HOME GROWN REMEDIES:

IN-HOUSE INNOVATION IN THE FILM-MAKING INDUSTRY

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Abstract

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In order to solve internal problems, some organizations develop and implement innovations in-house These in-house innovators have the capacity, resources and motivation to create new-to-the-world technologies and to apply them for their own use Typically, these technologies are not new products to be marketed but rather instruments developed and used in-house to help the organization produce a better final product The process of in-house innovation has not, as yet, been fully researched by innovation scholars As such, in the review of the literature, two established fields of innovation research, that of *new product development* and *innovation adoption*, are brought together as a means of understanding the in-house innovation process and the success factors for in-house innovations The work was carried out using a multiple case study of eight in-house innovations at the National Film Board of Canada Information retrieved from interviews, archives and observations allowed for the development of a preliminary in-house innovation model.

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Dedication

This work is dedicated to my parents, Eva N Mosonyi, artist, whose creativity and vision of the world inspired my love of learning and to Paul Nagy sr. who instilled in me a belief in myself and in the importance of finishing what I start,

and,

to my soul mate, my husband Shawn, without whom I wouldn't have been able to get this far...You are my rock, my light and my heart Thank you for being perfect.

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I. THE CALL TO INNOVATE

Companies must innovate to survive. Academic research and practical experience strongly suggest that an organization's ability to succeed is a function of its ability to innovate. For instance, Kanter (1984) asserts that innovation is the primary hope for the maintenance of high organizational performance levels and Hayes and Abernathy (1980) posit that low innovation adoption rates cause organizational and economic decline Innovation has become a consistent and integral part of long-term organizational survival strategies

Innovation is a means toward solving organizational problems. But, there is more than one way to be innovative When searching for a satisfactory solution to an internal problem, some companies adopt innovations from the external marketplace while others solve their own problems by creating and developing innovations in-house. For example, to streamline accounting procedures, some organizations might buy an off-the-shelf software package while other organizations would design, develop and implement their own software program Such companies, which favor home-grown remedies, are more numerous than one may think Companies in the telecommunications, aerospace, pharmaceutical, automotive and many other industries, especially those that already have an R&D function, or are "lead users" (Urban and Von Hippel, 1988) of new technologies or methods practice in-house innovation

Internally-generated innovations are generally not "new products" destined for the marketplace. Internally-generated innovations, or in-house innovations, are typically *instruments* created to facilitate the development or production of an organization's primary product or service In companies which practice in-house innovation, their focal products or services are developed with the help of such internally generated innovations as specialized tools, custom-software or automated assembly lines Unlike new products that are destined for the marketplace, these internally-generated innovations are not mass produced but rather tailored by in-house developers for their own particular use (Kimberly et al, 1990)

How does in-house innovation come about? We can try to understand how effective in-house innovation comes about by examining the activities that comprise the in-house innovation process This can be done by tracing several in-house innovations from the start of the process to its end point But, this empirical examination must be founded on two streams of innovation research the new product development process and the innovation adoption process Research in the field of new product development will help us understand the activities and events which take place during the creation of an innovation, while research in the area of innovation adoption will give us insight into how innovations are implemented in an organizational setting A study of both these processes can lead to an understanding of the factors, influences and sequences which comprise effective in-house innovation.

The present research will examine the process of internally-generated innovation and the factors which can contribute to innovation success and failure An empirical study will be conducted within the context of the National Film Board of Canada, a film production company under government ownership which is known for its state-of-the-art technological innovations Data will be collected on recent technological innovations at the NFB. The study will use a case study approach to evolve theory about the in-house innovation process This research approach is appropriate for under researched topic areas (Eisenhardt, 1989) such as the phenomenon of in-house innovation Based upon the findings, this work will put forth a preliminary model of the organizational innovation process for in-house technological innovations

II. A TYPOLOGY OF INNOVATION/ORGANIZATION RELATIONSHIPS

What kind of company creates and develops its own innovations in order to solve internal problems? We know that many organizations, seeking to improve their products or services, adopt new technologies from the outside Other companies, however, spend the time, effort and cost necessary to come up with their own solutions These latter companies prefer to, or have no other choice, but to grow their own "remedies" rather than acquire innovations that already exist in the environment

Organizations relate to innovation in a variety of ways Kimberly et al (1990) describe five specific innovation/organization relationships The most researched one is that of the organization as "user of innovation" Here, the organization adopts innovations from the external environment and implements them for their own use These companies experience the innovation adoption process Another form of the innovation/organization relationship is the organization as "producer of innovation" where a company develops new products for consumption by external users Next, the organization can act as a facilitator or "vehicle for innovation" Here, the organization plays an essential role in the adoption of innovation. It arises in situations where the new idea or product requires an organization which can act as a "bridge" so that the product can reach its intended users For example, in the United States the idea of prepaid medical care could not function without the existence of health maintenance organizations (HMOs) Pre-paid medical care has replaced the traditional pay-as-you-go system where the patient would simply pay the doctor for treatment as required The idea of pre-paying medical expenses required an organization which would handle the coordination of payments from patients to doctors The HMO acts as facilitator, or "bridge", between the patient and the medical care facilities A fourth innovation/organization relationship is where the organization itself is also an "innovation" The "organization as innovation" category includes those companies which are invented to solve a particular problem or number of problems. This type of relationship between organization and innovation is different from the previous type in that the organization as "vehicle" need not be innovative in itself The organization as "innovation", on the other hand, must be designed differently from other organizational forms For example, a new form of quasi-public agency was created to encourage a linkage between universities and industry in order to produce research funds and develop new technical breakthroughs This agency, the Industrial Technology Institute of Michigan, is an innovation in that it is a new form of organization dealing with an old problem The concept of acquiring funding for research is not an innovation, but the method of acquiring funding through the development of a quasi-public body is innovative Finally, an organization can also be a "producer and user of innovation" This last category describes the phenomenon of in-house innovation where organizations invent solutions to their own problems

The innovations which emerge from in-house activities are typically a means to solve internal, idiosyncratic problems rather than an attempt to meet external market needs Meeting market needs is the function of new product development, not in-house innovation. But, it is not unheard of that successful in-house innovations eventually end up on the market For example, robots and flexible manufacturing systems produced by GM, IBM and GE, primarily for in-house use, were eventually acquired by other organizations

III. TECHNOLOGICAL INNOVATIONS

Before looking at the process of innovation and innovation effectiveness, it is first necessary to define the term "technological innovation" The word "innovation" is a familiar one. But, when we think about what a technological innovation is, we envision everything from computer chips to rocket ships To complicate matters, the research literature abounds with numerous definitions of innovation. Van der Kooy (1988) lists 76 definitions of "innovation". Included among them is Zaltman et al's (1973) definition of an innovation as "idea, practice or object perceived as new by the individual", and Rogers (1983) also describes innovations in general as any "idea, practice or object that is perceived as new by an individual or other unit of adoption", while Damanpour and Evan (1984) define innovation as " a new system, device, policy, process, program, product or service". So, we see that there are multiple ways of defining the term "innovation"

Innovations have also been identified according to their particular category or "type". Damanpour (1990) describes innovations as either administrative, technological or ancillary. Administrative innovations are those which produce changes in the organization's structure or administrative functions Technological innovations are those that bring change to the organization by introducing changes in the technology (Dalton et al, 1968). These occur as a result of the use of a new tool, technique, device or system, and produce changes in products or services, or in the way products or services are produced (Damanpour, 1990) Ancillary innovations are those that go beyond the organization's primary activities to include other services or products For example, a library which maintains books and provides information as its primary activity may also implement such ancillary innovations as career development programs, tutorial services and adult continuing education programs (Damanpour, 1987).

Our focus, in this paper, is purely on technological innovation. The primary reason for this is because other types of innovations, such as administrative ones, though interesting and worthy of study, are more complex to trace and observe. (Rogers, 1983). Administrative or conceptual types of innovation, such as quality circles or just-in-time management, are made up of ideas, policies and procedures. Technological innovations are far more tangible and observable since they consist of technical systems or objects .

In this work, in-house, technological innovations are defined as *those state-of-the-art tools, devices, equipment, gadgets or instruments which are both invented and implemented within the same organization for the purpose of facilitating or improving the production or distribution of the said company's focal product or service.*

The term "state of the art" refers to the novelty of the innovation in its field (Schon, 1967). We assume that most in-house innovation is state-of-the art because organizations will not develop a technology which is already available on the market. It would be easier to acquire it. State-of-the-art innovations are considered new to both the organization and to the world as a whole.

The technological innovations we are interested in are those which involve physical objects/systems and are thus described as tools, devices, equipment, gadgets or instruments. Inventing and implementing these physical objects within one organization are criteria we use to describe the in-house innovation process (Kimberly et al, 1990).

According to our definition, the aim of in-house innovation is to facilitate or improve an organization's ability to produce and/or distribute its primary product and not to become a new product in itself. This is based upon Grossman's (1970) concept of "instrumental innovations" which are those that facilitate the creation of ultimate innovations. Ultimate innovations are those which are ends in themselves. For example, an ultimate innovation such as a heart transplant is facilitated by surgical tools which are instrumental innovations. Thus, the technological innovations to be studied here are considered, in Grossman's terms, to be instrumental innovations.

IV. NEW PRODUCT DEVELOPMENT, ADOPTION AND IN-HOUSE INNOVATION

The process of innovation is a complex and creative act. One part of the innovation experience is new product development. New product development is a creative process which seeks to develop an idea into a tangible object and then persuade users to adopt it for their own purposes. Research literature in the area of the **new product development process** typically focuses on specific stages which involve generating an idea, developing it into a new item and taking certain steps to commercialize it. Once that new item is launched in the marketplace, organizations and other potential end-users may select it if it is deemed a suitable solution to solving some problem. This field of new product development has been developed separately from the stream of research dealing with the adoption of innovations by users. Adopting an innovation involves looking out into the world for a product or service which would help solve some problem. The selecting, acquiring and implementing of that innovation by a user is termed the **innovation adoption process**.

The innovation development process and the innovation adoption process are two streams of research which, when synthesized, can help us understand a third type of innovation process: **the in-house innovation process**. In-house innovation occurs when a user, plagued by some problem and, not finding any suitable existing innovation, takes it upon herself or himself to create an innovation that will solve that problem. Organizations which practice in-house innovation have the resources and capacity to solve their own problems by developing suitable innovations and using them internally (Kimberly et al, 1990) For example, a film production company may require a specialized piece of equipment which must be able to withstand deep-sea arctic temperatures. If such a mechanism does not exist, the organization is forced to develop their own equipment (the development process) and use or "adopt" it internally (the adoption process) Therefore, innovation development models and adoption models are both relevant fields of research for the study of in-house innovation. In this paper, we will bring together these two distinct areas of innovation research in an exploration of the phenomenon of in-house innovation.

In this section we will provide an overview of a "typical" new product development process using the models of consulting firm Booz, Allen and Hamilton (1982), Cooper (1993), Urban and Hauser (1980), Bingham and Quigley (1989) and Wind (1982). We will provide observations on the major stages, and a discussion of factors which can influence new product performance. After looking at the new product development process, we will turn our attention to the innovation adoption process. Finally, by synthesizing these two areas of research, we will provide a model describing how the in-house innovation process unfolds and the factors which may influence in-house innovation performance.

Table 1: Five New Product Development Models

Booz, Allen and Hamilton (1982)	Cooper (1993)	Bingham and Quigley (1989)	Urban and Hauser (1993)	Wind (1982)
Product Objectives				Objectives
Exploration	Idea	Idea Generation	Opportunity Identification	Generation of Ideas
Screening	Preliminary Assessment	Idea Screening		Idea Screening
		Conceptual Development and Testing		Product Development and Evaluation
Business Analysis	Detailed Investigation	Business Analysis		Product/Marketing Strategy
Development	Development	Product Development	Design	System for Continuous Evaluation of Product Performance
Testing	Testing and Validation	Test Market	Testing	
Commercialization	Full Production and Market Launch	Product Introduction	Introduction	Product Introduction
			Life Cycle Management	

from Ragot (1994)

1. Defining the New Product Development Process

New product development models are, for the most part, very similar to each other. They are composed of stage-gate systems which are, in essence, theoretical and practical models for moving a new product from initial idea to commercial launch (Cooper, 1990). Most research on new product development falls into one of two streams. the process approach which describes the stages of the new product development process and the performance approach which evaluates the performance of the product and the process In this section, we will examine the sequence of the stages in the process and discuss factors (i.e decisions, events, etc..) within each stage which can have an effect on the performance of the new product.

1.1 A typical new product development process

In terms of describing the new product development process, the most commonly cited article is that of Booz, Allen and Hamilton (1982) It outlines the stages of the new product development process as: new product strategy development, idea generation, screening, business analysis, development, testing and commercialization. We will use the stages set out in the Booz, Allen and Hamilton (1982) model as a basis for our discussion of the events which occur during a typical new product development process

1.2 Setting objectives

The first stage of the new product development process is that of setting objectives. Setting objectives involves determining product-related goals (Wind, 1982). These goals must be clarified before embarking upon the development process and it is accomplished by determining why the firm is planning to innovate in the first place and how the new product will affect the company. By discussing such issues, decision-makers will be able to develop a *new product strategy*.

A new product strategy "identifies the strategic roles new products will play to fulfill corporate objectives" (Booz, Allen and Hamilton, 1982, p.22). Examples of strategic roles for new products include defending, increasing or preempting market share, maintaining a product innovator position, exploiting technology in a new way, capitalizing on distribution strengths, providing a cash generator, and using excess or off-season capacity (Booz, Allen and Hamilton, 1982). Innovations are thus used as instruments in helping the developer organization meet specific corporate objectives

Developing a new product strategy requires an analysis of the external environment and the company's own internal situation. This is accomplished by evaluating the growth potential of new markets, assessing emerging opportunities in the external environment, identifying internal strengths and weaknesses, and reviewing management style and new product experience (Booz, Allen and Hamilton, 1982) Once specific objectives have been set, an organization benefits by gaining a clearer sense of their direction and purpose in relation to the new product.

1.3 Idea generation

The idea generation phase consists of exploring new product ideas. New ideas can be gathered from innumerable sources including consumers and experts in a given field Relevant information is retrieved using such tools as focus group interviews, brainstorming and formal market and environmental analyses (Wind, 1982). These techniques, if done properly, can yield a number of interesting ideas The types of ideas which can surface during this stage include market-pull and technology-push ideas (Cooper, 1993) Market-pull ideas are those which arise due to a recognition of some market or user need Technology-push ideas come out of pure research, science or even by accident Cooper (1993) states that many technology-push ideas result in breakthrough products

Success of an innovation can depend upon decisions made at the idea generation stage Many researchers claim that the performance of a new product has to do with its orientation. Some scholars believe that a market orientation leads to a more successful new product while others believe that a technological orientation is more advantageous Banting (1978) states that new product failure is due to a product orientation over a customer orientation but Bennett and Cooper (1981) believe that an R&D orientation is the only way to ensure the development of truly innovative, breakthrough products Some researchers attempted to bridge the two opposing viewpoints Samli et al (1987) believe in fusing the marketing concept with a strategically focused R&D approach Relatively recent research indicates that the distinction between technology drive and marketing drive is simplistic and inappropriate For example, Rothwell and Gardiner (1988) state that firms should concentrate on generating ideas for robust designs - those designs which have the potential to spin-off into a family of new products Therefore, success at this stage seems to depend upon the organization's ability to balance the marketing and R&D approach as well as focusing upon the potential of the original idea to generate additional new ideas

1.4 Idea screening

The next stage, idea screening, involves conducting a detailed evaluation of all potential ideas in order to separate the poor ideas from those with higher potential for success. The categorization of ideas is accomplished by allocating ideas into subgroups based on their likelihood of success and the estimated time necessary for their implementation (Bingham and Quigley, 1989) This practice will determine which ideas are most likely to do well in a short period of time

During the idea screening stage, certain standard questions are usually discussed to help in the assessment of each new product idea. Wind (1982) offers the following examples

- How congruent are the ideas with management objectives?
- Are the ideas technically feasible?
- Are the ideas legal?
- What is the expected demand for them?
- What is the expected cost of manufacturing and marketing them?

The questions reflect a concern for the effects that a new product will have on the company and the performance of the product itself These concerns are similar to the issues which are brought up during the new product strategy stage Therefore, a close link exists between the first three stages of the process in that the original focus, developed early in the process by setting objectives, is followed through in later stages This, according to Booz, Allen and Hamilton (1982), provides focus to the project by reiterating, at each stage, the original objectives.

The key to product success during the screening stage is primarily the matching of the innovation to the goals and capabilities of the developer organization Can the company feasibly produce and support this product? Does this product reflect our current objectives as well as our visions of our future? For an idea to continue through the process, a solid new product /organization fit must be established (Booz, Allen, Hamilton, 1982, Cooper, 1993).

The establishment of a new product/organization fit occurs in the screening stage after the obviously flawed ideas have already been killed The task becomes more complex when one choice must be made from among several seemingly plausible alternatives Many researchers have created selection tools to facilitate decision-making For example, the consulting firm of Coopers and Lybrand (1986) present some specific techniques including checklist analysis, constraint analysis, environmental scoring model, profitability measures, sensitivity analysis, risk analysis, decision analysis and decision trees, and assessment of profitability Furthermore, de Brentani (1986) states that product differences/advantages, corporate synergy, technical and production synergy, and financial potential are the four most important screening criteria for managers Therefore, to ensure the eventual success of a new product, steps must be taken, at this stage, to properly match new ideas to the organization's own strengths, goals and capabilities.

1.5 Business analysis

Once a new product is selected from a list of alternatives, it is subjected to market and financial analysis. This is the last stage before development (where costs and demands on resources significantly increase) therefore, the information compiled during the business analysis stage is crucial.

The analysis done to date, such as internal costs, market potential, sales forecasts and projected profitability levels are translated into a detailed financial plan (Bingham and Quigley, 1989). This financial plan includes new product performance criteria. The three most common criteria are profit contribution, sales volume and return on investment (Booz, Allen and Hamilton, 1982). Besides agreeing upon the level of financial resources required, the project team must also agree upon the choice of target market, the definition of the product concept, the product positioning strategy, the potential benefits of the product, and on the features, attributes and specifications to be incorporated into the new product (Cooper, 1990)

To succeed at this stage, the analysis performed must accurately reflect the innovation's potential market As stated, detailed data must be gathered from potential users of the new product. But, is the right data being gathered from the right people? Most market research techniques concentrate on collecting information from heavy users But, Urban and Von Hippel (1988) argue that relevant information lies instead in the needs of "lead users" Lead users are those potential customers who possess specific needs months, even years, ahead of the rest of the market Urban and Von Hippel (1988) find that more effective market research can take place if lead users are consulted. Therefore, to increase the chances of developing a successful new product, not only must detailed analysis be performed, it must also be conducted using the best sources of information possible

1.6 Development

The development stage is the point when the new product idea becomes a tangible reality. At this point, several major activities unfold simultaneously: the new product is manufactured and assembled into a working prototype (Cooper, 1990), the project team organizes the manufacturing process to handle the new product, selects quality suppliers to ensure dependable delivery of components and raw materials, and presents completed designs to customers and suppliers for their review (Bingham and Quigley, 1989). Furthermore, the financial analysis is updated and any outstanding legal issues are resolved (Cooper, 1990). In a nutshell, resources have been allocated and the new product is being brought to life The development phase then, is a combination of the physical manufacturing and assembly of the new product and many other activities related to its continued support and future commercialization.

