Identification with the undefined

On the professional identification with a new and innovative domain

Ole S. Selg s1233343

27.11.2015

Master thesis

Enschede, July 27th 2015

1st Supervisor: dr. Matthijs Noordzij

2nd Supervisor: dr. Marleen Groenier

University of Twente, Enschede

Faculty of behavioral sciences

Study of Psychology

Human Factors Engineering (HFE)

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Abstract (English)

When a new area of expertise comes into life, the new experts have to find their niche in the professional world. Because it has only existed for a relatively short period of time, there is not yet a clear definition of the work field and as a result, no single identity for that profession. The present research examined identification in technical medicine (TM), a novel domain that forms a bridge between the medical and technical world and in which innovation plays a key role. Ten working TM graduates were interviewed on their identification with the domain and the ways in which they become innovative. Analysis based on Grounded Theory showed that there are four main types of identification among technical physicians that are often, but not exclusively, bound to the individual's field of work. It also showed that individuals differ in the ways in, and the extent to which they become innovative. Although identification and innovation appear to be linked, it was not possible to generalize clear patterns for the four identification types. The findings of the present study can be used as basis for future in-detail research and can help in curriculum construction.

Abstract (Dutch)

Wanneer er een nieuw vakgebied ontstaat is het aan de nieuwe experts om een niche voor zichzelf te vinden. Er is vaak geen duidelijk definitie voor het werk van de nieuwe expert en als gevolg is er ook geen algemeen bekend plaatje van het werk waarmee zich de expert kan identificeren. Technische geneeskunde (TG) is een voorbeeld hiervoor. Door een combinatie van technische en medische expertise brengen de TGers innovatie in de medische wereld. Voor dit onderzoek zijn er tien TGers geinterviewd over hun identificatie met het domein en da manieren waarop zij innovatief worden. De op voornamelijk op Grounded Theory gebaseerde analyse liet zien dat er vier hoofdtypes van identificatie bij technisch geneeskundigen bestaan. Deze types zijn vaak, maar niet uitsluitend gekoppeld aan het type werkplek van het individu. Daarnaast zijn er individuele verschillen in de manier waarop en in welke mate de technisch geneeskundigen innovatief worden. Hoewel er een verband tussen identificatie en innovatie blijkt te zijn was het niet mogelijk om duidelijke en generalizeerbare patronen voor de vier identificatie types te bepalen. De resulaten van dit onderzoek kunnen worden gebruikt als basis voor toekomstig onderzoek en kunnen een onderbouwing bieden bij de constructie van toekomstige curricula.

1. Introduction

Today's universities often offer a large variety of subjects to study. Many of these subjects like engineering, law, psychology and medicine have existed for decades or even centuries. They are linked to shared expectations about the career the student will pursue and students often choose these with a certain picture in mind of who and what they are going to be. Once in a while though, a new study emerges, bringing forth new types of experts who have to create their own niche in the market. There is not yet a definition of what they are going to be and what they will do, simply because time still has to show. These students don't have an elaborate profile they can adapt to, but instead have to find their own professional identity. Their individual identification with a new and innovative domain is an interesting subject on which the present research hopes to shine a light.

One such example is the study of technical medicine which has so far only been taught at the University of Twente and since September 2014 at the University of Delft. During the last twelve years this study has created a new area of expertise and with it a new type of expert, the technical medical expert. Because of the short existence of the study, little is known about this new type of expert. From the published papers within the field of technical medicine, two of which will be described later, and the study program of the University of Twente ("Technical Medicine", 2015) we have a few examples of the work of a technical physician. The technical physician is an academic professional who designs and safely applies improved diagnostics and therapeutics ("Technical Medicine", 2015). He or she mostly does this in a hospital setting but technical physicians can also be found working for educational institutions or companies. What we know little about are the technical physicians themselves. Who are these new experts? What is it that attracts young people to choose this new and innovative area of expertise? How do they perceive themselves and their domain and which implication does this have for their work? Answering these questions could be of practical relevance for the University of Twente, as it provides feedback for the faculty's study program. At the same time it also provides us with new insight on a theoretical level. How do people identify with a novel domain which combines aspects of at least two major areas of expertise? From medical experts we know that their work and professional identity play a big role in their lives (Broadhead, 1983). This is easily understandable considering the extensive personal contact with people in need of help and their ability and responsibility to improve or even save people's lives. But then there are also technical experts who, due to their area of expertise, are likely to perceive their work and professional domain in a different way. An interest in technology and the ability to fix or build things may be important to them. While

there are clear ideas about the previous two types of experts, there is not really a single definition for what technical physicians do. There is an idea on which the study program is based, but the jobs in which we can find today's technical physicians are far more diverse. This leaves us with the question how technical physicians actually identify themselves with their domain.

So far, the only research on technical medical expertise, and the only research with technical physicians as subjects, was done by Overkamp (2014a). He conducted an experiment on problem solving techniques employed by technical-medical experts and compared them to problem solving techniques linked to adaptive expertise. He concluded that there is at least a superficial similarity between the problem solving strategies of these two types of expertise. The concept of adaptive expertise is one that has been linked to technical physicians also by the study institute and can provide us with some insight into the technical physician's expertise.

Adaptive expertise can be distinguished from the classical concept of expertise, called routine expertise which describes the capabilities and knowledge of people who have a lot of experience in their domain and therefore outperform most others in what they are doing. Ericsson and Lehmann (1996) define expertise as "consistently superior performance on a specified set of representative tasks for a domain" achieved by years of deliberate practice, the attempt to constantly improve in what one is doing by training specific elements of one's work. While deliberate practice may be beneficial for routine expertise (RE), which can be doubted considering Macnamara, Hambrick and Oswald (2014) found an influence between 1% and 26% depending on the domain, adaptive expertise goes further by adding innovation as an important dimension (Schwartz, Bransford & Sears, 2005). According to Schwartz et al. (2005), routine experts and adaptive experts differ distinctively in the ways in which they tackle problems. While routine experts are focused on efficiency, solving problems accurately, rapidly and consistently by applying their prior knowledge, adaptive experts see problems as an opportunity for knowledge creation and are more flexible in their problem solving approach. This second type of problem solving is what the University of Twente tries to encourage in its Technical Medicine students and is one way in which they are expected to differ from traditionally trained physicians.

The following paragraphs elaborate the ideas of routine expertise and adaptive expertise a little further. From there, the step is made to the technical medical expert and the role of innovation in his domain. Two approaches to innovation are described and possible links with identification are discussed. Finally, I explain the present study which aims to

determine the ways in which technical physicians identify with their domain, how they perceive and practice innovation and whether there is a link between these two aspects. The results will be of theoretical and practical relevance as they show ways in which people identify with an emerging domain in general and also reflect on how well the university's study program matches the technical physicians' actual work.

1.1 Routine and adaptive expertise

Chi (2006) developed a list of characteristics of routine experts. She divides these characteristics into "ways in which experts excel" and "ways in which experts fall short". Experts excel in *generating the best*, which means that they are better and faster at coming up with a solution or design. Their designs normally outperform those of non-experts and they can come up with good solutions even under pressure. They are also extremely good at *detecting and recognizing* features that novices often cannot see. A radiologist for example, quickly recognizes a fracture whereas a novice would not even know what to look for on an X-ray. Furthermore, experts excel at *qualitative analyses* and *monitoring*. According to Chi (2006), experts have more accurate self-monitoring skills and are more accurate in judging the difficulty of a problem. They excel at choosing the appropriate *strategy* to solve a problem and are more *opportunistic*, which means they are better at making use of all available information and resources. They can more easily retrieve relevant domain knowledge and can act with more automaticity which leaves them with more cognitive resources for more difficult situations. At the same time, there are also ways in which experts fall short. Most of the ways in which experts exceed are *domain-limited* and *depend on context within that domain*. That means that experts do not normally excel novices once the object of interest lies outside their domain of expertise and also lose at least some of their advantage when there is a lack of contextual cues or background information. Another way in which experts fall short is that they sometimes *gloss over*. While they excel at remembering information that they deem relevant, they can come short of novices in remembering additional details. Furthermore experts sometimes lack *accuracy in predicting, judging and giving advice to* novices and about human behavior in general. An explanation might be that they do this from their point of view and do not sufficiently consider the difference in knowledge and expertise. Moreover experts often show *bias and functional fixedness*. Examples for this are that experts may form hypotheses based on knowledge from their area of expertise when this is not appropriate and that experts can be less creative in producing a solution because they are too fixed on what they already know. Lastly, experts sometimes are *inflexible* when they encounter problems

with a deep structure that deviates from the "acceptable" in their domain. They may even perform worse than novices once certain rules within their domain of expertise are changed (Chi, 2006). While Chi (2006) generalizes these ways in which experts excel and fall short for all kinds of experts, research on another type of expertise, adaptive expertise, suggests that especially these last two limitations are not applicable to all experts in the same way.

Hatano and Inagaki (1986) were the first researchers to come up with the term adaptive expertise. They noted that while most experts were very fluent and efficient in performing routine procedural tasks, not all of them could maintain this fluency when the situation that they were confronted with changed. Those who could, not only possessed the procedural skills they needed to perform efficiently, but also had extensive conceptual knowledge. They not only knew what they had to do, but also why, making them more flexible because they understood what had changed and why and could adapt to it. They are also better at identifying opportunities for innovation (Brophy, Hodge & Bransford, 2004). However, being able to see an opportunity for change does not necessarily mean that one is going to actually change something.

