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ABSTRACT

Technology plays an important role for any start-up – as an opportunity to be exploited, as well as an enabler to structure the start-up’s activities to better generate value. The business model is a useful tool in these settings to keep track of technology and understand its potential value for the start-up. To analyze the interrelation between business model development and technology change a multiple case study approach was conducted. Using a maximum variation strategy, three cases of start-ups depicting the range of technological discontinuity were selected. Analysis of these resulted in three different ways in which technology use in new ventures influenced business model development and vice versa. In addition, this paper introduces the Business Model Dynamics Framework as a tool for pro-active, continuous business modeling and analysis.

INTRODUCTION

The first step in any entrepreneurial activity is opportunity recognition (Shane & Venkataraman, 2000, Fayolle 2007, 37ff). Observing a number of new entrepreneurial ventures in different start-up support programs, it is noticed that entrepreneurs often struggle with the next step: creating from scratch, and maintaining, a strategy for their firm. Therefore, we suggest and use business modeling as a technique to support this second step. Additionally, it gives important insights to relate different types of technology use in new ventures to the way their strategy develops and changes over time.

The best-known type of venture is based explicitly on exploiting the opportunity provided by the development and use of a new technology. These ventures often make the mistake of losing sight of the primary purpose of any commercial venture: delivering value to the customer (Chesbrough & Rosenbloom 2002). Instead, technology and technological development for their own sake take center stage, driving out recognition and consideration of all other factors contributing to the primary purpose – such as customers, suppliers, end users, regulatory context, quality, or finance (Hamel 2000).

A different type of opportunity is more subtle for start-ups. Technology can not only be a value generator in itself but also enable firms to structure and organize some or all parts of their activities in such a way as to better generate value (e.g. Orlikowski 2000). This more implicit use of technology can take the form of an extended product range, shortened delivery times, higher quality, better
discrimination of customer segments, and many other gains that are not easily visible from the outside. This type of venture may fail to keep track of further developments in technology that might offer them advantages.

Since the potential value of these opportunities depends strongly on the environment, or “state of the real world”, at the moment an entrepreneur tries to exploit it, it is central to entrepreneurial success to keep track of the changes in the factors important to the venture that describe the environment (Shane & Venkataraman 2000). More general, recognizing the full potential provided by all types of opportunity is helped by a comprehensive overview of these factors as well as the current value-generating activities of the venture. A tool that enables value identification and quantification for all types of opportunities and encourages change during all stages of venture design contributes greatly to the success of a new start-up: this tool is the business model (Morris et al. 2005, George & Bock 2010).

Business models, just like the real world, cannot be static if they are supposed to enable start-up success, but have to be revised over time and adapted to maintain fit with changing technology, market and regulatory conditions (de Reuver, Bouwman & MacInnes 2009, Günzel & Wilker 2010). Design choices made at a point in time during planning of initial service and underlying technology typically change during subsequent stages of market entry and commercial exploitation based on new information gained from these processes. The alignment of developments in technology on the one hand and in the business model on the other – with technology being one of the most important reasons for business model adaptation over time (de Reuver, Bouwman & MacInnes 2009) – warrants closer examination. Additionally, insight into the dynamics of the links between external events and the configuration of internal value system components is highly relevant for practitioners in order to keep their business models adaptable and flexible over time. This holds for both entrepreneurial as well as managerial practice.

This paper aims to contribute to the understanding of the interrelationship of technology and change by proposing the Business Model Dynamics Framework (BMDF) as a tool for business modeling and analyzing. This research is conceptual and theory-generating rather than empirical and theory-testing. Therefore, we use a case study approach and analyze three cases of start-ups in detail to illustrate the use of the BMDF and the links between technological change and business model adaptation. The paper makes three important contributions. First, we suggest a framework for business model design and analysis. Second, we offer detailed descriptions of the linkages between technology and entrepreneurial activity for low- and high-tech companies. Third, we identify several practical implications of our findings for practicing entrepreneurs and start-up support programs.

LITERATURE REVIEW

As this contribution aims to explore the mechanisms and links between external technology change and business model adaptation, as well as internal technology development and business model enhancement in the start-up stage, the literature review in this section first briefly introduces the business model concept in an entrepreneurship context and the links so far explored between technology and business model design. Subsequently, tools to design and analyze the business model and its change are reviewed.

The Business model concept in entrepreneurship research

In venture creation, some authors view having a clearly articulated business model as early as possible as essential, since it is the central construct to coordinate start-up activities and thus to cope with complexity and uncertainty (Barringer & Ireland 2007, Sandberg 2002). This is one reason the business model receives more emphasis in the recent entrepreneurship literature (e.g., Morris et al. 2005, George & Bock 2010). But there is still much confusion about what a business model exactly is, how it can be usefully applied and how it can be distinguished from established organizational constructs such as strategy. Thus the interpretations of the term are quite diverse in the field of entrepreneurship. The business model is described as a facilitative intermediary in the opportunity creation process (Amit & Zott 2001), as the link between innovation and value creation (Chesbrough & Rosenbloom 2002) as well as the cognitive link between entrepreneurial appraisal of the opportunity and its exploitation (Fiet & Patel 2008). Other authors equated it to the underlying “business idea” or the firm’s value creation mechanism (Afuah 2003, Markides 2008).

