Chapter 1

Introduction
The ability to use scientific or engineering advances (new technologies) to meet market needs has become a primary business success factor for many firms. Success can be attained through new product introductions, improvement or extension of current product lines, or entering into new geographical areas. New technology is also a major factor influencing growth and productivity within a firm. However, the forces that lead to technological innovation are not always from inside the firm. Often a company receives technology (technology push) from outside sources. However, the transfer process is not always smooth. Public sector research represents an important source of technology. In the major Western industrial countries, government and university research organizations account for over 40 percent of the national research and development (R&D) expenditures (Large and Barclay 1992). However, many technology transfer efforts between public (federal government) and private sectors have been disappointing (Piper and Naghshpour 1996).

Given the importance of technology for corporate profitability and growth, and for national economies and international competitiveness, it is not surprising that there is strong and active interest in this subject (Irwin and Moore 1991). In the past, transferring technology was viewed as a unilateral flow process. More recently, the subject has been heavily emphasized for economic and marketing considerations. But there are problems with a purely market-driven or a purely technological-driven approach to the successful transfer of technological innovation. It has been suggested that the combination of the
two, technology innovation with appropriate marketing is necessary for real success and needs further investigation (Irwin and Moore 1991).

While this method may be recognized as a strategically sound way of approaching innovation transfer, the actual mechanism of how to achieve this approach is not quite so clear. Recently, researchers have been exploring the issue of differences in culture and communication. Such an approach might help overcome many of the associated problems involved, particularly the communication difficulties occurring among technology developers, message senders, and technology users (Irwin and Moore 1991). Therefore it is important to pay close attention to communication and information flow through different cultures involved in the technology transfer process. It is necessary to find means of effective information flow and communication to technological matter. The marketing of technology requires new skills, styles, techniques, and ways of thinking. Communication competence and effective information flow in transfer technology needs to be recognized as a cornerstone (Irwin and Moore 1991).

Like all businesses, government organizations buy, sell, provide, and deliver ideas, services, and goods. Government organizations today face limited funding and personnel, but they must grapple with growing needs for their services. Public organizations often find it necessary to seek help from other organizations and individuals to achieve their objectives. In the case of diffusion of government-sponsored innovation, it is challenging to find parties who can facilitate the innovation, and once the parties are identified, elicit the necessary assistance from them.
To date, little research has been conducted by the USDA Forest Service on how to facilitate technology transfer through a communication system to the target users. Smith and Cesa (1997) examined the effectiveness of “technology push” by one program under the USDA Forest Service supervision, the Wood in Transportation Program (WIT). A questionnaire was mailed to over 90 firms identified as suppliers of material for modern timber bridges. Overall, respondents rated the program’s “technology push” as only moderately effective in expanding markets for wood utilization.

This research only measured manufacturers’ response of technology push. It did not evaluate the information flow between the push side of government agencies and the other side, final users. To date, technology transfer efforts have been focused on permanent bridge structures for highways or pedestrian use. Another potential large market may exist and this market probably could utilize new timber bridge technology. The market for portable timber bridges for use in forestry and logging operations has not been evaluated.

The main goal of this study was to evaluate the information flow through the entire logging industry system, identify the communication differences between transfer participants, and identify the best channels (intermediaries) to facilitate technology transfer. In this research, the network concept was applied to the study of communication and information flow (among different groups and cultures). The study included a specific example from empirical research on the diffusion of portable timber bridge technology. Upon the analysis of the network of information flow, a strategic marketing plan for successful transfer of portable timber bridge technology was ultimately developed.
Objectives

The specific objectives of this research were:

1. Identify the best channels of information flow for diffusion of portable timber bridge technology.

2. Identify the communication differences between transfer participants.

3. Develop a strategic marketing plan to increase the utilization of portable timber bridge technology in the logging industry.

Literature Review
**Introduction**

Market expansion is considered an important factor for long-term success by most forest products firms. Success can be attained through new product introductions, improvement, innovations or extension of current product lines, or entering into new geographical areas. New technology is also a major factor influencing growth and productivity within a firm. However, the forces that lead to use of technological innovations are not always from inside the firm itself. Often a company receives technology transfer proposals (technology push) from outside sources.

