



# **Changes in Entrepreneurial Opportunities: New Capital Goods and Changes in Knowledge-Barriers to Entry**

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**CHANGES IN ENTREPRENEURIAL OPPORTUNITIES: NEW CAPITAL  
GOODS AND CHANGES IN KNOWLEDGE-BARRIERS TO ENTRY**

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**ABSTRACT**

The paper investigates how a particular type of knowledge development in an industry, namely the introduction of new capital goods, influences which individuals will identify and exploit entrepreneurial opportunities in the industry. We propose that during certain circumstances the introduction of new capital goods will change knowledge-barriers to entry into the industry. New capital goods enable the abstraction of specialized knowledge which enables actors without this specialized knowledge to identify and exploit entrepreneurial opportunities in the industry. At the same time, actors that specialize in the creation of the capital goods will be less likely to identify and exploit similar opportunities.

Empirically we test the argument using data from the Icelandic web design industry during the period 1992-2003. We compare the education and experience of founders before and after the introduction of web administration software in 1998 and find a significant difference, which supports the main thesis of our argument. But while we found knowledge-barriers to be lowered for individuals with background in graphical design, as expected, we did not find them raised for individuals with background in web programming.

One plausible explanation for this result is that abstraction provided by the web administration software was only partial. This means that the messy details of web programming were still, to some degree, necessary for effective use of the software, even if those needs are likely to be reduced with time.

## INTRODUCTION

Within entrepreneurship research there is a growing interest in the nexus of opportunities and individuals (Venkataraman 1997, Shane and Venkataraman 2000, Eckhardt and Shane 2003, Shane 2003, Sarason, Dean and Dillar 2006). Instead of following the previous tendency to focus separately on either the enterprising individual or the opportunities that the environment has to offer researchers are encouraged to investigate the interaction of the two. In that way it is possible to take into account the subjective nature of human action without putting too much emphasis on the unhelpful exercise of dividing the world into entrepreneurs and non-entrepreneurs (Sarasvathy 2004).

A central tenet within this line of research is the importance of prior knowledge for identifying and exploiting opportunities (Shane 2000). Previous experiences and accumulated knowledge are believed to shape what opportunities individuals will discover and how they are further developed into a viable business. From this follows that external knowledge development, for example the introduction of new technologies, will affect which individuals are likely to identify and exploit entrepreneurial opportunities (McMullen and Shepherd 2006).

This is certainly not a new insight. Even if not formulated in the same manner this view is clearly shared by the economists that have stressed the role of entrepreneurs as actor that cause, and respond to, changes in the economy. This is particularly evident in the works of economists sharing the common ancestry to the Austrian economist Carl Menger, such as Joseph A. Schumpeter (1934, 1939, 1942) and Israel M. Kirzner (1973, 1997).

Despite these early works, research has been sparse on how development of knowledge influences which individuals are able to identify and exploit entrepreneurial opportunities. While studies following the tradition of Schumpeter have studied the linkage between innovation and the development of technology they have not stressed the role of the individual in the process (e.g. Klevorick et al. 1995). Studies following more closely the subjective tradition of Menger, such as Kirzner (1973, 1997), have stressed the importance of individual action in the economic system, but have never given much attention to knowledge as a phenomenon (Lewin 1996). This paper argues that further

studies on this subject are warranted as it is important for explaining the emergence and existence of entrepreneurial opportunities, which is a fundamental issue for understanding the interaction between enterprising individuals and opportunities (Eckhardt and Shane 2003).

The aim of this paper is advance the knowledge of how changes in knowledge influence entrepreneurial opportunities. More specifically, we investigate how a particular knowledge development in an industry, the introduction of new capital goods, influences what individuals will identify and exploit entrepreneurial opportunities in that industry.

The investigation is in two parts. In the first part, after having defined the concept of opportunity and discussed its relation to knowledge we use Austrian capital theory as a starting point for developing two propositions on the relationship between the introduction of capital goods and the knowledge conducive for taking advantage of subsequent opportunities. Austrian capital theory is a helpful starting point as it attempts to link the development of knowledge, entrepreneurial action, and qualitative changes in the capital structure. However, the Austrian capital theory is not very specific about this relationship which requires us to extend the theory to derive our propositions.

In the second part, we evaluate the propositions by empirically analyzing the web design industry in Iceland. The industry is suitable for the study as we can study the whole population of firms in this growing industry since the creation of the worldwide web in the early 90s. The development of the industry has been dominated by independent startups, and in the middle of the period capital goods where introduced which helped simplify the creation and maintenance of web sites.

The paper is structured as follows. In the next section we develop our frame of reference resulting in two propositions. In the method section we develop subsequent hypotheses to be empirically tested and describe our method of data collection and analysis. After that the results of our empirical analysis are presented. Finally, we discuss the results of the study and their implications for further research.

## FRAME OF REFERENCE

To develop our propositions we need to define the concept of entrepreneurial opportunity and characterize its relation to knowledge. After that we investigate how particular changes in knowledge, as manifested by changes the introduction of capital goods, influence what individuals will take advantage of entrepreneurial opportunities.

### **Opportunities and knowledge**

Despite the current focus on the concept of opportunity in entrepreneurship research it is fair to say that there is yet to emerge a consensus on its definition or meaning. Two issues are of importance for the relationship between opportunities and knowledge. First, to what degree are opportunities objectively “out there” or subjectively “in the eye of the beholder”? Second, how does the kind and degree of novelty demarcate entrepreneurial opportunities from economic opportunities in general? To investigate these issues we use the definitions of opportunities put forward by Shane and Venkataraman (2000) and Sarasvathy (2003) as they represent different ontological views within entrepreneurship research.

Following Casson (1982), Shane and Venkataraman (2000) define entrepreneurial opportunities as “those situations in which new goods, services, raw materials, and organizing methods can be introduced and sold at greater than their cost of production” (p. 220). They add that entrepreneurial opportunities should be considered a subset of a larger set of profitable opportunities, the distinctive characteristic of entrepreneurial opportunities being the discovery of new means-ends relationships<sup>1</sup>. Further, they argue that opportunities are objective phenomena, but not known to all parties at all times because their recognition is a subjective process. The discovery of an opportunity occurs when a conjecture is made about differences in the current and future value of resources. If the conjecture is correct, entrepreneurial profits are created. If wrong, losses are incurred.

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<sup>1</sup> Means-ends relationships are relationship between results sought through action (ends) and what serves to attain these results (means) (von Mises 1998, pp. 92-94). In general terms these relationships include both direct and indirect relationships for satisfying human wants. New means-ends relationships may include new means, new ends, or new ways of linking the two.

Sarasvathy (2003) provides what seems to be a similar definition, but takes a fundamentally different stand in terms of the ontology of the opportunity. She defines an entrepreneurial opportunity as consisting of a “set of ideas, beliefs and actions that *enable* the creation of future goods and services in the absence of current markets for them” (p. 142, italics in the original). Ideas refer to conjectures on how economic ends can be achieved, which may be correct or not. Beliefs refer to judgments of conditions favorable to the achievement of the sought ends. Actions refer to the generation and implementation of the sought ends through the introduction of new economic artifacts, such as goods, firms, markets or institutions. By including cognitive aspects of the opportunity Sarasvathy (2003) presumes an actor “*for whom* it is *perceived* as an opportunity” (p. 143, italics included in the original), which makes it a subjective phenomenon. By including action Sarasvathy (2003) argues that she transcends a purely subjective or objective notion of the opportunity, as the meaning of the opportunity is obtained through individual action in the real world, within which it has to take shape.