With a few exceptions (Andries et al. 2006, MacInnes 2005, Vaccaro & Cohn 2004), most literature has taken a static perspective on business models, implicitly assuming them to remain stable over time.
While reasons for business model adaptation are researched widely, the process and structure of how start-ups include change in their business model is not addressed yet. In a previous study (Günzel & Wilker 2010) we used a grounded-theory approach to analyze the development of business models from opportunity realization to market exploitation. To our knowledge, these results are the first insights into the business model development process. The study finds initially that all observed start-up’s business models changed and thus change is an important aspect in the venture creation process and needs to be integrated in business model design. Second, it depicts the importance to analyze the effect of technology change on business model development and vice versa, with technology being one of the most important reasons for business model adaptation over time (see also de Reuver, Bouwman & Maalmsnes 2009). Besides this study, literature on business model innovation – with innovation laying at the heart of entrepreneurship – gives first directions for this research area.

**Business Model Innovation**

There are two generally separated but interrelated streams in the exiting literature on business model innovation: business models to capture value from technology innovation and business models as innovation forms (Teece 2009).

Many studies in this area assess the business model as a construct that mediates the value creation process – it translates between the technical and the economic domains, selecting and filtering technologies, and packaging them into particular configurations to be offered to a chosen target market (Chesbrough 2004, Chesbrough & Rosenbloom 2002, Chesbrough 2006, Doganova & Eyquem-Renault 2009, Teece 2009). This perspective frames business models within an innovation context, defining it as “a coherent framework that takes technological characteristics and potentials as inputs and converts them through customers and markets into economic outputs” (Chesbrough & Rosenbloom 2002: 532). Moreover, the business model ensures that the technological core of the innovation delivers value to the customer.

The second research stream argues that business model innovation does not rely on breakthrough technologies or product launches (Santos, Spector & Van der Heyden 2009). Here, a business model is a component of innovation commercialization separate from product and process innovation. This adds a new source of innovation to Schumpeter’s typology of innovation in products and services, methods of production, distribution or marketing, and in markets (Zott & Amit 2002). Innovation in business model design is regarded as a holistic concept with the transaction as its main focus (Zott & Amit 2009). It is a form of strategic entrepreneurship (Hitt et al. 2001). In fact, the design of a new business model strikes at the core of entrepreneurship (McGrath & MacMillan 2000). The business model may serve not only to exploit an opportunity for wealth creation, but its design may be part of the opportunity development process in and of itself. The entrepreneur-as-designer can co-create opportunities. Business model innovation may complement innovation in products and services, methods of production, distribution or marketing, and markets. Technological innovation often needs to be matched with business model innovation if the innovator is to capture value.

There are only a few methodological tools and frameworks developed to support business model innovation and development, unlike the highly developed ones for classic competitive situations. An adaptive framework for innovation suggests that business models adjust in parallel to the firm’s life cycle evolution (Andries & Debackere 2007). Business model innovation at the firm level would then be especially prevalent among immature firms in capital-intensive and high-velocity sectors. Voelpel, Leibold and Tekie (2004) develop a four-dimensional tool of business reinvention, which makes sense of environmental changes and the relevance of a possible new business model. Mahadevan (2000) develops a framework for business model innovation and suggests that incumbent firms and start-ups differ vastly in their approach towards business model innovation. It remains unclear, however, how entrepreneurs can design a new business model and thus how they can capture value from technological innovation. Hands-on approaches are needed to support entrepreneurs to solve their problems. Design approaches which were mostly developed by e-business researchers and practitioners may give first insights.

**Business model design and application**

The literature offers various business model frameworks. We selected those concepts that included a visualization method because visualization helps the entrepreneur as user to understand and communicate their business model (Eppler & Platts 2009, Seppänen & Mäkinen 2005). We briefly describe these approaches and evaluate them in regards to their applicability in the venture creation process before describing our own proposal for a business model design method in the next chapter.
Boulton, Libert, and Samek (2000) offer a business model concept based on asset values. The visualizing technique “Value Imaging” models four value categories but actors, relations or activities do not play a role and thus make the approach incomplete for the understanding of the entrepreneurs’ business model. Gordjin and Akkermans (2001) use value and its creation, expression and exchange in a stakeholder network as the core concept of their e-business model ontology. This technique was developed for identifying and analyzing variations of e-business models in practice, but the generated model is too complex and inflexible towards rapid changes. Wirtz (2001) designed a tool to graphically represent e-business models in a standardized framework, which may also be applied to conventional firms. This approach focuses mainly on internal structures while neglecting the external network necessary for a successful new venture. Weill and Vitale (2001) established the E-Business Model Schematics, which consists of eight “atomic” e-business models made up of a set of basic elements. This allows expression of any business model in the e-business world through a combination of these “atoms”; the approach has limits where the business environment or context diverges significantly from the given standard situations.

Osterwalder and Pigneur (2005) propose a business model ontology that draws extensively on the foregoing research. This consists of four business model “pillars” represented by nine business model elements and several sub-elements. This ontology and accompanying tools were conceived with a view to actual application by managers; the necessary prerequisites point to use mainly in existing, relatively large firms. The concept qualifies as the most complete one, but this goes along with diminished clarity and comprehensibility.