Technology push from outside forces has been demonstrated recently in the market for timber bridges. The U.S. Congress funded the Wood in Transportation Program (WIT) (formerly known as the National Timber Bridge Initiative), which is administered by the USDA Forest Service. In Fiscal Year 1989, it began to rebuild local infrastructures and increase the use of underutilized or low-value timber species for bridge construction. Since that time, over 20 million dollars have been authorized for research, construction, and transfer of technology information regarding the use of timber for modern bridges (USDA 1995). This technology push effort has been led by the Timber Bridge Information Research Center (TBIRC) located in Morgantown, West Virginia; the Forest Products Laboratory located in Madison, Wisconsin; and various research institutions throughout the United States (USDA 1997).

However, most of the WIT’s research emphasis has been placed on permanent bridge structures. There appears to be a large potential market existing for timber bridges
and this market has not been explored. This market is the utilization of portable timber bridges as temporary stream crossing structures during forest management and timber harvesting operations. Worldwide demand for wood products continues to increase along with increases in population and the standard of living. At the same time, woodland managers are being asked to maintain forests for other uses; such as recreation, wildlife, clean water, and fresh air. Therefore, as the world struggles to meet its growing need for wood products, it also has to do it in an environmentally-friendly manner (Russell 1997).

An opportunity exists for the forest industry to minimize erosion and sedimentation during timber harvesting and forest management operations. This can be achieved by utilizing portable timber bridges for stream crossings. Portable timber bridges enable quick, safe, and temporary access to a logging operation. Timber bridges are reusable, easy to install, environmentally sound, and cost-effective. Federal, state, and private interests are aware that these activities (logging and forest operations) can adversely affect the environment, especially water quality. To alleviate environmental degradation, many states have developed Best Management Practices (BMP) for forest operations (Russell 1997).

Background of BMP and Portable Timber Bridges
The increase in state and federal monitoring of water quality necessitates that harvesting and land management activities reduce their impact on waterways. Logging operations are being placed under increased scrutiny for their effects on water quality. To address these concerns and meet new regulations, logging operations must develop and use stream crossing methods to minimize or eliminate their impact on waterways (Russell 1997).

Research has been conducted to document the impact of harvesting activities, roads and road construction, and site preparation on forest stream water quality. Researchers have found that roads and road construction create more pollution in the form of sediment than harvesting activities, and that road crossings at streams are the most frequent source of sediment and erosion. Swift (1985) reported the cumulative amount of soil placed in a stream at road-stream crossings during construction was over 10 times greater than the sedimentation during logging operations.

In recent years, BMP have been developed and implemented by most states to comply with the Environmental Protection Agency’s (EPA) guidelines for preventing or reducing pollution generated by non-point sources in forestry activities. Originally, compliance with BMP was voluntary. However, in many states BMP implementation has become mandatory. In Virginia, forestry BMP encompass six basic goals in order to meet the water quality standards of the Commonwealth of Virginia and the goals of the Clean Water Act in 1987 (VDOF 1992).

The goals are as follows (VDOF 1992):
(1). To minimize surface runoff waters originating from any type of forestry-related soil disturbance and running directly into a water course;

(2). To maintain the integrity of all stream beds and banks;

(3). To prevent depositing of logging debris in stream beds;

(4). To prevent chemicals, pesticides, fertilizers, or petroleum products from entering or degrading (directly or indirectly) streams, ground water or surface water;

(5). To establish streamside management zones (SMZ) along perennial water courses that filter sediment from overland flow and maintain stream temperature; and

(6). To provide for rapid revegetation of all exposed mineral soil areas through natural processes supplemented by artificial revegetation where necessary.

Most erosion and sediment introduction during logging operations occurs at stream crossings. The use of temporary structures for stream crossings may alleviate this problem. Portable timber bridges are sound investments that allow loggers to cross streams without impairing water quality. Initial material, fabrication, and assembly costs may seem excessive, but portable timber bridges are cost effective in the long term versus the use of conventional stream crossing methods (Russell 1997). Taylor et al. (1995) made cost comparisons between culverts and portable timber bridges. The cost of one culvert installation was $2,700, which was approximately equal to the cost of a portable timber bridge that can be reused many times.
In this study the cost of installation and removal of the portable timber bridge was $2,500. This included the initial cost of the bridge, cost of bridge transportation to and from the site, equipment operations, and labor costs distributed over 10 installations. Taylor and Murphy (1992) reported that glulam or stress-laminated portable timber bridges cost an average of $41/sq.ft., while portable steel bridges were $43/sq.ft. The advantages of portable timber bridges are that they can use locally available materials and labor, have a long service life, are relatively light weight, easy to fabricate and transport, and can be handled by most logging equipment. According to Taylor et al. (1995), the most promising designs, for spans up to 40 feet, consist of longitudinal glulam or stress-laminated decks that are placed across the stream.