Despite the difference in ontological assumptions there seem to be less difference in the above definitions with regard to the degree and kind of novelty required for an opportunity to be considered an entrepreneurial opportunity. In both cases it is required that entrepreneurial opportunities are innovative, such as opportunities for introducing new goods into the economy or new methods of supplying them (Schumpeter 1934). This requirement has consequences for the cognitive aspects of the opportunity. It requires ideas about the new goods or methods being proposed, how they create economic value and how appropriation of returns takes place (Holmén, Magnusson and McKelvey 2007). This means that information about price differences is not sufficient and the entrepreneur also needs to possess and act upon knowledge about products, customers and markets.

A focus on entrepreneurial action as innovative usually implies a distinction between the innovators who lead the way to the market and the imitators that follow (Schumpeter 1934). Economic opportunities pursued by the former are considered entrepreneurial, while opportunities pursued by the latter are not. The former are considered to introduce new means-ends relationships on different markets, while the latter are seen to ‘optimize’ their use (Shane and Venkataraman 2000).

The distinction between innovators and imitators may not be particularly helpful when studying the cognitive aspects of entrepreneurial opportunities. In the case of a technological innovation, for example when a good based on new technology is introduced for the first time on some market, much refinement is likely to be needed before it has a significant impact on the satisfaction of customer wants (Rosenberg 1976; Christensen 1997). These refinements are often performed by ‘imitators’ who incrementally provide extensions and improvements using the same technology and serving the same market needs. The improvements are based on further development of the technology and how it can satisfy customer wants, regardless of whether these are new or not. This development has been observed in a number of industries, where prolific product innovation and new firm entry characterize its early development to be followed by the emergence of a dominant product design, and subsequently, an increased emphasis on process innovation and industry consolidation (Abernathy and Utterback 1978; Klepper 1996; Utterback 1994).

The prolific product innovation and firm entry following the original innovation demonstrate a period which can hardly be characterized by optimizing within existing means-ends relationships as the knowledge about these means-ends relationships is incomplete. Instead it can be characterized by a period where it is possible to create economic value through new ideas about improving the newly proposed means-ends relationship. Thus, the subsequent refinement of an innovation may share the same characteristics, as seen from the entrepreneur, with regard to novelty and only after the use of the particular means-ends relationship has become fairly standardized should its use for creating economic value cease to represent an entrepreneurial opportunity. What this entails in practice will vary depending on the observer as it cannot be deduced from first principles. Thus, the dichotomy innovator – imitator is arbitrary.

Based on the discussion above we define entrepreneurial opportunities as consisting of a set of ideas and beliefs about creating economic value and appropriating returns by changing means-ends relationships. We stress the subjective and cognitive aspects of the opportunity by representing it as ideas and beliefs of individuals. These ideas and beliefs

may be seen as provisional knowledge whose validity is yet to be confirmed, altered or denied.

Here, action is not considered to be a part of the opportunity. Instead, the ideas and beliefs are opportunities for action and can be refined, revised, or abandoned through action. The prospective effect of the action is the creation of economic value by changing the means-ends relationships currently in use. This may include the introduction of new means-ends relationships or changes to existing ones.

Representing opportunities as individual ideas and beliefs provides a direct connection between knowledge and opportunities. Even if the ideas and beliefs individuals have at any time are provisional, they are dependent on the knowledge they have accumulated before that time through experience (Cohen and Levinthal 1990). This is empirically demonstrated by Shane (2000) as he describes how the opportunities recognized by eight different entrepreneurs when becoming aware of the same invention were shaped by the entrepreneurs' prior knowledge leading to vastly different application of the invention.

The ability to learn new knowledge also is highly dependent on prior knowledge. As learning largely is cumulative it is more effective when the new things to be learnt are close to what is already known (Cohen and Levinthal 1990). As a consequence, two individuals sharing may same information may have widely different learning experience (Lane and Maxfield 2005). In the extreme case the information extends the prior knowledge of one of them, but has no effect on the other. It is therefore highly dependent on the individual's prior knowledge to what degree external changes in knowledge will lead to the identification and exploitation of entrepreneurial opportunities.

Even if we are stressing the importance of prior knowledge we neither assume that it is the only, nor the main prerequisite of entrepreneurial action. We are aware that other motivational factors, such as alertness or the willingness to bear uncertainty, also play an important role (McMullen and Shepherd 2006). However, we are in this paper only concerned with how changes in knowledge in an industry influences what entrepreneurs are likely to pursue entrepreneurial opportunities in that industry given no changes in

motivational factors.<sup>2</sup> In the next section we investigate a given a specific change in external knowledge, namely the introduction of new capital goods.

### **Introduction of new capital goods and exploitation of subsequent opportunities**

Despite the generally acknowledged importance of the accumulation of capital for economic growth there has been much controversy around the concept of capital in economic theory.<sup>3</sup> The source of the controversy can be traced to differences in motives, i.e. what problems of economic analysis are of interest, and the corresponding methodological approach. There are mainly two types of problems that are of interest for those who study the role of capital (Lachmann 1978, p. vii, Lewin 1996). First, and the most prominent in the theory of capital, is the problem of the generation and distribution of incomes. This requires an analysis of how different factors of production, one of them being capital, generate income and how this income is distributed. A central theme is therefore to quantify capital in an inclusive way using a common unit of measurement. In order to do so it is necessary to make simplified assumptions, most notably by assuming a steady state with regards to expectations about the value of capital.

The second problem of interest, which is closer to the objectives of this paper, is concerned with the character and composition of the capital stock and its changes. Instead of trying to homogenize the concept of capital through a common measurement unit the heterogeneous nature of capital is emphasized as well as the uncertain expectations about their future use and value. Entrepreneurial action therefore has a prominent role for shaping and changing the character and composition of the capital stock.

The second approach, often classified as the Austrian theory of capital, has its origins in the work of Carl Menger (1871/1976).<sup>4</sup> Menger made a distinction between

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<sup>2</sup> In the parlance of McMullen and Shepherd (2006) this purpose might be understood as to find out for whom perceived uncertainty is reduced due to external changes in knowledge.

<sup>3</sup> The best known include J.B. Clark's and F.H. Knight's critique of Böhm-Bawerk in the first and the fourth decade of the century, respectively, and the Cambridge controversy between economist at Cambridge, UK and Cambridge, MA. For an overview of these controversies see the introduction in Bliss, Cohen and Harcourt (2005).

<sup>4</sup> The Austrian theory of capital cannot be seen as a totally homogenous school of ideas. The main difference that is of importance for this paper is to what degree it follows the subjective focus of Menger's approach and thus includes a role for entrepreneurial action. One stream can be discerned through the works of Böhm-Bawerk, Wicksell, Hicks and later neo-Austrians where the subjective focus is quickly eliminated. The second stream of works by Hayek, Lachmann, von Mises and Kirzner is more adherent to the subjective approach (See Garrison 1990 for an overview of this difference and its early development).

goods of different order based on how close or distant causal relationship they had with the satisfaction of wants or needs. Goods of first order were consumer goods that could be “placed in *direct* causal connection with the satisfaction of human needs.” (Menger 1871/1976 p. 57). Central to Menger’s approach was his subjectivist perspective, leading him to stress individual knowledge and awareness of circumstances as being the basis for economic decisions rather than the actual circumstances themselves (Kirzner 1979). The value of consumer goods is therefore based on how well consumers perceive the goods to satisfy their needs, rather than the value of higher order goods, if any, needed for their production.

