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Institutional Entrepreneurship Relay for Science-based Innovation

How Did World Class Regenerative Medicine Come about in Tampere, Finland?

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Abstract

This paper investigates the institutional change process underpinning the emergence of regenerative medicine and related medical innovation in Tampere, Finland. The main aim is to investigate how institutional entrepreneurship has influenced the course of events and what roles the key actors have played. The empirical analysis shows that institutional entrepreneurship is a multi-scalar and multi-actor force in time and, that no single actor has led the process in a conventional sense but there have been several actors who have played leading roles in different phases of the process. This paper shows that institutional entrepreneurship is a strategic relay of power and knowledge in time. This paper is based on the analysis of secondary data and 28 interviews of key actors.

INTRODUCTION

This paper provides the answer to the question: what do people do to influence the course of events in their efforts to create local conditions for science-based innovation? More specifically, the question is about how world-class regenerative medicine came about in Tampere, Finland

The point of departure here is that we need to complement the relatively established focus of regional innovation studies from investigating mainly organisations (actors as components of systems), rules of the game (institutions) and interaction patterns (networks) (see e.g. Braczyk, Cooke & Heidenreich, 1998; Cooke, Uranga & Etxebarria, 1997; Asheim & Isaksen 2002) and/or innovation activities, knowledge flows and knowledge bases (see e.g. Asheim & Gertler 2005; Asheim et al, 2006) towards the integration of better understanding of what people actually do when they aim to boost science-based innovation. This is not to argue

that the traditional focusing devices would be irrelevant or would not produce good results. On the contrary, there is still a lot to do so that we can better understand the dynamics of various innovation systems in differing contexts. The argument here is that studies focusing on regional innovation systems have been relatively blind to the roles various individuals play in the innovation world (Uyarra, 2010) and that by adopting more micro-level analytical frameworks we might learn more about interactive innovation processes and, most importantly, we might learn to understand better how various actors behave in these contexts; how they interact, relate and evolve with wider institutional constellations in their efforts to create something new.

From this premise, the paper investigates the institutional and organisational change underpinning the emergence and intentional creation of regenerative medicine in Tampere, Finland. A deeper understanding of innovation in healthcare remains a major challenge for research in the social sciences, as well as being a major concern for human well-being. In healthcare, there is a major need for innovation and renewal; a need to provide services for more people and a need to increase the quality of health services without any significant extra finance. In this wider context, this paper focuses on regenerative medicine that has progressed rapidly with tremendous hype as well as hope. The most positive commentators argue that regenerative medicine will become one of the three main forms of medical treatment alongside medication and surgery (Valtakari, Rajahonka & Tikkanen, 2007). The most negative commentators argue that regenerative medicine is full of empty promises and more hype than actual treatments (for more see: Brown 2003; Nadig 2009).

This paper shows how a new concentration of regenerative medicine with strong local and global connections was established in Tampere. Furthermore it shows what kind of institutional path, relay of actions and decisions led to the radical new treatments that were carried out for the first time, anywhere in the world. The main aims of this paper are:

a) to identify what drives the emergence of a new concentration of innovation in the field of regenerative medicine and stem cell research;
b) to identify what are the main institutions facilitating and/or hampering this process; and
c) to identify who are the main agents of change in the selected context, and how they influence the course of events and attack those very same institutions that frame their own actions.

To answer the questions set out here we follow Kay (2006: p.39) who says that 'to understand how institutions evolve, it may be more fruitful to aim for a more fine-grained analysis that seeks to identify what aspects of a specific institutional configuration are (or are not) negotiable and under what conditions'. Hence, the aim is also to show how it is possible to 'account for and understand the layering of institutions and their multi-scalar interaction' (Gertler, 2010: p.7) from a processual and human agency point of view. We endorse Gertler's view that too much micro-level analysis on regional development and innovation systems would not provide much insight on institutional change. As Gertler (2010: p.4) argues, there often is 'too much actor, not enough structure'. By adopting institutional entrepreneurship and leadership as key focusing devices it is possible to find a balance between structure and actor.

Regional innovation systems and the challenge to mould institutions

Innovation systems and institutions

We limit ourselves from discussing the concept of regional innovation systems in depth and simply refer to the extensive body of literature that provides students of innovation and regional development with an abundant body of conceptual tools and empirical insights to work with. This dynamic body of work shows how industries and firms are embedded in national, sectorial and/or regional systems of innovation (Lundvall 1992; Cooke, 2004; Malerba 2002) and how regional innovation systems are constructed on knowledge-creating and knowledge-utilising sub-systems (Autio, 1998). The various approaches on innovation systems stress, according to a narrow definition, 'interacting private and public firms, universities, and government agencies aiming at the production of science and technology' (Niosi et al, 1993), and 'networks of institutions that in interaction initiate, import, modify, and diffuse new technologies' (Freeman, 1987). Additionally, according to a broader view, innovation system studies focus broadly on organisations and institutions affecting and supporting learning and innovation, in practice, embracing potentially the entire society (Asheim & Gertler, 2005: p. 300.)

To summarise, the system of innovation encompasses the determinants of innovation processes, i.e. all important economic, social, political, organisational, and other institutional factors that influence the development, diffusion, and use of new knowledge (Edquist, 2008: p.5) and have an influence on individuals', firms' and organisations' learning capacity and hence on their ability to innovate (Lundvall, 1992; Lundvall et al, 2002). All this is supposed to produce 'new creations of economic significance', i.e. innovations that are widely accepted as primary sources of renewal in a global and capitalistic economy (e.g. Edquist, 2005). Consequently, to truly reinvent itself and boost innovation a region needs to be able to:

a) identify institutions that are locking it into the past or slowing its transformation down;
b) abolish and/or renew these institutions; and
c) create new institutions which support the emergence of a new development path.

Edquist (2008: p.15) raises the creation, abolishing, and changing of institutions as among the most important activities in maintaining (and also increasing) the dynamism of innovation systems.

On a general level, institutions that need to be moulded for innovation are 'the kinds of structures that matter most in the social realm' (Hodgson, 2006: p.2) and 'a relatively enduring collections of rules and organized practices, embedded in structures of meaning and resources that are relatively invariant in the face of turnover of individuals and relatively resilient to the idiosyncratic preferences and expectations of individuals and changing external circumstances' (March and Olsen 2005: p.4). Scott (2001) maintains that institutions are composed of regulative (rule setting, monitoring, rewarding and sanctioning activities), normative (values and norms that lay emphasis on rules that introduce a prescriptive, evaluative and obligatory dimension into social life) and cultural-cognitive elements (external frameworks shaping internal interpretation processes). More specifically, institutions framing and shaping innovation systems include intellectual property rights laws; various standards;

laws; environment, safety and ethical regulations; organisation-specific rules; industry specialisation and structure; governance structure; financial system; structure of the research and development (R&D); R&D investment routines; training and competence building systems as well as operational cultural factors (see e.g. Edquist 2005; 2008; Autio, 1998; Braczyk, Cooke & Heidenreich, 1998; Howells, 1999).

The nature of institutions and institutional change

When studying institutional change there is a danger to fall into a 'radical change trap' and focus mainly on those changes that are easy to detect and observe and, to see change as a discontinuous period between periods of stability and continuity. It might be more fruitful to approach change as a normal state of affairs instead of an anomaly (Pettigrew, 1992). This notion highlights the need to be more sensitive to gradual transformations instead of abrupt changes only. Incremental changes are not only reactive and adaptive for the protection of institutional continuity. Due to accumulation over longer periods of time subtle, seemingly minor changes can lead to considerable discontinuity that may surface beneath the apparent stability. Indeed, 'creeping change' (gradual transformation), suggests that there are no optimum states but a constant search is a core in institutional change processes (Streeck and Thelen, 2005). All this suggests that when studying institutional entrepreneurship we need to be sensitive to continuity and discontinuity as well as incremental and abrupt changes and their combinations.