Deelmann and Loos (2003, 2004) constitute a synergy of the above-mentioned concepts. They define a business model as an abstract description of business operations. This abstraction is based on mapping of organization units, transfer processes, flows, influences and transformation aids. The authors define a set of requirements for business model visualization and, based on this, propose a toolkit. In addition to the previous concepts this approach introduces “influences” as a model element. This toolkit is furthest in actual usability, but due to the lack of demonstrated empirical testing further development and adaptation is needed.

Most approaches in the literature are either too complex to be usefully applied as a practical tool for proactive planning in entrepreneurship, or they are only applicable ex post, when all required information is easily available, delivering a static description at a single point in time of the development of what, at the time of analysis, most often is an ex-start-up. Another lack in existing conceptualizations of business models is the strongly interconnected nature of the elements. The business model conceptualizations do outline some links, but these concepts do not give a systemic picture on what decisions will lead to what outcomes and more specifically, the dynamical nature of changes between different elements in the models. Therefore, the existing concepts can only be used as starting points in building a new entrepreneurship-focused approach. The results of this research present promising directions for re-conceptualizing the business model along these lines.

**BUSINESS MODEL DYNAMICS FRAMEWORK**

**Background**

As we have described above, there is no definitive or consistent definition of what makes up a business model. The literature provides several diverging definition attempts, resulting in a certain amount of confusion. Thus, we base our approach on the following entrepreneurship-centric definition (Günzel & Wilker 2010):

> The business model is the configuration of the resources, the market offering and the network structure that describes how value is created and captured to act upon and exploit business opportunities.

In this view, the network structure consists of the transaction, governance and relationship structure, thereby embedding the network of managerial relationships within the organizational context. This element has been missing in previous definitions. People, relationships, and networks are as much part of a business model as are resources, technological dependencies and economic exchanges, and thus contribute to the venture’s success. Resources and the market offering describe the transaction content which describes both the goods and information being exchanged as well as the resources and capabilities required to enable the exchange.
Based on this definition, and extending from Gordijn (2001) and Deelmann and Loos (2004), we define the Business Model Dynamics Framework (BMDF). The framework consists of the business model definition, a graphical language for visualization, and a set of guidelines for application and analysis. The selection and design of these elements is based on our review of the business model literature, both normative and descriptive, as well as analyzing a number of real-life business ventures that we have accompanied during their planning and start-up phases in start-up support programs at our university. The visualization method is not covered in this paper, since the subject here is to examine the relationship between technology change and business model development.

Model components

Stated very simply, a business model must answer the questions “Who creates what value how” (Magretta 2002). To take account of the complexity of real life, we extend this set of questions by also giving answers to the questions “how much”, “when”, “where”, and “why”, providing information about all important parameters – business model components – for planning a start-up. The order in which these questions are answered in practice emerges from the way one analyzes a specific entrepreneurial venture. It is clear that since in some cases the answers to these questions do not make sense or are simply not available, they cannot and need not all be answered, at every point in time.

The most visible and accessible elements when thinking about a venture are the actors that are involved. Finding the actors answers the “who” question. The first actor to be identified usually is the start-up itself. Next in line are suppliers, customers, and consumers. We make a distinction between customers and consumers. This distinction is important for several reasons: First, the business opportunity may only be visible in the business model if the consumer, not just the customer, is taken into account. Second, a firm often has direct contact only with its customers, while the actual consumers are removed from direct contact. This can lead to misunderstandings regarding customer and consumer preferences about the value proposition of the product or service. Third, while a customer might often simply exchange a product for money, there are many cases where the connections are more complex and involve a network of multiple actors connected in a non-linear way. Partners mostly are some kind of service provider or enabler necessary for creating the value proposition inherent in the venture’s offering (e.g. advertisers, consultants, reviewers, licensors, universities). The final distinct class of actors are regulators (e.g. legislatures, state agencies or standards bodies) that can exert some kind of influence on the venture. All ventures are characterized by their capabilities and resources that are required to provide the offering and enable the execution of its envisaged business model processes.

As a further step in detailing, an actor is modeled as a combination of entity (or identity) and role. Actor entities can be single persons, other companies or organizations, or collections of these. Splitting the meaning of the actor element in two allows single entities to assume multiple roles in the same business model. This is important because different roles for a single entity may mean different and possibly contradicting preferences on the side of a supposedly monolithic actor, which in turn influences this actor’s behavior.

Decisions about which actors to include and which to exclude, in other words about the boundaries of a business model, can be taken by answering the “why” question or, more completely: “Why does this actor, in this role, act in this way?” The selection decision, then, is based on whether the actor generates value – both for the venture, leading to his inclusion into the business model, but also for himself, providing his motivation. For this, it is important to distinguish between the actor’s identity and his role, because motivation is based only on role, not on identity.

Since the venture’s network is an integral part of the business model, representing the relationships between actors – who are the main providers and controllers of the resources – is an important part of the business modeling process. These relationships also depend on the nature of social networks and the quality of relationships among the individuals engaged in the exchange. Relationships can be classified into social, political, and interpersonal dimensions. We model them in two forms: flows, describing the content of transactions, and influences, describing their governance.