The development process involves many substages and many different departments. The task of translating customer needs into specialized technical, or engineering, language is a task which is especially sensitive to miscommunication This miscommunication occurs when developers do not listen to user requests, when users judge an innovation concept as favorable when, ultimately, the idea proves to be unfeasible, or because customer requirements changed from the time the prototype was evaluated to the time that it was completed (Cooper, 1993).

Miscommunication at this stage can lead to the development of the "wrong" innovation. If user needs are poorly communicated or misunderstood, developers may end up creating an innovation which lacks the necessary requirements and features Such an innovation, which does not fully meet the needs of the users, is destined to fail.

1.7 Testing

The testing stage consists of evaluating the performance of the new prototype, its marketing strategy and its production process (Wind, 1982) During this stage, the company performs a number of feasibility checks Cooper (1990) states that developer companies conduct in-house product tests to verify product quality and performance, perform field trials to check product features and gauge potential customer reactions, test and debug the production process, pretest the market and finally, revise financial plans to verify the continued economic viability of the project Furthermore, to prepare for product introduction, entry strategies, including the selection of promotional and distribution avenues, are created (Bingham and Quigley, 1989) If the new product fails the testing phase, it is eliminated or sent back to the design phase However, if it passes the testing criteria it is introduced into the marketplace (Urban and Hauser, 1980).

An innovation may fail if the testing phase is ineffectively conducted Specific factors for success at this stage involve the length of time devoted to testing and the choice of a test market Both factors relate to the testing of the product's technology and the testing of the potential market for the product

The lack of extended trials for certain complex innovations may lead to an oversight of important technological flaws in the product (Cooper, 1993). Extended trials allow potential users to interact with the product for a substantial length of time. This enables a detailed evaluation of the product's strengths and weaknesses which would not have surfaced in a briefer testing period (Cooper, 1993). As such, technological flaws can appear after the product has been fully launched leading to customer dissatisfaction and potential innovation failure.

The choice of a test market is also an important element in assuring the success of a new product. If only one specific type of market group is consulted, such as experts, or engineers, or a market segment predisposed to giving a biased opinion on the new product, the innovation would not get a fair evaluation and the results of the test would not necessarily reflect the perceptions of actual consumers (Urban and Hauser, 1980) Therefore, the choice of a test market may mislead the developers into overestimating (or underestimating) potential customer interest in the new product thereby effecting the innovation's ultimate performance.

1.8 Commercialization

At the final stage of commercialization, the new product is launched into the market. This is accomplished with the support of the production and marketing plans developed beforehand (Cooper, 1983). Specifically, production is begun, engineering is supported by manufacturing, production schedules ensure that demands are being met, the sales force is servicing clients, advertising campaigns are being run, and the finance department is monitoring the numbers to ensure that their goals are being met (Bingham and Quigley, 1989).

Once commercialization has been achieved, a post-audit - an evaluation of the new product's performance - is carried out (Cooper, 1990). The information generated during this final evaluation allows developers to make any necessary corrections or adjustments to the new product, as well as allowing developers to take note of what has been done and what could be done better the next time (Cooper, 1993).

Cooper (1983) believes that given proper testing, a stable market and adherence to the plan of action previously agreed upon, the new product launch can be easily carried out. However, a new product can fail during the launch period if the timing of the launch is inappropriate. An overly cautious introduction can delay entry resulting in a missed opportunity, and too quick of a launch (usually done in response to competitive pressures) can result in cost and resource inefficiencies (Urban and Hauser, 1980). Therefore, coordinating the marketing, production and financial strategies, along with selecting the best entry time, is necessary for innovation success at this final stage of the new product development process.

2. Success Factors of New Products

New product failure can occur during the new product development process or after the product has been launched into the marketplace New product failure can occur if the developing company does not make use of a new product development program (Cooper, 1993) like the one set out in the previous section But, given that such a program is in use, what other factors relating to the product, the stages within the process, and other elements can influence the ultimate success of failure of a product? Specifically, what characteristics must a new product possess to succeed? What types of decisions, activities and choices can lead to the termination of the new product before it's introduction to the outside world? What role do the people directly involved with the product play to ensure success? Based upon a review of the literature, it becomes apparent that the success of a new product depends upon the quality of its own characteristics, the adherence to an effective new product process, the level of organizational support for the product, and the nature of the external market after launch. In the section below we will broadly discuss the internal and external factors which can influence new product performance.

2.1 The importance of preparing the organization for innovation

Early studies focused generally upon improving structural elements of the organization which support innovative ventures, and on understanding potential user needs. For example, Myers and Marquis (1969) discussed the necessity of identifying and meeting customer needs, and on the importance of communication within the developer organization Project SAPPHO, conducted by Rothwell (1972) argued for the importance of efficient and effective R&D teams during development and the influence of project champions on the success of the project. These findings were based upon a comparison of 43 pairs of successful and failed innovations in two different industries and was replicated on a smaller scale, with similar findings, in a study of the Hungarian electronics industry (Rothwell, 1974).

2.2 The need for an effective new product process

Cooper's (1975) early study involved looking at reasons for failure related to activities which occurred during the process of creating the new product. He found that weak product marketing, poor market research as well as an over-investment during the development stage led to unsuccessful product performance. In his later study, NewProd 1, Cooper (1979) found three new reasons for new product success. Specifically, he found that product superiority, a strong market orientation, and technical synergy between product development and production led to favorable results (Cooper, 1979, 1980). Two additional characteristics were added to the list given the results of Coopers later study NewProd 2. He found that market size and growth potential, termed "market conditions", and the technical superiority of a product could enhance the innovation's ability to succeed (Cooper and Kleinschmidt, 1987). NewProd 3 focuses on the quality of process execution where Cooper (1993) states that successful products have a clear definition from early on in the process and that predevelopment, marketing and technological tasks occurring at the development stage can, if neglected, impact negatively on the new product's performance (Cooper, 1993)

Booz, Allen and Hamilton's (1982) study of 700 companies determined that organizations, in order to increase their chances of producing successful products, must adhere to a new product process. Inherent in this recommendation is the importance of articulating a commitment to growth by way of innovativeness, the creation of a new product organization, the generation and use of new product development experience, and the implementation of a management style focused on taking advantage of new product opportunities (Booz, Allen and Hamilton, 1982).

2.3 The people factor of new product success

Brown and Eisenhardt (1995) provide an integrative model to explain the factors affecting the success of product development. Their model is based on a synthesis of three streams of innovation research. First, the "rational plan perspective" offers a general overview of the contribution that team, senior management, market and product characteristics make to financial success. Second, the "problem-solving perspective" concentrates in detail upon project team and management factors that lead to a better product development process and a more effective product concept. Third, the "communication web perspective" involves those internal and external communication factors which lead to success.

Brown and Eisenhardt (1995) break down the factors influencing performance into people factors. Specifically, the researchers posit that the project team, leader, senior management and suppliers affect process performance (the speed and productivity of product development); the project leader, customers and senior management affect product effectiveness (the fit of the product with firm competencies and market needs); and that, together, an efficient process, effective product and munificent market influence the financial success of the product.

The table presented below offers a summary of the correlates for success for new product development.

Table 2: Correlates of New Product Success

Correlates of Success	SAPPHO Rothwell (1972)	NewProd 1 Cooper (1979)	Booz, Allen, Hamilton (1982)	NewProd 2 Cooper and Kleinchmidt (1987)	NewProd 3 Cooper (1993)	Brown and Eisenhardt (1995)
Match customer needs	√	√	√	√	√	√
High value to customer		√		√	√	
Innovative		√		√	√	
Technical superiority		√	√	√	√	
Screen growth potential				√	√	
Favorable competitive environment	√		√		√	
Market conditions		√		√	√	√
Fit with internal strengths		√	√	√	√	√
Effective communication	√			√	√	√
Top mgmt support	√		√	√	√	√
New product organization			√			
Use process			√	√		
Skillful marketing	√	√			√	
Efficient development	√	√			√	

based on Ragot (1994) p.24

3. Defining the Innovation Adoption Process

We will now turn to the next major topic - adoption. We have, so far, seen how an innovation comes to life within an organization seeking to develop and commercialize a new product. But, what happens after the launch? The innovation is diffused, or spread, through the marketplace where it is sought out, acquired and implemented by adopters. These adopters can be individuals or organizations. What process does an adopter company go through once it has decided that it needs an innovation? Biemans (1992) states that the innovation adoption process is the process that a potential customer goes through to reach the decision to adopt a new product. In this paper, we are concerned with organizations as customers, rather than individuals. Organizations experience specific stages when adopting innovations. The first stage, initiation, comprises preparation tasks leading to the adoption of an innovation followed by the implementation stage which consists of putting an innovation into use (Rogers, 1983).

In this section, we have synthesized four adoption models into one "typical" standard model of the adoption process. We have drawn from the work of Hage and Aiken (1970), Zaltman et al (1973), Kimberly (1981) and Rogers (1983).

3.1 A typical innovation adoption process

In the late 1950's and throughout the 1960's, most innovation process research, at the organizational level, emphasized either the initiation stage of the process (March & Simon, 1958; Wilson, 1966; Harvey & Mills, 1970) or the implementation stage (Burns & Stalker, 1961). The initiation stage of the process includes such activities as articulating a need for a solution to an organizational problem, assessing alternatives and making the decision to acquire a particular innovation. The implementation stage involves putting the innovation into an organizational context, adjusting it to fit the organization and using the innovation for its intended purpose. Most innovation adoption models can be divided into two major sections: initiation and implementation

3.2 Initiation

The initiation phase begins with a company's awareness of a need to change (Hage and Aiken, 1970) Zaltman et al (1973) posit that this need to change begins with a perceived "performance gap". A performance gap is defined as "discrepancies between what the organization could do by virtue of a goal-related opportunity in its environment and what it actually does in terms of exploiting that opportunity" . In plainer terms, a performance gap is a belief among decision-makers that the organization is not doing as well as it could or should be. These performance gaps arise due to changes in an organization's external environment such as changes in government activity, technological developments, and education Such changes in society can create a need to innovate in organizations For some companies, this need is bridged or narrowed by taking on an innovation from the outside. A search is conducted with the objective of finding a suitable innovation. If the search is fruitful, decision-makers in the adopting organization become aware of several alternatives. Rogers (1983) believes that this awareness can come about in two ways: First, it can occur *proactively* where one or more individuals in an organization make a conscious effort to solve an internal problem by seeking out an appropriate innovation or, second, it can come about *reactively* where one or more individuals within the organization become aware of an innovation which they believe can benefit the organization.

Once an innovation becomes known to the organization as a possible solution to their problem, decision-makers form an attitude toward the innovation (Zaltman et al, 1973). Judgments are made about the innovation's potential suitability by conceptually matching it with the organizational problem. This matching subphase is, in effect, a feasibility test. It allows decision-makers to think about and anticipate potential problems and outcomes of implementation.

The conclusion of the initiation phase is the "decision to adopt" Rogers (1983) defines the decision to adopt as "all the events, actions and decisions involved in putting an innovation into use." If the innovation is deemed desirable during the initiation phase, it will then be adopted and moved into the implementation phase. If it is undesirable, it is terminated and an alternative innovation is sought out to take its place.

During the initiation stage, most reasons for innovation failure are due to human resource problems. If an innovation is perceived as a threat to employee positions within the organization or if new information about the innovation is not understood by employees, introduction of the innovation into the company may be resisted (Zaltman et al, 1973). Innovation acceptance at the organizational level depends upon the support of a large number of individuals or subunits within the company (Kimberly, 1981). Dealing with employee resistance is crucial in averting innovation failure during the initiation phase.

3.3 Implementation

The implementation phase is defined as "all the events, actions and decisions involved in putting an innovation into use" (Rogers, 1983). Early in the implementation phase the organization makes its first attempt at using the innovation. Often this activity is actually a trial of the innovation before putting it into full use in other areas or for other projects (Zaltman et al, 1973). This preliminary introduction of the innovation into the organization may require a redefining of the innovation to better fit the company and/or a restructuring of the organization to maximize the innovation (Rogers, 1983) At this stage, the innovation becomes more familiar to the organizational members since it is no longer a mere concept, but a reality. Once the innovation has been adequately tailored to the organization, it's place within the everyday life of the company becomes clearer to organizational members. At this point, stable arrangements are made for the innovation as it becomes embedded into the organizational structure (Rogers, 1983) The end point of most innovation adoption models occurs within the routinization stage of implementation. Routinization occurs when the innovation becomes less of a novelty to its organizational members and is put into wide use within the organization (Hage and Aiken, 1970, Rogers, 1983). However, Kimberly's (1981) life cycle of innovation goes beyond routinization to discuss exnovation. Exnovation involves the removal of the innovation from the company primarily for the purpose of recouping costs.

During the implementation phase, poor strategic planning can result in innovation failure. Unforeseen problems often arise and require contingency plans to deal with them. Poor prior planning or lack of formal procedures for innovation entry, can lead to termination of the project (Hage and Aiken, 1970; Kimberly, 1981). Taking extra care in planning implementation may help avoid innovation failure.

People also play a significant role in assuring successful innovation implementation. Conflict may arise due to employee power struggles (Hage and Aiken, 1970) and employees may resist the innovation, even at this stage, if they feel that it threatens the status quo (Zaltman et al, 1973) Therefore, even if an innovation functions according to plan, it may be defeated due to conflict and resistance among organizational members.

Decision-makers can aid in the smooth progression of an innovation's implementation. They must demonstrate commitment to the project (Kimberly, 1981) while managing conflict and resistance among lower-level employees. Reducing negative perceptions about the innovation can come about by allowing users to play a role in the design of the innovation, ensuring that any new staff hired to deal with the innovation is compatible with existing staff (Kimberly, 1981) and allowing for adequate adjustment time for employees to understand the innovation (Zaltman et al, 1973). Furthermore, certain policies should be instituted to encourage the innovation's progress such as theoretical guides and formal procedures to handle the innovation's entry and creating new roles to maximize the innovation's potential (Kimberly, 1981). These policies would help reduce feelings of ambiguity surrounding the innovation.

Table 3: Four Innovation Adoption Models

Hage and Aiken (1970)	Zaltman et al (1973)	Kimberly (1981)	Rogers (1983)
	Initiation stage		Initiation stage
Evaluation	(i) knowledge-awareness substage		(i) agenda-setting
	(ii) formation of		
Initiation	attitudes substage		
	(iii) decision substage		(ii) matching
		Adoption	
Implementation	Implementation stage		Implementation stage
	(i) initial implementation substage		(i) redefining/ restructuring
			(ii) clarifying
	(ii) continued-	**Utilization**	(iii) routinizing
Routinization	sustained implementation substage		
		Exnovation	

4. Success Factors of Adopted Innovations

In new product development literature, an innovation is considered to be most successful if it is chosen for adoption by a large number of users in a relatively short period of time. The outcome of the launch depends upon how appealing the new innovation is to potential users Certain innovation attributes cause users to perceive some innovations as more desirable than others and they are therefore adopted more quickly by a larger number of users. Thus, if an innovation possesses these desirable attributes, it will be adopted by users and, once an innovation is adopted, it is considered successful.

4.1 Innovation attributes and rate of adoption

In adoption literature, specific innovation attributes have been organized into a general classification scheme by Rogers (1983). The author states that all innovations can be assessed based on five standard attributes relative advantage, compatibility, complexity, trialability, and observability Relative advantage is "the degree to which an innovation is perceived as being better than the idea it supersedes (Rogers, 1983). An idea may be considered better than that which came before, if it offers higher profitability, higher status or other benefits. Consider the example of the pocket calculator Due to the availability of semi-conductors, the price of pocket calculators dropped from $250 in 1972, to $10 only a few years later The relative advantage of adopting semi-conductors was high. An innovation may be considered to have a high degree of relative advantage is it provides increased social status For example, buying a BMW may be perceived as being better than another type of automobile simply because of the status associated with driving such a vehicle On the other hand, if a software program appears on the market and claims to simplify tax accounting procedures when in reality it demands a great deal of time for input of data, it will not be perceived as better than the traditional method of filling out the tax forms by hand Therefore, it will not be adopted Rogers (1983), based on a summary of research findings, states that "the relative advantage of an innovation, as perceived by members of a social system, is positively related to its rate of adoption."

The next attribute, compatibility, is "the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters" (Rogers, 1983) A higher degree of compatibility suggests to potential users that the innovation will fit well with their "world" as they perceive it A compatible innovation will not cause conflict with existing, well-entrenched norms. For example, American farmers did not readily adopt soil conservation innovations because they conflicted with the belief that such an innovation would negatively effect production Soil conservation was thus not compatible with their existing ideas about agriculture. Sometimes a potential user may not realize that a particular innovation would meet some of their specific needs Often in such cases, a change agent may emerge seeking to generate needs by educating potential clients about the innovation's compatibility of meeting some of their existing requirements (Rogers, 1983) Based on previous findings, Rogers posits that a higher degree of compatibility leads to higher rates of adoption

The complexity of an innovation is "the degree to which an innovation is perceived as relatively difficult to understand and use" (Rogers, 1983) If an innovation is too difficult to understand, most users will be deterred from adopting it For example, (Graham, 1956) found that canasta was adopted less quickly than television as a form of entertainment because it required more learning Television, on the other hand, required turning a knob Therefore, Rogers (1983) states that the complexity of an innovation, as perceived by members of a social system, is negatively related to its rate of adoption

Trialability, the next attribute, is "the degree to which an innovation may be experimented with on a limited basis" (Rogers, 1983) Being able to try out an innovation and assess the results of its use lessens the uncertainty surrounding the innovation. The level of trialability is especially important for early adopters since, unlike late adopters and laggards, they cannot draw from the experiences of many others who have already adopted the innovation Rogers (1983) believes that the trialability of an innovation, as perceived by members of a social system, is positively related to its rate of adoption.

The final attribute, observability, is "the degree to which the results of an innovation are visible to others". If the results of using an innovation can be easily seen by others, then, it is expected to be more quickly adopted. For example, the benefits of using a laser printer over a dot matrix is observable by the degree of clarity and crispness of the text. However, the difference in using one type of shampoo over another brand may not be observable enough to convince a potential user to adopt it. As such, Rogers (1983) suggests that the observability of an innovation, as perceived by members of a social system, is positively related to its rate of adoption.

In adoption literature, a successful innovation is one which has been implemented by a user. Users adopt innovations after assessing the attributes of innovations. If users perceive these attributes favorably then the innovation will, most likely, be acquired and used. Rogers (1983) indicates that 49 to 87 percent of the variance in rate of adoption is explained by the five attributes The rest of the variance is explained by other factors including the type of innovation-decision, the nature of communication channels diffusing the innovation at various stages in the innovation-decision process, the nature of the social system, and the extent of change agents' promotion efforts in diffusing the innovation.

4.2 Decision-making, communication channels and social norms

Rogers (1983) states that innovations are adopted at a slower rate if several people are involved in making the adoption decision. He supports this by referring to the decision to fluoridate water in the United States. When the issue was to be decided by a municipal mayor, the innovation was more quickly adopted than when the decision was to be taken by a public committee.