Brophy et al. (2004) suppose that there are two other factors that play an important role in a person's motivation to become innovative. One is his or her willingness to deal with ambiguity and the willingness to preserver toward a solution. In being innovative, adaptive experts have to be willing to leave their comfort zone of extensive knowledge, to enter an area in which they have to try new things to solve a problem. They don't know for sure what the outcome of their new procedure will be or how long and how many attempts it will take them to reach their goal. The other factor Brophy et al. (2004) discuss is the identification of the expert with the domain he or she is working in. They compare it to a student who performs exceptionally well in mathematics and therefore takes advanced mathematics classes, but has no intention of pursuing a job in that domain in his or her later life. This student does not see him-/herself as a mathematician and is not interested in the domain as such and is therefore not likely to pursue problems in that domain. This would mean that an adaptive expert who identifies more with his or her domain, for example technical medicine, is more likely to become innovative in that area. At the same time, identification in general does not necessarily mean that someone becomes innovative. Doctors for example often identify strongly with their domain without becoming innovative. It appears that the object of identification may play an important role. The aspect of identification will be discussed further at a later point in this chapter.

1.2 Technical medicine

Technical medicine is a relatively new type of study. In the Netherlands, technical medicine was first taught at the University of Twente in 2003 ("Technical Medicine", 2015). It is a new academic discipline in which professionals improve patient care by applying medical technology. The idea is that technical medicine fills the gap between regular medicine and complex technology. At the University of Twente, technical physicians follow a six year Bachelor/Master program that is directed at teaching them the knowledge, skills and problem solving mind-set to design and safely apply improved diagnostics and therapeutics for the benefit of patients ("Technical Medicine", 2015). During these six years, students practice in simulated learning environments and also spend two years in rotating internships at academic and teaching hospitals. Most of the graduates work in the direct and individual patient care as legally certified technical medical professionals ("Technical Medicine", 2015).

In their work, technical physicians focus on improving and carrying out technical medical interventions. These are mostly related to complex, case-specific patient problems. Examples are giving advice on how to treat a tumor situated at a difficult location or a new model based therapy for ventilation ("Technical Medicine", 2015). Innovation plays a very important role in the technical physician's work. He or she must use a detailed understanding of technical and medical concepts and processes to come up with an improvement to an existing treatment or even come up with their own solution to a problem. This can, for example, be a technological improvement of an existing device or developing a more efficient or effective technique to solve a known or novel problem. In his/her career the technical physician faces a lot of different kinds of problems, many of which ask for new and innovative approaches. In order to handle the various situations they encounter, the University of Twente defined seven competences that technical physicians should have that are central to the domain of technical medicine (Overkamp, 2014b). First, technical physicians need to be *competent in the scientific domain* of technical medicine. This includes being up to date on the scientific knowledge within this domain. Additionally, technical physicians have to be skilled in *researching and designing* as well as in *acting in a technical medical way*. Innovation is a factor that plays a very important role in both of these competences. They should also be competent in *science* and *professional behavior* and finally have *intellectual* competences (e.g. arguing, reflecting, and judging) as well as *situational* competences that relate to the integration of social and organizational situations in the technical medical work (Overkamp, 2014b). The result is a knowledgeable professional, who uses their intellectual

and situational competences in an adaptive way to come up with innovative research and design ideas. Knowing *how* things work is crucial to the technical medical expert.

1.2 Innovation

As mentioned above, innovation is an important factor in the technical physicians work. But what exactly is innovation? Innovation has been defined and studied in many different ways. Innovative behavior, innovation in companies, and innovative characteristics are only a few examples of aspects of innovation that have been studied so far. The settings in which innovation has been studied are just as diverse. In the following paragraphs two particularly interesting studies are described in more detail. I chose these two articles because they discuss innovation on an individual level which fits the focus of the present study. The first one provides a description of what innovation is and mentions aspects that can be found in innovative individuals and that describe characteristics of adaptive experts. The second names a number of important skills for innovation and a number steps in the process of innovation.

1.2.1 Innovative behavior in individuals

Scott and Bruce (1994) researched determinants of individual innovative behavior in the workplace. They outlined innovation as having something to do with the production or adoption of useful ideas and idea implementation. This also includes the implementation of products or processes from outside the domain. In their opinion (Scott & Bruce, 1994) the generation of novel ideas is only one stage of the multi stage process of innovation. According to Scott and Bruce (1994) innovative behavior begins with problem recognition and the generation of ideas or solutions, which can be either novel or adopted. This stage is followed by the innovative individual's seeking for sponsorship and attempt to build a coalition of supporters. In the third and final stage of the innovation process, the individual completes the innovative idea by producing a prototype. While these stages typically start in this order, it is likely that innovative individuals are involved in more than one stage at a time throughout the entire process. This is due to the discontinuous characteristics of innovation (Schroeder, Van de Ven, Scudder & Polley, 1989). In their research, Scott and Bruce (1994) studied individual innovative behavior as the outcome of four interacting systems, namely individual aspects, leader aspects, work group characteristics and psychological climate for innovation. They found that the two variables most highly related to innovative behavior were leader role expectations and systematic problem solving style. This was in support of their

hypotheses that the expectations of supervisors were antecedents of the Pygmalion effect and therefore were expected to shape the subordinates' behavior (Scott & Bruce, 1994). Logically, the supervisor's expectations should mirror the role expectations of the subordinate individual in his/her work context. Furthermore, the negative correlation between systematic problem solving style and innovative behavior supports the hypothesis that intuitive problem solving, rather than systematic problem solving leads to innovative behavior. Scott and Bruce (1994) distinguish between associative and bisociative thinking modes. Associative thinking is based on habit and following set routines, while bisociative thinking is characterized by overlapping separate domains, a lack of attention to existing disciplinary boundaries and an emphasis on imagery and intuition. This separation and the discovered effects are in line with the distinction between routine and adaptive or technical medical experts.

1.2.2 Innovative characteristics in young people

In their study on innovative characteristics in young people, Chell and Athayde (2009) identified and tested five central skills needed for innovation. These were creativity, self-efficacy, energy, risk propensity and leadership. In their article Chell and Athayde (2009) stress that these skills can be learned to a great extent and that they are formed by social and environmental factors. Like Scott and Bruce (1994) the authors say that innovation is a process with different stages and that those different skills are more or less important at each of these stages. They suggest a model of four steps that shows how ideas develop into innovations, starting with ideation (formation of an idea/concept/thought), followed by opportunity recognition (evaluating, testing, deconstruction), opportunity formation (prototype, proposal, convince others) and opportunity exploitation (product, process, service produced and marketed, team process). This also makes clear that creativity, although necessary, is not sufficient to foster innovation. Chell and Athayde (2009) stress that self efficacy is another very important factor. Without self efficacy, an individual is not likely to engage in continuing in the innovation process after the initial idea. This is in line with another important aspect, risk taking. According to Chell and Athayde (2009) and others, innovators tolerate high levels of risk. People who flinch from uncertainty of outcome are not likely to become innovative. However, innovators do not blindly take risks but rather calculate risks and weigh them against potential benefits. Another important characteristic of innovative individuals is energy (Chell & Athayde, 2009). Attitudinal aspects like drive and enthusiasm form the basis for the innovators motivational energy to persist. The authors cite Thomas Edison: "Genius is one per cent inspiration and ninety-nine percent perspiration."

Finally leadership is needed to effectively communicate the innovative idea to others, convince them and fend off opposition.

1.3 Examples of innovation in technical medicine

If we follow the outline of innovation by Scott and Bruce (1994), as having something to do with the production or adoption of useful ideas and idea implementation, and the papers published by technical physicians, it becomes apparent why technical medicine may be called an innovative domain. Van Dijk, Jager, Mouden, Slump, Ottervanger, de Boer, Oostdijk and van Dalen (2014) for example developed and validated a patient-tailored dose regime for radioactive tracers. This allowed them to minimize the dosis of radioactive material administered to the individual patient, reducing the risks of damage from radioactivity. Another example is the design and evaluation of a robotic steering of a flexible endoscope by Ruiter, Rozeboom, van der Voort, Bonnema and Broeders (2012). Via an add-on robotic module they improved the usability of a flexible endoscope in a way that allowed a single physician to operate it in an easy way and thus making the process more efficient. In both cases, the technical physicians came up with a novel idea, created a new technique or device and implemented and tested it, fulfilling all aspects of Scott and Bruce's (1994) description of innovation. Both innovations can be characterized as leading to an improvement in the medical world which is the strength and purpose of the technical physician as according to the University of Twente.

1.4 Identification and its links to innovation

I mentioned before that technical medicine is a very young study. As a result, technical medicine is still a rather unknown domain and most people, even in the medical world don't know what a technical physician is. As a result, technical medicine graduates have to find their own way and work, contrary to for example lawyers, physicians and even engineers whose professions are well known and for whom there are well defined jobs.

Professional identification and its effects have been studied in many different ways. A study by Loi, Hang-yue and Foley (2004) found that professional identification of lawyers in Hong Kong affected their job attitudes in several ways. They showed that professional identification affected both job satisfaction and organizational commitment in a positive way. Especially the latter could be an important point when related to the motivational aspect of innovation. They measured professional identification with a modified version of the organizational

identification scale originally developed by Mael and Ashforth (1992) in which they replaced school with profession.

As mentioned in an earlier paragraph, Brophy et al. (2004) suggested a link between innovation and a person's identification with their domain. Someone who identified more with his/her domain was more likely to become innovative in that domain. Although they did not further specify how exactly this connection works it poses an interesting approach to the technical physician whose work is supposed to be innovative.

In their article about their study designed to develop a measure of employee identification with the work group, Riordan and Weatherly (1999) mention several aspects of identification with the work group such as experiencing the group's successes and failures as one's own and defining oneself by the same attributes that define the workgroup. This second aspect could be very interesting in a group that is characterized by innovativeness like e.g. technical physicians. This assumption is strengthened by Ashforth and Mael (1989) who state that "identification induces the individual to engage in and derive satisfaction from activities congruent with the identification…." Riordan and Weatherly's (1999) tool to measure identification with the work group is very similar to those used by Mael and Ashforth (1992) and Loi, Hang-yue and Foley (2004). It appears likely that the tool could also be used to assess domain identification which is very similar to professional identification and work group identification.

