ASSESSMENT OF INNOVATION IN MAINE'S LOGGING INDUSTRY

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ABSTRACT:

Innovation is widely recognized as a critical component to a successful business. The study of innovation in the forest industry is well documented for forest product companies, but there has been very little research conducted on innovation in the logging industry in North America – let alone Maine. In fact, a recent report concerning the future of Maine's forest products industry highlights the importance of innovation to the long-term sustainability of the industry as a whole, but the lack of attention to the logging industry is noticeable. Innovation in the logging industry can be defined as the adoption of a new product, process, marketing strategy, or organization method by a contract logging firm. Currently very little is known about the overall innovation system in Maine's logging industry, nor the criteria contractors use to assess specific innovations.

This paper presents qualitative findings from 10 case studies of logging innovators in Maine. The findings presented here focus on 1) innovations engaged in by logging innovators and 2) the development of mechanized logging systems among the cases studied and how this relates to the available literature. Results show that logging innovators can engage in multiple types of innovation and that logging system development is much more complex that previous studies show with a diverse set of factors and the innovation system influencing development patterns. Results also show a divergent rather than convergent developmental pattern resulting in a wide variety of systems being employed by the cases. In addition this project has outlined a methodological framework for studying innovation that is grounded in a blended innovation model approach collecting both qualitative data through case studies (presented here) and quantitative data through surveys (to be presented in future publications). This study fills a gap in the knowledge and literature on innovation in the forest products industry

INTRODUCTION

Innovation among contract logging firms is an area that is significantly understudied. At this point very little is understood about how logging firms assess innovations, their ability to self develop innovations, and the factors that influence this process. Innovation has long been recognized as a major component of successful and competitive businesses and industries (Schumpeter 1934). Recently innovation in the forest products industry has been a subject of attention in several U.S. states (Innovative Natural Resource Solutions 2005; Hansen 2010), Europe (Kubeczko et al. 2006; Rametsteiner and Weiss 2006), Canada (Anderson 2006), Australia, and New Zealand (Bull and Ferguson 2006). While these studies give some insight into

innovation among forest products firms and forest holdings, logging companies have been largely ignored. In 2005 the state of Maine completed the *Maine Future Forest Economy Project*, a comprehensive report on the state and future development of Maine's forest industry (Innovative Natural Resource Solutions 2005). This report states that innovation in Maine's forest industry is a crucial component of its continued vitality and stability. The report also recognizes that logging firms are a major component of the forest industry, but it contains no specifics on these firms or their innovation activities.

The only study available on logging innovation in Maine is by (Vail 1989), which focuses solely on mechanization in the 1980's and does not examine other potential innovation areas. This is also true of logging innovation studies, which have so far focused almost solely on descriptive accounts of mechanization (Rajala 1993; MacDonald and Clow 1999; MacDonald and Clow 2004; MacDonald and Clow 2010). No further study of innovation in Maine's logging industry has been performed leaving a 20 year gap in the study of innovation development in Maine's logging industry. Several other studies have been performed examining logging mechanization in Eastern Canada (MacDonald and Clow 1999) and the Southeastern U.S. (MacDonald and Clow 2010). A study of logging firms in Romania (Duduman and Bouriard 2007) concluded that there was a preoccupation with efficiency and productivity among logging firms and that this grew out of firms struggling to stay in business. Another study from Canada (Anderson 2006) examined innovation among firms providing forestry support services (which included harvesting services) to the Canadian Forest Service and concluded these firms were heavily dependent on suppliers of equipment to develop innovations. This study also found that process innovation tended to be the dominant type of innovation in these firms. Another study from the U.S. Inland Northwest (Allen et al. 2008) found that innovative firms (self scored) had les aversion to financial risk. Results from this study also suggest that larger logging firms could be more innovative than smaller ones. To better understand the development of logging systems employed by logging firms, the innovation activities of these firms, and factor influencing innovation it is important to study these issues from the firm's perspective. Failure to understand innovation among logging firms could negatively impact innovation efforts in the overall forest industry and could lead to a stagnated and less competitive logging industry.