Goods having indirect causal relationship with the satisfaction of human needs are of second, third, or higher order. Complementary goods at higher order can be progressively transformed into goods of lower order until, finally, resulting in the satisfaction of human wants and needs. Goods of higher order thus represented the means of production including the classical factors of land, labour, and capital<sup>5</sup>. Their placements in Menger’s scheme is determined from the causal connection between a good and wants and needs, and from existing means of production. A changed mean of production may change the ranking of a good from, say, the second order to the third order. Thus, there is not a natural, given ranking of the order of any goods but this is determined solely from a user and a factual production perspective.

The value of the higher order goods is based on the prospective value of the consumptions goods to whose production they are to be assigned (Menger 1871/1976, p. 150). This prospective value may often be very different from the good’s present value, meaning that the prospective value is based on subjective expectations whose correctness is not known beforehand.<sup>6</sup>

Lachmann (1956/1978) furthers Menger’s idea into a theory of capital structure. He argues that capital resources<sup>7</sup> are heterogeneous in use. Their economic significance comes from the fact that they are multiple specific, i.e. they can only be used for a limited number of purposes. The purposes for which capital resources can be used depends on

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<sup>5</sup> Capital goods are traditionally defined as man-made means of production, i.e. in Menger’s terms they would be considered man-made goods of higher order.

<sup>6</sup> Thus, Menger disregarded the labor theory of value.

<sup>7</sup> Lachmann’s concept of capital resources is comparable to Menger’s goods of higher order but it excludes labour and land.

how they are combined with other resources. Certain modes of complementarity are technically possible, and only a subset of them is economically feasible. Thus, multiple specificity and complementarity provides order as capital resources cannot be combined in an arbitrary fashion.

The entrepreneur has a very explicit role in Lachmann's theory (Lachmann 1956/1978, p. 13-16). Unexpected changes, such as disruptive changes in wants or technology will make possible or even compel changes in the use of capital goods. Thus the entrepreneur may choose to disintegrate existing capital combinations or create new ones. These changes reflect the acquisition and transmission of knowledge by those who operate the capital resources, but the dissolving and re-combining of the capital structure is done through entrepreneurial action. As for Menger, the entrepreneur's expectations about the future play a key role:

“The entrepreneurial interpretation of past experience finds its most interesting manifestation in the formation of *expectations*. Expectations, i.e. those acts of the entrepreneurial mind which constitute his ‘world’, diagnose ‘the situation’ in which action has to be taken, and logically precede the making of plans, are of crucial importance for process analysis.” (p. 15)

These expectations are based on subjective interpretations of experience. They are “provisional judgments to be confirmed by later experience, imperfect knowledge capable of being perfected.” (p. 21) Knowledge development is thus a sequence of expectations and experience from action based on these expectations, irrespective if experience has confirmed the expectations or not. They are a part of ongoing process of acquiring knowledge about peoples' needs and the means to satisfy them in an economical way.

There are two principle ways in which an entrepreneur relates to the capital structure. One is where the entrepreneur through entrepreneurial action changes the structure and takes economic advantage of these changes. The other is where entrepreneurial opportunities for new capital combinations are created by changes, for example in prices or technology. The exploitation of these opportunities will change the capital structure, making some capital combinations less likely to be used, others more attractive, and even opening up for new ones. The changes in the capital structure thus

create further opportunities for entrepreneurial action. The ability to identify and take advantage of these opportunities is based on the prior knowledge of available entrepreneurs, as it provides the foundation for new ideas on how capital resources can be combined and used. In other words, the capital structure is *a structure of means-ends relationships which are combined in an ordered manner based on the complementarity and multiple specificity of the resources themselves on the one hand, and the expectations, knowledge and actions of entrepreneurs on the other.*

In our case we are interested in analyzing how a specific change in the capital structure, namely the introduction of a new capital good influences which entrepreneurs are able to take advantage of the opportunities created by this change. This amounts to asking how the introduction of new capital goods, i.e. man-made means of production, influences the knowledge requirements needed to identify and exploit subsequent opportunities.

Despite linking knowledge development, entrepreneurial action and changes in the capital structure Lachmann (1978/1958) is never very explicit about the specifics of this relationship. Lewin (1996) even argues that while the Austrian economists, such as Menger and Lachmann, stress the importance of knowledge they tend to treat it as an exogenous variable never giving much attention to it as a phenomenon.

A way to remedy this shortcoming, is to use Menger's notion of goods of different order and based on that idea derive the idea of knowledge of different order. For simplicity, we will only show knowledge and capital goods that we assume will undergo major changes (see Figure 1).

Let  $N$  be an integer,  $N \geq 2$ . Let us assume that before a particular point in time,  $T'$ , a good of  $N-1$  order ( $O^G$ ) is produced by a combination of goods at the  $N$ th order. This production of  $O^G$  includes labor services based on knowledge field A ( $K^A$ ) and knowledge field B ( $K^B$ ).<sup>8</sup>

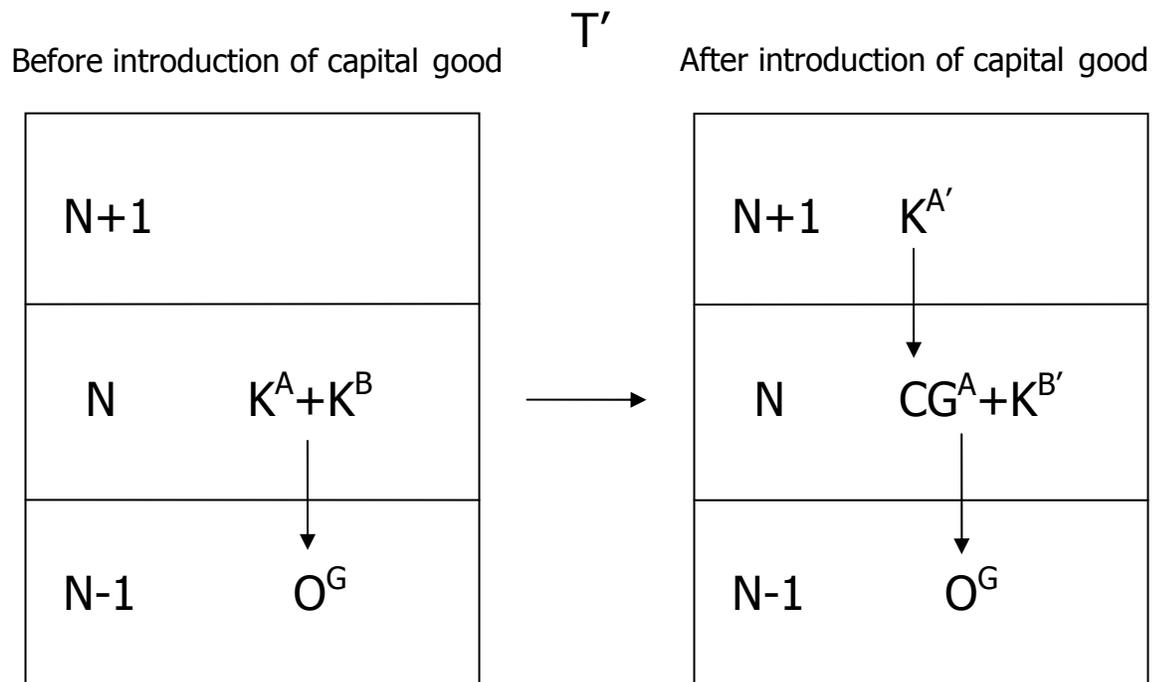
Let us assume that a new capital good ( $CG^A$ ) becomes commercially available at time  $T'$ . This capital good substitutes  $K^A$  so that the good  $O^G$  can be produced without labour services mastering  $K^A$ . An example could be a software program, which makes it