1.5 The present study

In the previous paragraphs, different types of expertise and innovation have been described in detail. The important role of innovation for technical medicine has been stressed and I described two examples of how such innovations can improve health care. Also, possible explanations for differences in innovativeness were described. However, a number of aspects still remain unexplained. Although adaptive expertise in general has been studied intensively and it has been linked to technical medicine, we still know little about technical medicine and especially the technical physicians. We know that the study of technical medicine is a young study and that the study itself is an innovation to some extent. What we don't know is who the technical physicians are and how they identify themselves. Of course they all studied technical medicine at the University of Twente and mostly followed the same courses. During their study, they learned problem solving techniques, acquired technical as well as medical knowledge and were prepared to be innovative, technical medical experts. At the same time, every individual is different from another and even though two individuals

enjoyed mostly the same education, they may still differ in many aspects. Although most technical physicians start working in a clinical setting after graduating with a master's degree, there are also other examples like technical physicians who start working for companies or decide to work for the university to contribute to the faculty. Many technical physicians continue their study with a PhD, but others don't. First conversations with technical physicians revealed that there are big differences within the group of technical physicians, regarding their perception of their domain and their ideas about the work and tasks of the technical physician. They identify with the area of technical medicine in different ways. In order to determine these different ways of identification, I decided to conduct an interview. Additionally, I let the participants fill in a modified version of the Mael and Ashforth (1992) questionnaire in order to check for possible links with degree of identification.

From the literature on adaptive expertise and technical medicine, we know that innovation plays an important role in the technical physicians' education and work. Technical physicians are trained to approach problems in new ways and to come up with new ideas for solutions. From Brophy et al. (2004) among others, we know of possible links between identification and innovation. They argue that identity is something that individuals perceive about themselves relative to their domain and which influences career choices as well as the ability to become innovative in one's job. Since technical physicians can be found in various jobs, it is likely that they also identify in different ways. We therefore can assume that they also differ in the ways in which they perceive and perform innovation. This is why the second part of the interview focuses on the participants' perception of innovation in general and within their domain specifically. Finally I will try to answer the question whether there are clear patterns linking identification and innovation.

2. Method

2.1 Participants

Ten former technical medicine students aged 23-29 participated in this study (five male and five female participants). All participants had a Master's degree in technical medicine and worked in a technical medicine related job (also including one participant who worked for an international electronics company in the health care technology branch and one who started and worked for a company developing medical software) at the time of the interview. The participants had graduated with a Master's degree between two months and four years prior to the interviews (1 Reconstructive Medicine, 2 Medical Sensing &

Stimulation, and 7 Medical Imaging & Intervention). Five participants were also working on their doctorate at that time, which many technical medicine master graduates do. Of the ten participants, five worked at least partly at the University of Twente as researcher and some of them also as lecturer. Two participants worked for companies and three worked predominantly as a researcher in a hospital. All participants took part voluntarily and were not paid or compensated for their participation in any way. Participants were gathered by first contacting technical physicians at the University of Twente via e-mail. Additionally, they were asked to send the e-mail forward to other technical physicians outside the University or to give me the names of such technical physicians. The latter were contacted by me via e-mail. The research was approved of by the ethics committee of the University of Twente.

2.2 Materials

The interviews were recorded using a dictation machine (Interview scheme can be found in the appendix). Additionally to the interview, participants filled in a 6-item Likert-questionnaire on identification with the domain of technical medicine. Participants graded six statements regarding their identification with technical medicine on a 5 point likert scale ranging from 1 = strongly disagree to 5 = agree completely. All statements were positive statements, with a higher score indicating higher identification. The questionnaire was a modified version of the organizational identification scale originally developed by Mael and Ashforth (1992) in which they measured identification of students with their school. For the present study, school was replaced by technical medicine.

2.3 Procedure

All interviews were held in Dutch. Most of the interviews were held at the interviewees' offices. All interviews were individual interviews between me and one participant at a time. At the beginning of the interview I welcomed the participants and shortly introduced myself. Participants were asked whether they had any questions regarding the topic of the interview which had been explained briefly in the e-mail. If this was not the case, I informed them that the interview would be recorded, that the recordings would be analyzed by me and that the interviewees' names would not be mentioned anywhere in my report if they did not specifically ask for it. Furthermore I made it clear that they could pause or stop the interview at any point and that they could also ask for the interview to be deleted afterwards. I explicitly encouraged the participants to contact me via e-mail if they wanted to add anything to their statements after the interview and that I would contact them if I needed

to clarify anything during the analysis. Finally I informed the participants that they were to fill in a 6-item Likert-questionnaire immediately after the interview. If the participants had no further question, I asked them to fill in and sign the informed consent form before starting the recording of the interview.

The actual interview was a semi-structured interview and consisted of three parts, starting with me addressing the interviewee by his/her name and asking a number of introductory questions like age, number of months/years since their master graduation and their current employment. The second part of the interview consisted of a number of questions about the interviewee's perception of, and connection and identification with the domain of technical medicine. Some examples of questions from this section are: " Wat hoort er volgens u bij het domein van technische geneeskunde?" (What does, according to your opinion, belong to the domain of technical medicine?) and "Wat betekent het voor u om technisch geneeskundige te zijn?" (What does being a technical physician mean to you?). In the third part of the interview, the questions focused on innovation and how the participants defined and perceived innovation within and outside of their professional domain (technical medicine). Examples of the questions from this part were "Noem vijf belangrijke eigenschappen van innovatie." (Name five important characteristics of innovation. and "Zijn er individuelle verschillen tussen technische geneeskundigen wat betreft hun innovativiteit?" (Are there individual differences among technical physicians regarding their innovativeness?). At the end of the interview, participants were asked if they wanted to add anything to their statements and if there was anything that they would like to add about which I had not asked any questions. From this, two further questions emerged during the course of the study. Participants who had already been interviewed were asked to answer these two questions briefly in an e-mail. For the other participants I added the two questions at the end of the interview so that they would not influence the other answers. After that I stopped the recording and asked them to fill in the Likert-questionnaire. While all participants basically answered the same questions in the same order, some questions were (re-)phrased slightly different depending on the previous answers of the interviewee. This was done to obtain comparable results when interviewees interpreted the question differently than originally intended or to better fit the conversational flow of the interview. No question was altered in a way that the meaning of the question would change.

Although all participants were asked the same questions, interview durations varied between 36 and 63 minutes. Most interviews took between 40 and 50 minutes. Six of the ten interviews were conducted at the University of Twente. The other four interviews were

conducted in different locations in the cities of Enschede, Amsterdam, Leiden and Zwolle in the Netherlands.

2.4 Analysis

The interviews were analyzed mostly in a bottom-up structure based on grounded theory (Charmaz, 2003) using ATLAS.ti. Meaningful units from the voice recordings were marked and labeled. Where possible, labels were grouped together by topic and were given codes. This was done in several iterations in a bottom up fashion, resulting in a number of themes. Two main themes, identification and innovation were handled from the start with the possibility of additional main themes based on the interview data. In the following step, the main themes were checked for distinguishable patterns. In the final step these patterns from the different main themes were compared in order to discover possible inter theme links. A second rater was given a randomly selected part of one of the interviews together with the coding scheme in order to determine an inter-rater reliability. The interview extract included 35 codes and the analysis produced a moderate inter-rater reliability coefficient (kappa) of .58 (SE = .084).

3. Results and discussion

This chapter comprises five main sections. First are a short summary of the interviews in general including complications encountered and a short description of the answers. Then the results for three main themes found during the analysis, identification, innovation and personality, are presented in detail in three consecutive sections. Finally there is a short paragraph for each of the ten participants, summarizing their answers and creating a picture of the different types of technical physicians I interviewed.

3.1 The interviews

While the interviews went well in general and most interviewees were able to answer almost all questions without difficulties, there were two terms that the interviewees had difficulties with. First was the term ‘domein’ (domain) which was then handled as the knowledge and working area of a technical physician, including e.g. his/her area of knowledge, typical tasks and other things that the interviewee associated with technical medicine. Secondly, none of the interviewees was familiar with the term ‘adaptive expert’. When the participants said that they were not familiar with the term I explained it in a

simplified and uniform manner to create an equal basis for the following questions regarding the comparison of technical physicians with other adaptive experts. I explained the term as an expert who is able to adapt to new problems and come up with novel solutions to these problems. The explanation also included the example of an engineer as a typical occupation in which one would expect an adaptive expert and a doctor as an example of an occupation in which routine expertise is typically dominant. After this explanation, all participants agreed that technical physicians were at least to some extent adaptive experts.

The interviewees' answers generally showed great variation within the different topics while there were also a number of things on which most interviewees agreed. These will be described in the following subsections. Most statements made by the interviewees could be assigned to four major categories. As expected due to the design of the interview, statements regarding the identification with the domain of technical medicine and statements on (the interviewee's perception of) innovation formed two of the four groups. The third category contained statements concerning personal interests, preferences and character traits. In the fourth category statements regarding the area of technical medicine in general and advice/feedback for the faculty of technical medicine at the University of Twente can be found. Although this fourth category may be interesting for the University of Twente, it does not add much to the aim of this paper and was therefore excluded from further analysis. This leaves us with the first three categories which, for ease of reading, will be named identification, innovation and personality for the rest of the document.

3.2The emerging themes

As mentioned in the previous section the three main themes discovered during the analysis were identification, innovation and personality. Within each of these main themes, a number of sub themes emerged. Within identification these were the tasks and goals in technical medicine (e.g. working with technology and bringing improvement to the medical world), the properties participants attributed to themselves and other technical physicians and technical medicine in general (e.g. the dual aspects of the work, concept thinking and being technologically oriented), what they liked about technical medicine and why they had chosen for it (e.g. being able to pursue several personal interests and seeing the results of one's work), and a theme I named typical identification because it contained statements which are comparable to the identification statements from the Mael and Ashforth (1992) questionnaire (e.g. feeling connected because of shared properties and the way in which one presents oneself to others in a professional setting).