Flows depict the transfer of a good, service, information, attention, or money from one actor to another. A flow always has a direction, and a dimension (size and unit of measure), thus answering the “how much” question. Existence of a flow-type relationship between actors may imply some kind of formal contract or agreement, but this is not necessary. Influence depicts a situation where one entity reduces or increases the range of options for another entity. “Entity” in this case can mean both actors and flows – the quantity of a flow can be influenced, as well as an actor directly. Examples for influences are laws, licenses, and advertising.
The combination of actors and relations into a network, finally, delivers the “where”. The relations between actors in the business model determine relative positioning of the actors in the value chain, allowing analysis and interpretation of relative importance which in turn can suggest modifications to the model in order to increase the entrepreneur's control of the venture. At this point, the type of the venture according to the canonical classification becomes clear: business-to-business, business-to-customer etc.

We introduce a dynamic component in order to track the development of the business model over time in reaction to changes in the environment. These changes may take the shape of new information, or new technology, becoming available, or of a different view of the business on the part of the entrepreneur. This is achieved by versioning the changing business models during the venture creation process. In practice, snapshots of the model are taken after significant changes, which can then be compared over time. Comparison of alternative business models during planning (before starting the venture) allows making decisions on these alternatives based on their different value creation potential. The same analysis of the business model evolving over time can show whether the planning process is moving in the direction of increasing the value creation potential.

In later stages of the venture creation process, the framework then serves as a base for identifying opportunities for changing and improving the current business model, thus facilitating change in order to stay on the path to continued success.

**RESEARCH DESIGN AND APPROACH**

The goal of this explorative study is to contribute to theory building in the field of entrepreneurship, with emphasis on the relationship between technological change and entrepreneurial activity, as well as on the influence of business modeling on enabling and encouraging change in the venture creation process. One interesting question here is what role external technology development plays in firms that do not have a product based directly on a new technological development. According to Yin (2002) and Flyvberg (2006), the key factors that underlay the proposed study, such as the complexity of the research topic, the nature of the study, the type of research questions, and the research purpose suggest the use of a qualitative methodological approach, and in particular multiple case studies which is a preferred method to study a complex social phenomenon deeply embedded within its real-life context (George & Bennett 2005, Hancock & Algozzine 2006, Stake 2005, Yin 2009). In line with this, Gartner and Birley (2002) regard multiple case studies research as an especially useful tool to understand the complex nature of entrepreneurship.

In a related study (Günzel & Wilker 2010) we assembled a set of fifty longitudinal case descriptions of start-up firms, both in Germany and the United States in six different industry sectors: information technology, retail, medicine, business and professional services, engineering, and logistics. Of these, 15 case descriptions were based on start-ups that took part in one of our university’s spin-off support programs.

In order to address our research questions, we first only looked at the 15 cases from our spin-off support programs, since our proximity to these local spin-offs over periods of several months enabled us to apply the BMDF while observing the development of the ventures’ business models, with continuous reactions and feedback from entrepreneurs themselves. To gain a comprehensive understanding of the researched relationships we applied the maximum variation strategy to select either firms that were not primarily technology-based, but exhibited changes in their business model due to external technology changes over time, or firms that were technology-based and in which technology had a strong influence on the chosen business model. An additional case selection criterion was that the person responsible for technology development or observation in the start-up was willing to cooperate with the data collection and review process required by the case study design.

We selected three cases from our collection depicting the range of technological discontinuity as needed. Data was collected from different relevant sources, in keeping with the triangulation of data sources suggested for this method to improve rigor and reduce misinterpretation (Hancock & Algozzine 2006, Makela & Turcan 2007, Yin 2009). For all cases we had access to written project-reports, business plans, meeting minutes as well as direct contact for any remaining open questions.

To structure this information we developed a robust coding protocol based on the BMDF approach. The descriptive codes were generated from our BMDF categories coupled with new themes that emerged from the data. Once coding was completed, we conducted in-depth case analyses highlighting the relationship between each company’s business model and technology, and the reasons for the observed linkages. In addition we applied pattern matching and cross-case synthesis to our case set. A single case study was written for each enterprise, in order to summarize the collected data from
different sources and especially the entrepreneurs’ personal opinions and considerations. The name of the companies has been disguised for reasons of confidentiality.

CASE STUDIES

This section presents the cases that best fit the selection criteria described above in overview form. Analysis and interpretation of the cases is the subject of the next section. Tab. 1 contains basic data on the three cases.

<table>
<thead>
<tr>
<th>Company</th>
<th>Industry</th>
<th>Year founded</th>
<th>Start-up support (months)</th>
<th>Sources used</th>
<th>Technology discontinuities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precious metals trader</td>
<td>Retail</td>
<td>2009</td>
<td>4</td>
<td>business plan, project report, feedback meetings, open sources</td>
<td>Technology adapting venture</td>
</tr>
<tr>
<td>Telemedical stroke care advisory service</td>
<td>Health Care</td>
<td>2010</td>
<td>8</td>
<td>Project proposal, project report, meetings, open sources</td>
<td>Technology advancing venture</td>
</tr>
<tr>
<td>Semi-conductor wafer manufacturer</td>
<td>Manuf.</td>
<td>2004</td>
<td>5</td>
<td>business plan, project report, feedback meetings, open sources</td>
<td>High-tech venture</td>
</tr>
</tbody>
</table>

Tab. 1: Case study characteristics

Case 1: Precious metals trader

The founder of this firm realized that certain segments of the precious metals market were very fragmented. Many people own inherited jewelry and decorative art on which they place no emotional or utilitarian value. The founder saw that since the monetary value of even small amounts of metal is considerable, these people would sell these metal objects if an easy way was available.

