand worker safety representation systems.

There was a lack of existing research exploring how the culture of the construction industry, and sub-components of the construction industry, has historically influenced its willingness to adopt new technologies as they relate to worker safety and health.

There is also a gap in research about government’s non-regulatory interventions (e.g., subsidies, tax breaks, etc.) to incentivize new technology adoption in the construction industry. In order to better facilitate successful technology transfer and diffusion in the construction industry, it is important to gain a greater understanding of the most effective non-regulatory government tools for incentivizing the development and commercialization of worker safety and health-related technologies.

End User Concerns

The *usability* of new technologies is a significant factor influencing the adoption of new worker safety and health technologies by end users in the construction industry. Research shows that workers have a tendency to abandon personal protective equipment (PPE) when it causes discomfort, impedes productivity, and/or affects work quality (Farooqui, Ahmed, Panthi, & Azhar, 2009).

Workers are also less likely to adopt a new technology, and more likely to remove safety equipment during a work shift if they lack a good understanding of the short-term and long-term health benefits of using it (Farooqui et al., 2009). Information about the health benefits of using a specific technology put into the context of financial impact is one effective strategy to encourage end user adoption.

Another important factor that can influence end user adoption is formal training on the proper use of the safety devices (OSHA, 2011).

Lastly, end users express a greater willingness to adopt new technologies when the tool is endorsed by respected fellow workers within their field (Johnson, Gatz, & Hicks, 1997).

Conclusion

Successful technology transfer and diffusion involves many important players at all stages of the development and commercialization process. Existing literature on technology transfer and diffusion as it relates to the construction industry recognizes that the process involves "a complex pattern of upstream, downstream, and intersecting relations between regulatory institutions, various users, suppliers, and construction firms" (Raesfeld, 2002). The literature suggests that the successful commercialization of new construction technologies requires the close and ongoing coordination of these various actors at all stages of a new technology's development to ensure *alignment* "between form and function of a technology" (Raesfeld, 2002).

Many experts stress the importance of early and continuous involvement of "end users" in the development of new technologies to ensure that they adequately consider the concerns of the workers. Literature suggests that technologies that adequately reflect the concerns of end users experience higher rates of success in industry adoption and worker utilization (Johnson, Gatz, & Hicks, 1997).

Secondly, it is important to acknowledge the characteristic variation among the institutions at each of the stages of development and commercialization. For example, an institution's size and resource constraints can influence the identity of its most pressing concerns, as well the degree of its accessibility to strategies to overcome these hurdles and barriers. One-size-fits-all solutions may have adverse effects on some institutions within each stage of the development and commercialization stages. Consequently, approaches to addressing challenges at each stage of development and commercialization should ensure that variation among institutions is considered as to promote maximized transfer and diffusion of worker safety and health technologies into the construction industry.

Government-funded grants and subsidized technology evaluation programs have successfully incentivized manufacturers and industry consumers to develop and adopt new technologies that may have otherwise been sidelined due to less-than-favorable markets and the high costs of performance testing. The National Institute for Occupational Safety and Health's (NIOSH) ***Research to Practice (r2p)*** program, and the Federal Highway Administration's (FHWA) ***Technology Partnerships Program*** provide at least two useful models for technology transfer and diffusion of new technologies aimed to specifically address issues related to worker safety and health.

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Appendix A: Technology Transfer Programs and Models for Construction Worker Safety and Health

In the last decade there have been a few programs and models that have focused on incentivizing the development and manufacturing of technologies with the capacity to improve construction worker safety and health. Among the more notable are the following:

National Institute of Occupational Health and Safety (NIOSH): Research to Practice

Research to Practice (r2p) was established in 2004. The program aims to increase the use of NIOSH-generated knowledge, interventions, and technologies in practice to prevent occupational fatalities, injuries and illnesses. The program involves an interactive process in which the occupational safety and health community – including researcher, communicators, decision-makers, and employer/employee groups work collaboratively to:

- Identify research needs
- Design, plan, and conduct studies
- Translate and disseminate NIOSH generated knowledge, interventions, and technologies to relevant users for implementation in the workplace
- Evaluate results to determine the impact on occupational safety and health

Research to Practice utilizes the following model to achieve programmatic goals:

- Prioritize: conduct research that addresses the most important occupational health and injury issues facing workers.
- Partner: Work together with both internal and external partners to encourage workplace adoption and use of research findings.
- Target: Adapt research results into information products tailored to the target audience.
- Translate: transfer and translate research findings, technologies and information into prevention practices and procedures.
- Disseminate: Use communication science to guide the movement of research into the workplace.
- Evaluate: Build data collection into each program to determine effectiveness in preventions workplace injury and illness.