Within innovation the sub themes were properties of innovation, areas and types of innovation, properties needed for innovation and found in innovative people, the extent to which innovation had to be something new. Examples for properties were e.g. that innovation was never really finished (never done) and that the user or stakeholder played an important role. Areas and types of innovation included things that could be innovated, while the third sub theme (Needed for innovation/innovative people) included statements regarding skills and properties that were necessary to become innovative. Finally the fourth sub theme (Improve/Invent/Re-use) summarized the interviewees' opinions on the extent to which an innovation had to be something completely new or could also be using something existing in a different way.

Personality was also comprised of four sub themes. The one that was referred to most was the inter-personal skills/ mechanistic know-how sub theme. It included all statements on personal interest in, and/or preference for either social and interaction aspects or aspects from the area of technology and natural sciences. In the second sub theme statements on individual ambition, drive and proactive thinking/behavior were gathered. These could be either positive or negative. The third sub theme included the personal interests and desires of the interviewees while the forth sub theme was based on statements that expressed something about the openness of the individual for new things and experiences. This sub theme is somewhat comparable with openness to experience from the big five (Goldberg, 1990). All themes are discussed in more detail in the following sections.

Table 1. Overview main themes and sub themes.

Main themes	**Sub themes**
Identifiction	Tasks & goals in technical medicine
	Properties of a technical physician and technical medicine
	What I like about technical medicine
	Typical ID
Innovation	Properties of innovation
	Areas/Types of innovation
	Needed for innovation/ innovative people
	Improve/Invent/Re-use
Personality	Inter-personal skills/ mechanistic know-how statements

	Ambitions/drive/proactive
	Personal interests
	Open for new things

3.3 Identification

This section is divided into three main parts. The first part covers the results from the Mael and Ashforth (1992) identification questionnaire while in the second part the results from the actual interview are presented. The third part builds on the second part and summarizes the different ways of identification into a number of main 'identification types'. These types are the four main ways in which the participants identified themselves as technical physicians.

3.3.1 Questionnaire

Participants in the present study averaged 3.87 out of five points with the lowest scorers having an average score of 3.33 and the highest scorers scoring a 4.5 points average. The lowest score for any item was 2 out of 5 points. Although there is no index in the literature that interprets absolute scores of this questionnaire, the scores Mael and Ashforth (1992) found among students' identification with their alma mater averaged 3.46 per statement. Even the lowest scores in the present study (3.33) almost reached that level while the average scores in the present study exceeded the scores from Mael and Ashforth (1992) by 0.41 points. It appears that technical physicians' identification with their domain is rather high. Thereby technical physicians fulfill one of the prerequisites for being innovative in their domain (Brophy et al., 2004). Interestingly, the two participants who worked partly as lecturers at the university both scored 4.5 points on average and two of the participants who averaged 3.33 points were one who had graduated with a specialization that no longer existed at the University of Twente and one who had also graduated with a Master's degree in Health Science previous to his technical medicine Master. Although it appears that the current job and type of education are related to differences in identification, there is no clear pattern to it.

3.3.2 Interview

The interview itself was the most interesting part because it went further than just giving an idea of the extent of the identification with the domain of technical medicine. In fact it showed that technical medicine is not seen as one well defined domain by many technical physicians. In contrast, the interviewees identified with different aspects of technical medicine

and also in different ways. The analysis of the interviewees' statements regarding identification with the domain produced three main categories of answers. One category included statements that said something about the individuals feeling towards technical medicine, statements on whether and why the individual perceived him-/herself as a technical physician and statements on how they showed their belonging to the group of technical physicians. This type of answers is somewhat comparable to the statements from the Mael and Ashforth (1992) questionnaire and represents a view on identification that is typical for identification literature. The second category of answers described the tasks and goals in and of technical medicine. Statements from this category described what kind of tasks technical physicians performed and why. The third main category contained statements regarding the properties of technical medicine and technical physicians.

Table 2. Sub themes and codes for main theme identification.

Main theme	Sub themes	Codes
Identification	Tasks & goals in technical medicine	Researcher
		Working with technology
		Supporting others
		University tasks
		Improvement
		Staying up to date
		Patient contact
	Properties of a technical physician and technical medicine	New application of existing
		Adaptive expert?
		Dual aspects
		Concept thinking /understanding why
		Social/Interaction aspects
		For the individual vs. for the group
		Scientific approach
		Problem solvers
		Technologically oriented
		Working around and with the doctor
		Drive & dare
		Keeping an open mind
		Knowledge & learning
	What I like about technical medicine	Seeing the results of one's work
		Independence is important
		Technical medicine combines interests
		TM is a hobby
		Technical medicine fits me
	Typical ID	Not in for the money
		Compassion/Affection
		Self presentation
		Being part of technical medicine
		Shared properties
		Not ONE technical physician

3.3.3 Typical identification

Although there was ample variation in the statements between interviewees, a number of aspects recurred in several interviews. One aspect was the definition of technical physicians and their work by the Nederlandse Vereniging voor Technische Geneeskunde (NVvTG), the Dutch society for technical physicians, which states that technical physicians are technical medical specialists who work in a hospital ("Wie is de technisch geneeskundige?,"n.d.). This definition is largely in line with the technical medicine faculty's orientation at the University of Twente in the recent years. Although all interviewees had studied technical medicine, this definition was a reason for some interviewees to question whether they were actually technical physicians.

"In that case, the question is whether I am still a technical physician." (Participant A, on her definition of a technical physician now that she had worked in a company for one and a half year).

Several participants answered that they did feel technical physicians but not by the typical definition. These participants mostly did not work in hospitals or had completed a Master's study in an area that was no longer taught at the university. Another aspect that may be a result of the previous is that several participants agreed that there is not 'one' technical physician. This was mostly due to the variety of types of work and areas of expertise that graduates entered after their study, although one participant argued from another position. Arguing that the technical physician can best be defined by his/her way of approaching problems, he argued that the technical physician was not a unique type of professional but that he already existed before in the shape of a doctor with a different mindset than most of his colleagues. He said that probably 2-5% of doctors in a hospital showed typical properties of technical physicians.

Generally, most interviewees felt connected to their domain. This was for example expressed in compassion for their work as a technical physician, a feeling of responsibility for the area of technical medicine and (future) technical physicians or simply because they had studied technical medicine at the university and therefore identified as technical physicians either directly or indirectly via the skills and way of thinking they had acquired during their study. Being part of the faculty's team and being responsible for the technical medicine education was another aspect linked to identification with technical medicine.

"I feel responsible for today's technical medicine students, to create an area of work for them, and that is something that we all do together." (Participant C).

"After my study I returned completely (to the university) and am, as a matter of fact, part of the institute."(Participant E).

Another aspect mentioned by some participants was the way in which they presented themselves to others. Although feeling as a technical physician, some participants mentioned that they did not always present themselves as such. This was mainly done to avoid lengthy explanation of the term technical physician and his/her work. One person on the other hand explained that she enjoyed presenting herself as someone who had studied technical medicine in front of other technical or medical experts because that positively influenced the way in which these other professionals interacted with her.

3.3.4 Tasks and goals in technical medicine and properties of technical medicine/technical physicians

The diversity in tasks and goals described by the interviewees mirrored the diversity of the technical physicians' types of work. Examples of tasks ranged from researching to lecturing, to various forms of cooperation with medical staff to the development and/or implementation of (new) technology. A point on which opinions differed was the actual performance of medical actions. While some interviewees saw this as an important part of their work, others disagreed, arguing that this was the doctors' task.

"You have to enjoy working with patients and with the medical staff." (Participant B).

"My idea of technical medicine is not that of a medical technical physician who also treats patients in a hospital. I don't really identify myself with that." (Participant H).

A task, which several interviewees agreed on, that did not belong to the technical physician's tasks, was the actual construction of new technology. Instead they saw themselves more as the one who made the connection with the actual specialists like e.g. an engineer or a specialized physician.

"I don't build something myself, I talk to the people who do." (Participant D).

"Based on the doctor's words, I can identify a certain technique and discuss this technique with an engineer." (Participant I).

The properties that the interviewees attributed to technical medicine, and the technical physician, were even more diverse. Although statements that were made about technical medicine in general or were explicitly made about other technical physicians than the interviewee him-/herself were excluded, reporting all types of statements here would still exceed the scope of this paper. Therefore I chose to present a number of key topics that came up in this category. First up was the characterization of the technical physician as a link or bridge. Typical properties in this category were the ability to 'translate' scientific information from one domain or person to someone from another domain, having a broad knowledge within at least two knowledge areas, being good at communicating and generally good at social interaction.

"The technical physician can be the link between two domains (medical & technical)." Participant B.

A second topic was problem solving. This included looking for existing problems, problem analysis and different ways of solving a problem. Participants agreed that technical physicians were exceptionally good at problem solving. Arguments supporting this statement were a critical approach, daringness, skills for thorough and scientific working and thinking, concept/system thinking rather than learning things by heart and a desire to learn and do new things.

"You are thinking in systems instead of individual pieces of knowledge." (Participant I).

The third point mentioned by many interviewees was that they were not doctors, although several interviewees described themselves as medical professionals and as being able to take the doctor's perspective. Instead they perceived themselves as a specialist who worked parallel to doctors and supported them in their tasks. Of course, due to their occupation, for a number of interviewees, this perspective was based on their experience during their many internships which are often done in hospitals.

"(Technical medicine is) making smart use of materials to provide a doctor with better information." (Participant H).

A point on which opinions differed was whether the technical physician's work should focus on individual difficult cases or on general improvement of areas/procedures/technology in health care from which a greater group would benefit. Not all participants made a statement regarding this point but those who did split equally across the two opinions.