For a number of reasons, this usually is not the case. For most households, this would be a one-off transaction; therefore, they have no knowledge of market prices and price movements. Such buyers as are available, e.g. itinerant traders or backyard dealers, are viewed as untrustworthy. Fear of losses from a sale at disadvantageous conditions is great, and the expected gains from a sale are unclear or perceived as not large enough to warrant seeking further market information.

This was the situation when starting out: many small-scale households/sellers meet many equally small-scale buyers/traders, which in turn sell accumulated, but still relatively small, amounts to large, industrial smelters. Price information from spot markets is not available to sellers, who therefore have an incentive to not put too much trust in the small-scale buyers. In sum, this results in many uncompleted transactions, and many unused, but unsold pieces of jewelry.

The potential value of the sum of these transactions, however, is huge, since there are many households possessing such objects and thus can be considered as potential sellers. The wholesale side of the precious metal trade is a conventional, business-to-business market, with no barriers to access. The founder saw an opportunity for arbitrage in consolidating the large number of these transactions and positioning himself as a middleman between the potential sellers and industrial wholesalers. Analyzing the prevailing business model on the market, it becomes obvious that the main barrier to overcome is the lack of trust towards buyers on the side of the sellers.

The founder’s firm therefore designed and set up small store-in-store buying modules at established retail locations. These locations are selected for existing trust with customers: jeweler’s shops, department stores and other suitable retailers. The buying modules are designed to project transparency: metal prices are looked up in a frequently-updated list instead of being quoted from thin air, scales and appraisal equipment is standardized; every seller receives a printed receipt of the
transaction; there is no haggling or negotiation. Sales personnel are trained to perform the buying transaction in an appropriate manner. The firm also raises trust by marketing the service using a single brand. The small amounts of metal gathered at each location are then collected regularly, consolidated into larger batches and forwarded to a wholesale smelter and processor with a mark-up. In order to tap the full potential of the market, it was still necessary to set up a relatively large number of buying locations so that sellers would have easy access to one. This business model would have been unwieldy, if not impossible to implement in the large scale achieved without cheap and ubiquitous Internet communications and computers to keep track of the large number of small, widely distributed transactions which are necessary to generate sufficient profits. It is important to note that in the beginning, the business model was simple, with buyers in the center performing a classic trading role. The size of each market participant was small, while their number was relatively large. The new business model envisions bringing a large part – or the whole – of this market under the control of a single firm. The number of actors is still relatively large, and the type of transaction has become more complex: the sellers are in principle paid directly by the firm, while the retailers running the buying modules receive a commission. The provision of the infrastructure itself and the necessity of frequently updating price information at each location is a moderately complex undertaking as well. Most market activities in this business model were present beforehand – some transactions did take place, with small amounts of metal from private sources ending up in wholesalers’ smelters. However, the firm assembled the activities in a new way, configured some of them differently and, importantly, added standardization to the selling transaction, all in order to draw new sellers into the market. New actors were introduced: the retail locations that before had nothing to do with precious metals, but possessed customers’ trust.

**Case 2: Telemedical stroke care advisory service**

Strokes are a suddenly occurring medical emergency with potentially far-reaching and grave consequences. The window of time for treatment is extremely short – only four and a half hours – and possible long-term effects of the associated brain damage include failures of higher brain functions, of motor control and loss of memory. Rapid treatment is hampered by the necessity to precisely diagnose the type of stroke in order to select the proper therapy. Requirements for this diagnosis are basically a CT scanner for detailed imaging of the affected area of the brain, and a specialist physician to interpret the imagery and the patient’s behavior. CT scanners are generally available even at smaller hospitals receiving emergency patients. Stroke specialists, however, are rare relative to the availability of CT scanners and stroke cases. The necessary therapy, after the diagnosis has been ascertained, can in turn be performed by non-specialized physicians.

The traditional course of action for a suspected stroke case requires the first responders to transport the patient, if possible, to a hospital with a so-called stroke unit: a unit that maintains the medical equipment, the patient beds and the specialists required for stroke care on round-the-clock availability. Since strokes happen seldom enough to make it prohibitively expensive to maintain such a stroke unit in each and every hospital, a large part of the treatment time window is often wasted in forwarding patients over considerable distances to the nearest stroke unit. Many stroke cases are not treated at all because a timely diagnosis is not possible; therefore, the cost in terms of patient deaths and deterioration of quality of life for survivors is considerable, and an improvement of the situation would deliver savings in rehabilitation and long-term care.