The call for conscious efforts to mould institutions signifies that there ought to be actors who work to change those habits, conventions, and routines as well as constitutive rules and practices that prescribe what is appropriate behaviour for specific actors in specific situations (Morgan, 1997; March and Olsen, 2005). When considering this, and all those institutions that govern innovation systems, there is no doubt that 'changing institutions' is not a joyride. To create and change institutions and hence innovation systems requires meddling with complex reciprocal relationships between actors as well as untying the old ones.

Institutions are more often than not treated as constraining forces that regularise and select behaviour rather than sources of change and innovation. Institutions are normally seen as sources of stability and order (Scott, 2001: p.181), but this is a more theoretical than empirical understanding (Harty, 2005). First of all, it is believed here that institutions also have an enabling role (Hage, 2006; Hollingsworth, 2000; Scott, 2007) and second, that institutions ought to be interpreted both as an object of change itself and as a constraining, as well as an enabling and incentivising, structure for change (Soskice, 1999: p.102). These two beliefs reflect two other assumptions that guide this study:

a) there is a need for a deeper understanding of transformation processes of innovation systems at an institutional level (Lundvall et al, 2002: p. 225); and
b) this can be achieved by studying those actors who work to change institutions (institutional entrepreneurs).

The latter part reflects the belief that there are indeed actors who work to change institutions governing also their own behaviour. Even though institutions select behaviour (March and Olsen 1996: pp. 251-255) actors also have some freedom to operate (Jessop 2004: p. 40).

Therefore, institutions can be studied as outcomes of complex social processes and as such they are seen here as products of human agency (DiMaggio and Powell, 1991).

Institutional entrepreneurship as a key analytical focusing device

From components of systems to purposive actors

In the field of regional innovation studies it is habitual to see actors more as components of the system rather than as purposive agents (Uyarra & Flanagan, 2010: p. 683). As they argue further, innovation studies tend also to focus more on the presence or absence of predefined actors and institutions than on their roles, relationships, and performance not to mention the lack of discussion about the emergence, evolution, restructuring, or even disappearance of actors and institutions. Consequently, one of the central challenges in regional innovation system studies is to show how and why embedded actors become purposive, motivated and enabled to promote institutional change for innovation, and to that end we also need to discover how various individuals and groups exercise power and aim to influence (Sotarauta & Pulkkinen, 2011).

Institutional entrepreneurs are the core of endeavours to shape the institutional base for innovation. Institutional entrepreneurship provides an analytical framework to study what various agents do in cooperation or competition with each other to change institutions; how they interact, relate and evolve with wider institutional constellations. Especially important for this line of study is the notion that micro-agent change leads to macro-system evolution, i.e. before change at a macro-level can be seen, it takes place at many micro-levels simultaneously and, this allows us to find fresh approaches to understand institutional change from the bottom-up. These kinds of micro-approaches are usually more actor-centred than macro-approaches and more often than not they concentrate on entrepreneurial behaviour of innovative firms that give rise to knowledge creation and diffusion inside firms and within a region (Uyarra, 2010: pp. 122-123). However, the entrepreneurial behaviour of institutional entrepreneurs who are engaged in various efforts to change institutions framing innovation systems is more or less a neglected issue. Institutional entrepreneurship highlights agency, interests, legitimacy, strategy and power (Levy and Scully, 2007) in the analysis of regional innovation systems while the more conventional approaches highlight actors, institutions, interaction patterns and knowledge bases.

Indeed, it seems that 'one of the most common pitfalls of an institutional approach is the constant temptation to want to "read off" individual behaviour from national (or local) institutional structures' (Gertler, 2010: p. 5.) Consequently, this paper proposes that there is a need to address contemporary challenges in the field of (regional) innovation studies by analysing the encounters of institutional entrepreneurs and institutions, i.e., the ways in which actors aim to change the very institutions that govern their own activities. The proposition, however, does not involve predestined causality between actions of a single actor and/or groups of actors and institutional change. At best, institutional entrepreneurship studies are a form of process-oriented inquiry where the role of actors is fleshed out by analysing the change processes.

How do we know when we see an institutional entrepreneur?

Institutional entrepreneurship challenges some of the prevailing notions of institutional change as well as regional innovation systems. First, institutional entrepreneurship challenges the relatively shared notion that institutions select behaviour (March and Olsen, 1996: pp. 251-255) by arguing that in the final analysis actors actually have some freedom to operate (Jessop, 2004: p.40) and, that there are indeed actors who entrepreneurially work to change institutions (Battilana, 2006).

Institutional entrepreneurship refers to the 'activities of actors who have an interest in particular institutional arrangements and who leverage resources to create new institutions or to transform existing ones' (Garud, Hardy & Maguire, 2007: p.957) and, as a concept, it is mainly associated with DiMaggio (1988: p.14) who maintains that 'new institutions arise when organized actors with sufficient resources see in them an opportunity to realize interests that they value highly'. Institutional entrepreneurs can be organisations or groups of organisations or individuals or groups of individuals who act as change agents (Battilana, Leca & Boxenbaum, 2009) and hence, they are actors who initiate divergent changes and actively participate in the implementation of these changes. Therefore, only actors who initiate changes that break with the institutionalised template can be regarded as institutional entrepreneurs (Battilana, Leca & Boxenbaum, 2009: p.67). The endeavours to shape the institutional base for innovation systems reflect the many strategies adopted by relevant groups of actors aiming to break out from the past path and create new ones. Of course, it goes without saying that the freedom of institutional entrepreneurs to forge change is often limited in a world dominated by rigid structures, politics, major economic players and formal policies. Institutional entrepreneurship is a form of 'embedded agency'. These actors are constrained by the very same institutions they aim to mould (see more, concerning embedded agency, in Battilana, 2006; Leca and Naccache, 2006; Seo and Creed, 2002).

Consequently, institutional entrepreneurship needs to be studied with three perspectives in mind (see Sotarauta & Pulkkinen, 2011):

a) the *process* perspective that informs a study on the dynamism of regional innovation systems and secures a temporally conscious approach (regional innovation journeys are discussed in more detail below);
b) the *network* perspective that informs about the social relationships of the actors in and beyond a regional innovation system; and
c) the *governance* perspective that informs about the wider systemic issues framing and moulding both the actual systems and journeys as well as forms of institutional entrepreneurship.

A core belief underlying our approach is the importance of understanding interactions between actors and their institutional settings. It is more or less impossible to understand institutional entrepreneurship without understanding how actors shape institutions they are embedded into and how institutions shape their actions. This calls for relational, contextual and systemic understanding. The proposition here is not to take regional innovation studies towards leader-centric approaches. On the contrary, to study institutional entrepreneurship is to study forces changing the institutions governing innovation and hence, the proposition is to take innovation system studies towards a micro-level/processual approach by using institutional

entrepreneurs as analytical focusing devices to study regional innovation journeys, i.e. all those processes that for their part transform ordinary regions into innovation-driven ones (Benneworth, 2007: p.4). Our process and network-oriented approach locates institutional entrepreneurship not in the attributes of individuals but in the relationships connecting actors in an innovation journey.

Leadership capacity and institutional entrepreneurship

It goes without saying that conscious efforts to change the socio-economic-political setting for innovation requires changes not only in formal institutions but also in delicate inter-personal relationships between autonomous agents. This poses a great challenge not only for innovation policy and governance system but also for the leadership capacity of people engaged in boosting innovation systems in one way or another. It is also a challenge because moulding institutions and leading complex networks is a dynamic process while the literature deals mainly with static structural elements of regional innovation systems with less emphasis on temporal issues. In dynamic regional innovation systems institutional entrepreneurs need strong leadership capacity.