RESEARCH OBJECTIVES

The overall research objective for this project was to understand factors influencing innovation in Maine's logging industry to determine how changes could impact future innovation. The specific objectives were to 1) better understand the development and use of current logging systems by logging contractors, 2) understand the overall innovation activities of logging firms and the driving forces behind them.

INNOVATION DEFINITIONS AND THEORIES

Innovation is an area that has been heavily studied, and dates back to the theories developed by Schumpeter (1934). Since that time the literature on innovation has grown and (Carlsson 2003) notes that there are now over 1,000 published studies on the subject. With numerous definitions

proposed (Schumpter 1943, Nelson and Winters 1977, Rogers 2003, OECD and Eurostat 2005, and Rametsteiner and Weiss 2006). Something common to all innovation definitions is a concept of "newness", which includes elements of change and improvement. By far one of the most comprehensive and widely accepted definitions is the one contained in the Oslo Manual (OECD and Eurostat 2005), which is a publication developed to guide cross industry innovation studies in the European Union and Canada. The Oslo Manual also sets the unit of adoption – the level at which something can be considered and innovation – at the firm level. This means that something only has to be new to the firm to be considered and innovation. Another key component of innovation definitions is the recognition of multiple innovation types. The Oslo Manual separates innovation into 4 categories. Table 1 gives a breakdown of these categories, their definition, and examples of each that can be found in logging. For the purposes of this study innovation was defined as: *The adoption of a new product, process, marketing strategy, or organizational method by a contract logging firm*.

Table 1: Definitions of innovation types from the Oslo Manual and examples of each type that can be observed in logging firms

Innovation Type	Definition (based on Oslo Manual)	Logging Examples
Product	Introduction of a new or significantly improved good or service	biomass or road work
Process	Implementation or development of a new or significantly improved production system	new harvest method or equipment configurations
Organizational	The implementation of a new organizational method in the firm's business practices, workplace organization, or external relations	new production tracking system or change in office management
Marketing	Implementing a new marketing method that involves significant changes in product design, placement, promotion, pricing, or other strategies	promotion of special services

One of the most prevalent theories of innovation development and adoption is the diffusion concept outlined by (Rogers 2003), which describes how innovations are developed and how they diffuse through a population. The central component of this concept is the linear adoption process, by which an adopter (individual firm or person) goes about making a decision whether or not to adopt a particular innovation. The process is separated in to 5 phases as highlighted in Figure 1.