Communication channels can also influence the decision to adopt an innovation. If information and awareness of the innovation is passed through interpersonal channels, then, generally, the innovation adoption rate is slowed. However, this is dependent somewhat upon the level of complexity of the innovation. If an innovation is highly complex, then interpersonal contact and information exchange is more appropriate than mass media channels such as magazines or television Choosing the most appropriate communication channel is important for ensuring a high rate of adoption

The nature of the social system also plays a role in whether or not an innovation is adopted Social systems linked by communication networks and possessing a high level of interaction adopt innovations more quickly. Rogers (1983) believes that innovations are more likely to have a higher rate of adoption in social systems which enjoy a high degree of interaction among its members

Change agents, given that they expend time and energy to promote an innovation, can influence its rate of adoption (Rogers, 1983). Innovations benefit more from change agents' efforts if these efforts occur at certain stages during diffusion. In particular, the rate of adoption can increase if the change agent's input occurs during the point when opinion leaders are in the process of adopting (Stone, 1952; Petrini, 1966). Rogers (1983) defines opinion leaders as those individuals within a social system who have the ability to frequently influence the attitude and behavior of others

In summary, we have seen that successful innovations, according to innovation adoption literature, are those which succeed in being adopted by users. To be successfully adopted, innovations were said to be judged on certain attributes. Rogers (1983) has provided us with a universal standard of five attributes by which potential users can assess innovations before adopting them. In addition to the five attributes, other factors relating to diffusion and aspects of social systems have been shown to effect the rate of adoption. In discussing these various factors is should be evident that the rate of adoption is synonymous with success of adopted innovations. If an innovation is chosen over others, has been favorably judged on its attributes, is acquired and implemented by the user, then, it is a successful adopted innovation.

Figure 1: Variables Determining the Rate of Adoption of Innovations

Variables determining rate of adoption	Dependent variable to be explained
I. Perceived Attributes of Innovations 1. Relative Advantage 2. Compatibility 3. Complexity ----------↓ 4. Trialability 5. Observability	
II. Number of Decision-makers ----------→	RATE OF ADOPTION OF INNOVATIONS
III. Type of Communication Channels ----------→	↑
IV. Nature of the Social System ----------┘	↑
V. Extent of Change Agents' Promotional Efforts ----------┘	↑

Based on Rogers (1983)

5. Applicability of the New Product Development Process and the Adoption Process to the Phenomenon of In-House Innovation

An understanding of the development and adoption of innovations allow us, at this point, to put forth some concrete questions about the in-house innovation process. Specifically, how does the process start? How does it end? What are the stages of the process? What factors within the process help ensure a successful innovation? What decisions, events or activities, arising during the process, lead to a failed innovation? In short, the interest here is in exploring the nature of an effective in-house innovation process. Below, we elaborate further on the questions as well as expressing our predictions or "hunches" about how the in-house process unfolds given what we have learned about innovation models so far.

5.1 The start of the process

The start of the in-house innovation process, like the typical new product development models and adoption models, most likely begins with a need to change or solve a problem. To respond to such needs new product development organizations create products for eventual commercialization, but in-house innovators, like adoption companies, would likely conduct searches of the environment to identify any existing innovations which would meet their needs. Therefore, adoption organizations and in-house innovators are similar in terms of the start of their processes

In adoption, a search is conducted with the intention of acquiring or purchasing, an innovation to implement This search is triggered by a "performance gap". Do in-house innovators also experience a performance gap? If so, does the performance gap come from outside the organization or from the inside? Does it come about due to a need to solve a problem, or does information about external innovations create a need? Like in-house innovators, companies which adopt innovations also want to solve internal problems, therefore, we expect that the start of the in-house innovation process will resemble the performance gap as defined in adoption models. This statement leads to our first question:

> *Question #1:Does the in-house innovation process start with an awareness of a performance gap?*

5.2 The end of the process

While the typical new product development process ends with the "birth" of a new product, the end of the adoption process comes about with the absorption of an innovation into the adopting company until it is no longer considered to be an innovation. In both cases, the innovation is transformed into "something else". That is, in the former situation, the new product becomes a commercialized object. In the latter situation, the innovation becomes a day-to-day tool. At some point, when the innovation is no longer desirable, or is performing poorly, it may be terminated or "killed". This can occur for both new products and for adopted innovations. But, what happens at the end of the in-house innovation process? Are they terminated at some point? Are they sold, traded or donated? Our contention is that in-house innovations, being highly specialized pieces of equipment would be of limited use to all but a very limited number of individuals in the same field In addition to this, unlike adopted innovations, in-house innovations, being state-of-the-art innovations which are unique to the world (usually only one of each in-house innovation exists) would never lose their identity of being an "innovation". It would carry its first-in-the-world status indefinitely due to its avant-garde form, function and purpose. Therefore, our second set of questions include the following:

> *Question # 2: Does the end of the in-house innovation process involve selling, trading or donating the innovation to other users?*
>
> *Question #3: Do in-house innovations, at the end of the process, retain their novelty status?*

5.3 Process Steps

Both new product development and adoption models involve well-defined steps and, though some minor overlap between stages may occur, for the most part, the stages progress in an organized sequence. How does the process unfold for in-house innovation? What are the stages and are they clearly identifiable? It seems logical that, besides the search stages, the early part of the in-house innovation process will resemble the new product development process since both involve the creation of a new innovation from an original idea. It follows then that, the second phase of the process will, most likely, resemble that of adoption models in terms of the implementation steps. We also expect that the process steps for in-house innovation will overlap to a greater extent than the process steps for new product development models or for adoption models The rationale for this statement is that, given that the needs of in-house users are highly idiosyncratic and that the users function within the same organization as the developers, process steps will be skipped, condensed, juxtaposed etc.. depending upon user input. Therefore we put forth the following questions:

Question #4: Do the early process steps for in-house innovation resemble the stages of a typical new product development model?

Question #5: Do the later process steps for in-house innovation resemble the stages of a typical innovation adoption model?

Question #6: Are the stages of in-house innovation subject to overlap and synergies?

5.4 Success factors

While the success factors for new products depend primarily upon meeting market needs and internal company objectives, the success factors for adopted innovations have more to do with the technical aspects of the innovation itself (i.e relative advantage, compatibility, complexity, trialability, and observability). We can expect that, since in-house innovations are not destined for an external market, its success will have more to do with the physical qualities and attributes of the innovation itself. The logic behind this statement is that though in-house innovation developers do not have to meet the needs of a mass market, they do have to meet the highly idiosyncratic needs of a limited group of internal people. Therefore we ask.

Question #7: What is innovation success in terms of in-house innovation?

V. RESEARCH OBJECTIVES

The particular phenomenon of interest in this study is in-house innovation. We define in-house innovation as the process of designing, developing and implementing technological innovations internally, where the resulting innovations are used specifically as tools to facilitate or improve the production or distribution of the company's focal product. To illustrate, a film production company which has created a new animation software to improve the quality of its animation films is considered to practice in-house innovation. The software is an instrumental tool which improves the production of the company's focal product - animated films.

The topic of "in-house innovation" is conceptually linked to a wide body of organizational innovation literature However, the process models available in current literature focus primarily on new product development models and innovation adoption models New product development models focus on the process of generating new products or services for the marketplace and adoption models are concerned with the process of adopting innovations from outside the organization. Very little research has been done on the phenomenon of the in-house innovation process.

The first objective of the present research is to evolve theory about the nature of the in-house innovation process, describing the steps, stages or sequences of events involved from its starting point to its ultimate end-point. How does the in-house innovation process unfold? What are the steps and sequence of events which comprise the process? This will be accomplished by bringing together the two distinct fields of research: the new product development process and the innovation adoption process.

The second objective is to determine specific success factors for in-house innovation and produce some practical insights into those factors which may impede the progress of in-house innovation. What is a successful innovation in the context of in-house innovation? Why do some innovations fail to make it to the end of the innovation process? At which stage can these failures occur? To accomplish this, we will again refer to the established innovation fields of new product development and innovation adoption.

These two objectives, involving both theoretical and practical aims, require a methodology capable of reflecting patterns and dynamic processes at individual, group and organizational levels and from the perspectives of developers, users and managers.

VI. RESEARCH METHOD

1. Major Methodological Choices

Two major methodological choices were made to accomplish these two objectives:

1) to use retrospective case studies

2) to use a multiple-case, holistic design (Yin, 1994)

1.1 Rationale for retrospective case study approach

The decision to adhere to case study methods was directed by the nature of the topic itself and the research objectives outlined in the previous section. Specifically, the present study focuses on a phenomenon which has not been widely researched (Eisenhardt, 1989) and on "how" and "why" research questions (Yin, 1994). Eisenhardt (1989) states that under researched topics are best examined using a case study approach since such methods do not rely on previous literature or prior empirical evidence Leonard-Barton (1990) also notes that a case study approach is useful for under-researched areas because it allows the researcher to slice vertically through the organization to gather information from many different levels. Thus, case study methods allow for the gathering of rich, detailed data from a variety of sources to help explain areas of research which have been neglected.

The two primary research questions in this study are: "How does the in-house innovation process unfold?" and "Why do some innovations fail to complete the process?". These "how" and "why" questions are best examined using a case study approach because these questions "deal with operational links needed to be traced over time, rather than mere frequencies or incidence" (Yin, 1994). To clarify, the present study does not focus on the rate of innovation (which could be studied using a survey or examining archival record) but rather how the process of innovation unfolds over time This exploration of patterns which emerge within and between cases over time requires a flexible research method capable of capturing dynamic processes and is thus best examined using a case study approach.

The decision to use retrospective case studies is dictated by the logistics of the study. Theoretically, longitudinal, real-time field study would be a preferable method to use, particularly if it can be paired with additional retrospective studies to capture both the detailed micro-view of the innovation process with the former method and a more broad, macro-view of the process using the latter method(Leonard-Barton, 1990). However, since the innovation process itself can take many years, the decision was made to recreate a historical account of the in-house innovation process for recent innovations (past 10 years). The retrospective view allowed for the inclusion of multiple cases which augments validity and prevents observer biases such as misjudging the representativeness of a single event (Tversky and Kahneman, 1986).

1.2 Using multiple case, holistic design

Multiple cases were used in the present study because evidence which is based on multiple cases, rather than a single case, results in a more robust study (Herriot and Firestone, 1983). In addition, a holistic design was used to examine the multiple cases. A holistic approach to examining a case involves studying the "global nature" of each innovation rather than including more than one unit of analysis (as in embedded designs) (Yin, 1994). Embedded designs are those which involve more than one unit of analysis such as a study of organizational climate which involves individual employees as a subunit of the study. The larger unit, that of organizational climate, is the focus of the study and the individual employees are subunits which provide data for analysis. Holistic designs are used when no logical subunits can be determined and when the underlying theory of interest is of a holistic, or global, nature (Yin, 1994). Since the present study involves research of the innovation process, it is more appropriate to use a holistic design since our goal of understanding process dynamics and patterns is best served by looking at the overall experience rather than its component subunits. Therefore, multiple cases were used to augment validity and a holistic approach was chosen because the topic of interest - the in-house innovation process - is best examined as a whole rather than by subunit levels of analysis.

2. The Research Site

A single site, the National Film Board of Canada (NFB), was used as the context of the present study. The NFB is an organization which practices in-house innovation and is known internationally for the quality and volume of its technological innovations. As such, the NFB provided a unique forum for examining a number of recent in-house innovations. Furthermore, since the NFB is a federal institution, archival data were well-documented and interviews and observational data were readily available.

2.1 Brief history of the National Film Board of Canada

The NFB was founded in 1939 as a federal government agency to produce films dealing with current socio-cultural concerns, and which enhance artistic expression, as well as to present and distribute these films to a growing public The organization is funded by the federal government. Innovation at the NFB is a company-wide effort. Though specific R&D tasks are accomplished by the Technical Research and Development Division, other departments, such as

Sound, Negative Cutting and Visual Effects, can be fully responsible for many different areas of the innovation process such as initiating innovation ideas, designing innovations or developing prototypes.

In-house technological innovation has been an important part of the NFB throughout its history, specifically in the areas of production, sound, post-production and presentation of films. Even during periods of government cutbacks, staff reductions, and difficulties in articulating the purpose and mission of the organization, the NFB has continued to innovate.

From the 1940's through the 1950's, the NFB's growth included numerous breakthrough innovations including the first feature film in the world to use a new Eastman color negative stock type which enabled filming in a coal mine with little light. The NFB also developed the Composertron - the first known system for synthetic music composition/recording using an electronic tone generator, as well as the world's first RGB additive light film printing machine.

From the 1960's to the mid 1970's, the NFB ventured into the world of television while facing cutbacks and increasing bureaucracy. However, the NFB continued to innovate with projects aimed primarily at improving and automating tasks such as an automatic pan and tilt camera mount and a half-inch automated videotape editing system. Also, technological breakthroughs continued to emerge despite reduced funding, such as a computer-controlled and -operated animation system - the first in the industry; a television camera housing unit which allowed for the first live color TV broadcast from under Arctic ice in the Atlantic ocean; and an underwater stereo sound recording system which allowed for the first recordings of creatures encountered under the frozen Atlantic.

During the mid-70's until the end of the 1980's, questions were raised about the value of the NFB to Canadians in the Applebaum-Hebert report The NFB strove to persuade the government as to its importance to Canadians and the need for its continued existence. As a result of the report, several recommendations were implemented in the areas of marketing and distribution.

During this period, the NFB produced innovations jointly with private companies in Canada and abroad For example, the Animaster animation stand control system and the Bran, a special-effects-motion-control system, were developed in cooperation with a Montreal-area electronics firm, the Phonologue, a computer-aided motion picture dialogue timing, spotting and editing system was developed with the help of the University of Victoria in British Columbia, and a captioning system for the hearing-impaired was developed in cooperation with two major American television networks and the National Institute for the Deaf.

The 1990's have proved to be the most difficult period in the NFB's history - a time when its very existence is threatened Budgets have been cut from $88 million to $56 million from 1993 to 1997, and staff has been reduced from 1000 people in 1984, to 619 in 1993, to 344 by 1997. Furthermore, the NFB film lab, shooting stage and Studio D are slated to close, the Grierson building (a large portion of the NFB's physical plant), is to be vacated, and the Centre Robotheque facility will also close by 1998 if no private or public partners are found to help defray its costs. The latest drastic measures were put into place by the NFB chairman, Sandra Macdonald, following pressures from the government-commissioned Secor report (1994) and the Juneau report of 1995. The former report suggests that the NFB should stop making movies and instead become a training school for young filmmakers. The Juneau report states that all English language documentary production should be moved to Toronto and that the remaining animation studio and French production department be vacated from the large headquarters on Cote-de-Liesse Road.

While these major transformations take place, the NFB continues to develop its technological innovations. For example, Cineroute, a joint venture between the NFB and Videotron will allow people to screen any one of 2500 NFB films on home computer via the Internet and the Cinerobotheque. Currently, the pilot project for Cineroute is being undertaken with connections to McGill University and the Université de Québec à Montréal. This innovation was introduced to the public by Sandra Macdonald in 1995.

3. Selection and Description of Cases

For the present study, the process of each technological innovation represents a case in itself. A total of eight (8) innovations, four (4) of which are successful and four (4) of which are failures, were studied. The logic behind this non-random choice was to highlight the factors which led to the success or failure of each innovation. Pettigrew (1988) states that, when presented with a limited number of cases, it is useful to choose those cases which represent extreme situations or polar types. Such a choice would cause the phenomenon of interest to become "transparently observable". The cases chosen for this paper were selected with the intention of building a theory of effective in-house innovation.

A retrospective study of eight innovations, each categorized as either successful or failed, adheres to Yin's (1994) "replication logic". Following Yin's reasoning, our successful innovations should have similar results in each of the four cases. If similar results do occur, *literal replication* is said to have taken place. Our four failed innovations will serve to produce contrasting results but for predictable reasons. If this occurs *theoretical replication* is said to have taken place. These replication procedures serve to develop a rich, theoretical framework about the in-house innovation process and the factors which explain innovation success and failure.

4. Crafting the Interview Guide

The interview guide used for prompting participants to discuss the stages of the in-house innovation process was loosely structured and open-ended The rationale for this approach was to allow the interviewee the freedom to discuss any new issue which s/he felt was relevant to the process of successful in-house innovation Furthermore, an unstructured interview encourages the respondent to provide a narrative of their experiences rather than over-simplified, broad responses Mintzberg (1979) states that theory-building requires the type of rich description that emerges from anecdote Respondents who provide facts as well as opinions during such open-ended interviews may be considered "informants" and, as such, may be capable of providing sources of corroboratory evidence which is critical to the success of a case study (Yin, 1994). The interview guide is provided in Appendix A.

5. Data Collection

Data Collection involved gathering information from organizational members using an interview guide; collecting archival data from the NFB library; and, when possible, observing the innovation in use or during a brief demonstration.

5.1 Phase One: Preliminary interviews with senior management and archival search

Beginning in February of 1995, three separate interviews of approximately two (2) hours each were conducted with a senior strategic manager of the NFB. The first two interviews, unstructured and open-ended, revolved around questions such as "How does in-house innovation occur in general?", and "What is a successful innovation?". The third interview was more structured in that I requested a list of innovations and identification of the people directly involved in their development and use.

Simultaneously, a search of the NFB library holdings was conducted to gather published works and reports which discuss NFB innovations. The senior strategic manager referred me to a senior Technical Research and Development manager who helped refine the list of technological innovations, categorize them as successes or failures, and provide the names of the developers and users in each case. Table 4 briefly describes the technological innovations included in this study.

Table 4: Description of Eight (8) In-House Technological Innovations Used in Study

Technology	*Innovation Performance*
1 **Animaster** The Animaster is a computer-controlled animation stand that automates the definition and execution of animation tasks	**Success**
2. **Flip** Flip is a software system developed for the electronic post-production of the visual portion of animated films.	**Success**
3 **Cinerobotheque** The Cinerobotheque is comprised of a robotized arm which routs NFB films into video machines for public viewing The arm is controlled by users who sit in one of 21 Cinescopes which are u-shaped ergonimically-designed booths with a personal computer and viewing screen from which a user may select an NFB film, view it, and obtain additional information about the topic or film	**Success**
4. **Helicopter Rig and Mount** The Rig and Mount, controlled by a console, are used to support IMAX cameras which are placed on the belly of a helicopter or other device used for "flying" the camera such as a crane The Rig and Mount are designed to reduce imperfections in image by reducing jolts	**Success**
5 **The Sound Genie** The Sound Genie is a robotic digital sound effects library composed of an automated robot, electronic catalogue of stored sound effects and workstations	**Failure**
6 **Digisound** Digisound is a technique of putting digital sound on film by allowing the sound to be written directly on the film, in the data channel beside the image	**Failure**
7 **Stockshot Viewing Table** The Stockshot Viewing table is a modified 16/35 mm film editing table which has been adapted as a telecine for viewing stockshot footage	**Failure**
8. **Film-Negative Handling Work Station** The Workstation is an ergonomically-designed and semi-automated work area for negative cutters and inspectors	**Failure**

Each case was restricted to certain characteristics: They must have been developed in the last 10 years, and their design, development and use must have occurred internally These criteria ensured that we were getting examples of in-house innovation and allowed for a controlling of outside influences such as market demand, commercialization, and competition.

5.2 Phase Two: Interviews with users and developers

Data collection for the replicated, multiple cases was accomplished over a period of two and a half months (May - July, 1995) Since each interview lasted from one to two hours, the maximum number of interviews scheduled per day was limited to two. Detailed notes were taken and each interview was taped to ensure that all details were captured. Each respondent was assured of confidentiality concerning their names.