National Institute of Occupational Health and Safety (NIOSH) – Office of Mine Safety and Health Research (OMSHR): Coal Workers' Health Surveillance Program

The Office of Mine Safety and Health Research's ***Coal Worker Health Surveillance Program*** monitors and assists the coal industry's efforts to limit miner exposure to dust that can lead to the potentially fatal respiration condition commonly referred to as "black lung". OMSHR has produced publications summarizing dust-control technologies to assist coal mine operators in selecting technologies most befitting for their respective mines. They have also helped to develop the Personal Dust Monitoring

System (PDM) that provides dust exposure information to the miner in real-time. OMSHR also participates in PDM performance evaluation.

Federal Highway Administration (FHWA): Highways for LIFE (HfL) – Technology Partnerships Program

The ***Technology Partnership Program*** is a grant program that aims to “partner organizations and companies with the highway construction industry to accelerate adoption of promising innovations that reduce congestion and improve safety and quality.” The program provides grants to the partnerships to “fund the critical final steps in developing technologies” (FHWA, 2009).

One project the program has funded related to worker safety and health is the “Automated Pavement Marker Placement System**”.** Applying raised pavement markers manually is time-consuming and dangerous for workers. The prototype device, which can be mounted on standard equipment, will automate the process of reflective marker installation on roads. Initial tests showed the system reduced labor hours, construction time and risk of worker injury.

Information on HfL Technology Partnerships Program is located here:
http://www.fhwa.dot.gov/hfl/tech.cfm

Department of Energy (DOE) Technology Transfer Program

DOE authorizes all 17 of its national laboratories and another 5 of its production facilities to conduct technology partnering activities. Most of these laboratories and facilities have established formal technology transfer programs with staff dedicated to the facilitation of the administrative and negotiating processes involved in entering into agreements with non-Federal partners (DOE, 2009).

In 2011, the program awarded funds to the Idaho national Laboratory’s “Rad-Release Chemical Decontamination Technology (Rad-Release)”**.** Rad-Release is a viscous foam that removes radioactive and concentrated metals from various surfaces. The technology allows contaminated buildings and equipment to become usable, is non-destructive, reduces workers' exposure to contaminated materials, and minimizes waste costs and volume.

More information about this program is found here: http://techtransfer.energy.gov/

Environmental Protection Agency: Environmental Technology Verification (ETV) Program

The ***Environmental Technology Verification (ETV) Program*** verifies the performance of innovative technologies that have the potential to improve protection of human health and the environment. ETV accelerates the entrance of new environmental technologies into domestic and international marketplaces. Verified technologies are included for all environmental media—air, water, and land.

ETV is a voluntary program and is operated as a public/private partnership, mainly through cooperative agreements between EPA and private, nonprofit research institutes called ETV verification organizations.

ETV efforts are guided by the expertise of stakeholder groups. These groups consist of representatives of verification customers for particular technology sectors, including technology purchasers and users, technology developers and vendors, state and federal regulators and permitters, consulting engineers, environmental organizations, and others. ETV stakeholders assist the program by developing verification protocols for testing, prioritizing the types of technologies to be verified, and implementing outreach activities to the customer groups they represent.

The general criteria for submitting a technology for verification includes the following:

- The technology must be commercial ready.
- The vendor should anticipate that the technology will perform well under ETV testing (all verification results are published).

The ETV verification process typically includes the following steps:

- Identification of area-specific technology categories
- Identification of verification factors
- Vendor solicitation and application
- Verification protocol
- Test/quality assurance plan
- Verification testing
- Verification report and statement
- Outreach

ETV centers set priorities for verification activities with the help of stakeholder input. In general, stakeholders apply three criteria in setting priorities among technology categories:

- Existence of an important environmental problem to be addressed
- Availability of techniques for performance testing
- Feasibility and practicality considerations.

Information about this program can be located here: http://www.epa.gov/etv/

Ohio Bureau of Workers' Compensation – Safety Grant$ Program

The purpose of the ***Safety Intervention Grant$ Program*** is to gather information about the effectiveness of safety interventions so that BWC may share the results with Ohio employers. The program is available to any Ohio state-fund or public employer who wishes to purchase equipment to substantially reduce or eliminate injuries and illnesses associated with a particular task or operation. The program is designed to work and partner with Ohio employers to establish safety intervention best practices for accident and injury prevention.