Several interviewees described technical physicians as rather intelligent. One argument for that was the difficulty of technical medicine and the selection criteria (grades, subjects). They also called technical physicians eager beavers and often driven people. Two participants argued that this was probably result of or at least strongly increased by the encouragement from the institute's organizers and lecturers. Lastly, many interviewees perceived themselves as some kind of pioneers, being self made men and women who were creating a domain, spreading word of technical medicine, and proving themselves to the medical world.

"We are some kind of pioneers." (Participant J).

3.3.5 Four types of identification among technical physicians

This subsection summarizes the aforementioned ways in which technical physicians identify themselves with their domain in four main types. These types are patterns that I discovered during the analysis of the interviews and have also partly been described as such by the interviewees. Of course it is possible that there are more than the four types that I found among the ten participants of the present study and identification with one type is not exclusively. On the contrary, it is likely that individuals identify with more than one type at the same time. However, based on the analysis of the interviews, most interviewees could be assigned to one type as their dominant identification type.

1. The researcher

The researcher sees him-/herself mostly, as the name states, as a researcher. He/she is not especially fond of performing medical actions on patients but prefers to investigate concepts and problems in the (technical) medical world.

"I think that we are good at recognizing, understanding and analyzing a problem."

"Other adaptive experts are better at implementing a solution." (Participant E).

Unsurprisingly a bit of the researcher can probably be found in all technical physicians, since this a big part of the study and domain of technical medicine. This is also why the researcher type can be found in different fields of work. In the present study, those participants who primarily indentified as researchers worked either for the university or in a hospital. Some, though not all, researchers appeared a bit more introvert than other types.

2. The medical professional

The medical professional is mostly, but not exclusively, found in hospitals. This type probably resembles best the definition of the technical physician by the NVvTG. He/she often combines research on and implementation of new techniques and technology and is interested in improving processes in the hospital. He/she has no problem with patient contact and may even see this as an enjoyable and important part of his/her work. These technical physicians identify themselves as another medical professional, but not as doctors. Instead they see themselves as someone who works parallel to the doctor and can help where regular physicians e.g. lack technical knowledge or fall short with conventional methods. In the present sample I found the medical professionals to be very outgoing people who enjoyed social interaction and were open to new challenges.

"I find it amazing that, when I compare myself to other medical professionals, I really have a technical background." (Participant I).

3. The lecturer

Since lectures are normally given at universities, this is where the lecturer can be found. Because technical medicine has so far only been taught at the University of Twente, the lecturers are only a small group of the total population of technical physicians. Although most lecturers are also researchers, they identify themselves foremost with the role they play in, and the responsibility they feel for the design of the study and the creation of the field of technical medicine.

"I feel a technical physician because I enjoy combining technology, medicine and being a lecturer and bringing this to a hospital." (Participant C).

Not only can the lecturers combine their interests in their job, but they also enjoy passing their knowledge and experience on to the next generation of technical physicians. Shaping and supporting this new generation is important to them.

4. The business technical physician

This type of technical physician still identifies with the skills and way of thinking acquired during his/her study, but has chosen to apply them in a different way. They typically work for or closely with a company. They rarely perform medical actions and do not necessarily work on research projects. Instead they help companies with marketing and distribution of their products in the medical community. They understand what the doctor needs and wants to know and can translate this for their company. These technical physicians identify less with the classical definition of technical physician. Their identification with technical medicine is less via the work they are doing and more via what they have learned.

"I think I still apply the way of thinking, which you learn in technical medicine, on a daily basis." (Participant A).
"Based on the study, I still call myself a technical physician." (Participant A).

Although often related to a certain type of work, identification does not necessarily result from one's field of work. For example, although working for a company, a technical physician may still identify most with the medical professional because that is how he/she sees his/her task and a researcher may identify more with the business technical physician because he/she is working very closely with a company and is committed to the company's goals. Also a technical physician may work full time in and for a hospital but still see him/herself predominantly as a researcher.

3.4 Innovation

During the literature research, it already became clear that there is no one good definition of innovation, but that innovation can be seen and measured in different ways depending for example on the subject of interest or the area or type of innovation. Therefore the findings on innovation are split into a number of subsections.

Table 3. Sub themes and codes for main theme innovation.

Main theme	Sub themes	Codes
Innovation	Properties of innovation	Budget
		Long process
		Small steps
		Never done
		Problem at base of innovation
		Outcome
		Keeping the user/stakeholder in mind
		Diversity
		Inside vs. outside the box
		Personal twist
	Areas/Types of innovation	Domain innovation
		New Knowledge
		Solving problems
		Enabling innovation
		Structural change
		Process innovation (area/types)
		Product
		Medical innovation
	Needed for innovation/ innovative people	Structured Working
		Passion/Motivation
		Knowledge
		Creativity
		Social interaction
		Daring/leaving the comfort zone
		Realization potential
		Open minded
		Thinking through
		Being goal oriented
	Improve/Invent/Re-use	From scratch vs. from existing
		New
		Re-use
		Change

3.4.1 Steps/stages

One recurring pattern in the literature was that innovation was often divided into different stages or levels (e.g. Chell & Athayde, 2009; Scott & Bruce, 1994). This can also be found in the interviewees' answers. Especially elements from the stages from Chell and Athayde (2009) were mentioned by several interviewees. One interviewee for example said that she was predominantly busy with evaluation, the second step from Chell and Athayde's (2009) model. Another interviewee described herself as engaging mostly in the implementation, this might best fit in the fourth step, opportunity exploitation.

"Innovation is to renew something, to implement something that eventually adds something (to the domain), is something new." (Participant H).

One participant explicitly said that she was not very creative and saw fewer possibilities than others around her, making a negative statement about her activity in the first step, ideation. Finally, one person expressed that he personally enjoyed thinking about and coming up with solutions but did not like the rest of the process as much. However, he still engaged in the other steps as part of his work.

"I am innovative because that is what my project required. I noticed that I liked thinking of solutions for problems. Seeing it through until the last details, I liked less. (Participant E).

3.4.2 Areas/types of innovation

Generally, participants agreed that innovation in technical medicine should be health care related. This, of course, is in line with what technical physicians are educated for and therefore not much of a surprise. A manner in which the interviewees differed was the types of innovation they mentioned and the ways in which one could become innovative. Three main categories can be formed based on the interviewee's answers, which comprise among them most of the individual statements. First is the development of new/improved techniques that allow medical personnel to better treat their patient(s). This may include the use of a different type of technology or a different use of an already existing technology.

"… Do you focus on the process or on the technology, on the hardware or the software, that is yet another way, those are yet again different strategies." (Participant I, about different types of innovation).

The second type is the improvement of doctor processes, making the doctor's work more effective and/or efficient. Examples for this could be a new system that allows faster information processing or the changing of a hospital's structure to improve patient care. These first two types resemble how most people would describe innovation and are in line with Scott and Bruce's (1994) description of innovative behavior, the production and/or adoption and implementation of useful ideas. The third type focuses directly on enabling innovation. This is done for example by supporting creative others, showing the need for improvement, gathering new knowledge that can contribute to an innovation and implementing and

evaluating innovative techniques or processes. This type of innovation was found exclusively among university staff and the researcher identification type. A possible explanation is that inside the university, technical physicians often work together with other technical physicians. As a result, they take different roles in the team related to different aspects of the innovation process. These roles also matched the tasks they attributed to technical physicians. The best example was participant D who said that monitoring and evaluation were two of the most important tasks of the technical physician and at the same time mentioned these as ways in which one could be innovative. It appears thus that the ways in which one perceives one's task and identifies with one's profession are indeed related to the ways in which one becomes innovative. The question that remains is whether identification influences innovation (as suggested by Brophy et al. (2004)) or vice versa or whether the two develop in a parallel way.

The construction of new machinery/technology was not a way in which technical physicians became innovative. They agreed that this was normally the task of a technical specialist, although they might very well be involved in the process by giving feedback or information on what they/the doctor needed. Although areas and types of innovation have been split into three categories, this does not mean that each interviewee was only innovative in one of these ways. This was true for some of participants, but others engaged in several types of innovation, although not always at the same time.

3.4.3 Properties of innovation and what is needed for innovation

Statements from this category were much in line with what has been described in the previous sections and a number of them can be related to the five central skills needed for innovation (Chell & Athayde, 2009). Creativity was mentioned as an important feature needed for innovation.

"More innovative technical physicians see more possibilities and are more creative." (Participant A)

However creativity alone does not result in innovation but is merely a starting criterion. Curiosity, daringness, the desire to change something and a good knowledge base of the target domain itself and other domains regarding their body of knowledge and structure were also mentioned as key aspects for becoming innovative. Once started, a list of other factors is needed to actualize the innovation. These aspects range from social interaction skills (e.g.: networking, communication, presentation) to resource management and creating a (financial)

foundation to scientific working and monitoring. Other aspects mentioned were passion and motivation, realizing ability and keeping a broad perspective (no blinders). Opinions differed on whether innovation had to be 'out of the box'. While some participants stated that real innovation had to be something completely new, others said that one could also become innovative 'within the lines', as long as there was a development that added something or made something better.

"If you change something and it is better for the patient, then you have become innovative." (Participant F).

Such improvements were often described in terms of effectiveness (better final result) or (cost) efficiency. Another aspect mentioned by most of the participants was the combination of domains, using knowledge of different domains to produce a solution. This is an important aspect of Scott and Bruce's (1994) bisociative thinking. The interviewees agreed that the problem owner and the user should remain central through the innovation process and that innovation was often a longer process consisting of small steps. Nevertheless small steps could already yield an important improvement. Several participants also mentioned that staying up to date was necessary in order to be innovative and one interviewee mentioned that this might be a major difference between technical physicians and doctors. Unlike technical physicians, the schedule of a doctor had not enough space for continuous learning, giving the doctor no chance to become innovative.