As Yukl (2002: p.2) concludes, most definitions of leadership involve a process whereby 'intentional influence is exerted by one person over other people to guide, structure, and facilitate activities and relationships in a group or organization'. Leadership scholars base their definitions of leadership on the nature of influence and the role of individuals who are defined as leaders. They often define leadership in terms of a group process, traits, behaviours, or as an instrument of goal achievement (Bass & Bass 2008 for a detailed review). In line with Yukl (2002), we define leadership as a process of influencing and teaching others to understand why and how certain activities and goals need to be accomplished. As such, it constitutes a process of facilitating individual and collective efforts to learn and accomplish shared goals. Leadership definitions include social influence and one of the leaders' key roles is to set a purpose or vision of change (e.g. Bass, 2008).

The much flagged 'stars of the knowledge era' (Silicon Valley, Cambridge, Boston, etc.) have provided the rest of the world with ways of how to construct competitive advantage, but as Benneworth (2007: p.12) maintains, 'ordinary regions typically face the challenge that they have an outdated understanding of their economy, and need to develop a new vision and understanding of how they can survive in the knowledge economy'. Indeed, as they push their view forward, 'the issue then becomes how regions can change their collective developmental model to something, which is more attuned to how their existing assets can produce global competitive advantage' (Benneworth 2007). In this kind of context, institutional entrepreneurship is fairly often seen simplistically as top-down command and control rather than a subtle and multifaceted process of pooling many kinds of capabilities, resources and power in time. By definition, it is more or less impossible to 'control' multi-actor efforts to promote regional innovation. Conscious efforts to boost regional innovation systems are constrained by a sense of what is possible and what is not as well as by legacies and forebodings. Indeed, the nature of regional innovation systems as an uncertain and ambiguous set of sub-processes is exactly why we highlight the need to study long-term processes from an institutional entrepreneurship perspective.

In spite of not discussing explicitly regional innovation systems Gibney, Copeland, & Murie (2009: p. 5) provide additional clues for the definition of leadership in this context by acknowledging that economic development increasingly calls for the integration of many earlier separate spheres of life, most notably economic, political and social life. As they also say, collective action requires a form of leadership that generates, renews and sustains the collective learning cycle over extended periods of time. As argued above, this kind of leadership is not time-limited but time-extensive. To make the challenge even more formidable, institutional entrepreneurs in innovation journeys need to look beyond the short-termism of performance goals and the mandatory (Gibney, Copeland, & Murie, 2009: p.9), i.e. everything under normal administrative radar.

Power and knowledge

If institutional entrepreneurship and leadership are not specialised roles but diffused processes in which different actors exercise different influences, the first question obviously is, who are they, and the second, how do they interact in time? The answer should not entail any predefined assumption based on formal positions but a careful process analysis on who have influenced and how and what kind of power base they have and how they exercise power in relation to other forms of power. Being aware of the fact that the concept of power is among the key concepts in social sciences, with its several dimensions and definitions and that there is a rich array of ways in which to conceptualise and study it, we define it here simply as 'the capacity of some persons to produce intended and foreseen effects on others' (Wrong, 1997: p. 2.). Hence, in power the question is about the actor's control of the behaviour of other actors. Of course, we also need to take into account the power of social systems and structures, i.e. the fact that institutions are actually both subjects and objects of change and/or stability. As Foucalt (1980) famously claims, belief systems gain power when groups of people accept a belief system and take it for granted. Belief systems define the arena for many actors, affect institutional design, and are often institutions in themselves (Foucault, 1980) and therefore, we also need to acknowledge networked relationships of power and see them as the relational effect of social interaction (Allen, 2003: pp. 2, 60-64).

Drawing on his empirical study on the power and influence tactics of Finnish regional development officers Sotarauta (2009: pp. 901-902) concludes that network power and interpretive power are the most important sources of influence in networked situations. The study shows that those actors having interpretive power can create a new vocabulary and a new way of seeing a region and its core activities and that actors having network power convene actors for dialogue and remove obstacles between various actors. Those actors having network power can utilise the resources and competencies of their partners, bring actors together, remove obstacles hindering communication, set the agenda, resolve conflict, enable information flow, build trust, link different matters to each other, orient people to their places and roles, inspire, excite, and so forth. Interpretive and network power are fairly invisible by nature. They do not refer to efforts to seek consensus but efforts to create common ground for shared thinking and joint efforts to transform the institutions for future. In the exercise of network power the significance of informal and personal contact networks as resources of

new information and credibility becomes important (Sotarauta, 2009). Power to frame issues discussed, to lead sense-making processes and hence to influence what issues are on the agenda and what are not, and consequently also who are involved in the interactive communication loop brings a significant amount of interpretive power to an actor who can actually do all this.

Even though interpretive and network power were highlighted in the study on regional development officers, we should not neglect the importance of institutional power and resource power. Institutional power refers to the power to act and decide and the power to create institutions and formulate official strategies, i.e. direct power exercised by official actors. Here, resource power is simply seen to refer to power to direct resources (see for more in detail Sotarauta, 2009: p. 902). In this study, we assume that the power exercised by institutional entrepreneurs is relational in nature and, that it is exercised either alone or in concert with other forms of power that in tandem draw as much from dialogue and interaction skills as on the expertise in substantial matters and legitimate power (power of an individual based on the relative position and duties of the holder of the position within a system) and formal authority. Therefore, it is assumed here that the forms of power institutional entrepreneurs exercise stretch from collective and integrative action (enabling, power to) to instrumental abilities that provide actors with influence at the expense of the others (power over) (Allen, 2003: pp. 51-52).

It is believed here that to mobilise actors from different walks of life with different resources of power and to pool their differing knowledge institutional entrepreneurship relay requires, alongside power, an integration of various forms of knowledge. The effective promotion of regenerative medicine, as will be argued below in more detail, requires in depth understanding and knowledge of the substance of stem cell research and regenerative medicine as well as tightly interlinked sciences supporting their development (substance knowledge). The process also requires a good view on how general policy processes and specific policy processes of that field come together (policy knowledge), what policies might serve the development process under scrutiny best, what their dynamics are, who the key people are and how issues can be pulled through the multiple chain of decision-making to secure funding and robust enough institutional positioning among all other possible recipients of funding and policy attention. In addition, there should be actors who know how people think in this field, what the driving forces of firms, researchers, and other key players in the field are, and what the right measures in building networks are in this specific field and how they can be linked to wider development efforts to gain more power (process knowledge).

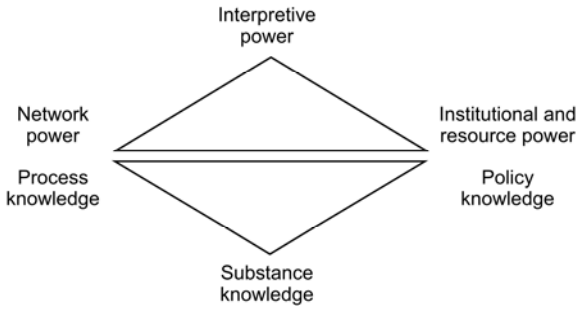

Figure 1. Power and knowledge in institutional entrepreneurship relays

The case, methodology and data

Stem cell research and regenerative medicine in a nutshell

The specific field of activity this paper focuses on is known as regenerative medicine and tissue engineering. The terms regenerative medicine and tissue engineering have different roots, but today they are used interchangeably. The term 'regenerative medicine' was created in 2000 and is now widely used to describe biomedical approaches to heal the body by stimulation on endogenous cells to repair damaged tissues, or transplantation of cells or engineered tissues to replace diseased or injured ones (Riazi, Kwon & Stanford, 2009). Thus, regenerative medicine refers to a group of biomedical approaches to clinical therapies that may involve the use of stem cells (Riazi, Kwon & Stanford, 2009; see also Lysagth, Jaklenec & Deweerd, 2007: p. 307; Mason & Dunnill, 2008b).

