CHAPTER 7

General discussion
In this chapter I provide an overview of the project described in this thesis. I do so in four different ways. The first part of this chapter aims to identify the ideas that traverse what was presented in preceding chapters. In it I identify trends, and make explicit where the ideas presented in this thesis could be located in relation to more general ideas; those in the field of dentistry, and those beyond it. The second part of this discussion presents the answers I reached to the research questions that were detailed in the introduction to this thesis. These questions were (1) which promoting and constraining characteristics can be identified in dentists’ adoption and rejection of digital developments? (2) Which changes impacting on the dental workforce can be expected to develop alongside the increasing role of digital techniques in the field of dentistry? and (3) How do dentists and dental practices adapt to these changes, and what are the consequences of these adjustments? I do this by detailing what was captured in each chapter relating it to the different methods used. It thus gives a methodological perspective on what was captured and what was left out, using comparisons between methods. The third part of this discussion looks back on the journey that thinking about, doing, and writing this thesis was. In it I use a more personal perspective. Finally, this discussion and the main body of this thesis close with recommendations derived from this process and from the ideas captured in this thesis.

Connecting ideas

In this thesis, the focus has been on the profession of dentistry and on dental practices, rather than on digital technologies in themselves. This was done with the aim to describe technology use by looking at individual, social and material factors that are involved in decisions around technology adoption, and in consequences of technology use. These incorporate and go beyond specific technologies. Thus, rather than a detailed and in-depth case analysis in this thesis, I provide an exploratory reading of developments in the profession of dentistry, the techniques used therein, and the social relations that are tied to these. I looked at (individual) dentists’ ideas about using technologies in the dental practice they worked in. Without knowing how dentists interact with, choose from, and deal with, digital technologies in their work, the process of technology use remains opaque. As chapters two and six have shown through interviews with dentists and others involved in oral health care, the consequences of digital technology use in dentistry are felt throughout the profession, rather than just individually. A first step in addressing these consequences can be made by exploring common problems and opinions on technology use in dentistry. This is what this thesis has mainly been about. Besides dentists, dental practices, and technologies, other actors – such as patients, other oral health professionals, insurance companies, technology providers, and dental educators - also influence how technology
use in dental practices develops. While recognizing the impact that actors outside of dental practices have on technology use in dental practices, in this thesis I focused on what happens in dental practices.

Looking at technology use in dental practices requires a perspective that is not static. Many processes take place that influence the use of technologies. Developments in the dental workforce, social processes, financial regulations, and legal requirements have an impact on dental practices, on the dental profession, and on how digital technologies are taken up. At the same time, developments in technologies themselves often take time, and the specific requirements and tasks that go with using a technology might change. In this thesis, I have attempted to bring into view which processes play a role in the use of digital technologies in dental practices. The aim was, then, to give an overview of the current state of affairs, with a view to identifying processes that have influenced this up to the present, as well as identifying those that are likely to determine the course these developments take in the future, although unexpected developments may have an impact as well. The view on technology use by dentists I present in this thesis is thus a reading of current processes, derived from questionnaires, conversations, reading, and combinations of insights from various methods. The view presented is not a claim to know either the current state of affairs fully or to being able to provide fool proof predictions of future developments.

Studying technology use in dental practices can be akin to studying other processes of social change and how people deal with these. Looking closely at what happens when decisions are made regarding whether or not to adopt a technology, or what happens when technologies are used, is often about looking at what people think, what happens between people, and what happens in wider structures of oral health care, rather than about technologies in themselves. The second chapter explored these points in relation to digital dental technology adoption: it identified barriers and facilitators of technology use on the level of a technology and how its attributes are perceived, individual users, processes in dental practices, and the socio-political context around it. The focus in that chapter was on identifying factors that contribute to decision-making regarding digital dental technologies. The third, fourth and fifth chapters looked into which technologies were used by dentists and to what extent, how they were perceived by dentists, and individual and dental practice factors. Thus, the socio-political context was in large part left out of the picture in these chapters. The focus there was on measuring actual technology use, and exploring possible reasons for variations in these. Specific technologies were often analysed together in these chapters. In the sixth chapter, the effects of using technologies in dental practices in terms of professionalization, and ideas associated with dental professionalism, were in focus. This chapter moved away from the emphasis on decision-making of the previous chapters. Here, implementation of digital dental technologies, and its possible effects on a group level, came to the fore.
On methods and vantage points