3.4.4 Individual differences in innovativeness

As has become apparent in the previous sections, there is not one single way of being innovative and therefore also not one single way to measure individual innovativeness. The interviewees' opinions on differences in innovativeness were also somewhat inconclusive. While most participants answered that there were indeed individual differences in innovativeness between technical physicians, they could not always say what the differences were and had generally difficulties in explaining how one could measure a possible difference. An idea that came up repeatedly was that researchers were more innovative than 'clinical' technical physicians. However, the clinical technical physician they described (one who would rather be a doctor and should have studied medicine instead) was not represented in the present sample of technical physicians. When asked directly whether they found themselves innovative, all participants answered 'yes'. When asked why they found

themselves innovative, answers differed significantly. Trying to come up with innovative ideas, making innovation possible, never standing still, being a frontrunner and accomplishing something inside the hospital that had not been thought of before, were some of these answers.

"Yes, I am innovative because I am changing things here in the hospital which nobody has thought of before." (Participant G).

This is in line with the perception of most participants that technical physicians differ most in the ways in which they become innovative. Furthermore it reflects the different opinions on how much of a change an innovation has to be. While all participants named some kind of change, about half of the participants said that innovation had to be something really new like a clear new idea, not thought of before. The other half did not go that far and stated that innovation could also be a new application of something that already existed, or a combination of existing things in another way. One individual named a 'change in direction' as a way to be innovative.

Although the interviewees could not really point out a way how to differentiate levels of innovativeness, two things became apparent during the analysis. First of all, not all technical physicians had the same amount of time available to work on innovation. For example, the lecturers prepared and gave classes as part of their work. This is time they normally cannot spend on research or implementation. This applies to an even greater extent to the business technical physician, whose primary task is to promote and distribute their company's products. Contrary, the medical professional would most of the time, if not all the time, be working on their innovation, either by researching or implementing their project. This does not necessarily mean that the medical professional technical physician produces the best innovations, but they normally have the most time available to work on innovation. The second discovery I made when analyzing the interviews was that most of the participants who did not describe themselves in common terms of innovation had chosen for a job at the university. Making innovation possible, not being very creative, or explicitly mentioning that innovation did not have to be out of the box were statements found among these participants. However, it cannot be said that university staff in general were less innovative.

3.5 Personality

Besides identification and innovation, the analysis of the interviews produced another interesting category of statements, personality. In this category, all statements that interviewees made over themselves or a group to which they belonged regarding, personality traits, personal preferences, personal interests and motivation. Most statements could further be divided into statements expressing the importance of social and interaction statements (inter-personal skills), statements regarding interest in and preference for natural sciences and technology (mechanistic know-how), statements regarding other personal interests and motivation and statements regarding individual ambitions and drive.

Table 4. Sub themes and codes for main theme personality.

Main theme	Sub theme	Codes
Personality	Inter-personal skills/ mechanistic know-how statements	Social/interaction/ inter-personal skills
		Natural sciences/ mechanistic know-how statements
	Ambitions/drive/proactive	+
		-
	Personal interests	Broad/diverse
		Understanding
		Like innovation
		Like evaluation
		Like freedom
	Open for new things	+
		-

3.5.1 Ambitions/drive

Remembering the innovation literature (Chell & Athayde, 2009), this category is probably the most interesting. Participants varied immensely in the number of statements they made about their ambitions and drive. Three participants did not make any statement in this category while one participant even said that she had started settling for the ‘80%.’ This is in contrast to others who described themselves and their colleagues as perfectionists, constantly searching for improvement. Other statements in this category included for example the desire to change something and being persistent, an important characteristic of innovative people according to Chell and Athayde (2009). Taking initiative and daringness were two other important aspects mentioned by the interviewees.

“Placing the bar high is very typical for technical physicians. That’s probably the result of the upbringing and education. (Placing the bar high) Not only for the result but also for the

functioning itself, you have to be good at everything, at the same time and immediately. I let go of that myself, but that is something which you see very often with a technical physician." (Participant D).

One participant also made a very interesting statement on another one of Chell and Athayde's (2009) central skills, self-efficacy. He said that students of technical medicine were made to believe in themselves and their abilities by the institute and the lecturers who expressed a lot of trust in them.

3.5.2 Inter-personal skills vs. mechanistic know-how

With the exception of one interviewee, participants made more mechanistic know-how statements than inter-personal skills statements, supporting the statement made by one participant that, although social interaction is an important part of the job, technical medicine is mostly focused on technology.

"A technical physician is beta (natural sciences/mechanistic knowhow oriented). You have to calculate all those difficult formulas in physics, mathematics, signal analysis. But you are not only beta. … You have to feel comfortable among other people. You must dare to start a conversation." (Participant I).

One interviewee even stated explicitly that she did not like the social aspect in technical medicine. A number of participants did not make any inter-personal skills statements but more than half of the participants mentioned at least one thing in this category and one based her choice for place of work on not wanting to be the only technical physician around.

3.5.3 Personal interests/motivation

Statements in this category could mostly be summed up in three subcategories. First up, many interviewees liked the idea of variation and a broad approach and therefore chose to become technical physicians. Secondly, they liked learning and researching and coming to understand why things work the way they do. Understanding, rather than just knowing was important to many of them. The third subcategory is about 'standing in the world', actually doing something instead of working in an office or researching in a laboratory behind closed doors. Two statements that could not be grouped were the love for innovation and enjoying evaluation.

"Category three does less in-depth work en does not like the long back and forth during research, but wants more action and therefore chooses to work in the business world." (Participant A, on the third of the three types of technical physicians she described and which she indentified with).

Generally, several interviewees described themselves as adaptive, free spirits, curious, enthusiastic and spontaneous. Differences could be found in willingness to leave one's comfort zone, although not all participants expressed a clear point on this aspect. The most distinct positions were enjoying leaving the comfort zone and having a preference for a familiar surrounding.

4. Conclusion

The goal of this paper was to determine the ways in which technical physicians identify with their domain, how they perceive and practice innovation and whether there is a link between these two aspects. From a theoretical perspective this provides us with information on how people identify with a new, emerging domain. At the same time, the present research also has practical value for the University of Twente, as it provides us with insight in the actual work of the technical physician which can guide the institute in optimizing its study program.

4.1 On identification

On the question of identification with an emerging domain the present research showed that for technical medicine there are several ways in which technical physicians identify with their domain. This is at least to some extent a result of a lacking universal definition of the technical physician's work. It is something that seems likely to appear in any emerging domain as there simply has not been enough time for a clear definition to settle in. Although all interviewees had relatively high identification scores on the Mael and Ashforth (1992) identification scale, most of them also said that there was not one single technical physician but different types.

A technical physician who performs research and implementation in a medical institution is what the University of Twente has in mind when it comes to their study program ("Technical Medicine", 2015) and indeed, a great part of today's technical physicians have become exactly that. They mostly perceive themselves as medical professionals. Many of

them appear extravert and energetic, which is an important characteristic of innovative individuals (Chell & Athayde, 2009). They combine research and implementation in their daily work without becoming routine experts, that is, they keep their eyes and ears open for new information (typical for adaptive experts (Schwartz et al., 2005)) instead of becoming fixated on what they already know (Chi, 2006). But then there are also other types of technical physicians. The university-employed technical physicians predominantly see themselves as researchers and/or lecturers. They see their tasks in researching and training new and even better educated technical physicians and often share a feeling of responsibility for the domain. Some of these researchers and lecturers appear a bit more introvert than the medical professionals. This was also true for the researcher in the present study who did not work at the university. Remembering the situational competences, one of the seven competences of technical physicians (Overkamp, 2014b), this may be a bit unexpected. At the same time it highlights individual differences, something every area of expertise has to deal with, and which can be a valuable source of diffusion. Especially in innovative domains, versatility, allowing for more perspectives, can be beneficial. Finally there is the business technical physician. This type identifies with the knowledge and way of thinking (technical-medical /system thinking) he has acquired during his study and not so much with the picture of the technical physician that the NVvTG promotes.

Each of the four types described above is mostly bound to one or two types of jobs. The medical professional mostly works in a hospital, the researcher and the lecturer can be found mostly at the university and the business technical physician normally works for a company. Interestingly though, there were also two individuals whose identification types did not match the dominant field of employment for that type, thus showing that employment and identification type are related to some extent but that there are also deviations. It could be interesting for future research to examine how strongly work and identification type are related and whether there might be another identification type, not discovered in the present sample. This could be the routine expert, doctor-like clinical technical physician mentioned by some participants. Especially if the identification type is formed during the study, this could yield implications for the guiding of students during their education.

4.2 On Innovation

Regarding innovation the present research showed that differences among technical physicians were mostly of four kinds. Firstly, and perhaps most interestingly, the interviewees differed in how they saw innovation and the ways in which they became innovative. Most

participants portrayed their innovative activities in aspects that can be found in innovation literature (e.g. Scott & Bruce, 1994), examples of which were problem definition, ideation, networking, and opportunity exploitation. However, there were also those who described only one or two aspects of innovation, those in which they engaged (e.g. evaluation). It is difficult to say if one of them is more innovative. It certainly should be a point of attention when it comes to forming a team, an essential aspect of innovation since innovation normally is a team process (Chell & Athayde, 2009). Secondly, participants differed in the fields in which they became innovative. These differences were mostly because of the different master orientations the participants had followed, something that should be kept in mind during curriculum construction for technical medicine in this case but also for other domains in general. Thirdly, the interviewees described different types of innovation. Process improvement, technique improvement and structural changes were examples of innovation types on which technical physicians worked. Considering that adaptive experts are exceptionally good at identifying opportunities for innovation (Brophy et al., 2004), this variety may not come as much of a surprise but might even be a confirmation of the university's effort. Fourthly, technical physicians differed in time they had available to spend innovating. While technical physicians working at hospitals spent almost all their working hours on innovative projects, lecturers also had to spend time on other tasks (like lecturing), and business technical physicians were left with very little time to become innovative themselves. This may be less important for the curriculum makers, but certainly a point of attention for employees.