Loggers can expect a minimum of eight to ten years of service from a properly constructed, maintained, and treated bridge. When compared to using culverts and logging mats, portable timber bridges are more quickly installed and environmentally friendly. Culverts require that soil be backfilled over and against them. Sedimentation, stream turbidity, and erosion can occur at installation and during stream crossing, resulting in erosion and stream turbidity during use. Also oil, grease, and logging debris potentially can enter the stream with the use of mats (Alderman 1996).

Most material used to construct portable timber bridges is available locally and can provide an economic stimulus to the area. Timber is a renewable resource and the bridge fabricators can use their own lumber to significantly reduce bridge costs. It is economically and environmentally feasible to manufacture and use portable timber bridges.

The most practical solution for the forestry operations on low-volume roads would be portable timber bridges. They can be easily designed, constructed, transported, and installed. Upon completion of the harvest operation, they can be removed and reused at another site. The ability to reuse portable timber bridges potentially makes them more economically feasible than other stream crossing alternatives.

**Technology Transfer in the Wood in Transportation Program (WIT)**

A significant opportunity exists in the United States to improve rural transportation networks and potentially revitalize rural economies by using wood for bridges and other transportation structures. To address this opportunity, the U.S. Congress funded the Wood in Transportation Program (WIT), formerly known as the National Timber Bridge Initiative, beginning in Fiscal Year 1989. In 1997, over 100 grant applications were received by the WIT Program. This indicates a great interest and need in the WIT Program (USDA 1997).

It is essential that the WIT Program be accessible to the public, which includes highway officials, bridge engineers, and community decision-makers. In order for the WIT Program to be successful, information about uses of wood in transportation must be transferred and disseminated to others. Technology transfer has been conducted primarily under the direction of the TBIRC located at Morgantown, West Virginia. Transfer
activities include a quarterly newsletter (Crossings), specific research reports, production of the Timber Bridge Manual, the sponsorship of several workshops and training sessions on timber bridges, and a library of information and staff ready to assist anyone who contacts them. The TBIRC also identifies emerging technologies, stores, retrieves, and disseminates information to meet the needs of managers, planners, designers, builders, engineers, and others (USDA 1997).

The Logging Industry

Traditionally, studies on loggers in the United States have focused on productivity, profitability, employees, and log markets (Egan et al. 1997). The United States forest products industry is heavily dependent on small, independent loggers for delivery of raw materials to mills.

In predominantly rural locations, logging operations are a major source of income and employment for many communities (Sinclair et al. 1985). Recently, some researchers have studied logger preferences on different issues not related to productivity or profitability. Results from a study by Smidt and Blinn (1994) indicated a need for logger education programs which include workers compensation, safety issues, and environmental regulations. Shaffer and Meade (1997) indicated that trained loggers achieved a higher mean score than control group loggers (with no training) in BMP implementation and landowner satisfaction, and they had less weather-related downtime. Lewis (1996) indicated that public image was the most important issue facing loggers. He
concluded that the logging industry is under severe pressure from governmental regulations and environmental and conservation groups. Egan et al. (1997) stated that loggers have been forced to operate within an increasingly restrictive regulatory environment. Also, loggers expressed anger about the increasing direct costs associated with training and mandatory operations (Egan et al. 1997). Most of this research was focused at the state level with a low-study population and response rate.

Marketing by Public Organizations

By and large, the products or programs marketed by government agencies fall into three categories—informational, educational, and political (Fine 1990). Informational marketing is used to bring important facts to the public’s attention; for example, information about the use of timber bridges, the announcement of a BMP training seminar, and so on. Educational marketing is used to disseminate public interest programs, such as those concerned with water quality during forest harvesting or increasing portable timber bridge use. Political marketing is intended to enhance the image of the party in power (Fine 1990).