Semi-structured interviews were used to gather data from both the developers and users. The interview guide served to prompt the respondents to describe events and decisions which occurred from the start of the in-house innovation process, through all its in-between stages, until its current status. The guide was based on the general steps described in the new product development and adoption-models discussed in the literature review at the beginning of this paper and on the information given by senior managers during preliminary interviews. The data gathered from the users and developers served to flesh out each step of the in-house innovation process and provide details about possible reasons for each innovation's failure or success.

The interview data were augmented by information derived from "Perforations" - an internal R&D publication, as well as R&D reports, annual reports, award documentation , photographs and periodicals available in the NFBs library and in senior managers' personal archives.

In addition to interview and archival information, I was, at times, afforded the occasion to observe the innovation physically. For three (3) of the successful innovations, I was able to see them in use during a brief demonstration.

The three methods of data collection: interview, archival and observational, served to limit the potential for "surrendering to the biases of the informant" (Leonard-Barton, 1990). By having multiple sources of information, the subjective perspective of each informant is supported or refuted by other data sources allowing for a more critical interpretation of historical events (Sears and Freedman, 1974).

6. Participants

Each case study required at least one in-depth informant interview. Ideally, two (2) interviews were conducted, where both the developer and the user participated. However, occasionally, the developer and the user of an innovation was the same person or one of the parties, either the developer or the user, was not available for interview purposes.

The study spanned across three types of positions within the organization: managers, engineers and technicians. Generally, managers were involved in developmental decisions, engineers were involved as developers, and technicians were the primary users of the technology.

7. Analysis

The primary focus of the analysis procedures was to highlight any patterns arising from the data. The retrospective studies were broad enough to provide a macro view of the overall in-house innovation process while detailed enough to provide insight into underlying reasons for success or failure.

Unlike statistical analytic techniques, qualitative case studies are vulnerable to subjective interpretations. However, Miles and Huberman (1994) provide valuable tools for analyzing qualitative data effectively. Specifically, the overwhelming volume of data is presented in narrative case summaries, themes are highlighted in contact summary sheets, and an event listing matrix is used to display the process of each innovation.

Once reduction of data is achieved, the descriptions of process steps for in-house innovations is matched with the process steps for new products and adopted innovations and the differences and similarities between them are discussed. Furthermore, successful and unsuccessful innovations are matched to uncover possible reasons for failure and success. This allows for a development of a preliminary model of in-house innovation

8. Validity and Reliability

For the present study, we have attempted to select a specific design that will maximize research validity and reliability within the constraints of the research situation. Furthermore, our measurement, data gathering, data preparation and analysis were performed with an aim toward ensuring an appropriate level of reliability and validity.

8.1 Construct validity

Constructs are the underlying theoretical ideas to be studied within a particular research project. Establishing correct operational measures for these constructs leads to construct validity (Yin, 1994) Yin suggests three tactics aimed at increasing construct validity in case studies: the use of multiple sources of evidence to encourage convergent lines of inquiry; establishing a chain of evidence to allow readers to judge the information independently, and to submit a draft case study for review by key informants in order to check the accuracy of data collected. These three tactics were used to increase the construct validity for the present study.

The first step taken to ensure construct validity was to select the particular type of innovation to be used in this study and to clarify our specific meanings of success and failure. For example, understanding the term "innovation" is made difficult by the volume and variety of definitions available. As such, we have limited our study to instrumental technological innovations which are developed and used in-house. Construct validity has been augmented for our description of this phenomenon by way of triangulation. Triangulation enhances construct validity by using multiple sources of evidence to measure the same phenomenon. Convergent lines of inquiry were established by way of documented information, archival records, personal interviews, observation of actual innovations, and photographs of innovations. Each case was checked to ensure that each innovation used in this study was technological in nature;

instrumental in helping produce, develop or distribute the organization's focal product (films), and developed and used internally rather than commercialized for use by outside companies.

The concepts of innovation success and failure were also checked to ensure correct operational measures. In this study, a successful innovation is one which has made it to the end of the in-house innovation process, has been implemented and is currently in use at the NFB. This definition of success was supported by multiple sources of evidence - information gathered during interviews , by observations of the innovation in use, by observations of the results of the innovations use (films), by documentation and by archival information.

The concept of innovation failure, defined as those innovations which do not make it to the end of the process, or are not implemented, or are not currently used, was reflected in several data sources as well. Specifically, interviews, observations of unused innovations, and documentation of evaluations. These data sources offered convergent results as to what constitutes a failed innovation.

A chain of evidence was also maintained in order to augment construct validity. A chain of evidence is defined as the link between questions asked, data collected and conclusions drawn (Yin, 1994). To form this link, all relevant evidence, such as specific questionnaires, interviews, documents and observations, has been presented in detail to allow the reader to independently judge the accuracy of the information presented in this study.

Finally, a draft case study report, which is composed of a descriptive narrative of the process of each technological innovation's initiation and implementation, was presented to a key informant at the NFB. The narratives were examined and modified as needed and returned to the researcher. As such, all essential facts and evidence presented in our case reports have been corroborated (see Schatzman and Strauss, 1973).

8.2 Reliability

Reliability has been assured in the present study by providing a detailed description of procedures used. Along with supporting construct validity, establishing a chain of evidence serves to increase reliability of case study information (Yin, 1994). A chain of evidence allows the reader of the case to follow the investigation from the initial research questions to the case study conclusions thereby allowing them to derive their own independent judgments about the case. Also, Yin's notion of a case study database was useful, this comprises the raw material used in this study including transcripts of taped interviews, archival and documentary evidence and photographs. Each case summary was first checked by a key contact in Research and Development and corrections were made accordingly. Then, the corrected set of case summaries were sent a second time to the key contact and to each of the interviewees for any further corrections.

8.3 External validity

In the present study, we use multiple cases (innovations) but only a single site (the NFB). The question at this point is : Are the findings generalizable to other companies?" Yin states that, for case studies in general, generalization of findings are made to "theory" rather than to other cases. Unlike survey research, which relies on statistical generalization, case studies (as with experiments) rely on analytical generalizations. In analytical generalizations, the researcher attempts to generalize findings to some broader theory. The present study attempts to generalize our findings to the theory of in-house innovation and the broader field of innovation research. In so doing, the resultant theory may become a vehicle for examining the process of in-house innovation at other sites.

VII. RESULTS AND DISCUSSION

1. Case Summaries

In this section, each case is described as a case summary, using a detailed narrative format (Miles and Huberman, 1994). The information in these case summaries is used in the construction of event listings (Miles and Huberman, 1994) (see Appendices C and D). The event listings concisely display the events which occurred at each phase of the process for each innovation included in this study. This format highlights patterns within and between cases. The qualitative data analysis methods used in this study served to meet the two primary objectives of the study:

(i) **Define the steps and stages of in-house innovation**: Are there clearly defined steps within the in-house innovation process? Do steps and stages overlap? How is the in-house process a fusion of the new product development process and the innovation adoption process?

(ii) **Discuss possible reasons for innovation failure**: What goes wrong during the innovation process to result in a failed innovation? Where can the process itself go wrong and how does innovation success come about? How is success defined by in-house innovators?

1.1 ANIMASTER

The Problem:

For some time, the creativity of animation teams was greatly restricted by the level of available technology. Specifically, the precise mathematical calculations required to properly coordinate the frames and fields of each animated sequence was performed manually by the animator. As a result, the animation team spent a great deal of time and effort planning and coordinating the technical aspects of each sequence rather than concentrating on the creative "story-telling" aspects. To circumvent the mathematics and to allow for higher productivity, a group of animation camerapersons at the NFB initiated the idea of creating a computerized animation stand - The Animaster. The Animaster allows animators and camera operators to complete their work more quickly and at a reduced cost

The Innovation:

The Animaster is **a computer-controlled animation stand that automates the definition and execution of animation tasks.** It allows the animator and the animation stand operator to input their information into a computer where the animation simulation software helps them to simulate and define moves The computer then manages the tasks of controlling the camera and stand via a sophisticated interface which records al' the moves and parameters involved in the shooting session. Therefore, the Animaster "consists of a computer-controlled animation stand that facilitates the definition and execution of multiple complex functions. It is a new creative tool that enables animators and camera operators to shoot an animated film in less time, at a lower cost" (Tolusso, 1991).

Initiation Phase:

An animation cameraperson stated during our interview session, that the innovation process began when he teamed up with a project manager from the NFB's Technical Research and Development Division, termed "Tech Research" with the objective of creating an automated animation stand. The animation cameraperson would be an eventual *user* of the innovation while the project manager, Tech Research staff and external contractors would be the *developers* of the innovation.

A formal search of the environment was not conducted because, being active in the field of animation technology, they knew that a device which would meet their needs did not exist. However, once the preliminary ideas for the innovation became clearer, Tech Research along with the project manager, conducted a search for a technology upon which they could base their new innovation. The cameraperson, who would be the eventual user of the technology, was not involved in the search. The Oxberry brand animation stand was chosen as the table upon which they would build their automated animation system

The cameraperson presented to the project manager a list of items and features which should be incorporated into the existing Oxberry animation stand. This list, presented verbally and in a written format, was then "translated" and rewritten by Tech Research into technical specifications. Tech Research made the decision to proceed with the full development of the innovation. Their three main objectives were as follows:

1. to facilitate the work of the camera operator and animator;

2. to improve communication between the two so as to better define their expectations regarding the end result,

3. to make it easier for them to conduct tests and trials on special effects and movements which have been less frequently used because of the complex calculations they require and the time this takes. (Dutrisac et al, 1991).

Their decision to go ahead with the project was based upon the potential for greatly improved productivity in the Animation Department.

A prototype was created by an external Montreal-area software firm. The animation cameraperson stated that trial runs were performed over the next few years. The definition of a trial run included using the system for actual production purposes rather than simple preliminary tests done within their laboratory setting.

Implementation Phase:

The Animaster concept was designed in-house. However, to manufacture the project, the NFB contracted a German software firm. After a while, the software firm's contract was terminated because the NFB felt that the project was going in the wrong direction. Soon after, a Montreal area software firm was contracted to continue the work. This software firm stipulated that a new engineer would have to be hired by the NFB for the project to go ahead. So, a project engineer was hired for the purpose of facilitating ties between the software company and the NFB. In addition, a Montreal area electronics firm was contracted to provide the interface.

Development and testing occurred sequentially. After the original prototype was completed, NFB users of the technology trial-ran it in order to debug it. The debugging stage lasted for several years and, even during production shooting, debugging often took place.

Tech Research management, when adequate funding became available, made the decision to proceed with the full development and implementation of the project beyond the prototype stage. The project was approved based on several merits: Animaster was to be easy to use, had many desired features, and allowed animators to maximize their creativity eventually leading to the production of more films. Even though the merits were well known, disapproval was shown by management at some points due to the length of time spent by staff on the debugging process. The animation cameraperson had to make a case for the continued improvement of the technology. During the actual development of the innovation, the project manager requested progress reports every two weeks

The first films to be produced by the NFB using the Animaster were Ishu Patel's film Divine Fate and David Verral's Dragon Bones. They were begun in November of 1990.

Modifications:

The organization did not require any major restructuring to accommodate the innovation except for the hiring of an additional engineer. The innovation itself did not require any redefinition to better fit organizational goals and resources, once it had passed the prototype stage. But, certain technical modifications and added functionality were specified, during and after its preliminary use, to improve the technology. Therefore, the animation cameraperson listed a number of features he felt should be added to the Animaster. It took several years for all the features to be added and the debugging to be under control. Modifications occurred during use in later films as well.

Though many organizational members were excited about the innovation at the outset, others in the organization expressed negative concerns due to the fact that during the later debugging process, the innovation did not seem to be a productive tool.

Performance:

The innovation is considered successful by the users and developers involved with the project, because it is quick to learn and it has many features and applications. It is always in use and is effective in meeting its purpose. It met the needs of the user by facilitating tasks, it met the needs of the NFB by improving filmmaking productivity and improving the institution's image as a pioneer, and it met the needs of the industry by providing significant advances in film animation.

Before embarking on a project using the Animaster, a cameraperson must first be trained on how to use the innovation. But, whereas a conventional animation system, such as the Oxberry, requires a full year to master, the Animaster may be mastered in only two to three weeks. The basic features, such as shooting and moving the camera, may be grasped in a single day. Also, the system greatly reduces the time consuming process of manually calculating camera movements. Using the simulation module method where on-screen graphic definition is automatically converted into motor positions, a user may drastically cut calculation time from seven hours to one hour. Furthermore, the Animaster system greatly reduces the costs of tests. Given that simulation tests can be conducted before shooting and that a "dope sheet" (task information) is generated by the computer, the animators may first test their work and, if satisfied with it, can send the information to the camera operator via diskette, modem or computer print-out. Also, the technology may be used for purposes other than animation such as titling, credits and photography.

So far, the innovation has been used for approximately 25 films. The Animaster was nominated by Canada's Production '91, which is the International Competition and Exhibit of New Technology held in Montreal, for a spot on the Top 10 innovations list.

1.2 FLIP

<u>The Problem:</u>

Computer programmers were searching for a more efficient way of allowing animators to handle the time-consuming calculations and tedious labor of transferring and painting in order to free up their time to concentrate on more creative tasks. Furthermore, the cost of these tedious and time-consuming functions absorb approximately 60-70% of an animation films budget. Flip greatly reduces this expense in labor and money by automating these activities.

The Innovation:

Flip is a **software system developed for the electronic post-production of the visual portion of animated films** that are drawn in traditional fashion and are ultimately to be recorded on 35mm film. Flip succeeds in performing certain aspects of traditional animation by way of computers The animation portion is done on paper but the tracing, coloration, composition and filming are automated Specifically, tracing, which used to be done by photocopying the image onto acetates, is now done by scanning the image into a computer. Coloration, which was traditionally done by hand-painting colors, currently uses PALCEL and PASTEL software programs. Composition, which originally involved manipulation by hand under the camera, could now be done by the COMP software program. Finally, Filming, which was done manually or automatically, was performed completely by computer, based on the animators pre-written instructions The users of the innovation are NFB animators and the developers of the innovation are software engineers at the NFB

The following table summarizes the differences between using traditional methods of animation and using the Flip software program. The most time-consuming tasks, tracing, coloring and composition have been automated.

FIG.2 : Comparison of Traditional and Flip Methods of Animation

TRADITIONAL METHOD		FLIP SYSTEM
	Script	
	Storyboard	
on paper	Animation	on paper
photocopy onto acetates	Tracing	scan into computer
hand-painted colors	Coloration	using 'Palcel'& 'Pastel'
manipulation by hand under camera	Composition	by 'Comp' program
manual and automatic under the camera	Filming	computerized
	Processing	
	Editing and Mixing	

(Leduc, J.J. 1991)

Initiation Phase:

Flip grew out of previous animation software. The first computer animated film to receive an Oscar was the NFB's "Hunger" (1974) by Peter Folès This film was the catalyst that encouraged filmmakers to seriously enter into the computer animation field. In the mid-60's to early 70's the NFB had signed an agreement with the NRC (National Research Council). Together, their mandate was to improve upon the technology used in the making of "Hunger". The resulting innovation was a "Key Frame Animation System" where the computer was capable of providing the drawings that fall between each key frame. This task is called "in-betweening". In 1978, the Head of the Animation Studio began directing research toward the imitation of cell animation techniques. (Leduc, Y. 1991).

The developers, software engineers at the NFB, decided to explore the most appropriate use of computers in animation. They realized that in-betweening involved only 10% of the animation budget and transferring and painting tasks required about 70% Therefore, they decided to focus on automating the latter tasks The developers knew that no technology existed which could perform these tasks automatically They based their innovation on a system developed at Cornell and used in Hannah-Barbera productions. They also met with users concerning features and requirements This venture ultimately resulted in the creation of Flip The project was developed by the NFB's Centre d'Animatique.

The preliminary use of the Flip prototype resulted in the creation of a film entitled "Mirrors of Time" by Jean-Jacques Leduc in 1990 The developers and users considered this film to be a trial run of the innovation. Furthermore, they consider Flip to be an unfinished version even though it has been used in many productions.

Implementation Phase:

The decision to fully develop and implement Flip was made by the management of the Centre d'Animatique. They decided to go ahead with the project based on the belief that the system would increase productivity and because no other system existed which could perform the tasks so effectively The idea of Flip did not need a special champion because it was not an independent project but, in fact, its creation and development was the "raison d'être" of the Centre d'Animatique. The Centre was created with the intention of developing animation-oriented innovations, one of which was the technology of Flip The organization as a whole was transformed since a new office was created and new people were hired in support of the project. These changes in the organizational structure gave rise to some unfavorable reactions from other organizational members who sensed favoritism and/or resisted the entry of computer technology into the animation department.

Modifications:

The innovation was modified, in terms of its software elements, before, during and after its original use in "Mirrors of Time".

Performance:

Flip is still active and NFB animators have access to it. Though Flip is still considered to be an "unfinished" prototype, it is believed to be a successful innovation since it is often used, it went beyond its original expectations, and it is more advanced than many other available technologies.

1.3 Cinerobotheque

The Problem:

The Cinerobotheque was created to provide the public with efficient and speedy access to the NFB film collection (Pennefather, 1993). The NFB felt that their methods of distributing films to Canadians was not effective. They believed that a completely automated innovation would encourage Canadians to research their interests more easily, retrieve certain films, to educate themselves and to satisfy their curiosity on certain topics (Rapport D'Activites, 1990)

The Innovation:

The Head of French Programming at the NFB described the Cinerobotheque during our interview session. **The Cinerobotheque innovation is an automated film and information distribution system**. It consists of two main components: a robotized arm and 21 Cinescopes. The Cinescopes are u-shaped, ergonomically designed individual viewing booths consisting of a chair, a personal computer screen and a personal film viewing screen. The chair pivots and there are speakers embedded into the chair to provide clarity of sound to the listener without disturbing other viewers nearby. The viewer can then search and select from among the collection of NFB films by way of the personal computer screen placed directly in front of the seat The monitor is a touch-screen so no keyboarding knowledge is required in order to interact with the system. Once the choice of film is made, the robotized arm, placed behind glass at the end of the room, receives the signal from the terminal and automatically retrieves the correct video disc from one of 195 drawers, routs it and inserts it into a player After the video disc has been watched or is terminated by the viewer, the robotic arm replaces the disc into its respective drawer.

Initiation Phase:

The concept has been around since 1969, but the task of implementing it often changed according to the technology and resources of each time period (from projectors, to video cassettes, to video disc) (Rapport D'Activites, 1990). With the Cinerobotheque, Head of French Programming (also being the founder of the Cinerobotheque), wanted a mini cinema approach. He wanted the client to have the same visual impact as in a normal cinema.

A search of the environment was conducted by the Head of French Programming. He was aware of similar concepts in Paris and New York. However those systems were mostly manual and time-consuming to use.

The Cinerobotheque was mostly developer driven since the end-users only participate and provide feedback once the innovation is completed. At one point, however, a study was done by the NFB to gauge customer reaction and satisfaction People were chosen off the street and invited in to try the system. The reactions were very positive except for two individuals who were illiterate and thus couldn't read the information on the screen In response to this concern, the NFB is looking into ways to resolve the issue perhaps by having the computer "read" the information out loud via the chair speakers.

The development team was led by the Head of French Programming and was in cooperation with another government agency, CRIQ (Centre de Recherche Industrielle du Quebec).