Analysis of the “standard” business model for stroke care, along with the recognition that the combination of specialized diagnosis technique and simple therapy renders itself well to a technological approach, led the firm in this case to explore a new business model opportunity. The technology is relatively straightforward and not especially new: transmitting CT imagery of a suspected stroke case, along with interactive high-resolution video of the patient, over fast data networks from a suitably-equipped hospital without a stroke unit of its own (a so-called spoke) to a remote stroke unit with corresponding equipment (so-called hub), where a stroke specialist reviews the case and pronounces the diagnosis. Treatment and further therapy is then performed by physicians in the satellite clinic.

The relatively recent availability of these technological elements – fast data networks between hospitals, combined with high-resolution cameras that can be controlled remotely – enabled the exploitation of this entrepreneurial opportunity by the firm in this case. The founders decided to set up a hub service center as an independent organization offering the full spectrum of products and services necessary for a small hospital to become a spoke, with technology and support for remote image transmission and patient observation, stroke specialists that are on call for teleconsultations 24 hours every day, records and data management and billing. Customers are hospitals without neurological
experts, who are billed for services rendered, and who in turn bill their patients or their patients’ health insurer. The personnel working in the hub service center are occupied exclusively with teleconsultations and the support of the service; no patients are treated locally at the hub.

In the complex environment of the health care industry, relationships between actors are not as simple as in many other industries: for example, patients receive services from hospitals and doctors, but pay premiums to a health insurance provider. Hospitals, in turn, bill the health insurers. Regulation plays an important role in this industry and influences the relationships between the other actors. Money and services are often not exchanged directly, and the receiver of services often is not the payer. To cope with this situation, the founders developed a series of business models with different configurations of network partners before settling on the model that is taken to market.

Case 3: Semiconductor wafer manufacturer

Semiconductor wafers are an important material input for integrated circuits and other electronic components; therefore, a manufacturer able to offer wafers with unique, desirable properties for a given application holds a potentially powerful – and valuable – position in the industry’s value chain. On the other hand, the high speed of innovation in the industry threatens obsolescence in many ways. The necessity of close co-operation with a large number of partners for indispensable services, and the complexity and size of the value chains in the industry make it hard to exploit such a position. In this situation, the careful design and continuous adaption of the business model already is an important and difficult decision problem even for an established firm’s management. In this case, things are even more complicated.

Research results and experience in wafer manufacturing technology gained at a university were spun off into a start-up. The specific wafer material in question is necessary for the manufacture of electronic components for a number of applications in completely different markets, all of which are expected to grow at high rates over the medium to long term. This adds another dimension to the business modeling problem: Which and how many of these markets should the venture address?

The consumers – the final customers of finished goods – are removed from the case firm by several steps in the value chain: wafers go to component manufacturers, who supply parts to device manufacturers or integrators; these may produce finished goods, or several more intermediate steps may follow. The type and properties of the final products, however, have an impact on the total value generated, as well as on the proportion of this value that can be captured by the wafer manufacturer. In yet another dimension in the decision problem, the start-up could also perform any one or a combination of several possible roles in the value chain: it might become a manufacturer in its own right, or work as a technology and service provider to other manufacturers, or simply act as a licensor of intellectual property.

Since the semiconductor industry is in a state of mainly technology-driven change, the start-up’s management used business modeling to keep track of all strategic options and to investigate their effects on value creation and capture. Globally speaking, the firm’s situation is as follows: The venture itself consists of an R&D part close to the university and of a production arm, which are linked mainly through information exchanges. There are three market types, all of which might be served by the company. Suppliers are a necessary part of this business model, but are not critical since there are multiple sources for all inputs.

Analysis of the business model pointed out one decision option to the entrepreneurs, in which regulatory and demand-side pressure in the lighting industry leads to the expectation of high growth in the market for LED lighting, one of the markets in which the specialist wafers made by the start-up are indispensable, and therefore quite valuable. The situation allowed the start-up to enter a close partnership with, an LED manufacturer – in principle a customer – exchanging not only products and money, but also know-how on production processes, customer requirements and markets. This results in increasing sales through this channel on the one hand, while potentially reducing or even removing both any other LED manufacturers as well the other markets on the other hand. This situation can now be analyzed in more detail for its impact on the start-up’s value generation.

DISCUSSION OF THE CASES

The cases described in this chapter are selected to demonstrate the general utility of working with the BMDF in designing the business model in the venture creation process. Additionally, the framework can be used to design, alter and adapt the business model in accordance with changed environmental circumstances or changes implied by the company itself. At the same time, the cases and their business
models provide an interesting insight into the mutual influence of technological change and entrepreneurial activity.

Results of BMDF application in the cases

The precious metals trader case demonstrates how changes in technology can instigate entrepreneurial activity that does not have a technological development at the center, but uses the new technology as an enabler for a new, previously impossible or impractical business model. Here, the technological enabler was the availability of cheap communications via Internet and of powerful computers, which together made it possible to manage and control a widespread, but locally small-scale precious metals buying and arbitraging operation. The entrepreneur, after gaining knowledge of the market and the potential customers (private small-scale sellers of precious metals), was able to assemble a business model that introduced a new actor – the retailers hosting the store-in-store modules – and took advantage of these technological enablers to set up a profitable business. It is interesting to note that all elements of the new business model in this case were in existence before its design – even the trusted retail locations. The main contribution from the entrepreneur came from arranging the existing elements in a new way to generate value, and introducing a business model change in order to achieve this.