4.3 Links between innovation and identification

As there was no way to clearly determine individual innovativeness, there was also no way to link it to the extent of identification with the domain. However, there were some links between how participants perceived innovation and how they identified as technical physicians suggesting that these two aspects are indeed related. Participants who saw themselves as part of a team of technical physicians or as part of the institute more often described innovation in terms of evaluation, enabling innovative others and being less creative themselves. Those who saw themselves as pioneers in the medical world also described themselves in more innovative terms. Whether there is a causal relationship between the factors of innovation and identification or whether it is a mere co-occurrence could not be answered in the present study and may be an interesting topic for future research.

4.4 Implications for the University of Twente

Most participants were very satisfied with the quality and content of their education. They experienced the skills and knowledge they had acquired to be of universal use in various situations. Especially the medical professionals felt well prepared for their work. Of course their work is what the institute had in mind when they developed the curriculum and if this is what the University of Twente intends to continue in the future then it is on the right path. However, several participants expressed their worries that, at least in the Netherlands, the point of saturation for this type of technical physician was close. Most hospitals and medical institutes who could afford employing technical physicians already did so and there were not too many spare positions left. Considering this, it might be interesting for the university to also take a glance in another direction. There are not many business technical physicians at this point in time while there are still a large number of companies who could use one, especially once the expertise of technical medicine becomes better known. Free choice subjects on sales and economics could be a valuable asset for these specialists.

4.5 Limitations and Suggestions

Evaluating the present study, there are some limitations which leave room for future research. Firstly, the rather small sample size of ten participants leaves us with the possibility that not all ways of identification of technical physicians with their domain have been discovered yet. Also, technical physicians working fulltime in hospitals were underrepresented in the present research. This is a result of the sampling approach which started by contacting university employees because their email addresses were accessible. This convenient approach was chosen after Overkamp (2014) encountered major difficulties when he tried to get contact information from external sources. At the same time, the ten individuals made up almost five percent of the total population of technical physicians in early 2015. With a little more than 200 graduates, it is not unlikely that there are still other identification types to be found in the future that cannot yet be found in the population. Again, this is a very young study. Secondly, future research may want to try to investigate the direction of a possible causal relationship between certain types of identification with particular ways of being innovative. As the present study was of qualitative and explorative kind, I was not able to answer this question myself. The findings of such research could be applied to develop a more diverse study program (e.g. special topic classes), giving more options to the individual student which may better fit their identification or innovation type. If such a relationship could be found, this could also be of interest for other domains that rely on

innovation. Finally, a tool to measure individual innovativeness would be practical to have. To my knowledge, something like this does not yet exist. Given a tool of this kind, it could be interesting to compare levels of identification in different domains with levels of innovativeness in these domains. This would provide us with a quantitative approach to the question if higher identification with an innovative domain is indeed related to higher innovativeness in that domain.

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6. Appendices

Appendix I

Description of participants

This section gives a short summary of each participant, describing the work of the individual, how they identify with the domain of technical medicine and the ways in which they see innovation and become innovative. For reasons of anonymity, no names are used for either the participants or their employers other than then University of Twente. Instead the participants are named Participant A – Participant J and the employer is described by type.

Participant A

Participant A had graduated two years prior to the interview with Medical Imaging & Intervention as specialization and worked for an international electronics company. At her company she was involved in utilitation management, service marketing and the company's own health care training program. She would not always introduce herself as technical physician, mainly because that was simply not practical (need to explain technical medicine). She described herself as a business technical physician and, although scoring 27/30 on the ID scale, was therefore not sure whether she was a technical physician by standard definition. Instead she identified with technical medicine mainly because of her study and the way of (system) thinking she had acquired during the study which she believed was helpful in almost any job. She had chosen technical medicine although she knew from the beginning that she did not want to become the typical technical physician. She especially enjoyed the social and communication aspect of technical medicine which is why she chose to become a business technical physician, which means less research and more 'action'. Although she liked beta subjects a school, social interaction, action and variation were most important to her. Regarding innovation she described herself as less creative than others, seeing fewer possibilities. Usability was the most important aspect of innovation according to her. While real innovation was something others had not thought of before, it was still important to keep these others, who would eventually use the product, in mind and to involve them in the (iterative) process.

Participant B

This participant was currently doing her promotional research at the University of Twente where she had graduated about one year earlier (Medical Sensing & Stimulation). She

did her research project at the hospital in Enschede. The role of the technical physician she described as that of a bridge in the hospital between medical experts like doctors and technical experts like e.g. engineers. In his/her position the technical physician was parallel to the doctor, moving from project to project and supporting others. Personally she got her main identification from being a researcher and part of the university's team (ID score: 22). Participant B liked the black and white thinking of math in which something is either right or wrong and preferred understanding a formula above knowing a line of facts. She chose for her current job partly because of the familiar surrounding and because she did not want to be the only technical physician around. Like Participant A, she wanted to stand in the world and actually do something but chose to pursue this in the form of conducting research in a hospital and having contact with personnel and patients. Innovation did not have to be out of the box as long as it solved a problem encountered in the (medical) world. This participant expressed a somewhat external locus of control when it came to innovation. She described innovation as being strongly dependent on the circumstances and the surrounding.

Participant C

Participant C had graduated almost four years prior to the interview (Medical Sensing & Stimulation) and worked at the University of Twente as researcher and lecturer. Although her job included both lecturing and research, she spoke mostly about her role in the university's education team, feeling personally responsible for technical medicine and the future generations of technical physicians. She said that she felt as a technical physician (ID score: 27) and saw the improvement of individual patient care by innovation as the domain's main task. This participant described herself as being driven, a perfectionist and having a desire to do new things. She didn't like routine and enjoyed looking outside the box. She was curious and eager to know why things work the way they do. At the same time she was the only participant who expressed that she did not like the social aspect of technical medicine that much. According to Participant C innovation was difficult to measure, but definitely had to be something really new and an improvement for the bigger group, not just for one individual. She called herself innovative because she always tried to think outside the box, not to come to a standstill and wanted to discover, mount and do new things.

Participant D

Being busy with her promotion in the field of robotics and megatronics, this participant was a researcher at the University of Twente who had graduated almost three years

before the interview with a Master's degree in Medical Imaging & Intervention. She saw herself as a researcher and not an inventor (ID score: 24). According to her, the technical physician was living and working in two worlds (technical and medical) where he/she often had to explain and defend the work and domain of the technical physician. Although being very interested in beta subjects, she saw her strengths mostly in the communication and evaluation. The freedom and variation that technical medicine offers were important to her. In contrast to participant C, this participant explained that she had let go of the urge to always achieve the 100% and instead had started settling for 80% but making sure that these 80% were useful. She found herself innovative because she enabled innovation and saw innovation as a team effort in which she was responsible for monitoring and evaluating to guarantee a success- and useful innovation process. Above all, innovation had to be an improvement on the current state.

Participant E

Being the only one in this sample, Participant E had graduated in Reconstructive Medicine, a specialization which is not taught at the UT anymore. Since then (> 3 years) he worked on his promotion research in a hospital which focused on optimizing the transplantation process of certain cell clusters. This participant scored lower than most of the others on the ID scale (ID score: 20) which came back in his interview statements. He did not really feel a technical physician, mostly because what he did was not a part of university's study program anymore. At the same time he mentioned that there was not one good definition of a technical physician because of the diversity of the domain. He saw himself predominantly as researcher who had chosen his job because enjoyed doing it and not because of the money. He expressed his belief that this was probably true for most of the technical physicians who, if money was their motive, would probably have chosen classical medicine. Personally he liked the combination of medicine and technology was willing to take a risk to be innovative. He especially enjoyed thinking of solutions for a problem and preferred this to the actual implementation. Innovation needed patience and was never truly finished because it could always be better. He mentioned networking as an important means in the process of innovation, a process that had to result in progress and something new.

Participant F

This participant worked exclusively at the University of Twente as a researcher in the university's experimental centre and as a lecturer. He had graduated in Medical Imaging &

Intervention about half a year before the interview. He already felt strongly connected to the domain of technical medicine (ID score: 27), especially now that he was part of the study's staff, but argued that this could become even stronger once he started giving his own classes. Participant F enjoyed the dual nature of technical medicine and his job which allowed him to combine interests and to keep variation in his work. He was the only one who literally said that a technical physician did not necessarily have to be an adaptive expert. He had a slight preference for the technical aspect of TM and had considered studying mathematics instead. Again, the variation TM offered was an important factor for his study choice. He described himself as curious and eager to learn. According to him, the researchers were the most innovative technical physicians. Innovation did not have to be something completely new but could also be giving a personal twist to something that already exists. It was a long process which was never really completed. He saw himself as very innovative because he was bringing a new technology to the university which he had to organize and implement all by himself.

Participant G

Participant G varied from most others in that he had two Master's degrees, one in technical medicine (Medical imaging & Intervention, < 1 year) and one in health science (3 years). He explained that this was probably a reason why he did not identify with technical medicine that much (ID score: 20). This participant mainly worked on his promotional research in a hospital while functioning as project coordinator for a cooperation project with another hospital for one day per week. He saw himself as a medical professional who formed a bridge between doctors and technical experts. In his opinion, the technical physician was not a unique type but that typical characteristics of technical medical experts like system or concept thinking and an interest in innovation could be found in about 90% of technical physicians but also in two to five percent of classical physicians. According to him this was only partly due to the type of person who chose to become a technical physician or doctor, but was also a result of the domain's and therefore the study's doctrine. While TM students were encouraged to come up with new ideas and to be more daring, medicine students were discouraged by the system to break with the existing order. He described himself as interested in the natural sciences and as a perfectionist. He liked the broad knowledge that he gained as a technical physician which fit his curiosity. He stated that being innovative was a character trait and that it could not be taught, only encouraged. He considered himself innovative because he came up with changes to the hospital that no one had thought of before. To him,

improvement, rather than technical perfection, was most important in innovation. He further stressed that having realizing potential was extremely important in order to become innovative.