The original prototype of the system with chair and terminal, was made of wood at the NFB carpentry department. It was immediately subjected to a variety of tests after which it was modified, adjusted and redesigned. The detailed efforts during the prototype stage permitted the innovation to advance through the later production stage in record time (Rapport D'Activites, 1990). The Head of French Programming stated that the wooden structure was presented to the Board of Governors in place of a feasibility study. Approval was unanimous based on the Board's interaction with the prototype. Trial runs were performed during the prototype stage. Essentially, a working prototype was used, rather than a report, to convince decision-makers to go ahead with implementation. The Head of French Programming believes that this approach was successful in gaining their approval because it allowed them to interact with the innovation.

Implementation Phase:

Once the wooden prototype was accepted, the team moved very quickly to develop a full prototype and to implement the system. The project was stalled at one point for 8 months during which time the Head of French Programming had to promote the project actively to ensure its continuance. Once it was back on track, the organization created a new facility, added staff and created joint ventures with other organizations

The whole organization was restructured by adding a new facility to house the innovation and new staff to run it.

Modifications.

Once completed, the Cinerobotheque was not modified since an over-abundance of features were built into the system from the start. For example, expandability capacity was built into the system so that, even after 2500 films were transferred onto videodisc, the Cinerobotheque would only be half-filled (Pennefather, 1993). In this way, all potential needs were thought out at the beginning and the technology was designed accordingly. But, given the spin-off potential and novelty of the technology, the Director of the Centre Robotheque considers the center which houses the innovation to be a laboratory where minor improvements and adjustments are constantly being made to the system.

Currently the Cinerobotheque staff along with a Montreal-based cable company Videotron Inc., are working on a spin-off project called "Cineroute" which brings the NFB collection to external terminals in universities through fiber-optic technology.

Performance:

The innovation is considered a success by the Head of French Programming because it has improved accessibility to NFB films and it generates revenue for the NFB. It is also considered to be a success because it is an innovation unique to the world. The robotheque is novel, not for the manipulation capabilities of the robot, but for its capacity to contain a very high density of information at a reasonable cost and less maintenance than a tape-based system (Rapport D'Activités, 1990)

1.4 Helicopter rig and mount

The Problem:

IMAX films are different from traditional movies in that they are shot using the largest film format available and are shown on giant screens. IMAX films are presented in specially designed theaters where the viewers whole visual field in encompassed, including peripheral vision. IMAX filmmakers required a technology which would reduce the number and size of jolts which occur during aerial shooting. The rationale for this lies in the fact that IMAX films are created for large-sized screens and thus, any movement on the cameras part during filming will be immensely magnified in the cinema during the film's presentation. The jolts and movement can disturb the audience's attention and make for a less effective cinema experience.

The IMAX company is independent of the NFB but they have collaborated with NFB staff on numerous productions. In this relationship, IMAX provides the technology while the NFB provides filmmaking and cinematography experience as well as developmental expertise. The IMAX team, including some NFB staff, have made significant advancements in the shooting of aerial footage. However, the problem of keeping the heavy IMAX camera steady at elevated heights required the development of a special device which could be "flown" from a helicopter, crane or other structure.

The Innovation:

The innovation consists of a **frontal, all-camera-format, remote controlled helicopter belly mount and gyro-stabilized rig** which is us for mounting IMAX cameras on the belly of a helicopter or on cranes to facilitate the shooting of aerial footage and improve the stability of the images.

The innovation's rig portion is gyrostabilized and designed to hold two ninety-five pound IMAX cameras (since 3D filmmaking requires one camera for each of the viewers' eyes).

The whole contraption weighs approximately 600 pounds. The cameras are controlled by a console.

An electrician who worked on IMAX shoots, states that the IMAX team was forced to design and build their own mounts, since there were no commercially available ones that met the special needs of such a shoot (Therrien, 1992). The innovation is considered by the user, a photography technology specialist, to be a spin-off of IMAX technology. The rig and mount were developed to support IMAX aerial filmmaking.

The decision to go ahead with the project was based on the fact that the NFB had made a commitment to support IMAX technology. By providing technology and filmmaking expertise to IMAX, revenue would be generated for the NFB once the films were shown in theaters

Initiation Phase:

The photography technology specialist at the NFB, specified a rig and mount for the purpose of achieving stable, aerial footage. The NFB development team knew that no suitable technology existed which could handle the special requirements of IMAX cameras. The concept and written specifications for the innovation originated within the NFB The innovation was based on previous mechanisms but modified to focus on reducing image imperfections and to be used in non-standard filmmaking.

Implementation Phase:

Though the initial specification of the innovation took place within NFB boundaries, the actual design and manufacturing of the rig and mount was done in cooperation with two external manufacturers from Ontario (Technical R&D, 1990). The move from one manufacturer to the other by the NFB was made because their key contact retired from the first one to start his own company. The innovation was based on previous rigs and mounts but modified to suit IMAX requirements. The newly developed remote control and helicopter belly mount were first used on an actual production in Quebec in June, 1989 (Rapport D'Activites, 1990).

Modifications.

Technology improvements were stalled many times due to budget constraints. Therefore, instead of waiting for R&D funds to come through, the developers were forced to use production funds to continue modification efforts.

Performance

The rig and mount are considered to be successful because they fulfill the needs of filmmakers for stable, high quality aerial footage. However, according to the photography technology specialist, the technology is very sophisticated and complicated to use. Anyone desiring to use the technology must be first be extensively trained by him.

1.5 Digisound

The Problem:

The initial need for the Digisound technology, according to the Assistant Director. Technical Research and Development at the NFB, was to create better sound for NFB documentaries in 16mm film. In the industry at large, an analog optical soundtrack had been the traditional medium for recording and playing back sound for both 35mm and 16mm films. But, this analog method resulted in a lower sound quality for 16 mm film since 16 mm runs through the projector at a much slower pace than 35 mm film. The difference in sound quality was a problem for the NFB because most of its documentaries were shot in 16mm film. Improving the sound quality of 16mm films would allow NFB films to be commercially marketable and more enjoyable for the audience. Therefore, in celebration of the NFB's 50th Anniversary, NFB Technical Research decided that they would be the first in the world to put digital sound on 16 mm film.

The Innovation:

Digisound is **a method of encoding a digital optical soundtrack on film as well as equipment capable of recording and playing back the soundtrack.** The project was carried out in 1988-89 (Gainsborough, 1992) The users of the innovation were to be the sound transfer department in the NFB, theater owners and distribution companies. The developers were NFB Tech Research and a consortium of Canadian technical research companies.

Digital sound is not new to motion pictures but most current methods involve using a separate medium for the sound track. Specifically, sound can be run separately on compact discs or digital tape or it may be attached to the film itself (Supply and Services Canada, 1989). As stated in the Supply and Services bulletin, these methods may provide good sound quality but using CDs and digital tape can lead to synchronization problems and having the sound attached to the film can lead to difficulties in splicing and film breaks. The bulletin states that the solution to the problem lies in developing a method of writing digitized sound directly on the film, in the narrow strip beside the image called a data channel.

<u>Initiation Phase:</u>

Tech Research searched the environment by speaking with projector manufacturers and film manufacturers, to find out if the technology was feasible Both gave positive feedback. However, since the industry consisted primarily of users of 35 mm film, rather than 16 mm film, the decision was made to try to first put digital sound on 35 mm.

In addition to finding a new method to put sound on film, the NFB planned to create solid state readers which would last longer, with less maintenance, and which could read regular and digital sound. The NFB identified a consortium of Canadian partner companies to help in the research and development of Digisound and to pool their resources The NFB obtained funding from the Department of Supply and Services Canada to design and develop the innovation

The technology was developer-driven; other than the NFB itself, another film distribution company and a major film projector manufacturer also participated in the project. However, users were not involved in the development of the innovation.

The Digisound system prototype was developed as an analog-compatible cinema digital sound system using optical recording on 35 mm motion picture film.

Almost simultaneously, Kodak had tested digital sound and confirmed some of NFB's preliminary findings. In addition, ORC a competing projector manufacturer and Kodak , with their Cinema Digital Sound and Dolby, with their SR.D System were developing similar, but incompatible, innovations. However, the NFB went ahead in the hopes of developing the technology first (Gainsborough, 1992). The Assistant Director of Tech Research at the NFB explained that Kodak mounted an enormous publicity campaign to publicize their new digital sound innovation. The NFB could not compete with their publicity or resources. The NFB's reader was patented but they stalled the project to see what would happen with Kodak.

According to the Assistant Director of Tech Research, the unit developed by one of the competing companies cost double [illegible]t of the NFB since the competitor had significantly higher manufacturing costs. Over the next year, the NFB had been approached by two of the competing companies One of the competitors proposed to work with the NFB, using the competitor design but manufacturing with NFB partners in Toronto The NFB turned down the offer since they were not interested in developing another company's design About a year and a half later, a representative from the Kodak/ORC project stated that Kodak and ORC had pulled out of their project since costs were too high and sales too low. This competitor wanted to team up with the NFB but the NFB did not have the budget nor the desire to go ahead with a project that had so many players and much confusion surrounding its development.

Performance:

Since Digisound did not proceed beyond the initiation (prototype) phase, the Assistant Director of Tech Research, did not consider the innovation to be a user success Technically, the innovation was a success at the time but changes in 16 mm technology made usage of the project less feasible. Furthermore, the NFB could not compete, nor did they desire to, with the multiple players and the high budgets of competing organizations. Therefore, it did not meet the needs of the user, the NFB or the industry since it was never developed for internal use nor as a commercial product Meanwhile, the rapidly developing video projector technologies and decline of the 16mm release print presentation could not justify the product, because the solution became too costly in relation to the alternative video approach. However, a detailed technical paper entitled "Digital Optical Sound on 35mm Motion-Picture Film" by Syd Wiles, Frederick Gasoi and Ed Zwaneveld, was presented at the UNIATEC 17th International Congress, Montreal in October 1989 and published in the SMPTE Journal, November, 1990. The NFB received a certificate of merit based on the technical quality of the research paper.

1.6 Sound genie

The Problem:

The need for the Sound Genie grew out of the fact that the NFB's sound library, called the Sonothèque, had accumulated approximately 1200 hours of analog tape material representing 40,000 sound effects varying in length from 5 seconds to 10 minutes. With the Sonothèque system, the user was forced to manually search through and operate the system. The sound editors would manually make selections from paper-back catalogues, locate and handle tape material for auditioning purposes and then order the required copies. Order processing was also performed manually. Furthermore, sound was subjected to quality limitations and possible deterioration due to the use of older, analog technology. Therefore, the process of finding, retrieving, and transferring specific effects from the tapes was laborious and time-consuming (Jaslowitz et al, 1990).

The Innovation:

The Sound Genie is a **"robotic digital sound library management system"** (R&D internal report). It is a high capacity fully automated R-DAT (rotary-head digital audio tape) technology. The system comprises four elements. They are the RSM (robotic system manager), which is an element consisting of a robot and its control computer and storage unit for R-DAT cassettes, a Playback/Copy system comprising multiple R-DAT players/recorders; a Sound Effects Database System, which is an "electronic catalogue" of all the stored sound effects; and Editor Work Stations, multiple work stations forming a network that can be linked to the

Robotic System Manager (R&D internal report) The innovation allows editors to search for effects electronically, using local or remote terminals - any effects selected can be robotically retrieved, auditioned and/or digitally copied, under computer control. The system has a capacity of 2000 hours of digital stereo sound (Jaslowitz et al, 1990)

The Sound Genie was designed to provide sound editors and sound librarians with an economical and efficient approach to archiving, selecting, retrieving, auditioning, transferring and copying digitally stored effects With the Sound Genie, sound editors would be freed from tedious "housekeeping" tasks and allowed to focus on the creative aspects of their work The unit works by directing one of its robotic grippers to the desired R-DAT cassette which it then grabs and automatically routs and inserts into the correct audio machine for playback and editing purposes After the dubbing of selected material has been completed, the mechanical arm returns the original cassette to its respective rack storage slot (Prince, 1989) Other applications for Sound Genie technology include automated radio stations with call-ins, automatic music selections, soundtrack archiving, music libraries; high capacity computer data storage (Data Genie); audio book/reference libraries; and audio archiving of courtroom proceedings (Jaslowitz et al, 1990)

Initiation Phase:

During an interview, the supervisor of sound operations at the NFB, stated that the original idea for the Sound Genie was conceived by the chief of the sound department at the NFB. Input concerning the features needed for the innovation was given by the supervisor of sound operations himself and other sound engineers The supervisor of sound operations, along with Tech Research and external companies, were the developers and the users are sound editors and the sound librarian at the NFB.

The environment was searched by Tech Research to see if any suitable innovations existed upon which to build their new innovation. Tech Research was then asked to do the actual research, designing and development of the Sound Genie with the cooperation of an Ontario company active in the fields of robotics, computers, electronics and communication systems while industrial design was handled by a company from Toronto, Ontario (Tech. R&D., 1990). With the help of the robotics company, the NFB's Tech Research Division, in consultation with the Sound Department, realized a project plan and specifications for the design and development of the Sound Genie.

Tech Research, along with the Sound Department at the NFB, prepared functional requirements for the Sound Genie:

1. the system should be capable of storing up to 2000 hours of high-quality sound effects;

2. it should have a user friendly interface which would allow for quick scanning of library contents on screen;

3. the operational equipment must be fully automated;

4. and the system must be compatible with current organizational practices and equipment, while adaptable to anticipated future needs (Jaslowitz et al, 1990)

After establishing the functional requirements listed above, the development team searched for a suitable storage medium. They decided upon R-DAT technology due to its capacity and low cost compared to other mediums. The team then discussed how to overcome certain problems inherent in R-DAT technology such as a slower access time than optical disc. They quantitatively defined the amount of time spent searching sequentially for selected effects of a given job, based on search strategies indicated by the sound department (Jaslowitz et al 1990)

Expandability was of critical importance in the design of the project as well as choosing a technology that was compatible with NFB current practices and future plans for upgrading R-DAT technology was selected for its storage capacity and cost-effectiveness despite the fact that many North American effects libraries were converting to compact discs which cost significantly more to produce. They modified the innovation to suit organizational cost objectives. However, the organization itself did not experience any restructuring in order to maximize the innovation

During the early phases of planning and designing, the sound department staff involved in the project felt that they were forced to translate their needs into engineering terms, a role they were not comfortable in playing. They also felt that too many individuals were involved in the project causing confusion

The prototype was developed and the software was created by the robotics company. Trial-runs were performed. Full development was green lighted by Programming who were convinced by the prototypes potential for increasing productivity by way of automating tasks that were previously very time consuming

The Sound Genie prototype was well received by the industry and a paper was presented at a seminar on digital sound sponsored by the SMPTE and the University of Southern California School of Cinema-Television. It was held in Hollywood on May 6th, 1989. The paper was titled: "Choices in Mass Storage for Sound Effects Libraries", and was presented by Ed Zwaneveld (Rapport D'Activites, 1990). Furthermore, a technical paper was published about the Sound Genie in the May 1990 issue of the SMPTE Journal, New York titled "Sound-Genie - An Automated Digital Sound Effects Library System" by Jaslowitz et al (1990).

The Sound Genie, though currently no longer active, is still considered to be a prototype because it is a unique technology and considered incomplete and in need of modification.

Implementation Phase:

The actual construction of the Sound Genie took place at the contractors location in Toronto. The sound staff did not see the innovation during the manufacturing period.

The Sound Genie was introduced as a prototype in 1989 on the occasion of the NFB's 50th Anniversary (Chevalier & Millette, 1991). The Sound Genie had undergone numerous modifications though the underlying aim of the design - easy, efficient access with minimal handling - remained unchanged (Chevalier & Millette, 1991).

Modifications:

Modifications to the Sound Genie were made based the suggestions of users who interacted with the system on a daily basis. The suggestions were forwarded to the designers via the project manager. As a result of this, some programs had been made more flexible and workstation computers had been upgraded to reduce waiting time However, major modifications were needed early on in the implementation stage and they were not done because the contract was considered "closed" meaning that the original contractor was not available to handle required modifications and the human and financial resources needed to do the modifications in-house were not available.

Performance:

Though the system was active for 4-5 years and used for hundreds of films, eventually technical problems with the robot made it inefficient to use By the end of the first year of implementation, the advantages and disadvantages of the Sound Genie came to light. Specifically, its advantages included the elimination of tape handling and the rapid access to those sound effects which were to be transferred to film. The disadvantages of the system included its linear access, which slows down the system and the unexpected software breakdowns (Chevalier and Millette, 1991)

According to the sound engineers interviewed, the NFB took a gamble on choosing the R-DAT medium. They lost the gamble because the industry went in the direction of discs instead. Prince (1989) states that "as the debate about Digital Audio Tape (DAT) rages on in production and editing suites, the controversial audio format soon could find a niche in at least one North American effects library, despite the fact that, of late, many libraries have been converting their collections to compact disc. At least that is what the National Film Board of Canada hopes will happen as it prepares to install Sound Genie...a system based entirely on the R-DAT format." As such, the NFB was not able to market the product as they had planned and the R-DAT technology portion of the system seemed to suffer many technical difficulties when in use.

To compound the situation, the sound department did not have the human resources available to maintain the system adequately and the original contract for the project did not allow for any further modifications once the main prototype was built. Eventually, the technology became obsolete and the decision was made not to pursue the project further.

Communication problems also contributed to the demise of the project. Though the users (sound editors) and developers (Tech Research) worked together throughout the developmental process, the users felt that there were too many people involved and that they were forced to translate their needs into engineering terms. They felt incapable of accomplishing this effectively. Also, the supervisor of sound operations championed the Sound Genie but felt that he did not receive enough support to continue improving the project. Currently, only the software portion of the Sound Genie is used. The robot mechanism, the part that resembles a large jukebox, is non-functional.

The Sound Genie failed to meet users needs, however it met the NFB needs because it was an advanced concept when it was first developed and it significantly improved the organization's image in the field of sound technology. It also met the needs of the industry because the robotics company learned from the technology and they were permitted to sell it, if they so desired.

1.7 Stockshot evaluation video system

The Problem:

The stockshot library collection contains more than 13 million feet of original negative film and an additional 600,000 feet are added each year (Rice- Barker, 1993). The collection includes almost a century of footage compiled over the past 50 years (Cartier, 1990) such as images of Canadian life and milestones in Canadian political events such as the Duke of York arriving in Montreal (1901), the funeral of Sir Wilfrid Laurier (1919) and the Canadian armed forces at the front in the two World Wars

At the NFB, footage was catalogued on index cards. Clients wishing access to the material would have to visit the NFB head office in Montreal, search the index cards, and then review the original negative material, marking sections of interest with little paper tabs stuck into the sprocket holes These sections were subsequently transferred either to film or to videotape at the client's request by the NFB stockshot librarian

According to the stockshot librarian, the need for improvements was voiced by users of the technology. The main users of the technology are filmmakers, television production staff, museums and cultural centers, and government agencies The selectors and cataloguers, who were working almost exclusively with negative images, wanted a video system that would be capable of inversion so that positive images could be obtained of the negative film originals. Negative images were too unclear and certain important elements, like snow or rain, were invisible when viewing negatives.

The Innovation:

The Stockshot Evaluation Video System is **a modified 16/35 mm film editing table which has been adapted as a telecine** (Rice-Barker, 1993). It facilitates library access to external filmmakers by making available evaluation-grade positive video copies on 3/4" or VHS media, with burned in footage and timecode to assist ordering and discourage piracy (Gasoi et al, 1991).

The stockshot library staff requested the help of Tech Research in the design and development of a piece of equipment which would screen both negative and positive images as well as transfer the material onto video so that stockshots can be sent to filmmakers by mail or courier.