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<sup>8</sup> By knowledge fields we mean reasonably distinct fields, such as for example the knowledge of software programming (A) and the knowledge of graphical design (B). We could of course identify other knowledge fields needed, such as management knowledge, but we keep it simple to help illustrate our argument.

possible to produce the same good of N-1 order as before, but using the new capital good without the labor service. What has essentially happened is that a new capital good of the Nth order has been created as well as the possibility of a new capital combination for producing the good at N-1 order.

**FIGURE 1: CHANGES IN CAPITAL COMBINATION FOR PRODUCING THE GOOD  $O^G$  FOLLOWING THE INTRODUCTION OF THE CAPITAL GOOD  $CG^A$ .**



$K^A$  and  $K^B$  represent labour services based on knowledge fields A and B which are needed to produce  $O^G$ .  $K^{A'}$  and  $K^{B'}$  represent labour services based on knowledge fields A and B after the knowledge fields have been updated for producing the capital good  $CG^A$  and use  $CG^A$  to produce  $O^G$  respectively.

The introduction of the new capital good at Nth order has important implications for the knowledge needed to produce the good at N-1 order. Through the use of the new capital good the knowledge field A can be ‘abstracted away’ when producing the good at N-1 order. That is, the details of production using knowledge field A are suppressed. Labor services at the Nth order are therefore able to ignore, avoid, or may simply be unaware of a number of ‘messy’ details which were a part of the production process before. Instead they have a simplistic view (interface), which allows them to use the new

capital good, but hides all messy details and the implementation of the functionality in full detail. Consequently, the knowledge field  $K^B$  will change into  $K^{B'}$  to reflect these changes in the procedure for creating the good at N-1.

Here we are still assuming that the knowledge field A is important for the production of the good of N-1 order. More precisely, as can be seen in Figure 1, the capital good  $CG^A$  at level N has been created by the application of a new knowledge  $K^{A'}$  on level N+1. The new knowledge  $K^{A'}$  is created through the transformation of the Nth order knowledge  $K^A$  into  $K^{A'}$ . A' here is a body of knowledge that creates the capital good  $CG'$  at the Nth order. Thus, instead of being developed towards meeting the needs satisfied by the good at the N-1 order, the transformed body A' is developed towards meeting the needs of producing the capital good. In some cases, for example in the case of technological convergence, the new capital good might not only be used for producing  $O^G$  but also for a wide variety of other goods at the N-1 order (compare Rosenberg 1976).

To be able to state propositions about how the particular changes we have been describing influence the knowledge requirements for identifying and exploiting opportunities we make two assumptions.

First, we assume a continued demand for the goods at the N-1 order after the introduction of the new capital good and that the creation of economic value through innovation is possible. This assumption simply assumes the existence of any entrepreneurial opportunities, for example that the industry supplying the good does not develop into a state where economic value is only created through optimizing existing means-ends relationships or that entry is prevented by law.

Second, we assume a condition of increasing, rather than decreasing, knowledge specialization in relation to web design. What this means is that the new capital combination, i.e. the use of the capital good  $CG^A$  in combination with labour services based on  $K^{B'}$ , is more economical for producing  $O^G$  than using labour services based on  $K^A$  and  $K^B$ . Thus, there are economic incentives for individuals with background in  $K^A$  to specialize in producing the capital good  $CG^A$  and for individuals with background in  $K^B$  to specialize in producing the good  $O^G$ .

While these assumptions are fairly general they are most likely to be met in young and growing industries. Such industries “require new kinds or qualities of materials and

hence make their own; they must overcome technical problems in the use of their products and cannot wait for potential users to overcome them; they must persuade customers to abandon other commodities and find no specialized merchants to undertake this task. These young industries must design their specialized equipment and often manufacture it, and they must undertake to recruit (historically, often to import) skilled labor. When the industry has attained a certain size and prospects, many of these tasks are sufficiently important to be turned over to specialists.” (Stigler 1951, p. 190).

Increased specialization is likely to precede and continue after the introduction of the new capital good as described above. However, specialized labor services based on knowledge field A will be specialized in a different way after the introduction of the capital good. Their specialization will not be directed towards the needs satisfied by the good at the N-1 order, but rather to the production of that good. We can argue that they will have less knowledge of changes in the requirements for goods at the N-1 than before. The opposite is true for specialized labor services based on knowledge field B, i.e. through specialization they are likely to obtain better knowledge of these requirements.

Given the conditions and assumptions described above we are able to propose the following relationship between the introduction of a new capital good and what entrepreneurs are likely to identify and exploit subsequent opportunities

*Proposition 1:* Individuals specialized in knowledge field B are more likely than before to identify and exploit opportunities for providing goods at the N-1 order after the introduction of the capital good at the N+1 order based on knowledge field A.

*Proposition 2:* Individuals specialized in knowledge field A are less likely than before to identify and exploit opportunities for providing goods at the N-1 order after the introduction of the capital good at the N+1 order based on knowledge field A.

The main thesis of this paper is therefore that the knowledge-barrier for entrepreneurial action will change following the introduction of a new capital good. In the next section we will turn to our method we use to empirically evaluate our propositions.

## METHODOLOGY

To empirically evaluate the propositions put forward in the previous section data was collected on the prior education and working experience of founders of new ventures in the Icelandic web design industry from 1992 to 2003.

In the following sub-section we will describe how we can use this empirical data to evaluate the propositions and develop hypotheses for empirical testing. After that we will describe the data collection methods, and finally the methods of data analysis.

### **Development of hypotheses**

The creation of new ventures is a specific institutional arrangement for exploiting entrepreneurial opportunities (Shane and Venkataraman 2000). Prior education and working experience of founders is thus the knowledge base on which these founders build the identification of the opportunities they set out to exploit through the founding of the venture, as well as the perceived ability to do so (Auida and Rider 2005).

While de novo startups have been considered the primary arrangement for innovation (Schumpeter 1934) research have found the dominant mode of innovation being related to market structure (Cohen and Levin 1989) and technology-specific factors (Breschi, Malerba and Orsenigo 2000). Both market structure and technology-specific factors have been found to vary during the evolution of an industry. Early on with high uncertainty where technology is changing rapidly, entry barriers are low and new firms are the key innovators. When industry develops and matures and technological change follows well defined trajectories, economics of scale, learning curves and access to financial resources create entry barriers (Abernathy and Utterback 1978, Klepper 1996).