In contrast to the previous case, the telemedical stroke care advisory service is an example of high-technology product and service development driving business model change. The development of fast, ubiquitous data networks and of cheap high-resolution video cameras allows this firm to transform the business model of stroke care from transporting patients over long distances, with questionable prospects of success, to sending bits over networks. The important insight in this case is the role of the specialists and the time factor. The specialists are at the same time the most important and the scarcest element of the business model. The time factor is a limiting element: the length of the treatment window is fixed, and very short. The technology is very much at the center of the service delivered, since with its help, the old business model is basically turned on its head: instead of bringing the patient to the specialist, which takes a long time, the specialist is brought to the patient, which is easy and fast in comparison. The business modeling process helped the founders to make sure that the network of actors was always set up in such a way that everybody received a net gain in value under the new model. In the complex environment of the health care industry, this is no easy task.

In the case of the wafer manufacturer, the situation was different: a decidedly high-technology start-up tried to position itself in a global network of suppliers, partners, customers and consumers. At first, the business model looked simple – the firm would buy raw materials and sell a semi-finished good. Closer analysis, however, resulted in the realization that things were not that simple. On the one hand, the newly developed technology gave the entrepreneurs a large number of potential options for positioning; on the other, the firm’s environment was changing fast and had many unknown parameters. The firm’s business model had to keep track of these changes and uncertainties. It helped to keep this process organized by identifying the important elements of the venture and focusing the entrepreneur's attention on them. At the same time, the big picture was kept in view, to make sure that nothing important was overlooked. This provided the flexibility and adaptability that was essential for frequent changes and what-if experimentation during iterations in the firm’s venture creation process.

General effects of using the Business Model Dynamics Framework

From analyzing the business model, and comparing different versions and options, an entrepreneur can as described above gain insight into a number of areas.

Designing a new business model requires creativity, insight, and information. An entrepreneur may be able to intuit a new model, but not be able to rationalize and articulate it fully as in Case 1; so experimentation and learning is likely to be required. As mentioned earlier, the evolving reality that influences customers, the environment and the cost structure of the business must be understood. It is often the case that the right business model may not be apparent up front, and learning and adjustments will be necessary: new business models represent provisional solutions. A business model is provisional in the sense that it is likely to be replaced over time by an improved model that takes advantage of further technological or organizational innovations. Learning and adjusting are key issues to succeed in the market place.

One of the main tasks of an entrepreneur is generating, managing and ultimately harnessing a network of resources which often are not under his full control (Dubini & Aldrich 1991, Wickham 2006). Therefore, our approach puts its emphasis on describing this network as a starting point for further modeling work. The BMDF is designed to help the entrepreneur understand the structure and
environment of his venture, and supports his strategy design work. It clarifies the complex and ever-changing situation that is characteristic for the venture planning process, and highlights the value creation potential at every step during this process.

The positioning of and relationships between the actors shows their relative importance which may e.g. lead to emphasis on certain contract negotiations, or to the search for alternative actors or completely different ways of achieving certain goals. The first effect was an important contribution in the third case of the wafer manufacturer. In the stroke care advisory start-up in Case 2, business model design helped the entrepreneurs to turn the conventional way of doing things on its head. The degree of dependence on certain actors becomes known as well. From this, the entrepreneur builds a good overall understanding of the structure of his new venture. This is an important requirement for redesigning the business model, e.g. when considering what-if-scenarios, when reacting to new developments in suppliers’ products or if a newly developed product is tested with customers.

The business model also gives information about the network complexity. Since all elements in the model have a representation in the real world, and these real-world elements of the network need to be managed or controlled in some way by the entrepreneur, there is a limit to how complex a business model can be for a given managerial capacity. A start-up in the complex semiconductor industry is a good example of this situation, and the small company in our Case 3 was able to analyze the situation’s complexity in detail. The dynamic component of the framework allows for planning an orderly growth in this environment. In addition, early recognition of too-complex situations allows restructuring of the model before irreversible decisions are taken.

Finally, the model displays the value creation potential of the venture, with all its contributors, their importance, and their roles. The entrepreneur can tune the model, trying out different configurations of value-creating actors and relationships as in Case 1, thereby optimizing his profit-making ability. From this tuning work may in turn spring impulses for new developments in the entrepreneur’s technology and products as in Case 2 were new add-on services are now implemented for pre-clinical care.

The relationship between technological change and business model design

Technology use in new ventures influences the business model, in ways that result in changes in the business model in order to enhance the start-ups ability to act successfully in the market. We found three main types of relationships (see Tab. 2). First, for technology-adapting start-ups the business model is an enabler, because newly available technology on the market can enable the firm to implement a value-generating business model. Second, for technology-intensive start-ups, the business model based on the deployment of the technological core of the venture can help ensure that the technology actually delivers value. Third, for technology-advancing start-ups, the business model acts as a design and analysis agent by combining the above-mentioned tasks. The BMDF supports the process of analyzing, understanding and designing new links in the business model that take new technological aspects (external or internal) into consideration, adding value to the venture as a result.