According to the Tech Research manager on the project, the motive for creating the innovation was threefold. to minimize the handling of the priceless original film materials, to make the contents of the library available nationwide, and to facilitate viewing of the stockshots by reversing negative film images to positive film images (Rice-Barker, 1993)

Initiation Phase:

The stockshot evaluation video system was initiated by Tech Research at the request of, and in collaboration with, the stockshot library management and staff

The Assistant Director of Tech Research at the NFB, explained the initial phase of the innovation process as beginning with a search of the environment which resulted in the purchase of a second hand 16/35 mm film editing table The table's redundant plates were removed and a video camera was attached to the table in order to capture the negative film on tape The system included a transfer component which allowed negative film shots to be transferred to Hi-8 video tape ready for VHS transfer and overnight shipping to the client (Rice-Barker, 1993) The unique challenge of the project was to obtain equally good viewing and transfer quality for 35 mm or 16 mm source material on the same workstation

A prototype was developed and trial runs were performed The developers noted that the image flickered and was uncomfortable to watch Adjustments were made

Implementation Phase:

The stockshot system was set up in the stockshot library But, explained the stockshot librarian, technical complications continued to arise with the innovation Specifically, the system had a poor optical quality in that the image had a constant flicker Furthermore, the table purchased for modification was not originally for negatives but for prints therefore, film material was scratched and the resulting image was not broadcast quality. It should be noted that achieving broadcast quality was not a design requirement

Modifications:

The system was reviewed and modified An optics expert was asked to examine the stockshot table's optical system (Rice-Barker, 1993) The stockshot librarian stated that the optical was sent to the optical expert's offices in Toronto for modification The optical was improved but the image remained unstable.

Performance

The innovation was not considered a success by Tech Research or the stockshot library staff since its technical problems were never resolved to complete satisfaction. Eventually, an entirely new, single format table, manufactured for the purpose of transferring film to video, was purchased from CTM, France The Stockshot Evaluation Video System was transferred to the National Archives of Canada.

1.8 Negative handling work station

The Problem

Filmmaking is a process of many individual steps which make up the pre-production, production and post-production stages. At each stage, a different group of specialists handle and manipulate the film in order to eventually arrive at a completed film Some steps in the process are considered to be "bottlenecks" In other words, the project moves along until it arrives at a certain department where it remains for an inconveniently lengthy stay due to the complexities of that department's tasks One of these so-called bottleneck departments is that of negative cutting and inspection Here, the specialists (working with white gloves in glass enclosed rooms) are responsible for the cutting of negatives with scissors, cataloguing negative materials, synching of optical soundtracks, inspecting trial prints, preparing orders for production, and a variety of other jobs including operating computers for cataloguing and making up dummy rolls (Shipley, 1993)

Negative cutting is considered by staff to be one of the most strenuous and demanding jobs in the industry. Not only must the cutter deal with tedious tasks and an ultra-sterile environment, but also with physical dangers such as amputation of fingers and migraine headaches (Shipley, 1993) Tech Research decided to respond to negative handling complaints by designing an ergonomic work station that would improve staff comfort and increase productivity by way of automating certain tasks.

<u>The Innovation</u>

The innovation is **an ergonomically-designed workstation for the cutting and inspection of negatives.**

Initiation Phase:

The NFB decided to involve an external company early for assistance in the design phase of the innovation The NFB contracted "Ergo Designers" (the real name of the designer is not used for confidentiality purposes), an ergonomics consultant, to develop a design report in conjunction with Tech Research and the negative handling department

The project objectives were three-fold (1) to minimize the handling of film to reduce the incidence of dust and fingerprints, (2) to increase the speed of processing by incorporating the Digisync device which reads timecode at a high speed and (3) improve staff comfort The users and developers worked together in coming up with a solution

The Assistant Director of Tech Research at the NFB stated during our interview session, that the designers used personal interviews and observation of tasks to assess the needs of the negative handling staff by the ergonomics expert Ergo Designers developed a preliminary concept and then sketches and drawings were presented along with a final report

A prototype was created and specialized equipment was produced and purchased However, certain features recommended by Tech Research were neglected Specifically, negative handlers needed tables which could be adjusted in height The ergonomics expert stated that if the chairs were adjustable in height, the tables may remain stabilized. As a result, workers who were short in stature were forced to elevate themselves too high from the ground In so doing, they lacked adequate foot support resulting in physical discomfort Furthermore, the negative handlers poorly communicated their needs resulting in an overabundance and confusion of design criteria which Ergo Designers was unable to address The project did not reach the implementation stage

Performance

The project was not successful in that it did not reach the implementation stage and did not meet users needs. However, it was considered a success by Tech Research in that the project resulted in the documentation of new knowledge concerning human factors and their resolution A technical report on the project was presented at the 136th SMPTE Technical Conference and World Media Expo on October 14, 1994. It was published in the November 1995, SMPTE Journal, under the title "Re-engineering negative inspection and cutting: A study of its work process ergonomics and the definition of computerized workstations for each activity "

2. Cross-Case Analysis

In describing the eight cases, certain recurring themes and patterns emerge providing clues about which variables are important to the in-house innovation process, about how success and failure are defined in the in-house context, about what antecedent factors may lead to innovation failure, and about how the process of in-house innovation differs from and/or simulates the new product development process and the innovation adoption process. In this section, we will explore the salient themes and concepts which emerge from the narrative case summaries.

2.1. Recurrent themes and variables

In terms of the overall process, six (6) primary themes surface across more than one of the cases First, several respondents stated that the notion of being the **"first-in-the-world"** to achieve a technological breakthrough was an important motivating factor, especially when generating in-house innovation ideas The impetus to create breakthroughs is tied in with the concept of enhancing the NFB's image The desire to innovate in-house goes beyond solving internal problems to include a desire to be recognized as being highly innovative. This is evident in the NFB's interest and aptitude in garnering awards for their technical achievements. For example, the Digisound was a technological breakthrough which was to be presented publicly at the NFB's 50th Anniversary celebration. It also won a 1990 Journal Certificate Award though the in-house innovation never went beyond the prototype stage

Second, companies which adopt innovations are concerned with acquiring those innovations which possess favorable degrees of relative advantage, compatibility, complexity, trialability and observability (Rogers, 1983) If an innovation is readily and easily adopted by a company, it is considered to be a success from the view point of the new product development company as well as the adopting company In-house innovators will proceed with "internal adoption" if the **innovation attributes** are favorably represented at the prototype stage For example, innovations which are easy to learn (low complexity) are likely to be adopted (or accepted) for full implementation

Third, the issue of **idea champions** arose in the narratives of more than one innovation. The need to persuade decision makers as to the value of the innovation occurred, interestingly, toward the later phases of implementation The actual initiation, researching and developing of the project usually unfolded without management intervention or negative feedback from staff members However, resistance to the innovation often developed during the later phases of implementation if too much time was spent debugging and modifying

".. each new feature had to be tested .. It took a few years.. ..Sometimes my supervisor at that time was questioning the true foundation of this project . I had to stand up for it . While you do research and experiment you're not doing your job... While you debug you are losing time ..I'm not producing what my supervisor would like me to produce We have to sacrifice time to test the innovation ..."

- Animation cameraperson, Animaster

Idea champions, for in-house innovations, are comprised of one or more individuals who push for the *acceptance of an idea, and the continued development and modification* of a project. In the new product development process, an idea champion is an individual who pushes for the *development and marketing* of a particular new product (Cooper, 1993) For adoption-oriented companies, idea champions are those who strive for the *adoption* of a particular innovation (Rogers, 1983). Idea champions, for in-house innovations, are usually present throughout the entire in-house innovation process They are often required to champion the project from initial idea and through any additional modifications.

Fourth, the relationship between the NFB and **external entities** is a complex one whether dealing with contracted partners such as manufacturing firms, independently hired consultants or friends and associates in related industrial fields The NFB is, at once, a highly autonomous institution in terms of generating ideas; yet, the NFB is also dependent on external bodies for information and expertise This dependent relationship seems to cause some difficulties when the NFB cannot adequately control the relationship due to the distance between parties or due to problems in communication

" *[The Animaster] was started by a German company. But it was not successful .*"

-Animation cameraperson, Animaster

" *[The Animaster project] was getting nowhere We asked a Montreal software company to check what was going on [The original contractor] was not going the way we wanted them to go* "

-Engineer, Animaster

However, external friends and associates can be valuable sources of information which can help generate new innovations or provide information which can effect the innovation's continued development. For example, an NFB filmmaker and NFB cinematographer were personal friends with IMAX developers and thus had the opportunity to develop support innovations for IMAX productions such as the Helicopter Rig and Mount

"...Three filmmakers got together to spread the [IMAX] technology around the world ..They formed a company .Two of them at various times worked for the NFB. The NFB connection is through (an NFB filmmaker) who encouraged those three to form a company .We at the Film Board became supporters in that we felt that we could encourage its development in areas WE thought would be good for the future. . We made films for IMAX and enhanced the technology of IMAX . We improved aerial photography..We built mounts to do that . "

-Cinematographer, Helicopter rig and mount

Occasionally, external entities function, not as sources of expertise or information, but as customers. This occurs when the original idea behind the in-house innovation is expanded or modified from one that seeks to serve internal users, to one that focuses on meeting the needs of external users This transformation is a dangerous one because the organizational philosophy at the NFB is not to compete with large, private organizations for the development of the same innovation The NFB is aware that their resources can be better spent and that their funding is not capable to withstand the fierce competition of multinationals if campaigns were to be launched, etc Furthermore, the NFB is not interested in competing with other players because it negates their first-in-the-world philosophy

"...One of the [competitor's representatives] said to me: 'You know you are not the only ones developing digital sound' I said "Gee whiz, you won't tell me who it is? " He wouldn't tell me who it was..but he said that he just wanted me to be prepared for that..."

-R&D Engineer, Digisound

In-house innovators, given that most of their innovations are not destined for the external marketplace, develop cooperative relationships with outside companies as a way of generating new information and encouraging alliances with organizations capable of participating in the manufacture, design or assembly of NFB innovations For new product development companies, external communication with other companies is generally for the purpose of gathering diverse viewpoints which can lead to improved productivity (Clark and Fujimoto, 1991; Imai et al, 1985, Katz, 1982, Katz and Tushman, 1981) Adoption-oriented companies, especially if they are "laggards" depend on external communication as a form of uncertainty reduction (Rogers, 1983) The more information they gather from their peers, the more certain they will be about the potential benefits of adopting a particular innovation Relationships with external companies for in-house innovators, however, is much more complex External input comes in the shape of partner companies, or consortiums, brought together specifically for the development and, at times, implementation, of an innovation The understanding is that the partnership between the NFB and the other companies will be disbanded once the innovation is complete However, some partner organizations can be contracted to help maintain the technological components of an innovation if problems arise.

Fifth, some of the innovations strongly effected **administrative and managerial structures**. Changes, such as acquiring new offices, building new facilities, and hiring of personnel, were implemented in order to fully maximize use of the in-house innovation during implementation Some of these changes produced resistance and conflict among existing personnel

"...The initial reaction wasn't good. People asked why so much money was going to the [Animation] studio. The door is kept open to try to invite people in..."

-Computer engineer, FLIP

Like in-house innovators, adoption-oriented companies can also experience resistance with the introduction of innovations (see Rogers, 1983, Zaltman et al, 1973). The difference lies in the types of resistance these companies experience. For in-house innovation, interviewees stated that organizational members felt that those individuals involved with the new innovation had more than their share of "favoritism" from upper management in terms of allocation of budgets, facilities and other resources. The pull is then toward wanting to be a part of the innovation and share in its benefits.

For adoption-oriented companies, the pull is away from the innovation. Organizational members resist innovations if it threatens their place in the organization (Zaltman et al, 1973). Furthermore, the degree of resistance seems to play a more minor role in in-house innovator companies than adopter ones. This may be due to the fact that the culture of in-house innovation is one which is motivated to innovate and is subject to experiencing the introduction of new innovations often. On the other hand, for adopter companies, the innovation has not "grown out of the company" as it has for in-house innovations, therefore, adopter companies may be less familiar with the innovation and overall, they experience the introduction of new innovations less frequently than do in-house innovators.

Sixth, the in-house innovations had varied reasons for being started in the first place. Some reasons consisted of improving the productivity and conditions for internal users (and, at times, external users), while others focused on protecting the NFB's existing assets. These reasons for creating an in-house innovation will be termed " **Initial Focus**" since they comprise the original aim or goal for proceeding with the research, development and implementation of an in-house innovation

Specifically, in-house innovations at the NFB are created to speed the rate of production and distribution, improve the quality of the resulting films and distribution activities; reduce the cost of film production and distribution; and, occasionally, to meet external needs Another reason for initiating an in-house innovation is the need to protect important NFB archival material such as sound effects and stockshot footage

The most cited Initial Focuses are listed below

Table 5: Various Initial Focuses

INITIAL FOCUS	# of times mentioned
Increasing the rate of production/distribution	5
Improving the quality of production/distribution	3
Reducing costs	2
Meeting external user needs	2
Preventing deterioration of materials	2

Increasing the rate of film production and distribution is accomplished primarily by automating tasks. At the NFB, in-house innovations with the capacity to streamline previously time-consuming and laborious activities while freeing up additional "creative time" are the most initiated and implemented forms of technology Apparently then, the Initial Focus of many in-house innovations is to reduce "housekeeping" tasks while increasing the time available for more important work.

"....The question was 'What could we do to use computers more productively [in animation]. .The early 3D computer animation systems were not user friendly..We wanted to put animation tools in the hands of the users.."

-Computer programmer, FLIP

While increasing the rate of production and distribution was cited as the most common Initial Focus for NFB in-house innovation, improving the quality of production and distribution was also important Quality can be improved by creating in-house innovations which help create a better film or a more effective distribution system Quality involves improving the look or the operations of a final NFB product as opposed to getting the product out within a speedier time frame The helicopter rig and mount were created to improve the "look" of IMAX films and the Cinerobotheque was created to improve the quality of distributing NFB films to the public

".. When you have a high quality image, anything that is disturbing in the image - any imperfection is very apparent.. so we have been fighting very hard to perfect the image. "

-Cinematographer, Helicopter rig and mount

"...We wanted to produce a facility to allow the public to access the NFB collection...We used to have a librarian who put the cassette into the [video] player. It worked but I felt it was time for a different [distribution] concept..."

-Manager, technical services, Cinerobotheque

Reducing the cost of film production and distribution has also been voiced as an Initial Focus of innovation. However, it had been suggested only as a secondary reason, usually with increasing the rate of production/distribution being slated as the primary Initial Focus. In this innovative company, cost is not stated outright as an Initial Focus for very many of the in-house innovations because it is eclipsed into, or is a fundamental part of, the other reasons to innovate. For example, cost reduction is a natural extension of increasing the rate of production since faster work can mean a speedier recoup of costs and improving the quality of productions can lead to a wider audience and thus higher revenues. Another factor at play here is the fact that the NFB is a government agency which works on prearranged budgets - therefore, though cost is still an important factor it is not viewed in the same way as in private organizations. Private companies are based on making a profit while the NFB is founded on a mission of making socio-cultural films to educate, inform and bring nationally relevant messages to Canadians and to people abroad about Canadians. Therefore, the cost of an in-house innovation is factored into its ability to help the NFB achieve its mission.

Occasionally, the Initial Focus shifts from meeting internal user needs to meeting external client needs. As stated earlier, when this occurs, the NFB goes against the fundamental purpose of in-house innovation which is to meet internal users needs first. However, if after such internal needs are met, a market is found for the innovation, it can then be safely marketed and additional revenues can be generated from its sale or from licensing fees. The practice of putting external needs first has resulted in failure for some of the innovations. For example, the original aim of Digisound was to develop digital sound for 16mm film to be used for NFB documentaries. However, the Initial Focus changed from improving the quality of production for NFB films to meeting the needs of external film-making companies and companies in related industries. In doing so, the NFB found themselves surrounded by intense competition from large, multinationals The NFB was unable to compete with such players due to their level of resources and, in fact, was uninterested in competing with them since the NFB risked losing their first-in-the-world status. If they could not be first to bring the innovation into the world, then they would rather not spend resources trying to develop an innovation which was being developed elsewhere.

".. Most of our productions are 16mm so we would have loved to be able to put a decent sound track on our film ..We talked to a number of manufacturers of projectors..They gave us positive feedback We hoped [this innovation] would make 16 mm more popular..Because of the market potential of 35 mm film - there are a lot more projectors out there with 35 mm sound, we decided to do it in 35 mm rather than 16.."

-R&D Engineer, Digisound

Being founded in 1939, the NFB has amassed an enormous collection of archival material. The Initial Focus for some of the innovations, then, has been to protect this collection while still maximizing its use. For example, the stockshot library contains over 13 million feet of film. The stockshot department wanted to make this footage available while protecting it against scratches and deterioration. The Stockshot system failed, in part, due to its inability to meet this Initial Focus.

"...We experienced a few problems...[The innovation] scratched our material..."

-Stockshot Librarian, Stockshot System

Apart from the cost issue, the reasons for initiating an innovation are, for new product development companies, to increase profits and meet corporate objectives (Booz, Allen and Hamilton, 1982), while adoption-oriented companies acquire innovations in order to solve internal problems. It is evident from the discussion of initial focuses, that in-house innovations, like those of adopted companies, are created to solve internal problems. The difference lies in the fact that companies which adopt innovations do so, generally, with the intention of implementing the innovation throughout the company while in-house innovators implement their innovations within a very limited group of individuals and for the purpose of satisfying the needs of a particular project (i.e a film) It is important to note, however, that the creation of in-house innovations, does involve considering the usefulness of the innovation beyond its primary objective (i.e use in other films)

Though there are several reasons *why* an in-house innovation is initiated, there is only one desirable outcome - **a successful innovation**. Success can mean many things in different contexts, but at the NFB, the definition of a successful innovation is inextricably tied into its capacity to meet the users needs while adhering to the NFB's mission objectives.

The NFB's mission, according to its 1993-94 Annual Report is, in part, to :

- Produce and distribute and to promote the production and distribution of films designed to interpret Canada to Canadians and to other nations;

- To encourage research in film activity and to make available the results thereof to persons engaged in the production of films.

How does in-house innovation at the NFB help achieve these objectives? First, the production and distribution of films requires innovations that meet user needs. The innovations must also have an image-enhancing element, such as the notion of breakthrough technology, to meet the NFB needs as a representative of Canada to the world. Third, the needs of the film industry at large must be met, being that the NFB is a public agency and much of its information is thus also public. An innovation developed in-house must then also be useful to other Canadians in the film industry or in related fields. This last point is complicated since, as discussed, in-house innovation is not always conducive to external use unless significantly modified for new users or if potential users with very similar needs can be found. However, information related to the innovation's development and use can be of significant value to others trying to develop and use innovations.

Successful in-house innovation for the NFB involves meeting its mission which is one of social and cultural significance. This orientation is due to the NFB's status as a government agency. We cannot assume that all in-house innovators are socially or culturally motivated. We can, however, assume that innovation performance, for private organizations, is based on economic measures such as increasing revenues, recouping costs or achieving a better return on investment. Future research in this area may reveal whether cost is as important to in-house innovators as it is for adoption-oriented companies.