Government marketing efforts should not be confused with conventional public policy research in marketing, which has been limited to regulatory issues; nor with viewing the government as a market (a buyer of goods and services). “Government marketing views public sector jurisdictions and organizations as marketers or sellers – developers
of benefits who can communicate, value-added, and deliver those benefits to complex citizen or consumer markets” (Mokwa and Permut 1981).

Like all businesses, public organizations buy, sell, provide, and deliver ideas, services, and goods. They transact with suppliers, middlemen, and customers and they too are counseled by other specialists. Public organizations find it necessary to use other organizations and individuals to achieve their objectives. They have limited funding and personnel. As a result of the aforementioned factors, they seek to find others to help in the diffusion of technologies. Clearly, it is challenging to find parties who are involved in the purchase or usage decision, and once the parties are identified, eliciting help from them. Public organizations today must grapple with a growing need for their services, shrinking funds, and fierce competition with other organizations. “To achieve success in such an environment, a public organization must rely on an effective marketing strategy: an integrated communications program to present the organization and its services and/or programs to effective intermediaries who can assist the organization reach prospective users” (Kotler and Andreasen 1996).

Technology Transfer

Technology transfer is not new. Segman's (1989) historical review of technology transfer has traced the process from Neolithic times, stressed the role Arabs played in transferring technologies from East to West, and illustrated the two-way Britain-America transfer of textile technology in the 18th and 19th Centuries (Irwin and Moore 1991).
Other studies have shown certain industries collapsed because of resistance to the opportunities of technology transfer. For example, in the 18th and early 19th Centuries, “the British clock and watch industry enjoyed domination of the world clock and watch market. However, the labor intensive industry rejected new machine tools, new production methods, and new workers’ training programs developed in Switzerland and the United States. By the early 20th century, the industry declined significantly and collapsed before World War I” (Irwin and Moore 1991).

While technology transfer is nothing new, it has been revived by pressure from governments around the world. The government laboratories and agencies are being expected to contribute more than they have done previously to national and international economic activity and development. They are also being expected to have greater responsibility for technology development ventures with private sectors and the transfer of those technologies, an equally important role for these public institutions.

It is well known that technology transfer involves moving or shifting discoveries, inventions or innovations from research laboratories or government agencies to the marketplace. The definition of a marketplace usually implies commercializing the application of these innovations. It is also known that technology transfer refers to something that is moved, a physical or tangible product or application moved from one place or one organization to another place or organization. “There is now a recent and broad recognition that abstract concepts, ideas, and information also constitute technologies” (Irwin and Moore 1991).
Steele (1989) stated that the process (technology transfer) is more complicated than that (moving something from point A to B) because the technology itself is changed as a part of its movement from one organization to another. “In corporate R&D … in GE, this process is called transition, and the word is used both as a verb and a noun, because it implies a change of state as well as movement … Technology transfer involves two different dimensions. The first or substantive one, addresses the problem of transferring information about physical phenomena, equipment, analytical and manipulative techniques, terminology, etc. associated with the technology. The second is affective – it concerns the feelings and attitudes required in both organizations in order for two sets of people with different skills, values and priorities to become successful in passing the baton from one to the other” (Steele 1989).

Early Methods of Technology Transfer

Several technology transfer models (or stages) were developed after World War II in the U.S. Each model or stage employed different approaches to shape government technology transfer efforts. In the early years, the technology transfer process or thinking, has commonly proceeded as “good technology automatically sells itself” model, or more recently as a “innovation dissemination/diffusion” model. Both models viewed technology transfer as a unilateral process (Irwin and Moore 1991).

The “automatic” or “appropriability” (Devine et al. 1987) model suggests that quality research or technology sells itself. The transfer process simply happened where
technology had found users or been discovered by the market. But over the years, increasing evidence shows that quality technologies do not often sell well by themselves (Devine et al. 1987; Gibson and Smilor 1991).

The dissemination model emphasizes the need to diffuse publicly developed technology to potential users by experts or opinion leaders. When the need is recognized by experts or leaders, they help technology to find users through the channels. Experts select what is deemed good for users and make it available for them. However, the model remained unilateral with no involvement from users.

The most recent research on technology transfer, particularly on international technology transfer, has emerged from the fields of corporate policy, organizational behavior, marketing, and strategic management, as well as from sociology and political science. Some studies, in particular, examined why new technologies often move slower than expected, even if the technologies clearly indicates increased productivity and quality. Some studies suggest a more dynamic diffusion process incorporates many adaptations and improvements in the technology, as well as in production and consumption systems (Irwin and Moore 1991). However, little research illustrates the concerns of communication and information flow in the process of transferring technology.