<table>
<thead>
<tr>
<th>Start-up is …</th>
<th>Technology is …</th>
<th>Business Model main task</th>
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</thead>
<tbody>
<tr>
<td>Technology-adapting (Case 1)</td>
<td>BM enabler</td>
<td>Analysis – newly available technology may enable value-generating business model</td>
</tr>
<tr>
<td>Technology-intensive (Case 3)</td>
<td>BM driver</td>
<td>Design – the business model ensures that the technological core delivers value</td>
</tr>
<tr>
<td>Technology-advancing (Case 2)</td>
<td>BM enabler or driver</td>
<td>Analysis and design of value creation and capture</td>
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Tab. 2: Relationship between technological change and business model development

A start-up developing a new product or service can actively use the business model methodically in its development process. Early exposure of prototypes to customers and feedback gathered from this can be used explicitly to adapt both the business model as well as the product under development. The precious metals trader in Case 1 was able to follow this path: without large capital expenditures, the entrepreneur tested and refined the business model at a small scale, optimizing the design of the links between actors, before scaling it up. This goes hand in hand with the observation that technological change often provides the impetus for new and better ways to satisfy customer needs, as in Case 2. Generally, when the underlying technology changes, the business model must change too.
IMPLICATIONS

Implications for practitioners

This study is, by design intended to generate theory elements for further research. Despite this, the findings on the relationship of technology development and business model change described in the previous chapter lead to several implications for entrepreneurial practice, including entrepreneurs themselves, educators and policy makers in the area of entrepreneurship support.

The most obvious observation for entrepreneurial practice is the importance of a venture’s resource base and network structure, and the fact that these are not static, but dynamic elements. Continually adapting these elements to changes in technology, the environment and to new external challenges from the very start is an important driver of success. Entrepreneurs must first construct their resource, relationship and network base and build a foundation from which capabilities can be developed. People, relationships, and networks are as much a part of a business model as are technological dependencies and economic exchanges, and thus contribute to the venture’s success.

The process of working with the business model can be of great value for entrepreneurs. Planning the development of the venture, the business model gives them room to sort the available alternative paths for opportunity and market exploitation, based on the interrelation with available technology – both for product or service development and for business model purposes. The business model helps to understand the interrelations of network partners and activities. Since business model change plays such an important role, entrepreneurs should include it in their planning processes.

In entrepreneurship education, business modeling is a good vehicle for translating a creative idea or recognized opportunity into a real business concept. Given the time constraints imposed by most course programs, performing the necessary research to develop a fully-fledged business plan within a semester can be quite difficult, and often requires a lot of ancillary work by students that is not strictly useful for understanding the central ideas of entrepreneurship. Teaching business model-based entrepreneurship also allows much better illustration of the importance of evolving the business model during the venture creation process, since it is much easier to demonstrate and discuss this concept by means of a business model than it would be to discuss changes between multiple versions of a purely textual business plan.

For policy makers, the results on low-tech entrepreneurship may provide a motive to look into support programs that are not targeted exclusively on high-technology ventures. These could offer specific training in business model design and in using technology for business model innovation.

Implications for research

The approach underlying this analysis has several limitations. The results cannot be assumed to be typical of all businesses. Since we examined only cases from our university’s spin-off support programs, there may be a location or industry bias. The quality of the case descriptions may vary; despite our generally close proximity to the developing ventures, there may be differences in insight or access. This proximity may also cause personal biases, which we tried to reduce by discussing cases and interpretations among a number colleagues involved with the spin-offs. However, the detailed insights available from being able to take part in a new venture’s early development are, in our view, worth coping with these limitations.

In the course of our study, a number of insights, but also some open questions, were revealed. The usefulness of longitudinal studies of new ventures for research on business model development became apparent. Our data set has been built over a number of years. Ideally, these studies would be conducted in close proximity to and in cooperation with the founders. In this way, motivations and backgrounds of decisions can be documented, and details of business model elements and changes from one version to the next can be explained in context. The large effort required for this type of research will always be a barrier to creating large data sets quickly. However, certain start-up support programs, which mostly are conducted by public institutions (e.g. chambers of commerce, universities, innovation and business agencies), would be a good venue for anchoring such long-term research, with those programs most suitable that offer early-stage support.

Much previous research has high-tech entrepreneurship as its main subject. This is based to a large part on the belief that only high-technology firms can create meaningful value. Our findings on technology use in the design of new business models show that low-tech entrepreneurship can also be an equally interesting topic. In many cases, a start-up based on a specific technological development does not look very interesting from the business model perspective, especially if product, market and value proposition are obvious from the start. In contrast, for many low-tech ventures, the business
model – in its depiction of the value network – itself contains the core value proposition and is therefore of a considerably higher importance. An interesting question here is whether business model-based, low-tech, start-ups mainly exploit the “Internet effect” of cheap communications and easy management enabled by networked computers, or if there is genuine business model innovation; and if the latter, if there are identifiable common elements in those cases.

The business modelling process would benefit from further development of the BMDF method. Model comparisons and decisions based on business modelling could be improved with appropriate quantification of model elements, especially of flows and influences. Ideally, it should be possible to determine a quantifiable total value for a business model. This would at the same time be a first attempt at assessing the quality of a business model, which is important for conducting systematic design and development work as well as for business model research.

Finally, a search for success factors in business model development is indicated. This would entail looking at possible correlations between business model changes and growth or other desirable outcomes (e.g. winning investors or achieving profitability).

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