Specifically, the success of in-house innovations at the NFB are evaluated using the following criteria:

Table 6: Various Criteria for Success

CRITERIA FOR SUCCESS	# of times mentioned
Extent of usefulness	4
Ease of use	2
Efficiency	2
Capacity to expand and create spin-offs	1
Ability to generate prestige for NFB	1

If an in-house innovation did not meet one or more of these criteria, they are still not necessarily considered failures. Apparently, a mid-range measure of performance exists between the two extreme points. For example, though the Negative Handling Work Station was not considered to be a success, it was not cited as a total failure because, according to a Tech Research manager, it "added to knowledge about human factors". Also, the Sound Genie, which is considered to be a "closed" project, overall, is still partially functional since its software portion is still in use.

"The project was simply to 'make a box' - when that was done - Well plug it into the wall and 'that's it, that's all'..That was the major cause of [the robot's] failure...But we still use the software."

-Sound Engineer, Sound Genie

Like in-house innovators, adoption-oriented companies define a successful innovation as one which has been implemented and used (Kimberly, 1981). It then follows that failed innovations are those which have not been implemented or were terminated due to undesirable consequences. But, for the NFB, even failed innovations, such as the Negative Handling Work Station, or the Sound Genie, were not considered complete failures because they had "increased knowledge" about the relevant technological field. An in-house innovation, then, can draw from the knowledge gained in the development process even for failed innovations.

If a failed innovation is one which is useless, difficult to learn, etc.. Why did it turn out that way? Developers and users obviously set out with the intention of creating an innovation which would meet all relevant needs, so, what went wrong during the process to result in a failed, or a not completely successful innovation? An analysis of the NFB data surfaced three (3) primary antecedent factors related to failed innovation:

a) Timing and Nature of External Input

b) Performing of Necessary Modifications

c) Choice of Base Technology

See Appendix B for the Innovation Performance and Event Matrix.

In-house innovations can fail if external input is received too early in the innovation process. For in-house innovation, it seems that the needs and desires of internal users as to features to be included, design and ergonomics of the innovation, etc should be clarified before external experts appear on the scene. External input at the early stages can result in confusion, misunderstanding of needs and poor communication For example, an ergonomics expert participated in the early design phase of the Negative Handling Work Station, and information relating to needs was both poorly communicated by users and misunderstood by the expert.

On the other hand, the nature of external input, if it is in the form of new information, may be beneficial to an organization during early stages in the innovation process. For example, Digisound did not go beyond the prototype stage due to new information received from friends in the same technological field By informing an NFB R&D manager about a private company's entry into the marketplace, the NFB withdrew from the process before large amounts of development funds were spent on a project which would be developed by someone else

Another reason for failure of in-house innovations is the neglect of performing necessary modification to an innovation after or during its first use or trial-run This had occurred for the Sound Genie where modifications were not done because the contract did not allow for extra resources for this purpose. Technical problems thus began to accumulate until the robot portion of the in-house innovation was not longer useful

In-house innovations can also fail if the technology upon which they are based is a poorly chosen match A base technology is a technology which is chosen from the external environment, by internal developers, to serve as a skeleton which can be modified, added to and built upon in the development of a new innovation for internal use For example, the development of the Stockshot System involved searching the environment for a viewing table which could be transformed into an in-house innovation capable of displaying negative images as positive ones, among other features. But, the search resulted in the purchase of a base technology, an editing table, which was unsuitable for modification and which scratched the archival material which the NFB was trying to preserve.

"...[R&D] looked for a piece of equipment that would give us the opportunity to screen the neg[ative] in positive and also to give us the opportunity to transfer the material to video.. . What they did was they purchased an old table that was used for editing...They start

working on it and the result was not very good because, first of all, that table was not made for negatives. When you do editing you work with a print, not a negative..."

-Stockshot Librarian, Stockshot System

In adopter companies, innovation failure can occur due to a high level of resistance from employees, poor strategic planning, lack of upper management support and absence of policies surrounding the innovation's introduction into the organization (see Hage and Aiken, 1970; Kimberly, 1981; Zaltman et al, 1973) These concepts relate to the context into which the innovation has been adopted. Often, the innovation is perceived as a "foreign body" - a threat to the existing structure of the adopting company New product development companies suffer innovation failure if the new product is not accepted by the marketplace. In-house innovation failure, on the other hand, has more to do with the technological aspects of the innovation itself, the gathering of information about it, maintaining/modifying it, and choosing the right alternative to serve as a base technology This goes beyond the five attributes of innovations (Rogers, 1983) to include an attribute of *adaptability* which can be defined as *the degree to which an innovation is adaptable for other uses or purposes*

In looking at the process of in-house innovation, the eight cases will be analyzed from two perspectives. First, the general steps of the in-house innovation process will be studied: How does the process unfold for in-house innovations? Second, possible reasons for in-house innovation failure will be looked at: What went wrong during the process of in-house innovation?

3. A Model of the In-House Innovation Process

The process question will be explored by comparing across the cases with the intention of highlighting the similar steps they go through to reach the end of the process. In so doing, we will also uncover the definite start and end points of the in-house innovation process. This exercise will be achieved with the help of an event listing which allows for a clear presentation of the sequence of events for each in-house innovation See Appendices C and D for the Event Listing matrix for successful and failed innovations.

What happens at the beginning of the in-house innovation process at the NFB? How is a project initiated? Who initiates it? How did the idea of a new, unique technological innovation begin to develop? In this section we will describe the steps which comprise the in-house innovation process for technological innovations

The findings of the present study suggest that the process of in-house innovation is basically a fusion of elements of the new product development process and the innovation adoption process. The in-house innovation model is divided into 3 major phases. Initiation, Implementation and Post-implementation. The Initiation stage is further broken down into 5 stages: Awareness, Initial focus, Assembly, Search and Specification. The Implementation phase is also further divided into 4 stages: Prototype, Trial-run, Debugging and Modification. The Post-Implementation stage is composed of Active and Inactive states The proposed model is flexible in that stages may overlap and can occur in a time sequence different to the one set out here. For example, Modification may occur before a Trial-Run.

The process of in-house innovation begins with an "Initiation Phase". Overall, the Initiation Phase is composed of an awareness of a "performance gap" and specific activities relating to the information-gathering, searching and acquiring of expertise and resources as well as conceptualizing, designing and planning for the creation of a prototype. The five stages of the Initiation Phase are described below:

3.1 Awareness

Each of the cases began with an "awareness" that something was needed or desired. This awareness consisted of either (1) an opportunity to fill a void in some technical field or (2) as a way to meet certain users needs which have been neglected by the available technology. This "void awareness", mentioned in (1) is usually felt by developers since they are knowledgeable about developments in their respective fields. Thus, they may find room for improvements or changes which can then be transferred to internal users The awareness of needs, mentioned in (2) comes, for the most part, from users themselves, who require very customized technology in order to fulfill their distinctive needs

In this study, users were responsible for identifying the problem for four (4) of the eight in-house innovations, developers were responsible for identifying the problem for three (3) of the in-house innovations and one (1) problem was identified by an individual who was both a user and a developer.

3.2 Initial focus

The Initial Focus stage occurs after a problem has been identified by either a potential user or developer of the in-house innovation. Initial Focus involves the determination, by the users and developers, of the primary need or driving force behind the innovation's eventual creation. The need to innovate arises for a number of different reasons. In the present study, the most common reason is the desire to speed up the rate of production or distribution Five (5) out of eight in-house innovations comprised this as the primary reason for starting the in-house innovation process. Improving the quality of production was the next important instigating factor for three (3) of the in-house innovations

Quality improvement was cited for three (3) of the eight in-house innovations Quality improvement relates to the enhancing of *the film itself by way of improving production-related innovation* or enhancing *distribution of films by way of distribution-related innovations* such as the Cinerobotheque

Cost reduction was cited as an Initial Focus for only two (2) of the eight in-house innovations and this issue was secondary to other reasons such as increasing the rate of production. This cost issue may be a more salient factor in a private company than in a public one such as the NFB. The NFB, being a government agency, receives a certain amount of R&D funding specifically for the development of in-house innovations.

Meeting External Market Needs was cited as an Initial Focus for two (2) of the eight in-house innovations. As stated early in the study, our definition of in-house innovation involves those innovations which are created for internal users rather than an external market. However, in two of the cases, the primary focus became outside users rather than internal ones.

Prevention of Deterioration of materials was an important focus for two (2) of the eight in-house innovations In these cases, the in-house innovation would involve manipulation of archival sound recordings and stock footage which are as important to the NFB as an art collection would be to a museum.

Failure can occur during the Initial Focus stage if an innovator receives new information which negates the Initial Focus of the innovation. This will lead to a decision to terminate the innovation. For example, the Digisound developer learned about strong competition in the digital sound field. He decided that several players would negate their Initial Focus of being the first in the world to produce digital sound for 35 mm therefore, the project was terminated.

It is important to note that development does not include the *actual manufacturing* of the innovation The NFB supervises all aspects of Initiation and Implementation of their in-house innovations, however, it would be impossible to acquire all the tools and materials required to manufacture and assemble such a high number and widely varied group of in-house innovations.

3.3 Assembly

Once the Initial Focus has been decided upon, and users consulted if possible, the developers assemble their team of experts for input during Initiation and/or Implementation.

This consortium of experts may include designers and/or manufacturers gathered from outside of the organization. The in-house innovators then create a formal working relationship with these other organizations.

The Assembly stage is an important factor in assuring the success of an in-house innovation. If the wrong experts, whether internal or external, are chosen for a project, their participation may lead to a stalling of the project (until new contractors are hired) or failure of an in-house innovation The Animaster innovation suffered a stall period because the German software firm hired to participate in the development of the project, was not performing to the NFB's expectations A Montreal-area firm was later hired to take their place and re-orient the project.

3.4 Search

The Searching phase in adoption-models involves looking for innovations in the external environment which may be acquired and implemented to solve some organizational problem. However, for in-house innovators, the concept of a "Search" is somewhat different. "Searching", for in-house innovators, does not involve looking for a new innovation to purchase but rather a base or benchmark technology which, once significantly modified, becomes a tailored in-house innovation. A base technology is one which is used as a *skeleton* upon which a new innovation is built. These base technologies or some of their components may be purchased to serve as building blocks for the future innovation. A benchmark technology is one which serves as a *model*, or an overall concept, upon which the in-house innovator may improve or modify. Most often, these benchmark technologies are not purchased but the ideas behind them are researched and used for the development of in-house innovations.

It is apparent from the analysis that user-driven in-house innovations involve searches for base technologies while developer-driven in-house innovations comprise searches for benchmark technologies. This may be traced to the fact that user-driven in-house technologies arise from specific, idiosyncratic needs where the user is not necessarily privy to information about developments in the relevant technological field On the other hand, developers are aware of relevant technologies and are in a position of expertise to understand how these technologies may be enhanced or re-invented to suit their own organization's purposes. As such, user-driven technologies must be "built up" from scratch whereas developer-driven innovations are chiseled down or restructured from existing technology.

Though the in-house innovators who search for base or benchmark technologies are highly knowledgeable about their relevant fields, poor choices may still be made It is possible, as illustrated by the Stockshot Evaluation Video System example, for the search to be ineffectively performed. In this case, the fruits of the search yielded a piece of equipment which was purchased and modified but which remained unsuitable for user needs and detrimental to stockshot materials. (A later search yielded a company which produced equipment which more than adequately satisfied the needs of the users.)

3.5 Specification

Once a base or benchmark technological concept is found, the in-house innovators develop a list of technical specifications For user-driven in-house innovations, needs and desires are translated into technical features to be added to the innovations. The communication flows from the user to the developer For developer-driven in-house innovations, these specifications flow from the developer to the external contractor - sometimes with some user input beforehand

In-house innovation failure may occur at the specification phase if (a) a miscommunication exists between the user and the developer whereby information about needs, features or objectives are unclear (as experienced during the design process of the Negative Handling Work Station), or (b) in specifying a technological choice, (for example, using R-DAT for the Sound Genie which proved to be less than effective in the long term)

The next section of the model is the Implementation phase which consists of the development, testing and improving of a prototype. It also involves using and re-modifying the innovation.

3.6 Prototype

The Prototype of an innovation may be a simple wooden mechanism, a base technology upon which major improvements will be made, or a fully active working innovation. Regardless of the stage an in-house innovation is in, it will always be considered a Prototype due to its breakthrough technology. However, for the purpose of differentiating the various stages of the innovation process, we refer to an innovation as a Prototype during its early stages in the Implementation phase.

If simple to construct, the original Prototype may be created in-house as a visual aid to help persuade decision-makers of the eventual innovation's benefits or it may be manufactured by an external contractor thousands of miles away. Modifications to the Prototype can occur before, during, or after a Trial-Run. As explained below, a Trial-Run may include a first use such as an actual film production shooting session.

3.7 Trial-Run

A Trial-Run may involve a simple laboratory test to see if all the components of the innovation are working However, for the majority of in-house innovations a Trial-Run is synonymous with the preliminary use of the innovation. For example, the Trial-Run for FLIP was an actual animated production called "Mirrors of Time" (see case summary section). Trial-Runs, as well as the next two stages - Debugging and Modifications, may also occur simultaneously or in a variety of different time-order sequences.

3.8 Debugging

Debugging, often associated with improving computer programs, is a stage which involves slight but necessary improvements to the technology. Debugging involves adjusting elements of the technology that are already part of the in-house innovation. This is different from the next stage, in that Modifications consist of adding or subtracting technological elements to or from the in-house innovation. The Debugging stage often takes several years to complete.

3.9 Modification

As opposed to the slight improvements of Debugging, many of the in-house innovations studied underwent major Modifications to increase usefulness and, when possible, to incorporate new technology.

This Modification period was cited as crucial to the success of an in-house innovation. The failure of an in-house innovation does not occur due to the presence of modifications but rather due to their absence. To survive, an in-house innovation must be subjected to continuous improvements and adjustments Without these modifications, the in-house innovation's technical problems can snowball until it loses all of its usefulness. The Sound Genie was considered a "closed contract" meaning that the manufacturer was not available to aid in any modification activities, nor was any funding made available for this purpose As such, the technology was not maintained and eventually broke down to the point where it now rests in storage with no plans for revival.

3.10 Post-Implementation

The next phase, Post-Implementation, is the status of an innovation once it has been used for several projects. After a time, an innovation may be considered Active or Inactive. An

Active Post-Implementation stage occurs when the in-house innovation is still useful to the needs of its users. However, this status will not last as newer, more advanced technologies will arise causing either major modifications to the existing technology or replacement of the in-house innovation. Once an in-house innovation is Inactivated, it can be transferred - for example, the Stockshot Evaluation Video System was sent to the National Archives of Canada or it can be simply stored away within the organization such as the Sound Genie. None of the innovations studied had been sold. The possibility of selling technology may prove to be difficult since the specificity of its features have been tailored for the idiosyncratic needs of in-house users and not the external market.

Fig. 3: Proposed Model of the In-House Innovation Process

Initiation	Awareness
	↓
	Initial Focus
	↓
	Assembly
	↓
	Search
	↓
	Specification
	↓
Implementation	Prototype
	↓
	Trial-Run
	↓
	Debugging
	↓
	Modification
	↓
Post-Implementation	Active/Inactive

4. A Synthesis of the In-house Model with New Product Development and Adoption Models

In this section, we revisit the questions posed early in the study. By bringing together two well-established traditional fields of innovation research we were able to gain some insight and understanding of the workings of in-house innovations. Below we will review the questions in light of our discoveries.

4.1 The start of the process

Early in this paper we asked the question: " Does the in-house innovation process start with a performance gap?" The purpose of asking this question is to understand how the notion of a performance gap is interpreted in the context of in-house innovation We have seen that, in the innovation adoption literature, Zaltman et al (1973) define a "performance gap" as "discrepancies between what the organization could do by virtue of a goal-related opportunity in its environment and what it actually does in terms of exploiting that opportunity ." For example, decision-makers receive information via trade-shows, journals, media, etc . and they may come to believe that their own organization would benefit by adopting a new innovation such as an advanced color photocopier. However, in the case of in-house innovation, a performance gap has a slightly different focus. While adoption-oriented companies measure the gap based on internal or external changes or information which cause decision-makers to take action, in-house innovators perceive performance gaps based to a great extent on internal needs only. In-house innovators are not generally motivated by outside forces to create an innovation.

Rather, internal needs, wants and desires instigate the in-house innovation process. In addition, in-house developers may create an innovation with the foresight that it will benefit internal users in some way. A performance gap for in-house innovation, then, may be defined as *an awareness of a need to innovate to either (i) meet the idiosyncratic needs of internal users or (ii) to fill a void in technology with an innovation that would benefit internal users.*

4.2 The end of the process

In exploring this issue, we asked: " Does the end of the in-house innovation process involve a selling, trading or donating of the innovation to other users?" We expected that in-house innovations would, for the most part, be difficult (if not impossible) to sell because they are so highly customized for specific internal users. According to our findings, in-house innovators did experience difficulty in selling their in-house innovations due to the fact that these technologies have been tailorized for specific needs. To successfully use an in-house innovation in a context different from the one in which it was developed and originally used would likely require major modifications by the buyer unless the new user had needs that corresponded to those of the original user.

Our second question about the end of the in-house innovation process was: " Do in-house innovations, at the end of the process, retain their novelty status?" Our impressions at the beginning of the study were that in-house innovations, due to their new-to-the-world status (and also due to their uniqueness) did not lose their status of being an "innovation". Our findings suggest that this is true. In-house innovation are not routinized in the same way as adopted innovation are. Adopted innovations become part of the day-to-day life of an organization until they are no longer considered "new". However, in-house innovations, such as the Cinerobotheque, are unique to the world If many cinerobotheques cropped up around the world, then predictably, cinerobotheques would no longer be considered innovative. But, the fact is that there is presently only one such technology and it is unlikely that similar innovations will be implemented on a great scale, therefore most in-house innovations will always be considered as "innovative".

4.3 Process steps

Our first two questions about the stages of in-house innovation were: Do the early process steps for in-house innovation resemble the stages of a typical new product development model? And, do the later process steps for in-house innovation resemble the stages of a typical innovation adoption model? We expected that the early in-house stages would resemble the new product development process because the early in-house stages are, in fact, stages focused on the development of an eventual prototype. We found that the first stages of the in-house innovation process consisted of steps and stages which were more similar to the innovation adoption process rather than the new product development process. Specifically, awareness of a need for both the in-house innovation process and the adoption process was triggered by an internal problem. This is contrary to the start of the new development process which generally involves a desire to increase profits, market share and other economic or market objectives. The stage

"Initial Focus" for in-house innovations was also similar to the Matching activities described in the Initiation section of the adoption process. Both involve conceptually fitting a new innovation idea to an internal problem. The difference lies in the outcome of this activity. For adoption-oriented companies, a suitable innovation usually exists in the environment and is available for acquisition. But, for in-house innovation, the Matching involves thinking about which base or benchmark technologies can be purchased and modified for use The Assembly phase is unique to the in-house process. However, creating innovation-specific partnerships with other organizations for the purpose of developing a new innovation is comparable to creating project teams as in the new product development process. Though both the in-house innovation process and the adoption process involve a Search phase, the search activities of the in-house innovation process are fundamentally different from the searching activities performed by adoption-oriented companies Specifically, in-house innovators search for the base or benchmark technology which will serve as a foundation for the in-house innovation. On the other hand, adoption companies search for innovations which will fit their organization's needs with the least amount of difficulties. Therefore, we see that, contrary to our expectations, the beginning of the in-house innovation process did not resemble that of the new product development process, but rather the early stages of the innovation adoption process.