Communication and Information Flow
Communication is the process by which messages are transferred from a source to a receiver. Many marketing or communication models utilize a linear, one-way communication process such as the S-M-C-R model. A source or sender [S] sends a message [M] via certain channels [C] to the receiver [R]. Most communication research under the linear model assumption has been conducted to gather data from a sample of receivers. The research pertained to the effects of communication on receivers' knowledge or attitudes. The variables of source, message, channel, and/or receiver are viewed by the researchers as independent variables, in order to test dependent variables, which is the effectiveness of communication (Rogers and Kincaid 1981). Rogers and Kincaid (1981) pointed out these communication models describe a simple communication act, but not the process of communication or information flow. Many important aspects of human communication do not fit into linear models. Berlo (1960) stated that the behaviors of the source do not occur independently of the behaviors of the receiver or vice versa. In other words, in any communication situation, the source and the receiver are interdependent. Berlo (1977) claimed that linear models of communication are appropriate for directional persuasion, but Berlo concluded that our interests in communication are changing, mainly from directional persuasion to “communication-as-exchange.” The limitations of linear models became apparent in their application to the study of mass communication and the diffusion of innovations (Rogers and Kincaid 1981). When mass media and diffusion of innovations did not achieve their expected effects, researchers realized that the linear model has constrained the capacity to study human
communication as a process of mutual information exchange, such as sharing meanings (Rogers and Kincaid 1981).

**Network Paradigm**

In the early 1980s, researchers began to use a valuable alternative to the dominant model, the network paradigm (Yum 1989). The network paradigm views communication as a two-way process and concerns itself with the social effects of communication on relationships among individuals within network (Rogers and Kincaid 1981, Yum 1989). The network concept is not revolutionary, it is as old as the fields of anthropology and sociology. “In anthropology and sociology, the network model of social systems is a logical outcome of four theoretical trends toward (a) an interest in relations rather than things, (b) an interest in process rather than form, (c) an interest in elementary phenomena rather than institutions, and (d) an interest in construction of generative models rather than functional ones” (Wolfe 1978, Yum 1989).

A network (as a noun) describes a collection of actors (individuals, organizations or countries) and their structural connections such as, social, strategic, or business alliances (Iacobucci 1996). The main objective of the network paradigm is “describing an approach to studying relational phenomena and structural analysis of interconnected actors” (Iacobucci 1996). Actors are understood to be a part of such networks, and networks are meaningful because of the actors who constitute them. In this sense, “the network paradigm is closely related to the system approach, which also emphasizes
interaction among the parts of a system” (Yum 1989). The goal of researchers working within the network paradigm is to understand structures of relationships: who is connected to whom? what are the differences between parties? how do these people interrelate? and so on (Iacobucci 1996).

In terms of research methods, the recent networks approach has favored qualitative, case-based methodologies. Araujo and Easton (1996) reviewed 10 different network approaches, social networks, interorganization theory, actor-network theory, networks of innovators, network organizations, policy networks, networks in economic geography, comparative studies, entrepreneurship studies, and industrial networks. Except social networks analysis using sociometric techniques, the rest of the approaches favored mainly case studies. Easton (1995) examined, in detail, the set of assumptions governing research in business-to-business networks and has mounted an argument in favor of a realistic epistemology and case-based methodologies to capture the interdependence and dynamic aspects of the networks.

**Communication and Information Flow vs. Transfer Technology**

Williams and Gibson (1990) present a case for considering technology transfer as a communication and information flow process, with communication understood to be concerned with full exchange and sharing of meanings. They see technology transfer as an ongoing, two-way interactive process by continuous and simultaneous exchange of ideas among the individuals involved. “So much a two-way interactive process is technology
transfer, according to network communication paradigm, that feedback is all pervasive and the participants in the process become transceivers, rather than sources and receivers” (Irwin and Moore 1991).

Irwin and Moore (1991) urged the need to apply contemporary views of communication to technology transfer, which refers to two-way, interactive, meaning-centered views of interpersonal/organizational communication. In doing so, there also needs to be an explanation for many failures of technology transfer strategies based on one-way flow automatic and dissemination/diffusion models (Irwin and Moore 1991). The network communication paradigm analysis is one promising method to overcome the problems.