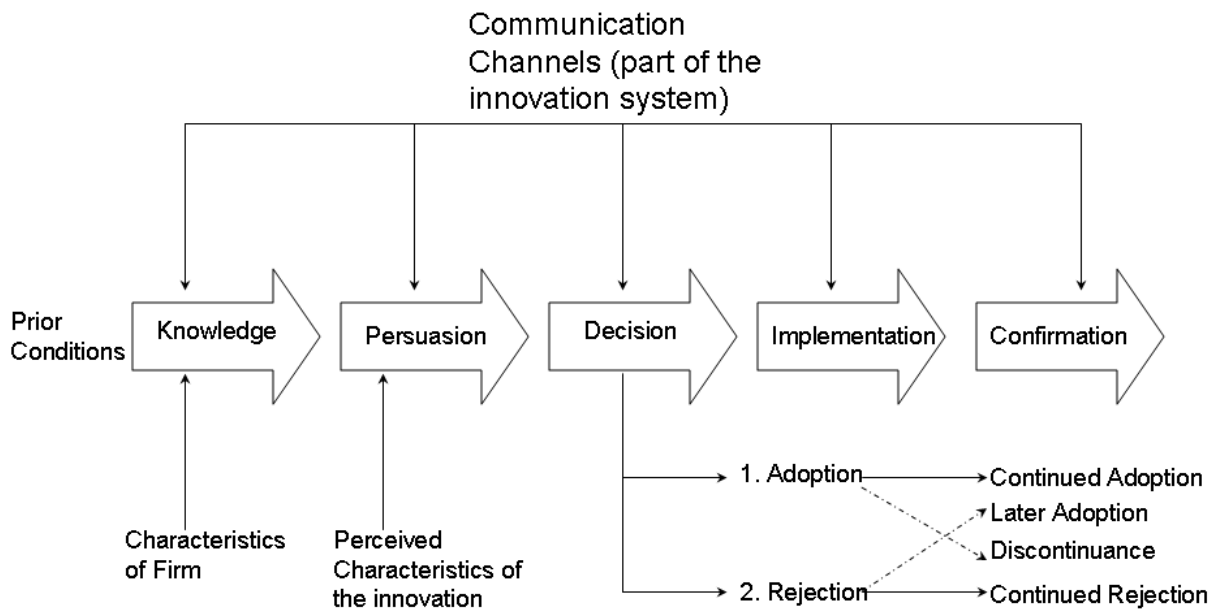

Figure 1: The linear adoption process (Reproduced from Rodgers (2003))

The second major component of the diffusion process is adopter categories, which describe an adopter's innovativeness and the speed at which they develop and embrace innovations. Rogers (2003) separates adopters into 5 different classes: innovators (most innovative and quickest to adopt), early adopters, early majority, late majority, and laggards (least innovative and slowest to adopt).

Another major theory of innovation development is the innovation system. Multiple studies have applied and used this model (Nelson and Winter 1977; Nelson 1993; Rogers 2003; National Innovation Initiative 2004; OECD and Eurostat 2005). The innovation system is a series of interconnected units that influence innovation development and adoption. The Oslo Manual places the firm at the center of this system with numerous connections to other entities. Stone et al. (2011) adapted and refined this model to fit Maine's logging industry based on a series of 10 case studies (see Figure 2).