The roots of tissue engineering can be traced back to 1933, but the modern era did not begin before the outset of the 1980s as a result of the research community's increased knowledge and understanding of stem cell biology. Tissue engineering has been broadly defined as 'the design and construction in the laboratory of living, functional components that can be used for the maintenance, regeneration or replacement of malfunctioning tissues' (Polak & Bishop, 2006). Tissue engineering utilises cells as building blocks for regenerated tissues; the basic components of it are cells, scaffolds and signals.

Stem cells are cells, which are found in all multicellular organisms. The first observations of stem cells can be traced back to the mid-18th century, but research on stem cells has been developed over the last 6 decades, the most dynamically since the 1980s and 1990s (History of Stem Cell Research, 2010). Stem cells are able to regenerate tissues and organs and act as building blocks for all tissues in the body. Thus the potential of stem cells in clinical treatments is based on their multi-potent ability. Stem cells can be harvested from multiple sources, such as embryos, bone marrow and the stem cell populations of different organs and tissues (Nordforsk 2007; Regea 2010; NIH, 2010). The use of stem cells in cell-based therapies requires removing the cells from their natural habitat, growing them to a large number in a culture dish, and either directly grafting them into a specific tissue environment, or using them for the generation of cells or tissues intended for transplantation (Nordforsk, 2007).

Stem cell research can be divided into the research of *embryonic stem cells, adult stem cells and induced pluripotent stem cells (iPS)* (NIH, 2010).

Embryonic stem cells are derived from embryos. Embryos are usually received as donations from couples that have undergone in-vitro fertilisation treatments. They are not derived from eggs fertilised in a woman's body. These stem cells are the most promising cells for clinical application due to their great multi-potency. Neuron, muscle, fat, heart muscle and hepatocyte cells, among others, have been diversified from embryonic stem cells (Regea, 2010).

Adult stem cells can be isolated from the patient's own tissue. Cells have been identified in many organs and tissues such as adipose tissue or bone marrow. Cells can be cultivated in cell cultures and then transferred back into the patient (Regea, 2010; NIH, 2010). Adult stem cells are less multi-potent than embryonic stem cells. Bone, cartilage, fat, tendon and muscle cells, among others, can be diversified from adult stem cells. The diversified cells can be used e.g. in the treatment of musculoskeletal injuries. (Regea, 2010; NIH, 2010).

iPS, introduced by Japanese researchers in 2006, are adult cells that have been genetically reprogrammed to an embryonic stem cell-like state by being forced to express genes and factors important for maintaining the defining properties of embryonic stem cells. Generating pluripotent stem cells from normal adult cells opens up novel possibilities in regenerative medicine. Cells and tissues used in clinical transplantations could be derived from iPS cells generated from the patient's own cells thus avoiding immunological problems. In the near future, iPS cells are believed to offer new efficient tools for drug development and even for patient-specific drug development. However, there is still a lot of work to be done. The iPS cell methods are based on the use of different viruses and the risk of cancer for patients today is still remarkable (NIH, 2010; Bongso & Richards, 2004).

Stem cell research has grown rapidly in the 2000s and the scientific achievements have created hopes for new treatments of severe incurable diseases in the field of regenerative medicine and tissue engineering. The promise of regenerative medicine is very exciting indeed but simultaneously the cost of product development, and most notably clinical trials, for the high-end applications is very high. Scientists are required to convince governments, insurance companies and major pharmaceutical or device companies to open their 'deep pockets' for future developments (Mason and Dunnill, 2008a: p. 351.) At all events, regenerative medicine has created new hope for such incurable diseases as, for example, diabetes, Parkinson's disease, cancer and heart diseases. It is predicted that many of the diseases that are currently incurable or which require regular drug treatment will be beaten with therapies based on stem cell research and tissue engineering.

Stem cell research differs from other types of research, it faces constant complex ethical and legislative questions, which have a huge impact on the research. From an ethical point of view the most complex debate concerns embryonic stem cell research and the moral status of the human embryo (Nordforsk, 2007.) Some cultures and religious groups see that embryos have intrinsic value and they regard very early human embryos as individualised human entities. They consider that the life of a person starts at the fertilisation of the ovum. Thus, using an embryo to derive stem cells (thereby destroying the embryo) is tantamount to killing a baby (Wertz, 2002). Other doctrines hold different views of the embryo's moral status. At the other end there is a view of life, that a foetus outside the mother's body does not have the same value as a foetus within her body, thus it is ethically acceptable to use, for example, surplus embryos

from in-vitro fertilisation treatments in order to derive stem cell lines (Nordforsk, 2007).

Stem cell research is also a very specific subject matter to legislate. Only few countries have adopted legislation devoted to stem cell research per se. Much of the stem cell research, namely research on stem cells taken from born humans, is covered by statutes concerning clinical medical research in general. The legislation on human embryonic and stem cell research varies widely in Europe, from a total ban on all embryo research to permissive regimes allowing even the creation of embryos solely for research purposes (Nordforsk, 2007). The most permissive positions are held in Belgium, Spain, Sweden and the United Kingdom. The EGE (European Group of Ethics) categorises the European Union (EU) Member States into four distinct groups according to how they regulate research on human embryonic stem cells:

1. *Permissive position* (embryo creation is allowed for research purposes): Belgium, Spain, Sweden and the United Kingdom.
2. *Permissive position with restrictions* (human embryonic stem cell derivation is allowed from embryos created as a result of assisted reproduction technology and in vitro fertilisation): e.g. Czech Republic, Denmark, Finland, France, Greece, Iceland, the Netherlands, Norway and Portugal.
3. *Restrictive position* (derivation of new human embryonic stem cell lines is restricted, but importation (under certain conditions) is allowed: Germany and Italy
4. *No specific legislation* e.g. Bulgaria, Cyprus, Estonia, Ireland, Luxembourg, Latvia, and Romania. However, some countries have indicated in the EU process that they are against human embryonic stem cell research although they do not currently have specific legislation covering it (e.g. Austria, Lithuania, Malta, Poland and Slovakia).

   (Nordforsk, 2007)

In Finland, the legislation is permissive with some restrictions. Dating back to 1999 (9.4.1999/488) the Medical Research Act (Research Act) regulates Finnish stem cell research. It applies to research on born human beings, human foetuses and embryos. The law permits the research on surplus embryos for up to 14 days from the fertilisation and storage of embryos for up to 15 years. The creation of embryos for research by way of fertilisation is prohibited. The research to enable reproductive cloning is also prohibited. In addition to the Medical Research Act, the Act of the Medical Use of Human Organs, Tissues and Cells (Tissue Act) (2.2.2001/101) also stipulates the use of human embryos. The main difference between these two acts is that the Medical Research Act covers research on living foetuses inside a uterus, whereas the Tissue Act applies to research on dead human foetuses and stem cells derived from them (Finnish National Ethics Committees 2005.)

The ethical issues and legislation have a huge impact on stem cell research. In Finland, the ethical atmosphere has been permissive – due partly to the Protestant, Lutheran religion (Nordforsk, 2007). The legislation has also been permissive, but the problem is that all the boundaries for the research are not fully covered by the legislation at the moment. From a global perspective ethical and legislative questions are relevant. For example, in the USA president George W. Bush forbade the creation of stem cell lines with public finance. Bush forbade public finance for the research of embryonic stem cells concerning the lines created after 2001. He also forbade public finance for cloning research. Radically reduced finance had a huge impact for the researchers as well as the geographical focus of the global research networks (Nordforsk, 2007; Finnish National Ethics Committees, 2005).