To participate in the program an employer must pay into the Ohio State Insurance Fund, maintain active coverage, be current on all monies owed BWC and demonstrate the need for a safety intervention.

With the safety intervention grant, private and public employers are eligible for a 2-to-1 matching grant, up to a maximum of $40,000, meaning a total of $60,000 — $20,000 from the employer and $40,000 from BWC. The employer benefits through a substantial reduction or elimination of workplace injuries and illnesses, and their related costs.

In return, the employer submits quarterly data reports and a case study one year after the date of the intervention. BWC will use this information to determine the effectiveness of the intervention and share successes with other employers.

One output of the program is the Ergonomics Best Practices for the Construction Industry document. The document can be viewed here:
http://www.ohiobwc.com/downloads/brochureware/publications/ConstSafeGrant.pdf

More information about BWC Safety Grant$ program is found here:
http://www.ohiobwc.com/employer/programs/safety/EmpGrants.asp

FIATECH – Capital Projects Technology Roadmap (Model)

The purpose of the Roadmap is to establish a consensus vision for the capital projects industry and a unifying initiative to achieve the vision. The capital projects industry is a critical element of the industrial base, providing physical infrastructure for economies and standards of living worldwide. Maintaining this infrastructure is an immense challenge. The industry, however, lags other sectors in exploiting technological advances. Vast disparities in business practices and in implementing usable technology application combine to hold possible advancements by the industry in check. The industry's own fragmentation, with a great divergence in tools and technologies from company to company and across its supply chains, adds to the challenge.

The Roadmap includes a Construction Industry-focused strategic element aimed to provide the forum for construction practitioners, material providers and technology providers to make a concerted and systematic effort to identify, develop, deploy and evaluate the impact of the components, systems, standards and deployment strategies that are needed for successful Intelligent and Automated Construction Job Sites.

More on the Roadmap here: http://fiatech.org/index.php/tech-roadmap/roadmap-overview/purpose

Appendix B: Johnson, Gatz, & Hicks (1997): "Technology Readiness Questions"

The chances of successful transfer are enhanced by understanding the technology transfer process and by developing strategies that can enhance the prospects of successful transfer. The following lists identify many of the important strategies for successful transfer that emerges from the concepts discussed in the literature. While incomplete, these strategies highlight the complexity of issues that need to be addressed when supporting a technology transfer process. These strategies are categorized according to technological readiness questions, design considerations, and end user needs.

Technological Readiness Questions

These questions provide the basis for an initial overview or 'scan' of a user environment. Answers to these questions help assess whether a user environment is prepared to embrace and develop the knowledge needed to successfully adopt a new technology.

- Who will be using the technology?
- What is their current level of technology?
- Who are the stakeholders? the decision-makers? the influential people?
- Do the end users have the education needed to adopt the technology?
- Will training be needed?
- What are the available financial resources? Will they be sufficient to sustain the technology?
- Will the current infrastructure support the technology and its expected growth?
- What other aspects might affect by this transfer?
- Is the full benefit of the technology limited by other bottlenecks in the system?

Design Considerations

- These design considerations build on the concepts of the appropriateness of technology and emphasize factors important in achieving more than a material transfer of technology.
- Design the technology and infrastructure so that it can grow with the user.
- Develop and adapt technology so that it is appropriate for the culture and intermediate if the society's needs dictate.
- Present demonstration programs to assure small-scale success.
- Keep the end user in the loop during the design process to assure that needs are being met.
- Document technology procedures (in terms the user can understand) so that the user has as much information as needed to operate the technology independently.
- Provide research and/or training support to facilitate the transfer of knowledge.
- Maintain a systems view. Recognize that the technology is not independent, but affects other parts of the system.

End User Considerations

Central to the models of technology transfer is the role of user needs and wants in the technological development process. The issues described below build on the importance of the user in the design process and extend this consideration of users to the technology transfer process.

- Evaluate end user's needs and available resources.
- Consider how large a system the user will be able to staff and maintain.
- Identify influential people, stakeholders, and decision-makers. The power of the change agent may dictate a technology's success or failure.

- Facilitate communication among those involved, and foster a cooperative relationship.
- Treat the end user’s values and culture with respect.
- Develop technology solutions that are fitting for that environment.
- Do not impose status and education on the receiving culture.
- Maintain two-sided innovative dialogue and establish communication channels