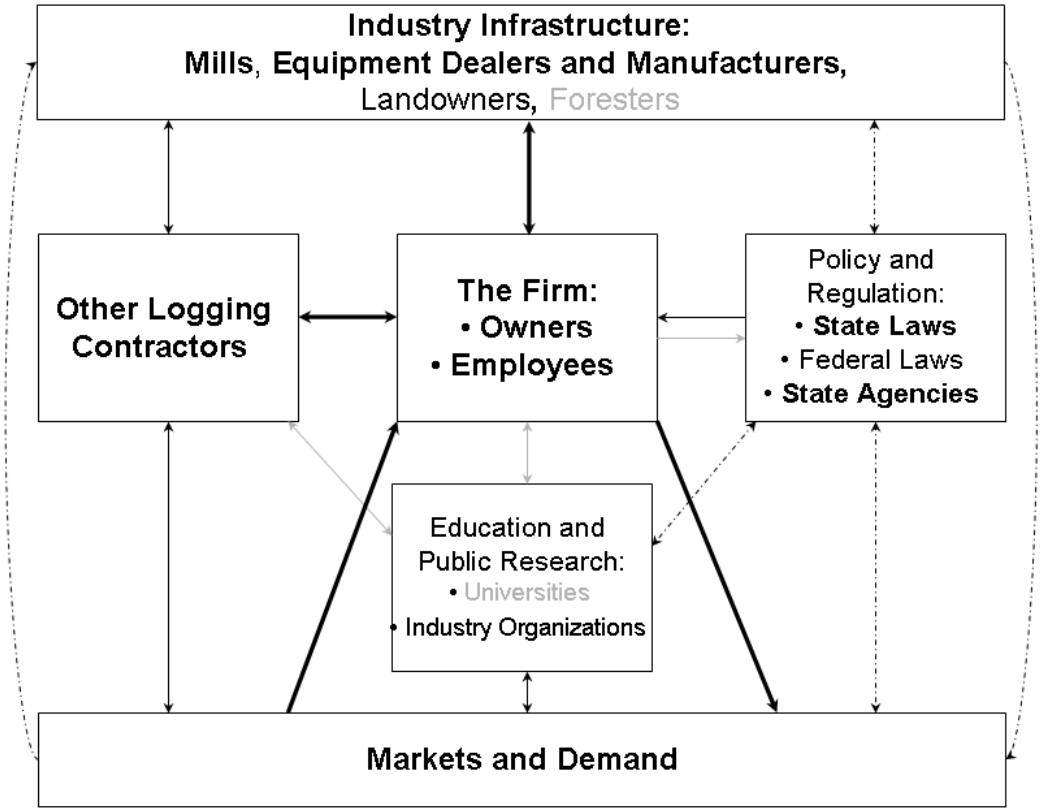

Figure 2: Representation of the innovation system in Maine's logging industry taken from Stone et al. (2011) and based on the Oslo Manual (OECD and Eurostat 2005). Lighter font and arrows represent weaker linkages, while thicker and bolder fonts and arrows represent stronger connections in the system. Dotted arrows denote connections that were not directly tested within this study.

This system and the connections in it can have significant impacts on the innovation types and developmental patterns in a certain industry. It is also possible to blend these two models together, as has been suggested by Rametsteiner and Weiss (2006).

METHODOLOGY

The methodology chosen for this study was a series of case studies of innovative logging firms. Case studies are ideally suited to answering question around why and how phenomenon occur (Yin 2003), so they provided an ideal framework for this study. In addition this study focused on studying logging innovators since they could provide large amounts of information on innovation activities and the development of logging systems. Innovators are also very important to the diffusion process and often serve as opinion leaders in a given community (Rogers 2003).

Sampling innovators represents and extremity sampling technique (Eisenhardt 1989), where cases are pulled from the portion of the population high above the mean.

A mixed mode survey of multiple groups in to forest industry (foresters, equipment dealers, landowners, and others) was conducted to identify innovative logging firms. A total of 154 individuals were surveyed and after removing repeats, wrong numbers, and disconnected numbers an effective sample size of 139 remained. A total of 89 responses were received for the survey leaving an effective response rate of 64%. Participants were asked to: 1) identify logging contractors in the state that they considered most innovative, 2) rank them in order of innovativeness, and 3) explain the firm's innovation activities. Based on the responses potential cases were indentified and a group of 13 firms was selected for the study. They were selected based on how often they were identified, how they were ranked, regional nature of the identifying respondents (identified mostly from one region), and uniqueness of innovation activities. Of the 13 cases selected 10 agreed to participate in the study. Cases represented a variety of firm sizes and included at least one case from each region.

An in-depth semi-structured interview was performed with the owner and key personnel form each firm as well as a visit to one of the company's active sites. On occasion, distance and inclement weather prevented an active site visit, so alternatively previous harvested or inactive sites were included. While this methodology allowed for effective study of system development and innovation activities among innovative firms, its weakness is that it prevents generalization to the entire industry and other adopter classes. To counter this, a survey of logging contractors in Maine was designed and is being distributed at this time. Results from the case studies were used to aid in survey design. At this time survey results are not completed and available, but they can be used in the future to better understand the overall innovation activities of Maine's logging industry and differences between the various adopter groups. Coupling qualitative data from case studies with results from a broad industry or sector wide survey has been shown to an effective method for studying innovation (Rametsteiner and Weiss 2006), and this project is testing this method for application in studying logging innovation in a U.S. state.

RESULTS AND DISCUSSION

Innovation Activities

The logging innovators studied were found to engage in all four innovation categories (product, process, organizational, and marketing). Process innovation was the most frequently engaged in by the cases and also showed the greatest amount of development. Product innovation was found to be the next most frequently engaged in innovation type and showed the second greatest amount of development. Organizational innovation followed process and product innovation in the frequency of engagement, but showed levels of development and advancement on par with product and process innovation. This type showed the most instances of innovation initiated and developed from within the firm using expertise from firm employees. Marketing innovation was engaged in the least by the cases and showed the least amount of development. Several cases did; however, have advanced marketing innovations and were heavily engaged in this area.