The second half of the in-house innovation process, however, did resemble certain stages of the new product development process. In particular, the Specification stage, Prototype stage and the Debugging stage of the in-house process very closely resemble the activities which take place during the Development and Testing stages of the new product development model In addition, both the new product development process and the in-house process make use of Trial Runs for their innovations. But, whereas the Trial Run stage for new product development involves testing the innovation, the market and production processes, the Trial Run stage for in-house innovation involves actually implementing the innovation for preliminary use. The example offered in the previous section concerned Flip. Flip's Trial Run was actually its use in an animated film production called "Mirrors of Time". Therefore, we see that developing in-house innovations involves taking enormous risks since they are implemented during the Prototype stage. The Modification stage for in-house innovations serves to correct any problems resulting from the first use of the innovation. For new product development these types of modifications are usually completed during the testing phase.

Our next question about the process steps for in-house innovation was. " Are the stages of in-house innovation subject to overlap and synergies?" Our findings suggest that there is indeed a greater amount of overlap and synergy between in-house innovation process steps than the process steps for new product development or for adoption Though some researchers in the latter fields assert the flexibility and, at times, the cyclical qualities of their process models, the models are still, for the most part, quite clear in terms of the time sequence of events This is not the case for the in-house innovation process The process stages overlap and can occur in a variety of time-order sequences Furthermore, many activities which had occurred within one stage can reoccur later. For example, an assembly of partners can occur early in the process after the Initial Focus has been determined and an additional assembly of partners can occur during the prototype stage if additional expertise is required.

4.4 Success factors

The question we posed about success factors for in-house innovation was "what is innovation success for in-house innovation?" Our intention was to determine how innovation performance was assessed by in-house innovators. Our findings suggest that in-house innovations are judged on the basis of their technical qualities. Rogers' (1983) attributes of innovations (relative advantage, complexity, compatibility, trialability and observability) are useful tools for in-house innovators when evaluating the success of an innovation. Is it better than the technology that preceded it? Is it easy to learn and use? Is it compatible with the organizations goals, values and mission? Can we experiment with it? Are the benefits of its use visible in our final products? These are the types of questions NFB users and developers ask themselves and each other when evaluating their in-house innovations. It is evident that these questions are technological in nature and can be expressed in terms of Rogers' (1983) five attributes of innovations. As we stated earlier, however, an additional attribute has arisen in relation to the judging of an in-house innovation's performance. The attribute of Adaptability is an important criteria for success. If an innovation is not adaptable it risks becoming obsolete very quickly and adding features to the main technology becomes problematic.

VIII. LIMITATIONS

The present study is a preliminary, exploratory work and does not claim to reflect causality. Rather, our interest lies in preparing a foundation from which further research may evolve to develop a theory of in-house innovation.

The most important limitation is that only one organization, the National Film Board of Canada, was used for the study, hence, there is less basis for the generalization of the research results.

Another limitation is that the study used retrospective case studies. As such, recall during interviews may have been effected by time A more favorable approach would have been to simultaneously study an innovation during its real-time development while also gathering data on retrospective case studies. This would allow for a more detailed micro view of the process while also achieving a broader overview of the general process (see Leonard-Barton, 1990).

IX. FUTURE RESEARCH

The field of in-house innovation would greatly benefit from a testing and re-testing of the model presented in this paper in other private and public organizations. Other areas of interest include the following:

1. **Exploring the relationship between in-house innovators and their external contractors**. An interesting relationship exists between in-house innovators and their external contractors which should be further explored. This is a form of joint venture, where the outcome is not a commercial product but an instrumental innovation, created for the benefit of the in-house innovator How does this in-house innovator choose external contractors? What are the criteria? What type of supervisory relationship can develop (especially if the contractor is located at a distance from the in-house innovator)? Given that in-house innovations require continuous modifications and improvements, what role does the contractor play in such maintenance activities? Can the external contractor claim credit for breakthrough innovations? This is an area still unexplored in innovation literature and is increasingly relevant to the present day economy which encourages farming out contracts to external consultants rather than hiring new employees.

2. **Analyzing communication patterns between in-house developers and in-house users**: Users and developers make up two very distinct groups of individuals. Developers tend to be more technically-oriented while users can be individuals from any organizational group or department. This relationship is interesting in the context of in-house innovation because, unlike innovations destined for the marketplace where developers are internal and users are external, in-house innovator companies house both the users and the developers. How do these individuals express their needs? Where can miscommunication occur? Does miscommunication occur less in organizations which practice in-house innovation than in new product development or adoption-oriented companies? How are user needs understood by developers and then translated into technical specifications? Understanding this communication network would benefit in-house innovators by reducing the number of failures due to poorly understood needs.

3. **Identifying the role of "idea champions" in an in-house innovation context:** The concept of idea champions is not new to innovation literature. However, it remains unexplored in the context of in-house innovation. Who are these idea champions and why are they forced to promote their projects? Who must they appeal to - peers, management, committees? How do they persuade decision-makers as to the benefits of their innovation? How are in-house champions different from other champions and change agents? Recognizing the role of champions in an in-house context would shed light on how innovations may avoid being stalled and what types of concerns decision-makers have as to an innovation's advantages.

4. **Exploring the in-house innovation process in terms of its impact on administrative and structural changes**: Innovations can substantially effect the world around them. In organizations, new innovations can result in restructuring departments, building facilities, hiring and firing personnel, etc... all in the interest of maximizing the innovation's potential. What type of impact does in-house innovation have on organizational structure? How does in-house innovation in one department effect the organization as a whole? When can conflict, resistance and resentment among employees increase? What happens if major restructuring occurs and the innovation then fails? This area of research applies to organizational development and strategy literature in particular In-house innovators would benefit by (i) understanding the effects such innovation related changes have on their employees and (ii) by gaining some insight into how such changes can be handled and planned for strategically.

X. RECOMMENDATIONS

In light of the findings presented in this paper, we may offer several recommendations to the NFB to help them reduce the number of unsuccessful innovations. Overall, our in-house innovation model will allow for a better understanding of the sequence of events and activities within each process stage. As such, the NFB can use this information to help plan activities, allocate budgets, develop strategies and manage human resources more efficiently throughout the process.

Our specific recommendations are as follows:

1. Clarify and adhere to internal needs: User needs must be clearly articulated and understood by developers at the start of the process and before engaging external contractors. We have seen that the Negative Handling Work Station failed due to unclear needs and miscommunication. Also, for Digisound, internal needs for 16mm digital sound were relegated to a secondary position when interest shifted to external client needs for 35 mm sound. The NFB did not cope well when attempting to become a 'manufacturer' for external customers rather than internal ones.

Clarifying needs should be accomplished in a standardized, yet flexible, manner in the form of brainstorming meetings between developers and users The team members would meet before the start of the project and discuss the needs of the users and the technical requirements and features which would address those needs These meetings should occur throughout the process as a method of evaluating whether or not user needs are fully being met and to guide future adjustments and modifications Although evaluations are performed periodically at the NFB, they are in the form of written reports. Such reports would be more effective if they were paired with problem-solving sessions.

Ideally, users and developers would be able to interact with the evolving prototype. However, in the cases where manufacturing occurs at a distance from NFB headquarters, each development stage, as it unfolds, should be described in detail by the developers to the users, perhaps with the aid of photographs, during the meeting. Once basic needs are set down in a written format, ideas for built-in expansion possibilities should be added. We have seen that the success of Cinerobotheque had to do, in part, with its capacity to hold the entire NFB collection with a large amount of room to spare.

Clarifying internal needs can become a greater problem when external contractors participate in the early phases of initiation. Timing is important. If such external input occurs before needs are clarified, confusion may result. For example, an external designer was hired to participate in the preliminary stages of the Negative Handling Work Station project. Internal staff flooded the designer with requirements and desired features. These elements were miscommunicated and/or misunderstood, resulting in an innovation which was not useful to workers.

Therefore, the NFB must take the necessary steps to clarify user needs, adhere to the needs of its internal clients over those of external ones, and control the timing of external input to ensure that development doesn't occur before user needs are understood by all participants.

2. Encourage necessary modifications: Modifications are vital to the success of in-house innovations. "Closed" contracts, those which do not allow for modifications (such as the Sound Genie example) allow technical problems to snowball until the innovation is so plagued with difficulties that it becomes useless. The NFB can avoid this problem by implementing policies to ensure that necessary modifications are made and by allocating a portion of the innovation's budget specifically toward modification activities.

Timing is also an important factor for maximization of the innovation. In the successful innovation examples, modifications occurred *before, during* and *after* the Trial-Run of the innovation. For failed innovations, modifications were performed only *before* and *during* Trial-Runs or they were neglected altogether. Therefore the NFB should encourage post Trial-Run modifications to ensure that the innovation is truly well-tailored for the user.

3. Select appropriate base technologies: User-driven innovations are founded on base technologies which are those pieces of equipment purchased by the NFB to be modified for internal use. Base technologies are found via a search of the environment carried out by the developer. The information in this study suggests that some searches yielded unsuitable base technologies ultimately leading to a failed innovation For example, the Stockshot System was founded upon an editing table which, when used, scratched the stockshot footage and presented a poor, flickering image. Developers and external contractors were unable to modify it to user satisfaction. This was, thus, a poor choice for a base technology. The NFB's search must be thorough and developers (and users, if at all possible) should personally interact with the base technology as a way of assessing its appropriateness and ability to handle major technological modifications.

XI. CONCLUSION

The in-house innovation process is not a rare occurrence in today's organizations. But the field of innovation research has been overrun by the wave of new product development, innovation adoption and diffusion literature. Here, the attempt at a preliminary model of the in-house innovation process has been presented with the hope that it will generate some interest in this important area of research. On more practical terms, the NFB is currently undergoing major cuts in funding and human resource. On the day I write this conclusion, the Montreal Gazette (March 19, 1996) headline states "NFB cuts 170 jobs here, 10 elsewhere". The story reads that the NFB has downsized in response to a cut of almost $20 million for 1997-98. Wha. ioes this mean in terms of the findings presented in this paper?

We have seen that NFB innovations are created in response to gaps in technology and to meet the needs of Canadians in the film industry. We have also seen that the NFB is an important partner to other Canadian and international companies in several industries. We have come to realize that the NFB is indeed a think-tank of highly knowledgeable experts and technicians. Furthermore, this expertise is extendible to areas other than cinema such as computer programming, electronics, and robotics. And, finally, it is evident that all of this is accomplished with the intention of flashing a mirror in the face of Canadians by way of NFB films.

Will this "mirror" be effected by budgetary cuts? Certainly. Projects will be stalled, needed modifications will not be done, valuable alliances will not be formed and technological breakthroughs will never make it from the mind of the inventor to the hands of the user. Does this matter to Canadians as a whole? Hark back to the opening paragraph of this study. In the words of Kanter (1984) and Hayes and Abernathy (1980): "Innovation is the primary hope for the maintenance of high organizational levels" and "low innovation adoption rates cause organizational and economic decline." The question is: What position does Canada want to occupy in the competitive world of global technology? If the country desires to become a forerunner in science, technology and the arts, cutting from institutions such as the NFB will seriously jeopardize its efforts.

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XIII. APPENDICES

APPENDIX A
INTERVIEW GUIDE

1. PROCESS: Describe the innovation process at the National Film Board .
How does it differ for successful vs unsuccessful innovations?

2. PEOPLE: Define the people involved in the innovation process.

a) What positions do they hold?
b) Do some work for organizations outside the NFB?
c) What level of authority are these people in? (staff, mid-mgmt, top mgmt)
d) Is the same developer used for every innovation?
e) Do idea champions exist?
f) Is there a mediator who brings the user and developer together?
g) Do users and developers work together?
h) Who decides whether or not the innovation will be implemented?
i) Sometimes, the organization must be restructured to accommodate an innovation. Describe such an event. Who is in charge of restructuring (position, authority, function)
j) Once an innovation is used in the users film and has become part of the NFB's "knowledge bank", who has access to the innovation for further usage (eg. in other films)?
k) Once the innovation has become routine in NFB activities, how is the innovation evaluated as a successful innovation or a failed one?

3. STRATEGIES: Define the standardized processes and formalized procedures that are used in the innovation process .

a) Do any meetings take place? when? where? with who?
b) Is the meeting formal or informal?
c) Are there any forms that must be filled out during the innovation process?
d) How formalized and standardized is the decision-making process?
e) Once the innovation is part of the "knowledge bank", are forms needed to access it?
f) Does the NFB have a formal evaluation process to judge the success or failure of a particular innovation?

4. OTHER VARIABLES: Outside of the people involved and the strategies, what other factors seem to consistently influence the success or failure of an innovation?

a) Has the NFB changed in terms of its context over the past 5 years?
b) Rewards for innovation?
c) Incentives or motivation for innovation?
d) Leadership in innovation?
e) Departmental groupings?
f) Resources?
g) Mission, goals or objectives of the NFB?
h) Cultural changes?
i) Market demand for innovation?

cont...

j) Any interventions? (consultants, training, new processes or internal innovations)

k) Other?

INTERVIEW GUIDE (specific innovations)

1. Describe the innovation process for this particular innovation.

STAGE 1.
Who was the user? Who was the developer?
Was the environment searched for suitable innovations?
Who did the search?
How did the user and developer meet? Any mediator?
How formal was the meeting?
Any standardized procedures, forms..?
How was the problem presented to the developer? (verbal, sketch..)

STAGE 2.
Did the user and developer work together in finding a solution?
Were any prototypes made?
Were any trial-runs performed?
Are there any formal procedures to follow when creating an innovation? (reports...)

STAGE 3.
Was more than one alternative presented to the user?
Did the user choose the most suitable alternative?
Who made the decision to proceed with the full development and implementation of the innovation?
What criteria persuaded the decision-maker as to the "goodness" of an innovation?
How was legitimization shown?(memo..)
Was there an idea champion?
Was the innovation rejected at this stage?

STAGE 4.
Was the organization modified in any way to accommodate the innovation?
Was the innovation modified in any way to better fit organizational goals or resources?
Who controlled the modifications ?
How long did it take?

STAGE 5.
How did others in the organization come to know about the innovation?
What were their reactions?
Did information about the innovation flow quickly or slowly?
If someone wanted to know more about the innovation what would they have to do?

STAGE 6.
Was the innovation used in the users film?
Was it modified before or during use?

cont...

Was it modified after its original use?
Was it used for another function before being implemented in the user's film?
What happened to the innovation after it was used in the users film?
Who was responsible for it?
Who had access to it?
Were any procedures followed at this stage?

STAGE 7.
Was the innovation used in any other film? How many?
Was it modified for these films?
If someone wanted to use the innovation for their film, what would they have to do?

STAGE 8.
Do you think this innovation was successful? Why?
How do you judge the success of an innovation?
Do you feel it met the users needs? the NFBs needs? the Industry's needs?
If it did not meet these needs could it still be considered useful? Why?
Were there any standard, formal evaluations of this innovation?

For USER, DEVELOPER, DECISION-MAKER, MEDIATOR, IDEA CHAMPION, OTHER

- age
- gender
- seniority
- education
- skills (years at same job)
- type of job
- level of authority

APPENDIX B

Innovation Performance/ Event Matrix

Innovation Performance

Events	Success	Failure
External Input: **External input involves the influence or hands-on participation of all designers, contractors, manufacturers, assemblers or other sources of skills, experience or information from outside the organization.**	External input emerged during the *implementation* stage for Cinerobotheque External contractors hired after original idea was crystallized and wooden protoype was built Rig and Mount External contractor was hired after the in-house user specified the features of the innovation Animaster Problem with original external contractor was solved by terminating their contract and hiring a more suitable external contractor This may have saved the innovation from failure since the original contractor was "going in the wrong direction" - project engineer, NFB	1 External input emerged during *initiation* stage for 2 Workstation External input occurred early in the design phase before all needs were clarified in-house 3 Digisound External input emerged in the form of information from other companies This new information led to the termination of the in-house project
Modifications: **Modifications include all technological changes to the innovation with the objective of improving its usefulness to the user.**	Modifications occurred before, during and after the first use (trial run) of the innovation for all of the four successful innovations	1 Modifications either did not occur after the trial-run or were ineffective due to the nature of the base technology 2 Modifications did not occur after trial-run for the Sound Genie, or Negative Handling Work Station 3 Modifications did not occur at all for the Digisound 4 Poor choice for base technology for the stockshot system ,did not allow for effective modifications
Choice of Base Technology **The choice of a base technology includes selecting and purchasing an existing technology from outside the organization with the objective of making significant modifications to it in order to meet the specific needs of internal users.**	The choice of base technology is easy to add to and modify Animaster An Oxberry animation stand was used as the base technology and it was capable of handling the additional automation mechanisms added to it to create Animaster	1 The choice of base technology is poor and other alternatives exist which would have better served the objectives of the innovation 2 Sound Genie The Sound Genie developers chose to use R-Dat technology rather than CD 3 Stockshot An unsuitable base technology was chosen which was not capable of handling the necessary modifications

APPENDIX C
Event Listing Matrix
Successful Innovations

Innovations	Initiation	Implementation	Post-Implementation
1. Animaster	a) Awareness of gap by user b) Assemble team of experts c)Initial focus. list features and objectives d) Search for benchmark technology e) Translate features into technical specifications	a) Decision to implement the innovation b) Prototype by external contractor c) change of contractor d) Prototype modified by new external contractor e) Trial run f) Debugging g) Modifications	Active but closed for modification in anticipation of new technology
2. Flip	a) Awareness of gap by developer b) Decision to implement innovation c) Initial Focus: listing features and objectives d) Search for benchmark technology e) Translate features into technical specifications	a) Prototype created in-house b) Trial-run c) Debugging d) Modifications	Active
3. Cinerobotheque	a) Awareness of gap by developer b) Initial Focus listing features and objectives c) Search for benchmark technology d) Assemble team of experts e) Translate features into technical specifications	a) Prototype created in-house b) Decision to implement c) Stall and championing d) Modifications e) Restructuring company	Active, continued spin-off innovations
4. Heli rig & mount	a) Awareness of gap by user/developer b) Initial Focus listing features and objectives c) Search for benchmark technology d) Translate features into technical specifications e) Assemble team of experts	a) Decision to implement b) Prototype by external contractor c) Trial run d) Debugging e) Modifications	Active

Appendix D
Event Listing Matrix
Failed Innovations

5. Digisound	a) Awareness of gap by developer b) Initial Focus listing features and objectives c) Assemble team of experts d) Search for benchmark technology e)Translate features into technical specifications f) External input in form of new information g) Termination of the innovation		Deactivated
6. Sound Genie	a) Awareness of gap by user b) Initial Focus listing features and objectives c) Assemble team of experts d)Search for base technology e)Translate features into technical specifications	a) Prototype by external contractor b) Decision to implement c)Trial-run d) No modification e) Terminate	Robot portion is Deactivated Software portion is still Active
7. Stockshot system	a) Awareness of gap by user b) Initial Focus listing features and objectives c) Assemble team of experts d) Search and purchase a benchmark technology e)Translate features into technical specifications	a) Negative user feedback b) Modified by external contractor c) Additional negative user feedback d) exnovate	Deactivated, transferred to National Archives of Canada for their use New base technology purchased and is Active
8. Neg. work station	a) Awareness of gap by user b) Assemble team of experts c) External contractor input d) Initial Focus listing features and objectives e)Translate features into technical specifications	a) Prototype by external contractor b) Negative user feedback c) Terminate	Deactivated