Regenerative medicine in Tampere

The case specific research question addressed in this article is: How did world class regenerative medicine come about in Tampere, Finland? The Regea Institute for Regenerative Medicine is the core of this narrative case and the regenerative medicine concentration in Tampere as well as being one of the cornerstones of the local biomaterial concentration. Established in 2005 Regea is a joint institute under the administration of the University of Tampere. Regea was founded by the University of Tampere, Tampere University of Technology, Pirkanmaa Hospital District, Pirkanmaa University of Applied Sciences and Coxa, the Hospital for Joint Replacement. Regea's activities are based on three foundation pillars: research, tissue bank operations and other services (e.g. renting clean room facilities, consulting, etc.). The focal research areas are stem cell research and research combining stem cells and biomaterials. The main goal is to focus on such R&D that enables the design of new forms of treatments based on tissue engineering. Although Regea is an academic institute under the auspices of a university, its focus is distinctly on clinical applications, not primarily on basic research. Therefore, Regea's motto 'from research to clinical care' describes its strategy well. Regea started to conduct stem cell research in the beginning of 2005, and succeeded in implementing the first clinical treatment in 2007 (Regea, 2010).

In 2009 Regea's budget was €3.7 million. The basic funding from the University of Tampere covered about one-fifth of the total budget. The rest of the budget has mostly been generated through project funding from such funding bodies as the Finnish Funding Agency for Technology and Innovation (Tekes), the Academy of Finland (research councils) and the Employment and Economic Development Centre[11]. Additionally, grants from other funding bodies, foundations and associations have formed an important part in the funding of Regea. It has also received some private donations every year. Only three of the total personnel of round 50–60 (including doctoral students) have permanent positions while the others are employed by fixed-term contracts because of the non-permanent nature of the funding. On top of that there are 20 students preparing their advanced special studies of final theses or working as trainees (Regea, 2009).

Stem cell research and tissue engineering utilise several technology areas such as biotechnology, biomaterials and biomedical technology. The research, tissue bank operations and the clinical work in Regea are thus conducted in close collaboration with clinicians, cell biologists, technical experts, animal model experts and so on (Regea, 2010). Thus, Regea has numerous partners both in and outside Tampere. One of the strategic partners is the Tampere University of Technology. Its department of Biomedical Engineering represents the highest expertise in biomaterials and tissue engineering as well as biomeasuring in Finland. Thus, the research groups working at Tampere University of Technology supplement Regea's know-how in cell growing and tissue engineering.

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1 From the beginning of the year 2010 Centres for Economic Development, Transport and the Environment.

Data and methodology

The study comprised four main phases. The first phase was a literature review of the theoretical framework focusing especially on institutional entrepreneurship in the context of regional innovation systems and science-based innovation (see also Sotarauta & Pulkkinen, 2011). The second phase consisted of the literature review of the history of Regea as well as stem cell research based on written material from the Internet, relevant journals, dozens of related newspaper articles, annual reports of Regea, respective policy documents as well as minutes of Regea's founding planning group. Drawing on the secondary data the history of Regea and related activities were constructed chronologically. The main aim of this exercise was to describe the case and its evolution from the early days to the present day at a general level with the focus being on a sequence of events and critical incidents. The main aim of this phase was to identify a generic development pattern for further data gathering and analysis.

In the third phase, 28 people were interviewed. The average duration of the interviews was 70 minutes the longest interview lasting 90 minutes and the shortest 30 minutes. Six of the interviewees were employees of Regea (the director, the team leaders and the quality manager), and the rest of the interviewees were from local and regional development agencies, Tampere University Hospital, Universities, the Finnish Funding Agency for Technology and Innovation and Finnish Medicines Agency. All the interviews were recorded and transcribed into written format. The interviews followed the idea of the narrative interview (see Czarniawska, 2006) that was augmented with thematic clarifications. The themes were:

1. *Temporal change*: what happened and why while the interviewee participated in the process, what were the critical incidents and significant events, why were they significant? What actually happened and when, and who did what in these events? When did these events occur?
2. *Institutions*: what kind of institutions enabled and/or hampered the regenerative medicine development in Tampere, how were institutional obstacles crossed?
3. *The roles of the actors*: Who influenced the course of events, how and why?

In all the above-mentioned themes the main aim was to construct a narrative of the sequence of events to identify the actions of key people in their efforts to influence the course of events for regenerative medicine and thus to find out what drives the emergence of a science-based innovation concentration and how these kind of change processes are intentionally directed to serve several fields of interest. Finally, at the fourth phase, the analysis was carried out from three perspectives, already raised above, in mind (the process, network and governance perspectives) the main aim being to find the place and nature of institutional entrepreneurship in innovation systems.

The unfolding sequence of events and institutional entrepreneurs carrying the relay

How to grow an upper jaw within a stomach muscle? Successful treatments as a point of departure for the process analysis

The point of departure here is the fact that in 2008, for the first time in the world, a patient's upper jaw was replaced with a bone transplant cultivated from the stem cells isolated from the patient's own fatty tissue. The patient had lost roughly half of his upper jaw because of cancer. After the treatment the patient has been able to live a normal life with a normal upper jaw. Regea, with its collaborators, created the technology and Helsinki University Hospital carried out the surgery. In the process, the scientists were able to produce new bone cells by combining stem cells and biomaterials and then growing them into a jawbone of the correct shape and size (with the aid of a titanium frame) inside the patient's stomach muscle. In six months the contents ossified and were filled with blood vessels and thus the designed bone and the surrounding muscle were removed together with their blood vessels and fitted in place (Bionext, 2010; Suomen Kuvalehti, 2008). This operation was a continuation of the successful clinical treatments of 2007, in which two deficiency patients were treated, jointly with the Tampere University Hospital, with a combination of fat stem cells and biomaterials. These treatments were also based on the adult stem cell technology developed at Regea. By the end of 2010, based on the technologies developed by Regea and its collaborators, approximately 30 patients with serious bone deficiencies had been treated in Finnish hospitals (Bionext, 2010). As a comparison, by early 2010, analogous treatments (external to the Regea network) have been received by only one patient in Germany (Tekes, 2010). The special feature in Regea's technology is that no material derived from animals is used in the stem cell cultivation processes, which makes stem cells suitable for direct transplants to humans.

The emergence of regenerative medicine in Tampere can be divided into four main phases:

a) seeds of change;
b) constructed collective interpretation;
c) launch of activity; and
d) hanging institutionalisation.

In practice, the four phases in combination is about a long institutional change process and institutional entrepreneurship relay.

Seeds of change

The strength and the competitive advantage of Regea's research is that it combines stem cells and biomaterials. It continues the established and acknowledged science-based capacity in Tampere for research and innovation in biomaterial and tissue engineering that has engendered several spin-off firms in the field. The emergence of regenerative medicine in Tampere, and Regea at its core, was not a result of serendipity but of a conscious search for ways to strengthen the existing local biomaterial concentration and to find new possibilities in the intersections of biomaterials, tissue engineering and stem cell research.

The local roots of the biomaterial cluster and, hence also those of Regea, originate in Professor Pertti Törmälä's and surgeon Pentti Rokkanen's breakthrough in 1986 when, in a world first, they produced a bioabsorbable screw for repairing bone fractures. Törmälä and Rokkanen had been developing bioabsorbable bone screws and pins with their research groups since the mid 1970s. In the mid 1980s, Törmälä and his group established the first two enterprises to launch new products for the European and US markets. Since then the industry has evolved and today Tampere is acknowledged as one of the key centres of biomaterials in Finland (Restructuring and Development of Biosciences in Finland, 2007). In addition, the research on adult fat stem cells at the University of Tampere and the research on biomeasuring (biological and physiological measurement of human beings) conducted at the Tampere University of Technology and Technical Research Center of Finland (VTT) formed the basis for the local science capacity on stem cells and regenerative medicine.