Process innovations among the cases typically focused on new equipment or changes to the harvest method and system(s) employed by the firm. Other forms of process innovations encountered included production monitoring devices, on-board machine computer systems with GPS and other capabilities, multiple system integration programs (e.g. combining two harvesting methods and systems), and the use of concentration yards. The focus of process innovation activities among the cases was generally increasing profitability through reducing cost of production and increasing efficiency. The effectiveness of these innovations was measured through a variety of approaches designed to quantify efficiency and cost performance. These systems ranged from general simple systems to highly advanced and detailed tracking systems. That the logging firms studied focus heavily on productivity and efficiency is similar to the findings of Duduman and Bouriard (2007) who suggest that this grows out of these firms struggling to stay in business.

The focus on productivity and efficiency among the innovators studied was moderated by concerns over site quality, harvesting impacts, and aesthetics. The majority of cases focused a great deal of effort on doing high quality work and did not want to sacrifice this for production gains. In these cases site quality became another metric by which process innovations were measured. In fact, four cases stated directly they would close the business before doing sub quality work.

While less prevalent than process innovation, product innovations were frequently cited by cases. Among the cases studied new services (e.g. road maintenance, power line maintenance, specialty harvesting services) were more prevalent than new goods (e.g. biomass, firewood). Product innovations were also heavily integrated with process innovations. Product innovation adoption focused on increasing profits and presented opportunities for business diversification. This also included harvesting services that were simply not provided by other contractors in the area. Success of product innovations was measured through increased profitability, repeat contracts, and client satisfaction.

Organizational and marketing innovations were the least prevalent of the four innovation types, with organizational innovation being much more prevalent among the firms studied than marketing innovation. Organizational innovations were adopted to improve efficiency of operations or improve the information gathering process associated with monitoring operational performance. They were frequently used to measure the success of other innovations along with being used to identify areas for future improvement. This innovation category showed the most internal research and development of the innovation categories, and three cases had even developed complex information gathering systems with specially designed computer programs in house.

The majority of firms studied did not engage in marketing innovations, with only five cases being active in this area. Over half of the cases marketed by word of mouth or contracted primarily with one large landowner and had no need to market the firm. Cases with highly developed marketing innovations were from areas with smaller tract sizes and numerous small landowners. Despite the fact that all contractors in the study were certified by at least one logging certification system (i.e., Certified Logging Professional Program or Northeast Master Logger Program), only two firms used this as a marketing tool. Four cases did state that certification gives them access to timber markets that non-certified contractors do not have.

The results from the case studies show that logging innovators in Maine are capable of engaging in all four innovation categories and self generating innovations. While process innovations were the most prevalent, innovation among the cases was not confined to this area as results by Anderson (2006) would suggest. While the cases studied did state that they were heavily dependent of others in the industry to develop innovations and make them successful; the cases studied did show the ability to self generate innovation, particularly with regard to organizational innovations. Additionally it was found that innovative logging firms often play a major role in driving the innovation system. Logging firms occupy a unique position in the innovation system, as they are the only unit that routinely communicates with others in the supply chain. An innovative logging firm can take a landowner's or mill's need and communicate it to an equipment manufacturer who may then develop a new piece of equipment. Again these findings were unexpected considering the previous findings of Anderson (2006). Contractors also applied equipment in new and innovative ways through new configurations and unique applications. While they may be dependent on equipment dealers to develop the equipment logging innovators are not limited in how they apply it. This often exposes areas for improvement, which logging innovators are often eager to share with equipment manufacturers. In addition there was no difference between larger and smaller firms in the level of development or amount of innovations adopted. This result was unexpected give some of the findings by Allen et al. (2008). Cases identified capital access as the biggest barrier to logging innovation, which suggests that the conclusion by Allen et al. (2008) that firms with lower aversion to financial risk will be more innovative holds true for logging innovators in Maine.