The web design industry is a relatively young industry. It traces its origin to the creation of the World Wide Web (WWW or web). In late 1990 Tim Berners-Lee, then at the CERN, created the first Hyper Text Markup Language (HTML) editor/browser and launched the first web server. The first browsers which could view graphical information were released in 1992, but the popularity of web did not accelerate until the release of the Mosaic browser in 1993 and the subsequent release of the commercial Netscape Navigator in 1994 (Wikipedia 2006a). During these times the first firms are founded

which specialize in creating and maintaining websites which are a collection of connected information sources which the user views with the help of a web browser.

Web design services are a subset of the larger class of Internet service. Christensen et al (2003) argues that corporate opportunities for Internet use have expanded from being an instrument of communication into being an instrument for improving company performance. He proposes a five stages evolution of Internet use generating three generation of services which today are offered in parallel. The first generation services constituted of communication consultation. This included both external market communication as well as communication within the corporation. The second generation services constituted of online commerce services. These services include assistance with online strategies and changes in business processes, as well as the implementation of online commerce systems. The third, and the final, generation of services are technical system integration services. These services strive to assist firms with building an overall Internet-based infrastructure.

Web design services belong to the first generation of services. Web design firms are the only de novo entrants in the Internet service industry, other entrants being incumbents from other industries holding core, or complementary competencies needed for the provision of second and third generation services, such as management consultants or information technology integrators (Christensen et al. 2003).

As in other countries the web design industry in Iceland experienced an explosive growth in the late 90s extending the market for its services.<sup>9</sup> During that time there was a constant development of web technology, i.e. techniques for including and visualizing new type of information sources, to allow for allowing contents of web pages to be contingent upon the context in which they are viewed, etc. Additionally, there were changes in customer needs as described by Christensen et al. (2003).

There are two main fields of knowledge fields involved in the delivery of web design (Christensen et al. 2003).<sup>10</sup> One is web programming that constitutes the writing of the necessary program source code to create a website (The Free Dictionary 2006).

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<sup>9</sup> In the following we describe the development of the Icelandic web industry. While it parallels the global development to a large extent, timing may differ. The description of the Icelandic web industry is based on (Hilmarsson 2004).

<sup>10</sup> Here we are focusing on the knowledge needed to product websites, omitting, for the sake of simplicity, any knowledge related to the managing the delivery and promoting it in the market.

The other is graphical design which is the act of arranging text and visual elements to communicate a message to the viewer (Wikipedia 2006b).

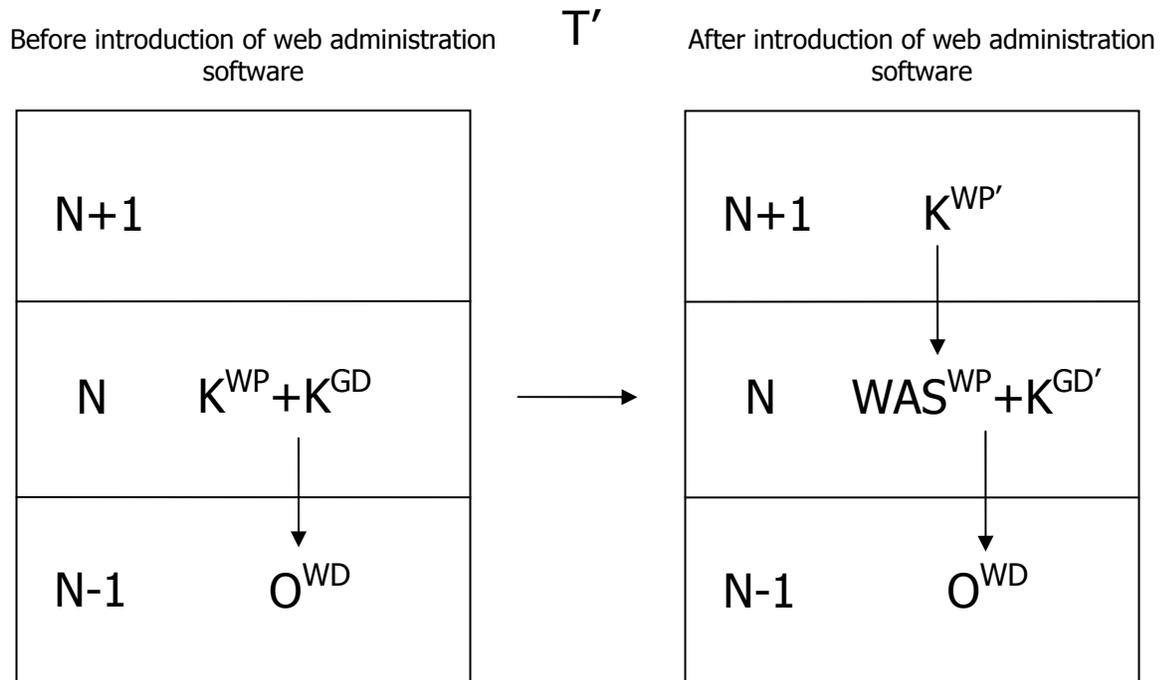
Around 1998 capital goods in the form of web administration software started to become commercially available; consequently when such tools were used, they were not just developed in-house. Web administration software is a collective name for bundle of tools that are used to aid the creation and maintenance of websites.<sup>11</sup> These tools help users to input content to display, aid in maintaining an overall visual design and consistency, automate interaction with databases, and keep track of files belonging to the website. While the owners of websites, e.g. industrial companies, usually are able to update some of the information on the website, professional web design firms are used for the original design and subsequent redesign.

Web administration software automated many web programming tasks. It allowed graphical elements to be arranged without being concerned about the underlying HTML source code needed for its display in a web browser. It also allowed the inclusion of dynamic content which means users may not need to consider implementation details of database programming that may be necessary for a functioning application. Through web administration programs knowledge of web programming could be abstracted away, which made it easier to create websites without much knowledge of web programming.

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<sup>11</sup> These tools have also been named web development software, or web content management software.

**FIGURE 2: CHANGES IN CAPITAL COMBINATION FOR PRODUCING WEB DESIGN SERVICES ( $O^{WD}$ ) FOLLOWING THE INTRODUCTION OF WEB ADMINISTRATION SYSTEMS ( $WAS^{WP}$ ).**



$K^{WP}$  and  $K^{GD}$  represent labour services based on web programming (WP) and graphical design (GD).  $K^{WP'}$  and  $K^{GD'}$  represent labour services based on web programming and graphical design after the knowledge fields of web programming and graphical design have been updated for producing web administration systems and using them to produce web design services respectively.

The introduction of web administration software in the web design industry, see Figure 2, corresponds to the introduction of capital goods in a young and growing industry as specified in the previous section. In this particular case knowledge of web programming ( $K^{WP}$ ) corresponds to knowledge field  $K^A$  specified in the propositions and knowledge of graphical design ( $K^{GD}$ ) corresponds to knowledge field  $K^B$ . In the same manner,  $WAS^{WP}$  refers to the web administration software which is based on knowledge of web programming, and  $K^{WP'}$  and  $K^{GD'}$  refers to the updated knowledge fields. As this is a young and growing industry we assume new ventures to be the primary mode of exploitation of entrepreneurial opportunities. We also assume that the education and experience of the founders are an appropriate measure of their prior knowledge, representing their ability to identify and exploit entrepreneurial opportunities.