However, when the network communication paradigm and practice is applied to the technology transfer circumstance, what must be recognized is that the situation and context is very complicated. Most problems associated with the communication of technology transfer are based on the fact that they are comprised by different organizations or people from different cultures. For example, the agricultural and logging community are a relatively close-knit group with shared values and emotional attachment to the land which facilitates communication among its members. But scientists and engineers are a highly diversified group, not wedded by shared emotions (McFall and McKelvey 1989). In fact, the cultural differences between technology developers and loggers makes any technology transfer mechanism a difficult task.

Recognition of the complexity of technology transfer has given rise to consideration of the use of “linkage champions” as communication experts to assist in
technology transfer (Irwin and Moore 1991). These so called brokers, middle-men, intermediaries, or strategic alliances offer the best chance for facilitating technology transfer. The notion of linkers is not new, it has been used in the management literature for a long time, especially in the field of international management and marketing. The function of linkers is to bring key people from each world, technology developers and users, together effectively. In marketing literature, these linkers can be considering as channels. Kotler and Andreasen (1996) point out that a channel is a conduit or outlet for bringing together a marketer and a target customer at some place and time for the purpose of facilitating a transaction. The careful planning of channel strategy can have important positive payoffs. In this study, the linkers play an important role as technology developers and users in the information flow network analysis.

The investigation of information flow network is interdisciplinary in nature. The main objective of the network paradigm is to “understand the communication structure of a system by means of the analysis of relational data about communication flow” (Rogers and Kincaid 1981). Communication structure is the arrangement of the differentiated elements that can be recognized in the patterned communication flow in a system. Another objective through the network analysis is to understand the "big picture" of human interacting behavior in a system.

Most of the network literature is: (1) over emphasized mathematics formulas, (2) focused on hardware instead of understanding of human behavior, and (3) confusing in concepts (Rogers and Kincaid 1981). Rogers and Kincaid (1981) point out that network analysis has been dominated in the past by tool-makers rather than tool-users. And the
field has been characterized by “sophisticated methodologies looking for theoretical problems to answer”.

This current research emphasized the information flow network concept rather than employ a heavy mathematics formula model. This study utilized the backward trace method (Figure 1.1) to gain an understanding of how innovations are diffused. The research consisted of the following steps to attain the final goal of developing strategies to successfully diffuse portable timber bridge technology from public research sectors to private sectors. First, it evaluated how the final users receive information, what are their preferred channel(s) to receive information, and how they make decisions to use or not use portable timber bridge technology from the WIT Program. Second, it traced back to the intermediaries who were identified by users and evaluated how they receive information from technology developers; how they evaluate the information; how they currently promote and diffuse ideas or innovations. Finally, it traced back to the technology developers and evaluated how they currently promote and diffuse ideas or innovations.
Summary

The literature review has demonstrated that ideas and innovations, like commercial products, must be accessible to potential adopters at a time and place and in a manner that will facilitate adoption. To accomplish this, the marketer constructs a network of organizations or individuals, each of which performs certain functions. A typical network for public organization marketing includes the organization initiating the ideas or innovations, intermediaries, and consumers. There has been little research on the communication system for effective technology transfer for the USDA Forest Service WIT Program. Only a thorough understanding of the network will enable technology developers and adopters to work closely to overcome the barriers of technology transfer.

The premise of this study is that previous technology diffusion models between public research and private sectors have not worked well. There must exist methods for the successful transfer of advanced technology to users, which potentially will increase their competitiveness or economic activities. Examination of a system structure provides insights as to which organizations or individuals are involved in the communication/distribution process, what their roles and functions are, and is the message being effectively carried out. The identification of all potential effective intermediaries in the system/channel, by ideas or innovations, developers and adopters, will lead to a better understanding of the network structure, concept, and effect on overall performance. The development of a comprehensive strategic marketing plan will further advance the effectiveness of technology transfer in the WIT Program.
Objectives

The specific objectives of this research were:

1. Identify the best channels of information flow for diffusion of portable timber bridge technology.

2. Identify the communication differences between transfer participants.

3. Develop a strategic marketing plan to increase the utilization of portable timber bridge technology in the logging industry.
Literature Cited