Development of Logging Systems

All of the cases studied had been in business for at least 15 years and although they started with the same system (i.e. chain saw and cable skidder) they now use different logging methods and systems (e.g. cut-to-length, whole tree, or combinations). The cases studied in Maine exhibit divergent rather than convergent paths as Rogers' (2003) diffusion process suggests. This is also in contrast to findings from the Southeastern U.S. which show a trend towards one dominant harvesting method and system (Baker and Greene 2008; MacDonald and Clow 2010).

The mechanization process produced multiple modes of production among the cases studied even though many had mechanized for similar reasons. An illustration of system development in Maine can be seen in Figure 3.

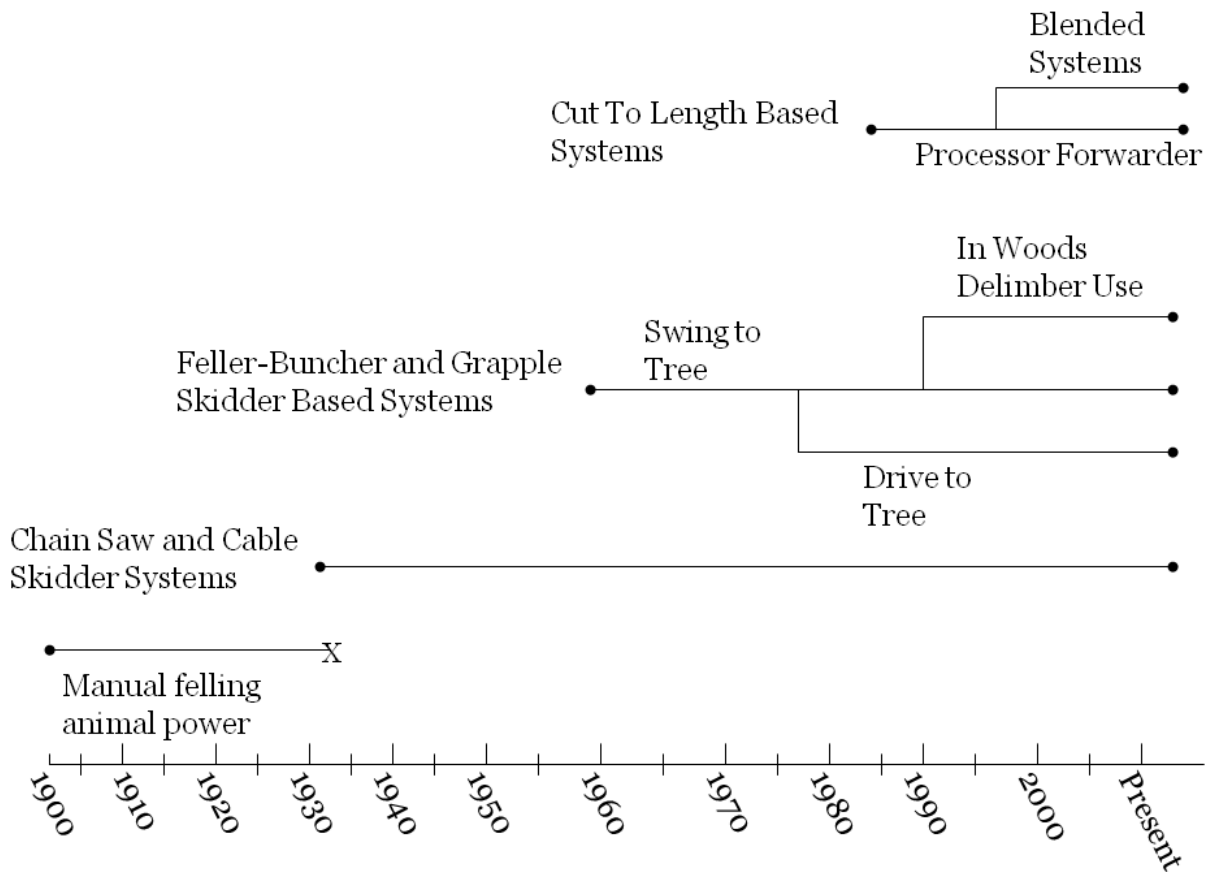

Figure 3: Development of logging systems in Maine over the past century. Compiled from the 10 cases studied and accounts of regional developments by: Vail (1989), Silversides (1988), Richardson et al. (1991), Favreau (1991), and MacDonald and Clow (1999 and 2010).