Participant H

Graduated a half year before the interview (Medical Imaging & Intervention), Participant H was a researcher at the University and the hospital who was being financed by an external company which was interested in her research on endo-prosthetics. She therefore also identified more as a business technical physician (ID score: 20) although she also functioned as an internship supervisor for university students. She definitely did not see herself as a clinical technical physician or technical doctor which is how she perceived the image the university had in mind. Instead she saw herself as a researcher in a company's service. She described herself as driven, interested in innovation and wanting to stand in the real world. At the same time, patient contact in the hospital was not among her favorite aspects of her job. Taking on problems and solutions from a new perspective was how she became innovative. She saw the researcher as the more innovative type of technical physician but could not really describe at the time what was important in the innovation process.

Participant I

Perhaps the most radical thinker in the sample was Participant I. He had graduated in Medical Imaging & Intervention 2 months prior to the interview and had since then started a medical software company together with a friend. Although expressing a very strong emotional connection with technical medicine and being proud of being a technical physician, he was not among the highest scorers on the ID scale (ID score: 24). Despite starting his own company and calling himself definitely a beta type, this participant saw himself predominantly as a medical professional and not as a business technical physician. System thinking was a big strength of the technical physician whom he perceived as a hybrid, much in line with the technical doctor described by Participant H. His most striking statement was that he predicted the future takeover of most of the doctor's tasks by technology, making the social aspect of patient interaction the most important part of the doctor's work. Of all participants, Participant I made the most Alfa statements. Having a bit of a big mouth, being good at networking, being socially driven and engaging in activities outside his study/work he thought to be properties of himself and innovative technical physicians in general. He also used a lot of ambition statements to describe himself, calling himself ambitious, driven and

daring. Keeping a free spirit and thinking and acting out of the box were important to him. ‘I see no limits’, was one of his statements which was in line with his description of himself as curious and enthusiastic. He perceived himself to be a front-runner of new medical technologies, which is how he became innovative. Real innovation had to be something new and benefited from passion, networking and daringness. It was also important to look outside one’s own box/ area of expertise and to maintain a broad perspective.

Participant J

As a medical professional, but not a doctor, described Participant J himself and the way he saw his role as technical physician. He worked on his promotion as a researcher at a hospital, focusing on stent placement while also guiding students in their internships. He had graduated in Medical Imaging & intervention half a year before the interview and felt a technical physician mostly because of the appreciation he got from the clinic (ID score: 21). Being a technical physician for him meant to be a pioneer in a rather undefined occupation. He thought that TM should focus on producing general solutions to problems rather than solving individual problem cases. Also, figuring out the technical details of something was a task that could better be put out to technical experts; the technical physician was the one who had to come up with the idea. He disliked pigeonholing of any kind and instead described himself as curious and borders as being something set by others. To him, the innovation aspect of his work was most important, even more so than helping patients with problems. In line with that he liked researching and being productive and described himself as someone who to the initiative. During his internships, he said, he had always chosen and formed his assignments in a way that forced him to come up with something new. Innovation did not have to be some new technology, but could also be the improvement of a process, making it more efficient or effective.

Appendix II

Contact Mail

Master onderzoek - Innovatie bij technisch geneeskundigen

Beste meneer

Mijn naam is Ole Selg en ik ben masterstudent Psychologie aan de UT. Op dit moment doe ik in het kader van mijn masterthese onderzoek naar de innovatie van technisch geneeskundigen en hun identificatie met het domein van Technische Geneeskunde. Dit gebeurt in samenwerking met Marleen Groenier (zij vertegenwoordigt binnen dit onderzoek de studie TG). Met mijn onderzoek hoop ik meer inzicht te krijgen in de manieren waarop technisch geneeskundigen innovatief kunnen zijn en welke rol de identificatie met het domein daarbij kan spelen.
Omdat TG nog een relatief jong domein is en er nauwelijks direct onderzoek naar is gedaan (hooguit indirect via adaptive expertise), zijn technisch geneeskundigen, zoals u, de belangrijkste bron van informatie. Om deze reden ben ik op zoek naar technisch geneeskundigen die hun persoonlijke mening en ervaring in een interview van 45-60 minuten zouden willen delen. Van Marleen heb ik vernomen dat u een opleiding TG heeft afgerond en op dit moment aan de Universiteit Twente werkzaam bent. Daarom zou ik graag bij deze aan u willen vragen, of u wellicht aan mijn onderzoek mee zou willen doen, zodat daarmee een waardevolle bijdrage geleverd kan worden aan de kennis van het jonge domein van de technische geneeskunde. Als u binnen de komende 6 weken de tijd heeft en geïnteresseerd bent om ongeveer één uur door mij te worden geïnterviewd, zou u mij erg helpen.
Tot slot ben ik ook op zoek naar technisch geneeskundigen buiten de UT die eventueel mee zouden willen doen aan dit onderzoek. Kent u wellicht iemand die ik nog zou kunnen interviewen (en zou u mij in dat geval het e-mail adres kunnen geven)? Dit zou een grote steun zijn.

Graag hoor ik snel van u. Voor vragen en verdere informatie ben ik per mail goed bereikbaar. Voor nu wens ik u alvast een fijn weekend!

Bij voorbaat veel dank en met vriendelijke groet,

Ole Selg

Appendix III

Interview scheme

Introductie

Naam

Hoe oud ben je?

Hoe lang geleden ben jij afgestudeerd met je master?

Wat doe jij op dit moment?

Hoe ben je bij je huidige werk terecht gekomen?

Vragen idendificatie (van en) met het domein

Wat hoort er volgens u bij het domein van technische geneeskunde?

Wat zijn de belangrijkste onderdelen van de technische geneeskunde?

(kijk op TG)

Hoe voelt u zich verbonden aan het domein van technische geneeskunde?

(persoonlijke relatie met TG)

Wat zijn typische charakteristiken van een technisch geneeskundige?

Welke eigenschappen heeft u die volgens u bij een technisch geneeskundige horen?

Welke eigenschappen horen volgens u bij een technisch geneeskundige?

Wat maakt van iemand een technisch geneeskundige?

(kijk op TGer)

Wat betekent het voor u om technisch geneeskundige te zijn?

Waarom bent u technisch geneeskundige (geworden)?

(eigen identiteit/ motivatie)

Hoe onderscheidt zich een technisch geneeskundige van een gewone geneeskundige?

Hoe onderscheidt zich een technisch geneeskundige van een ander soort adaptive expert als bv. een ingenieur?

(afbakening TG tegen gerelateerde domeinen)

Vragen innovatie

Wat is volgens u innovatie?

Noem vijf belangrijke eigenschappen van innovatie.

(eigen definitie innovatie/ eigenschappen innovatie)

Hoe ziet innvoatie binnen de technische geneeskunde eruit?
Hoe onderscheidt zich innovatie binnen de technische geneeskunde van innovatie binnen andere domeinen?
(innovatie binnen TG anders dan daarbuiten?)

Zijn er verschillen in innovatie binnen de technische geneeskunde?
Zijn er verschillende typen van innovatie binnen de technische geneeskunde?
(verschillen binnen TG (typen innovatie) – bestaan volgens gesprek Marleen met de 2 Tgers)

Verschillen technisch geneeskundigen in hun mate van innovativiteit?
Zijn er individuelle verschillen tussen technische geneeskundigen wat betreft hun innovativiteit?
(Verschillen binnen TG (typen TGers))

Welke eigenschappen hebben technische geneeskundige die meer innovatief bezig zijn dan anderen?
Hebben innovativere TGers bepaalde eigenschappen meer dan hun minder innovative collega's?
(innovative chrakteristiken – innovative persoonlijkheid?)

Later opgekomen vragen
Heb je voldoende mogelijkheid tot innovatie gehad tijdens je opleiding?
Zou je zeggen dat je zelf innovatief bent en waarom?

Appendix IV

Informed consent

Toestemmingsverklaringformulier (informed consent)

Titel onderzoek: Identification with an innovative domain

Verantwoordelijke onderzoeker: Ole Selg

In te vullen door de deelnemer

Ik verklaar op een voor mij duidelijke wijze te zijn ingelicht over de aard, methode, doel en [indien
aanwezig] de risico's en belasting van het onderzoek. Ik weet dat de gegevens en resultaten van het
onderzoek alleen anoniem en vertrouwelijk aan derden bekend gemaakt zullen worden.
Mijn vragen zijn naar tevredenheid beantwoord.

Ik stem geheel vrijwillig in met deelname aan dit onderzoek. Ik behoud me daarbij het recht voor om op elk moment zonder opgaaf van redenen mijn deelname aan dit onderzoek te beëindigen.

Naam deelnemer: .....

Datum: ..... Handtekening deelnemer: .....

In te vullen door de uitvoerende onderzoeker

Ik heb een mondelinge en schriftelijke toelichting gegeven op het onderzoek. Ik zal resterende vragen
over het onderzoek naar vermogen beantwoorden. De deelnemer zal van een eventuele voortijdige
beëindiging van deelname aan dit onderzoek geen nadelige gevolgen ondervinden.

Naam onderzoeker: .....

Datum: ..... Handtekening onderzoeker: .....

Appendix V

Six-item-likert questionnaire based on Mael and Ashforth (1992) which was administered in English

Name: Date:

Items ranging from 1 (strongly disagree) to 5 (agree completely).

When someone criticizes the domain of technical medicine, it feels like a personal insult.

1 2 3 4 5

I am very interested in what others think about technical medicine.

1 2 3 4 5

When I talk about technical medicine, I usually say ‘we’ rather than ‘they’.

1 2 3 4 5

The successes of technical medicine are my successes.

1 2 3 4 5

When someone praises the domain of technical medicine, it feels like a personal compliment.

1 2 3 4 5

If a story in the media criticized technical medicine, I would feel embarrassed

1 2 3 4 5