In the late 1990s, Professor Timo Ylikomi from the University of Tampere, and the above-mentioned Professor Pertti Törmälä from Tampere University of Technology, took the lead in initiating a new development trajectory that eventually led to the above introduced facial bone replacements. Both of them believed that there is 'something more' in their research, and more widely in their field, something that, if applied correctly, might lead either to new business or other forms of societal benefits. Of course, at that time they were not fully capable of convincing other actors of what kind of solutions might emerge from their research if correctly cultivated.

Drawing from their research groups and local expertise on biomaterials and adult fat stem cells they both introduced individually the idea of having an organisation for regenerative medicine in Tampere. The idea was fresh at that time; the first global findings in the field of stem cell technology were found only a few decades ago and the 'human spare parts' industry had just begun to emerge. Instead of their universities they both approached local and regional development agencies with their ideas and launched a series of informal discussions about the possibilities of having an organisation for regenerative medicine in Tampere. They were prevented from fast action by two institutional obstacles:

a) the academic orientation of the University of Tampere rather than a proactive search for new innovations or business ventures slowed Professor Ylikomi down somewhat in the early days; and especially
b) the scarcity of funds and know-how in supporting innovation and commercialisation.

At all events, from the early beginning the core idea was to establish a firm to exploit emerging global opportunities and local expertise. The planning for the forthcoming business venture relied on the local and regional economic development community.

Fortunately the enabling factors were stronger than the preventing factors. The major enabling factor to initiate the process was the conviction of the professors that science needs to be translated into practice. For these two professors science is not only something that is debated and developed within the scientific community but something that pushes some aspects of society forward. Related to that Törmälä's experience that this actually can be done as well as him being a local role model in translating science into practice gave a strong push. Additionally, at that time academics and the local economic development policy community

already had a forthright locally embedded collaborative relationship that made it fairly easy for the professors to seek help outside academia.

It should be noted that in retrospect it is possible to see what the outcomes of the science in question has been and, the successful treatments provide us with a convincing story that there was indeed something in the air. However, at that time, nobody was able exhaustively to explain what the possible outcomes might be and hence the first steps were hard to take. This is hardly a novel situation in the advent of a science-based innovation. By definition, innovation challenges prevailing mind-sets and practices and, innovation is usually born in ambiguity, uncertainty and a lack of clear vision (Lester & Piore 2004) and, as in this case, the inventors are able to discuss their work in professional language but what they often lack is the capacity to simplify the story and convince the resource-holders outside the scientific core about the future potential. It is also hard for policy-makers, funding bodies and possible beneficiaries to see the actual innovation through the hazy cloud of scientific reasoning flavoured by general noise generated by hype and hope, speculations and often fairly hollow innovation policy rhetoric that is more embedded in wishful thinking than factual evidence.

In the seeds of change phase, the professors clearly took the lead in pushing their ideas forward and making them visible. They did not have the power required to take major steps forward by themselves nor knowledge on policies and processes about how to do it. They were able to push the relay forward to the second phase towards the local and regional development regime and hence towards the creation of collective interpretation because of their substance knowledge being deep, reputations as solid scientists being robust and by having adequate links to outside their immediate academic spheres.

Emergence of a collective interpretation

Even though the two professors opened a new development path, and in retrospect can be labelled institutional entrepreneurs, it is important to note that they did not work alone. The professors, as prominent as they were in their own fields, were not fully able to describe what the benefits, products and/or treatments based on the research might be. For these reasons, and from the outset, they started to use their network power to engage core actors, both from academia and policy community, in deliberations on how to proceed and what actually might be at stake in this field of research. The professors were able to tell convincing enough stories about their research and its potential to engage regional development agencies and other experts in collective deliberations about how to proceed and what might be gained by the commercialisation of this kind of research. Hence, they started attracting attention and, consequently, a local support community external to the academic spheres emerged to support their search for new solutions to exploit the opportunities 'in the air'. At this phase, the support community appears as a crucial enabling factor for the institutional entrepreneurship relay to proceed without breaking. We define support community as a group of people having a feeling of fellowship with others, as a result of sharing common attitudes, interests, and objectives towards the willingness to provide the process with all possible assistance at their disposal.

In this case, the support community consisted of the local and regional economic development actors as well as selected experts from the universities and the Tampere University Hospital.

The Centre of Expertise Programme for Health Care Technology proved to be especially beneficial for the continuation of the relay. First, working for the programme there were development officers whose job it was to boost university- society (incl. business) interaction in the fields relevant for this case, second, they followed closely the latest developments in the field and were quick to realise that there was indeed a lot of potential in the local human fat and biomaterial research. Consequently, in collaboration with other local and regional development agencies, they were able to take the lead in making the issue more understandable also for the wider policy audience, decision makers and resource holders.

Simultaneously, with the intensifying local discussions, the tissue engineering industry (regenerative medicine) witnessed an ever-accelerating global growth (Lysaght & Reyes, 2001). This, of course, boosted enthusiasm and belief in the local capacity and, fairly quickly the core group decided to aim for a global business instead of strengthening the local research capacity. An official planning group was assigned that was excited about the global prospects and composed a business plan for a new business venture by the funding of the Employment and Economic Development Centre (state development agency at a regional level). Everything looked promising; in early 2002 there was a strong belief that the new venture would obtain funding from venture capitalists. However, in the course of 2002 the situation began to change and already by the end of 2002 it became obvious that there was more global hype and hope than real business opportunities. Even though the number of firms active in the field globally did not decline dramatically, the financial community's faith in tissue engineering began to diminish (Lysaght & Hazlehurst, 2004). Despite the public sector's investments in R&D the industry had not yet succeeded in producing a single profitable and commercially successful product (Lysaght & Hazlehurst, 2004). The technology was not mature enough and true business opportunities were too far in the horizon. Consequently, the local planning group in Tampere realised that it is not possible to accomplish the business plan; there was no global business. At this stage the institutional entrepreneurship relay might have broken down. There was no business and hence no venture capital, the entire field appeared risky and enthusiasm started to wither away. But it did not wither away totally. The local potential was seen as too promising not to be developed further and therefore, the discussion moved to emphasise both the basic and applied research idea being that if there is no business opportunity then let the research capacity at the university be strengthened by launching a major research project.

In the collective interpretation phase the key actor was the assigned planning group with adequate substance knowledge about stem cell research and regenerative medicine complemented with the interpretive power to make the wider societal and economic potential visible as well as adequate policy knowledge to identify local, regional, national and international policies that could be used as funding sources. The support community consisted of local and regional development agencies as well as university and clinical actors (from the university hospital) and hence substance knowledge met understanding of the policy jungle. Additionally, the fact that the planning group was able to create a convincing interpretation of the science-based business potential and to quickly adjust thus emerged collective interpretation in the light of new global developments proved important to keep the relay going and move from interpretation to action.

The launch of activity

As indicated above, when the belief in business opportunities faded away the key actors started preparing more academic and clinical involvement. Instead of establishing a business venture the launch of activity included three main actions:

a) the establishment of a tissue bank[22];
b) the eventual establishment of the Regea Institute for Regenerative Medicine; and
c) the recruitment of highly skilled person(s) to lead Regea.

The launch of activity and the continuation of the institutional entrepreneurship relay, saw not only new emphasis but also new actors taking the lead and, the ones having been on the front in the previous phases gradually moved to become backstage operators.