Propositions 1 and 2 therefore correspond to the following hypotheses which we intend to test empirically:

*Hypothesis 1:* Founders entering the web design industry after the introduction of web administration software are likely to have different education and experience as compared to those who entered before the introduction.

*Hypotheses 1a:* Founders entering the web design industry after the introduction of web administration software are more likely to have education and experience related to graphical design than before the introduction.

*Hypotheses 1b:* Founders entering the web design industry after the introduction of web administration software are less likely to have education and experience related to web programming than before the introduction.

One of the basic assumptions needed for the development of the propositions was the assumption of increasing knowledge specialization. In order to validate that assumption we also test the following hypothesis:

*Hypothesis 2:* Founders entering the web design industry after the introduction of web administration software are likely to have more specialized education and experience compared to those who entered before the introduction.

Web administration software was introduced in Iceland in 1998. In order to be able to compare differences before and after the introduction it is important to study a time series prior to that date and after. Studying the time period from 1992 to 2003 is appropriate as it is almost symmetrical around the year 1998. The relatively small size of the Icelandic web industry allows us to study the whole population of firms in the industry.

### **Data Collection**

There is no separate industrial classification code for the web design industry. Many of the firms belong to the ISIC 7220 category, which is a broad category of information technology services but they may also be found in other categories. It is therefore difficult to estimate with some certainty the total population of firms.

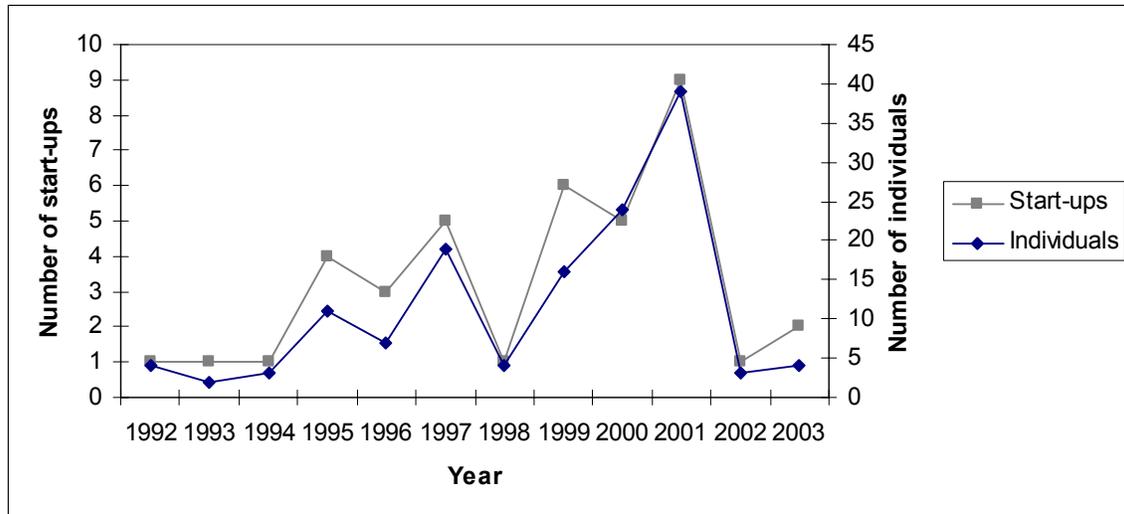
In order to identify as many firms as possible four approaches were used:

- 1) A complete list of firms established during 1992-2003 in ISIC 7220 category was obtained from statistics Iceland. With the help of an expert who has been linked to the web design industry from the beginning this list was cut down firms who were potentially involved in web design.
- 2) As web design firms are likely to be presented on the web, a web search was performed using key words linked to web design.
- 3) A popular Icelandic computer magazine (Tölvuheimur) published since 1994 was scanned for names of firms working in the web design industry during the period 1994-2003.
- 4) Founders who were contacted were asked to identify other firms in the industry or other people that could help with that identification.

The final list included both firms that are currently in business and firms which have gone out of business. An attempt was made to establish contacts with at least one of the founders in each of the firms identified. They were asked about the founding year of the firm, the number of founders, the educational background of each of the founders as well as their previous experience from web design or related activities.

In total information was collected about 136 founders in 39 firms during the period 1992-2003 (Figure 3). Of those 46 individuals (34%) were involved in starting 15 firms (39%) during 1992-1997 and 90 individuals (66%) were involved in starting 24 firms (61%) during 1998-2003. Additional 11 firms were identified as a part of the industry but did not respond. Four of them (36%) were established between 1992-1997 and seven (64%) during 1998-2003. The final list of firms was checked with the help of the same expert mentioned before.

**FIGURE 3: NUMBER OF NEW VENTURES AND FOUNDERS IN THE ICELANDIC WEB DESIGN INDUSTRY 1992-2003.**



Respondents were asked about the number of founders and background of each founder. Open ended questions were asked of education at the time of founding, as well as what professional experience they had which could be related to web design.

### Data Analysis

The data analysis starts by categorizing the education and experience of founders. We categorize education into three knowledge fields: web programming, graphical design, and other. Knowledge of web programming includes any education related to computer programming, irrespective of the level of education. Knowledge of graphical design includes any education having to do with visual arts, again, irrespective of the level of education. We also classify education into two groups based on the level of education: Primary or secondary education, and post-secondary education. Higher level is associated with stronger specialization. Experience was categorized into two categories, related to web design and unrelated to web design, based on the subjective evaluation of the respondents.<sup>12</sup> Experience related to web design is associated with stronger specialization.

<sup>12</sup> After the data collection was finished it became apparent that specific information about working experience was lacking in a large number of the cases. Hence, it was not possible to derive the dominant knowledge field associated with this experience, only to what degree it was related to web design.

In addition the startups were classified into three groups based on their overall focus: web programming, graphical design, and other. The classification built on the education and experience of the founders based on two rules:

1. If no founders had a background in web programming or graphical design firms were classified as other. In other cases the classification was based on the relative number of founders with background in web programming or graphical design.
2. If the number of founders having their background in web programming and graphical design were equal in number, the one is select which has individuals with higher level of education and more experience.

To test the hypotheses we compare the education and experience of founders before and after the year 1998. For changes in knowledge fields we compare differences in education as well as in the focus of the new ventures. For changes in specialization we compare differences in the level of education and differences in the degree of related and unrelated experience. We use Chi square test to determine if observed changes are statistically significant.