Contractors cited labor costs and availability, worker compensation insurance rates, the spruce budworm outbreaks of the 1980's, concerns over worker safety, and the need for higher productivity as major reasons for mechanizing operations. These reasons are similar to the conclusions by Vail (1989), but several major changes took place since this article was published. Cut-to-length processor-forwarder based systems were adopted by multiple firms studied in the 1990's. As noted by Vail (1989) these systems have been popular in Scandinavia for some time and were originally developed there. Three cases cited the passage of the Maine Forest Practices Act of 1989 as a major reason for adopting these systems. Contractors utilizing this technology also cited a desire by landowners for thinning services as a reason for adopting this production method.

Still other contractors utilized a tree length system with feller bunchers, grapple skidders, and in-woods stoke delimbers around the same time and for similar reasons. Several cases still utilized this type of system to a degree, but many had abandoned it with some going to cut-to-length systems and other going to whole tree feller buncher based systems with roadside delimbing. The in-woods delimbing system appeared in Maine around the same time as it did in Eastern Canada

(Favreau et al. 1991). A key difference in Maine was that no industry wide studies were performed on this system as was done in Eastern Canada. The contractors utilizing this system had to investigate productivity and effectiveness on their own. Cases were found to have little connection to public research and education components of the innovation system (Figure 2), and no organization such as the Forest Engineering Research Institute of Canada or similar European organizations exist in Maine. In this way Maine resembles the Southeastern U.S. (MacDonald and Clow 2010) more than Eastern Canada (MacDonald and Clow 1999), with no centralized organization to guide or inform innovation efforts in the industry.

The use of multiple systems and production methods by a single firm and the blending of whole tree technologies with cut-to-length technologies by several cases cannot be explained by the division of labor theory or social and policy concerns alone. The non-uniform pattern of development and adoption among the cases appears to be related to how the cases interacted with the innovation system during the development process coupled with the unique challenges that each firm faced in their area of operation. In addition differences in terrain, forest type, regional markets, and forest management goals and techniques of landowners had significant impacts on the systems used by an individual firm, something that is not addressed in the existing literature. There does not appear to be an industry or region wide "winning technology", rather there is a specific set of innovations tied to the land base and available markets of any given firm. The factors influencing the firm's linear adoption process (Figure 1) and the structure and important connections from the innovation system (Figure 2) were found to be much more effective at explaining and understanding the divergent development of logging systems among the cases studied.

CONCLUSIONS

The results from the cases studied show that logging innovators can and do engage in all four innovation categories. The innovators studied also possessed the ability to develop innovations from within the firm, though this ability was limited and was largely confined to organizational innovations. Innovative contractors were also found to be a major driver in the innovation system, helping to communicate and identify areas for innovation among many groups in Maine's forest industry. The innovators studied focused heavily on profitability and efficiency, though this focus was moderated by concerns over performing to a high standard and leaving a high quality site after harvest. Results also show that logging innovators are often dependent on others to develop innovation such as equipment and new forest products markets, but they may apply and use these innovations in new and imaginative ways.

The methodology used in this study has proven to be a robust way of understanding innovation activities among logging contractors through qualitative means. While the cases in this study were limited to innovators the methodological framework can be applied to any adopter class. The case studies also proved valuable in designing the associated survey that will accompany these case studies. While no results from the survey area available at this time, it is expected that the survey results coupled with the case studies will provide a solid understanding of innovation in Maine's logging industry.