After a series of negotiations between all the main parties in 2002, the Employment and Economic Development Centre committed to take part in the funding of Regea's establishment and especially the funding of a GMP (Good Manufacturing Practices) level laboratory and clean room facilities. Another important funding body was the Pirkanmaa Hospital District (which owns and runs Tampere University Hospital). One of the reasons behind the decision of the Pirkanmaa Hospital District to become involved in Regea's establishment was that at the same time the quality requirements for tissue bank operations changed dramatically. In Finland, the tissue bank operations had typically been taken care of by the hospitals by themselves. The staff had usually taken care of it in addition to their own duties. In the beginning of the 2000s the new National Tissue Act and European Union's Tissues and Cell Directive (2004/23/EC) set strict quality requirements for tissue banks storing and handling human tissues. The new institutional regulations set a challenge for hospitals to modify their facilities to an adequate level. The Pirkanmaa Hospital District had two options: they were either to reorganise and upscale their own tissue bank internally or to outsource the operations to some other organisation with the required facilities. Regea, with new facilities to be built up, was a good option to cope with the changing situation.

The collective interpretation created in phase two proved to be enticing enough. Now there was a broader interpretation of the prospects and requirements of regenerative medicine, a concrete project to work with and making a tissue bank was a crucial step for future development. At this point, it was significantly easier for the resource holders and decision makers to see what might lie ahead. Also the leadership of the University of Tampere came along and consequently Regea was established as a research project in 2004 under the Institute of Medical Technology at the University of Tampere. Later, in 2005, it became an independent joint institute under the administration of the University of Tampere but being founded and run in collaboration between the University of Tampere, Tampere University of Technology, Pirkanmaa Hospital District, Tampere University of Applied Sciences and the Coxa Hospital for Joint Replacement. Oral and maxillofacial surgeon Riitta Suuronen was invited to become the director of Regea. She was the first person to be recruited and from that humble start Regea has grown in a few years to be a prominent research centre with 60 employees. Professor

2 Tissue bank is an organisation dealing with the operations pertaining to the handling, preservation, storage, and/or distribution of human-based tissues or cells. The tissue organisation may also be responsible for the acquisition and research of the tissues and cells. (Source: Regea)

Suuronen herself has said that in the beginning there was basically nothing; she was asked to join the University of Tampere and Regea by a promise that 'there is no money, no faculty, no premises but some prospects and ambitious goals'.

At that stage, it seemed like there were only enabling factors such as a strong knowledge base and research capacity in the field, endowed professorship to the University of Tampere by the city of Tampere and successful recruitments. The most visible of the recruitments, due to professorship endowed by the City of Tampere, occurred when Regea succeeded in recruiting a world-leading Finnish scholar, Professor Outi Hovatta, from Karolinska Institutet in Sweden to Regea. Professor Hovatta is one of the leading stem cell researchers in the world. She has a long internationally recognised career in the fields of fertility treatments and stem cell research. Professor Hovatta's credit in Regea's early days was twofold:

a) Regea's stem cell research began quickly because of her know-how and she also brought along the first seven embryonic lines from Karolinska Institutet to Regea, which was one of the reasons behind the expeditious start of stem cell research in Tampere.
b) By appointing professor Hovatta Regea, who also became more or less instantly a credible player in the academic and funding spheres, Regea also gained a lot of media visibility in Finland.

A few years later, in 2008 Hovatta resigned from Regea and continued her research work at the Karolinska Institutet and at the University of Kuopio in Finland. Of course, as stated above, the changing legislation and consequent establishment of the tissue bank operations also had a remarkable role in enabling the surface of Regea. In addition, the atmosphere for new innovative ideas in the field of biotechnology was favourable in Tampere. In 2003, the City of Tampere launched the BioneXt Tampere programme aimed at further developing the city's biotechnology sector[3]. The programme also aimed to set up new openings in the field of biotechnology. Regea fulfilled this objective perfectly; it was a long sought after new piece in a larger constantly emerging puzzle.

In the launch of the activity phase the lead of the relay moved from the support community back to the university and, after her recruitment especially, to Regea's director. Simultaneously, the support community started to change gradually. If it earlier consisted of local and regional development agencies possessing policy and process knowledge, now the research and clinical community with the substance knowledge took a more prominent role. This also meant that the policy and process knowledge started to diminish and substance knowledge began to be the main driver again. Prior to the establishment of Regea, policy and process knowledge in concert with institutional and network power were needed to carry the relay forward but after the launch of tissue bank and research projects the process stabilised to fairly standard research operations for a while, but not for long. Already at this phase, it was obvious that regenerative medicine was not fully institutionalised in Tampere. In practice Regea was a collection of projects and only the core management personnel (director, quality manager, a secretary) had a permanent contract with the university and everybody else was employed on a temporary basis.

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3 BioneXt Tampere is an investment and development programme that focuses on biotechnological education, top-level research, product development, clinical application and possibilities in international commercialisation. The programme unites the strong technological expertise in the Tampere region with new biological and medical research (Bionext, 2010).

In Finland, as critics argue, innovation is preferred to basic research funding and the entire system is based on funding fixed-term (relatively short) projects instead of long-term research or structures and the lack of financial capacity to invest in new openings at the universities (for the evaluation of the Finnish national innovation system see Veugelars et al, 2009). The regenerative medicine case under scrutiny here seems to verify these observations. The characteristics typical of the Finnish innovation and science policies make the system fairly dynamic and enable integration of various policies and funding sources to support bottom-up initiatives but simultaneously it makes the institutionalisation of new and promising developments difficult.

The regenerative medicine case indicates that during the critical incidents the role of local and regional development agencies becomes more pronounced. The academic community is not capable of navigating in the midst of several policies and power regimes. For example, in the case under investigation here, the question is not only about innovation policy but also about science policy, healthcare policy, local and regional economic development policy as well as individual decisions of such big players as universities and the university hospital. Local and regional development agencies may not have abundant financial resources or much understanding on the substance in question but at their best they are the ones who can influence across the sectors and enable a collective dominant interpretation to emerge (see also Sotarauta 2009 and 2010).

In a way, the third phase ended with excitement and prospects that characterised the early phases too. The institute was established; the first treatments were great successes that guaranteed not only scientific and clinical credentials but also global media attention. The future appeared as nothing but glorious. In practice, the relay was far from the goal line. Regenerative medicine in Tampere was still more a collection of research projects than an established research and innovation concentration. The collective interpretation had been translated into activity but new challenges lay ahead: how to institutionalise regenerative medicine in Tampere? Who would carry the relay forward?

The hanging institutionalisation

Breakthrough operations opened up new ways to treat severe tissue damage and made the prospects of custom-made living spare parts for humans a step closer to reality. Obviously, success in implementing the first pioneering operations has paved Regea's way towards standardised clinical treatments and the 'business' of human spare parts. However, in the advent of the fourth phase, there is clearly a lack of knowledge and power to make Tampere's regenerative medicine a permanent element in the Finnish science and innovation system. One might argue that it is still hanging in the air and even though the future prospects are obvious and promising there are also several strategic issues. One of the main issues is the commercialisation of the created technology with limited financial resources available in the country. There have been several attempts to find a way to do this but so far the board of Regea and related actors have not been able to find a way to accomplish it viably and from Finland without selling the patents abroad.

Second, among the strategically important issues is also whether, how and when Tampere University Hospital, or some another hospital, would change its routines to integrate regenerative

medicine into its standard repertoire. At this point in time, according to our interviewees, the treatments are hugely expensive but without them becoming a standard part of the hospital operations the cost will not decrease. There have been some initial discussions to establish a 'Tampere Hospital for Advanced Therapies' that would serve not only Finnish taxpayers but also as a hub for healthcare tourism especially in the field of facial bone replacements. However, at the time of writing, there is no indication as to whether this initiative will move forward or not. Additionally, if the number of treatments were to grow, Regea would need to go through a series of expensive clinical trials necessitated by the pharmaceutical legislation. So far the institutional obstacles have kept the number of treatments at a low level. The third strategic issue is that while Regea's reputation is growing rapidly so is the key persons' global visibility and reputation. Consequently, one of the main issues is that the key persons may leave Tampere to go abroad to gain a more established position without the constant need to hunt for external funding.