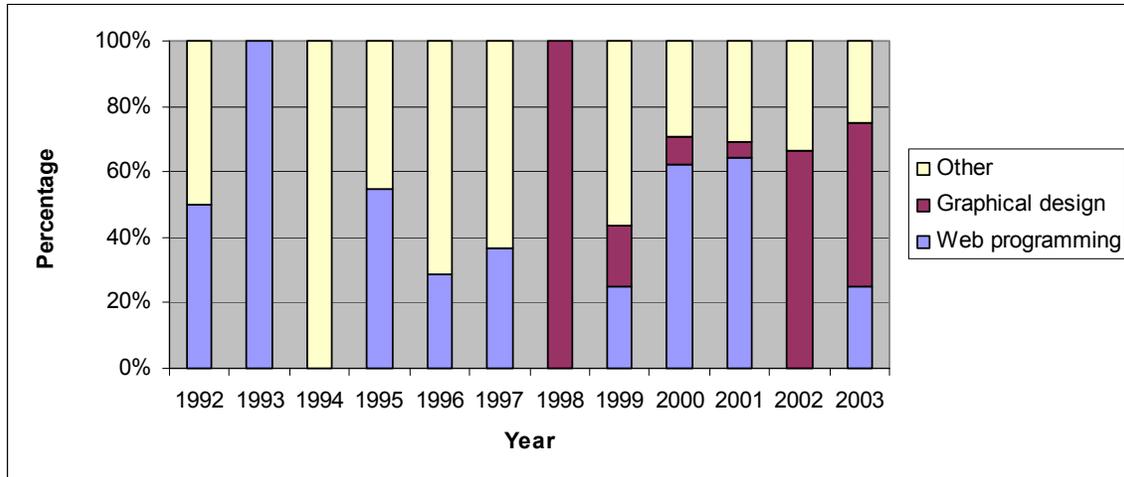
## **RESULTS**

In this section we present the results of our analysis for testing our hypotheses. We start with changes in knowledge fields followed by changes in specialization.

### **Changes in knowledge fields**

In order to test hypotheses 1, 1a, and 1b, we analyze changes in knowledge fields. Figure 4 shows the changes in the education of the founders of new ventures in the Icelandic web design industry during the period 1992-2003. Visually we can see that individuals having their education in graphical design did not enter the industry until after the introduction of web administration software in 1998. However, there are still a number of founders that have a programmer's education.

### **FIGURE 4: EDUCATION OF FOUNDERS OF NEW VENTURES IN THE ICELANDIC WEB DESIGN INDUSTRY 1992-2003.**



If we compare the education of founders before and after 1998, there is a difference between the ratio in each category (Table 1). While the relative number of founders having a background in web programming is similar across the two periods the difference is due to opposite changes in the number of founders having an education in graphical design and the number of founders having education which is unrelated to either web programming or graphical design. While this results support hypothesis 1 and hypothesis 1a it does not support hypothesis 1b.

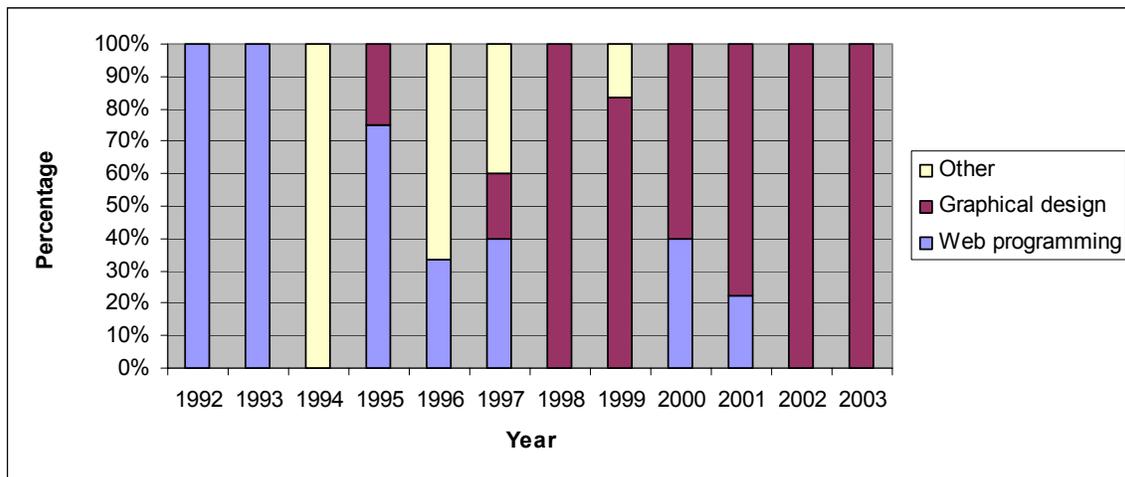
**TABLE 1: COMPARISON OF THE EDUCATION OF FOUNDERS OF NEW VENTURES IN THE ICELANDIC WEB INDUSTRY BETWEEN THE PERIODS 1992-1997 AND 1998-2003.**

	Graphical design	Web programming	Other	Number of founders
1992-1997	0%	41%	59%	46
1998-2003	17%	50%	33%	90
Total	11%	47%	42%	136

Chi square test of difference between periods:  $t < 0.01$

If we look at the knowledge focus of the firms a different picture emerges (Figure 5). Here we see that the knowledge focus is more on graphical design after 1998 and at the same time less on web programming.

**FIGURE 5: KNOWLEDGE FOCUS OF NEW VENTURES IN THE ICELANDIC WEB DESIGN INDUSTRY 1992-2003.**



When we compare the knowledge focus between the two periods (Table 2) we see that there is a difference in the composition of the knowledge fields where there is both an increase in the number of firms having knowledge focus on graphical design and a decrease in the number of firms having knowledge focus on web programming. These results therefore support hypotheses 1, 1a, and 1b.

**TABLE 2: COMPARISON OF THE KNOWLEDGE FOCUS OF NEW VENTURES IN THE ICELANDIC WEB INDUSTRY BETWEEN THE PERIODS 1992-1997 AND 1998-2003.**

	Graphical design	Web programming	Other	Number of firms
1992-1997	13%	53%	33%	15
1998-2003	79%	17%	4%	24
Total	54%	31%	15%	39

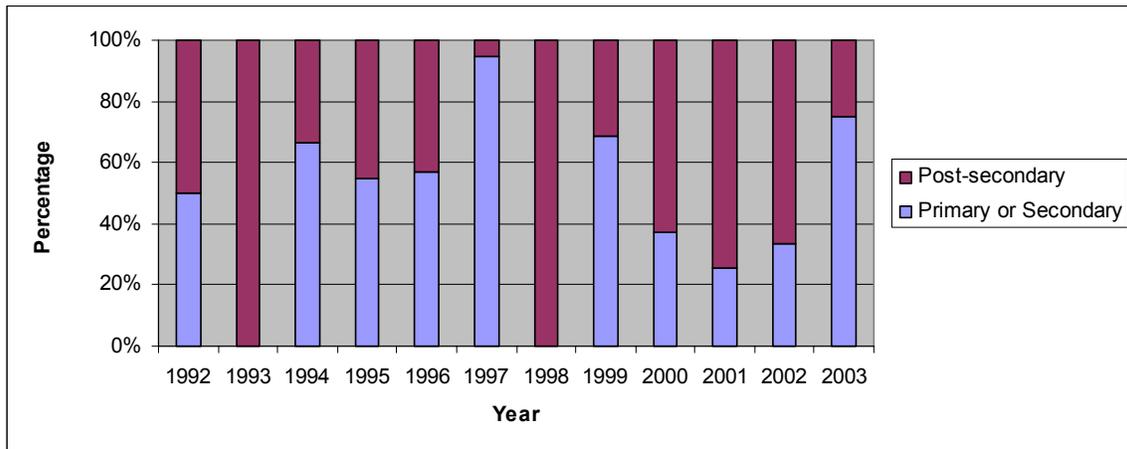
Chi square test of difference between periods:  $t < 0.01$

### Specialization

In order to test hypothesis 2 we look at changes in knowledge specialization, both in terms of education and experience. Figure 6 does not provide a very clear picture of

changes in the level of education with time. However, there is a statistically significant difference between the two periods, where larger share of founders have a higher level of education in the latter period (Table 3), which supports hypotheses 2.