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LITERATURE CITED

Allen, T., H.-S. Han and S. Shook (2008). "A structural assessment of the contract logging sector in the Inland Northwest." Forest Products Journal 58(5): 27-33.

Anderson, F. (2006). "A comparison of innovation in two Canadian forest service support industries." Forest Policy and Economics 8: 674-682.

Baker, S. and W. D. Greene (2008). "Changes in Georgia's Logging Workforce, 1987–2007." Southern Journal of Applied Forestry 32(2): 60-68.

Bull, L. and I. Ferguson (2006). "Factors influencing the success of wood product innovations in Australia and New Zealand." Forest Policy and Economics 8: 742-750.

Carlsson, B. (2003). Innovation Systems: A survey of the literature from a Schumpeterian perspective The Companion to Neo-Schumpeterian Economics A. Pyka. Cheltenham, Edward Elgar

Duduman, G. and L. Bouriard (2007). "Managing innovations in wood harvesting and primary processing firms – case study of Suceava." Forestry Studies 46: 89-101.
Eisenhardt, K. (1989). "Building Theories from Case Study Research " The Academy of Manegement Review 14(4): 532-550.

Favreau, J., E. Swift and J. F. Gingras (1991). Comparison of Roadside and In-Stand Stroke Delimbing: A Case Study of Two Harvesting Systems Forest Engineering Research Institute of Canada

Hansen, E. N. (2010). "The Role of Innovation in the Forest Products Industry " Journal of Forestry 108(7): 348-353.

Innovative Natural Resource Solutions, l. (2005). Maine Future Forest Economy Project: Current Conditions and Factors Influencing the Future of Maine's Forest Product Industry, Maine Department of Conservation Maine Forest Service Maine Technology Institute 474.

Kubeczko, K., E. Rametsteiner and G. Weiss (2006). "The role of sectoral and regional innovation systems in supporting innovations in forestry." Forest Policy and Economics 8: 704-715.

MacDonald, P. and M. Clow (1999). ""Just on damn machine after another?" Technological innovation and the industrialization of tree harvesting systems." Technology in Society 21: 323-344.

MacDonald, P. and M. Clow (2004). "Policy and the Sucess and Failure of New Technology: The Case of Tree Harvesting Sytems on the Miramichi in New Brunswick " British Journal of Canadian Studies 17(1): 61-80.

MacDonald, P. and M. Clow (2010). "“Things Was Different in the South”: The industrialization of pulpwood harvesting systems in the Southeastern United States 1945-1995." Technology in Society 32: 145-160.

National Innovation Initiative (2004). Innovate America. C. o. Competitiveness: 68.

Nelson, R. (1993). National Systems of Innovation. Oxford, Oxford University Press

Nelson, R. and S. Winter (1977). "In search of a useful theory of innovation " Research Policy 6(1): 36-77.

OECD and Eurostat (2005). Guidelines for Collecting and Interpreting Innovation Data (Oslo Manual). Paris, France OECD.

Rajala, R. (1993). "The forest as a factory: Technological change and worker control in the west coast logging industry." Labour/ Le Travail 32: 73-104.

Rametsteiner, E. and G. Weiss (2006). "Innovation and innovation policy in forestry: Linking innovation process with systems models." Forest Policy and Economics 8: 691-703.

Rogers, E. M. (2003). Diffusion of Innovations. New York, NY, Free Press.

Schumpeter, J. (1934). The Theory of Economic Development New York, NY, Oxford University Press

Stone, I. J., J. G. Benjamin and J. Leahy (2011). "Applying Innovation Theory to Maine's Logging Industry " Journal of Forestry Manuscript Accepted for Publication

Vail, D. (1989). "How to tell the forest from the trees: A comparison of recent technological innovations in logging systems in Sweden and Maine." Technology in Society 11: 347-376.

Yin, R. K. (2003). Case Study Research: Design and Methods Thousand Oaks, California Sage Publications, Inc. .