Fourth, regenerative medicine is a field of science that requires patient and long-term funding to revolutionise medical care and, therefore the main issues also include the scarcity of long-term research funding in the system as a whole and within the universities (University of Tampere and Tampere University of Technology) involved in the process. In 2010, the universities were negotiating and planning for a joint Faculty (Faculty of Medical Technology [working name]) that would integrate the main departments and research groups from two universities into one entity. This, of course, can only serve as a partial solution but is a step forward nonetheless.

The institutional entrepreneurship relay will not move forward to the institutionalisation of regenerative medicine in Tampere without reborn support from the outside research and clinical community. What is now needed is 'big institutional and resource power' to channel adequate resources to something that has proven its innovative capacity and global reach. Here, also a new kind of interpretive power is needed. In the course of institutional entrepreneurship relay the key actors with their support community were first able to construct a credible enough interpretation of the local scientific potential in the field of biomaterials to get things moving and, secondly they were able to integrate several organisations and funding sources to support the launch of activity. This required an interpretation that linked science with local and regional economic development as well as developments in healthcare. Now, the challenge is to move forward again and to create such an interpretation on the role of regenerative medicine that would open new horizons for the Finnish hospitals, most notably for Tampere University Hospital. Additionally, all this may not be able to be implemented without considerable commitment into basic funding by the national level players.

In the advent of the fourth phase, there is clearly a lack of knowledge about the wider policy processes needed to keep the relay moving and the institutional and interpretive power to push it forward. The first breakthrough treatments, an emerging global reputation, the expertise of the local knowledge community and the active work of the main institutional entrepreneurs function as enabling factors for the future but it seems obvious that fresh institutional entrepreneurs are needed to enable the relay to move on towards new and still unknown phases.

Conclusions

The study reported in this paper shows, *first* of all, that institutional entrepreneurs do exist. The case of regenerative medicine in Tampere clearly shows that there are indeed individual actors who initiate divergent changes and work to implement them. This is connected to the *second* general observation that institutional entrepreneurs are required to influence not only within the boundaries of the organisations and communities that authorise them or within their 'own policy domains', but they consciously need to reach beyond their familiar fields of activity and policy spheres to reach such spheres and spaces in which their actions and words need to have influence despite having no authorisation. The institutional change process involves a series of interrelated decisions and actions crossing many boundaries that are continuously shaped both by contemporary challenges, future prospects and earlier decisions. Institutionalisation of a new science-based innovation concentration is a long process that is based on an existing and constantly evolving expertise as well as reinterpretations of it all.

Consequently, *third*, the main conclusion of the study reported here is that institutional entrepreneurship is not a solo activity but a relay of power and knowledge in time. Institutional entrepreneurship involves an array of actors with various backgrounds, resources and sources of power and thus institutional entrepreneurship might offer us a way to study institutional change processes as multi-scalar and multi-actor processes in time as well as innovation systems from a fresh perspective; to achieve results a development process needs to be, one way or another, shared in time. No one can master all the pressures and all of these spheres of knowledge and power alone.

The *fourth* observation is that for an institutional entrepreneurship relay to proceed successfully a support community is required that is not always at the core of the relay but that removes institutional obstacles and enables the process in many ways depending on the phase it is on. The scientific knowledge base was the core in the first phase but the future prospects stemming from it needed to be reinterpreted for a wider decision and policy-maker audience. This was done in the collective interpretation phase with the help of the support community external to the science and clinical community. At this phase, the support community pushed the relay forward by seeking differences and similarities in actors' interpretations and especially by being able to synthesise different interpretations and goals derived from them in collaboration with the scientific and clinical players. The support community's role was to convene actors for dialogue, mediate information and hence also to construct new knowledge; it interpreted, for example, academic thinking and talk to policy language, and vice versa. It was able to exercise wider network power than the scientists, i.e. power to engage biomaterials with the local and regional economic development discussion and policies.

The *fifth* observation is that, in the course of relay, there is a need to integrate interpretive, network and institutional power in time and place. The integration of various forms of power provides the relay with necessary force that keeps it going. In the case under scrutiny here, the advent of regenerative medicine in Tampere, it is fairly easy to conclude that in spite of a fairly general conviction among the support community of the second phase regenerative medicine is not yet an established element of the local institutional configuration in Tampere. It does

have a prominent and recognised position but the success has hidden the fact that it is still a collection of projects instead of a long-term investment in a revolutionary medicine. The growth of Regea outpaced the rest of the system. The successful finalising of the institutional entrepreneurship relay would require new institutional entrepreneurs to emerge; the ones having had key positions at the previous phases do not possess the power and/or knowledge needed to carry the relay further. What is needed is a high-level institutional power that for its part requires wider network power. It may well be that these forms of power cannot be unleashed without appealing and convicting enough interpretation about how regenerative medicine will change medical care and healthcare policy nationally. Perhaps a business venture is not the way forward at this phase either but reaching hospitals and changing their routines is. As is well known, this is a daunting task indeed.

Sixth, the study reported here shows how crucial but difficult it is to keep a relay in motion without letting it break down in the critical phases of the process. In the case of regenerative medicine in Tampere, the institutional entrepreneurship relay was not a conscious and pre-designed relay but rather a phase-by-phase evolving search for next steps, vision, required forms of knowledge and power. Therefore, *seventh*, in dynamic innovation systems institutional entrepreneurs need strong leadership capacity. Here we are in line with Yukl (2002: p. 2) who sees leadership as involving a process whereby 'intentional influence is exerted by one person over other people to guide, structure, and facilitate activities and relationships in a group or organization'. This study also shows that instead of focusing on 'heroic leadership', or other forms of leader-centric analyses, a process, network and governance oriented study with a strong temporal flavour not only adds new insights on institutional entrepreneurship and leadership but also on institutions framing and shaping innovation systems.

This study also reveals, *eighth*, that when approaching innovation systems and related institutionalisation processes through an institutional entrepreneurship lens, the differentiation between national, sectoral, and regional innovation systems appear not as clear-cut as the literature seems to imply. The case under scrutiny is clearly about strengthening the local innovation capacity in biomaterials and especially in regenerative medicine. Simultaneously, it is clearly part of the sectoral innovation system in respective fields and the main funding bodies (Academy of Finland; Tekes; and the Regional State Office; the Employment and Economic Development Centre) being among the core elements in the national innovation system (see Veugelars et al, 2009) one might also argue that the question is about the strengthening of one specific local element in a wider national system. Furthermore, to make the situation more complicated, from a local economic development point of view this case is one of the strategic priorities in the efforts to boost local economic development. Of course, various 'innovation systems' are analytical and policy-focusing devices that are useful in efforts to understand and explain some specific feature of innovation and they need to be complemented with specific analytical lenses that provide additional analytical leverage.

In their efforts to change institutions, institutional entrepreneurs of the case reported here operate in the middle of open-ended and fuzzy situations where they are constantly required to cross the innovation, science, local and regional economic development and healthcare policy boundaries; they influence beyond their own territories and policy spheres. For these

reasons, institutional entrepreneurship is a relay in time instead of straightforward actions here and now. An institutional entrepreneurship relay for science-based innovation differs from, say, a relay race significantly. In a relay race, there is a fixed team and everybody knows their place in the team and one runner is replaced by another runner. Even more importantly, they know that they are members of a team and that they are participating in a race. In an institutional entrepreneurship relay for science-based innovation, it is much harder to know what is the team, coalition or network one is a member of, as hard as it may be to know what the race is about or to detect its beginning and finish. The kind of relay discussed here usually has many 'runners' on a track simultaneously, there is no clear order of runners, there are many managers, team leaders, anchor runners and other specialists 'who know best'. The trick is to keep the relay in motion and continuously search for both desired futures and needed ingredients for the next phases.

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