**FIGURE 6: EDUCATION LEVEL OF FOUNDERS OF NEW VENTURES IN THE ICELANDIC WEB DESIGN INDUSTRY 1992-2003.**



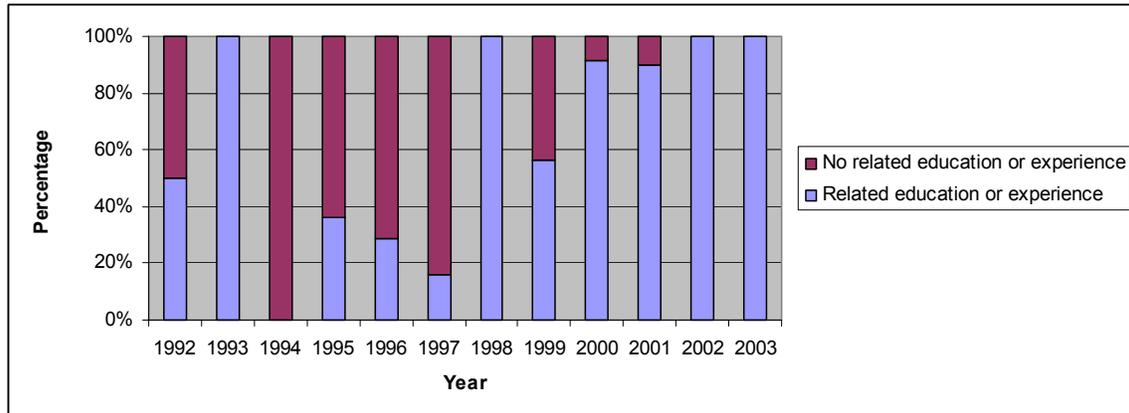
**TABLE 3: COMPARISON OF THE EDUCATION LEVEL OF FOUNDERS OF NEW VENTURES IN THE ICELANDIC WEB INDUSTRY BETWEEN THE PERIODS 1992-1997 AND 1998-2003.**

	Primary and Secondary	Post-secondary	Number of founders
1992-1997	70%	30%	46
1998-2003	38%	62%	90
Total	49%	51%	136

Chi square test of difference between periods:  $t < 0.01$

If we look at changes to what degree education and experience is related to web design the picture is much clearer (Figure 7). After 1998 founders have to a much higher degree education or experience which is related to web design than before. This difference is further corroborated in Table 4, which further supports hypothesis 2.

**FIGURE 7: EDUCATION AND EXPERIENCE RELATED TO WEB DESIGN OF FOUNDERS OF NEW VENTURES IN THE ICELANDIC WEB DESIGN INDUSTRY 1992-2003.**



**TABLE 4: COMPARISON OF EDUCATION AND EXPERIENCE RELATED TO WEB DESIGN OF FOUNDERS OF NEW VENTURES IN THE ICELANDIC WEB INDUSTRY BETWEEN THE PERIODS 1992-1997 AND 1998-2003.**

	Related education or experience	No related education or experience	Number of founders
1992-1997	28%	72%	46
1998-2003	86%	14%	90
Total	66%	34%	136

Chi square test of difference between periods:  $t < 0.01$

## CONCLUSION AND DISCUSSION

Recently, much entrepreneurship literature focuses on the nexus of individuals and opportunities. A central issue is the role of previous experiences and how accumulated knowledge shape what opportunities individuals will discover and how they are further developed into a viable business. The paper investigates how a particular type of knowledge development in an industry, namely the introduction of new capital goods, influences which individuals will identify and exploit entrepreneurial opportunities in the industry.

This is an important issue which has got scarce attention. In the paper we argue that the Austrian theory of capital can help to explain how the introduction of new capital goods, together with subsequent vertical disintegration, may change the knowledge required for identifying and exploiting opportunities. We proposed that new capital goods enable the abstraction of specialized knowledge which was previously needed for production, thereby enabling actors without this specialized knowledge to identify and exploit opportunities in the industry. At the same time, actors that specialize in the creation of the capital goods will be less likely to identify and exploit similar opportunities. In effect, knowledge-barriers to entry have changed and one group of actors are more likely to identify and exploit entrepreneurial opportunities than before, while others are less likely to do so.

We evaluated these propositions by empirical analysis of the educational background and working experience of founders of new ventures in the Icelandic web design industry between 1992 and 2003. New venture creation was the dominant mode of exploiting entrepreneurial opportunities in this young and growing industry. In the middle of the period (1998) the commercial introduction of web administrative software is documented in Icelandic computer magazines. In the literature, these are claimed to dramatically change the way websites are created and updated. Based on our propositions we hypothesized that we would observe differences in the educational background and experience of founders before and after 1998. We expected that we would be more likely to observe founders having a background in graphical design after 1998 than before. We also expected that we were less likely to observe founders with a background in web

programming, which is the field of knowledge on which the creation of web administration software is based, after 1998 than before.

As expected we observed differences in the educational background and experience of founders before and after 1998. We also observed a relatively higher number of founders with educational background in graphical design after 1998 than before. However, we did not observe a relatively lower number of founders with background in web programming after 1998 as we expected. When we looked at the firm level we could nevertheless observe a clear difference between the two time periods, where new ventures were much more likely to have a focus on graphical design after 1998 than before.

While our empirical analysis supports the main thesis of our propositions, namely that the introduction of capital goods during certain circumstances may bring about a change in the knowledge-barriers for entrepreneurial action, there are discrepancies which need to be explained. The most important is the difference between the founder and team level, and the observation that individuals with their background in web programming were equally likely to be involved with the identification and exploitation of entrepreneurial opportunities before and after the introduction of web administration software.

One plausible explanation, which addresses both of the discrepancies, is that the abstraction provided by the web administration software was only partial. This means that the messy details of web programming were still, to some degree, necessary for effective use of the software. Thus, while the majority of an entrepreneurial team has background in graphical design web programming knowledge is still needed for successful exploitation of opportunities.

This explanation is plausible for software development but may be more generally valid as well. In a previous paper where we analyzed the use of abstraction in software creation we found the problem of partial abstraction to be a long standing and indeed even a defining problem in the fields of computer science and software engineer. Thus, despite numerous software development paradigms having been launched as the final solution to the problem, ‘abstraction leakages’ change but they are never entirely eliminated (Holmén and Saemundsson 2002). However, the abstraction of web

programming is likely to improve with time in much the same way that computer users do not require any knowledge of assembly programming language in order to use the computer, let alone identify or exploit entrepreneurial opportunities based on information technologies. Thus, it is likely that our proposed substitution of labour services for the use of new capital goods is prolonged only temporarily.

The results of this paper have several implications for further research. We have taken only a small step towards a better understanding of how external knowledge development influences which individuals are able to identify and exploit entrepreneurial opportunities. We have looked at a very specific type of knowledge development and there are opportunities for extending the analysis to include other types. In addition there are opportunities for replicating the results for other industries or regions.

A more general analysis of knowledge development, changes in capital structure and entrepreneurial action requires further extensions to Austrian capital theory. Such extensions are not only interesting for further use within entrepreneurship research, but are important contributions to the development of the theory itself and its use for better understanding economic growth and development.

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