The literature this thesis was based on was described in chapter 1. As I detailed in chapter 1, this thesis was informed by studies from diverse fields, mostly that on technology use in health care among patients and health care practitioners, and technology use in other professional groups. As there were few studies I could find on attitudes of dentists to using digital technologies, I took an exploratory approach in the studies that form this thesis. In order to do this, mixed methods were used. This work should thus be considered as one of the initial steps to shed more light on the topic of technology use in dental practices from a social perspective, and serves as a basis for formulating more specific questions. At the outset, therefore, methods were chosen to reach a combination of richness in detail and openness to dental practitioners’ experiences and views, as well as gauging the extent of technology use and attitudes towards this among general dental practitioners.

In chapter 2, an exploration of barriers against and incentives for using digital technologies in dental practices was presented. It focused on factors that may influence dentists’ decision-making, and laid the groundwork for the subsequent parts of this thesis. Using semi-structured interviews with experts from a variety of positions in dentistry, this approach gave the means to map which factors need to be taken into account when studying technology use in dentistry. This study thereby answered the first research question posed at the beginning of this thesis: which promoting and constraining characteristics can be identified in dentists’ adoption and rejection of digital developments? These were factors related to four domains. The first domain were technologies and their attributes, mainly what advantages they are perceived to bring and what costs and ease of use they are perceived to entail. The second domain is the user, in this study, dentists, and mainly their age and education, skills, mind-set, and the type of orientation to their work. The third domain relates to dental practices, mainly the division of tasks and communication within the practice, as well as its size and the frequency of performing specific treatments. Finally, the fourth domain is that of the socio-political context, principally peer influence, including opinion leadership, external influences, ethical and juridical concerns, as well as the time it takes for skills and knowledge to develop around new technologies. By identifying the main impeding and facilitating factors within each of these domains, this study drew up a categorization of the main factors influencing developments in digital technology use among dental practitioners.

Furthermore, this study allowed us to identify which digital technologies were important to participants in this study, making a distinction between technologies for administration and communication, and those for clinical and diagnostic use. Moreover, this study indicated that differences among individual dental practitioners - in their characteristics and working situation, as well as in attitudes and experiences - need to be taken into account. As is characteristic of qualitative research, this study gave an account rich in detail.
However, as the analysis was done with the aim in mind to identify and give an overview of factors influencing dentists’ use and rejection of digital technologies, the approach taken was more empirical than theoretical. Furthermore, qualitative methods were used in this chapter to describe categories of influential factors and processes, rather than to trace how technology use develops over time. This was not necessarily inherent in the methods used. Rather, it was a choice made during the data analysis, based on the aims of the study.

The findings of the study described in chapter 2 were used as a basis for developing a questionnaire, which was used in the study described in chapters 3 and 4. A questionnaire study was chosen as a way of providing insight into the current state of adoption of digital technologies in dental practices, with the aim to get an overview of technology use, personal and practice characteristics, and opinions about using technologies, among general dental practitioners in the Netherlands. These chapters aimed to answer the research questions (1) which promoting and constraining characteristics can be identified in dentists’ adoption and rejection of digital developments? and partly (2) which changes impacting on the dental workforce can be expected to develop alongside the increasing role of digital techniques in the field of dentistry? Chapter 3 showed that use of digital technologies was fairly widespread among dentists, yet the extent of use of these varied. The average age, the graduation year, having a specialization, the working hours, and the time spent on professional activities of dentists differed with respect to the extent to which they used digital technologies. Moreover, the practices that dentists who used more digital technologies worked in had on average more staff working in them, and more patients visiting the practice. These findings reflect those of the interviews described in chapter 2. Chapter 4 described that the extent to which dentists held various opinions about technology use and were motivated by specific aspects of work, differed between low and high technology users. How dentists scored on being focused on using technologies, and on perceived added value of technologies for themselves, appeared to have the strongest association with the number of technologies they used, when taking other factors into account.

In this study, some of the factors identified in chapter 2 had to be left out. As the focus was placed on characteristics and opinions of dentists, socio-political factors were not included in the questionnaire study due to limited resources. Other factors were operationalized to measure them in the questionnaire, which left some aspects difficult to ascertain. For example, graduation year as a way of measuring what a dentist has learned during dental training is a very general measure, which skips over many differences in courses taken, or differences between university programs. Furthermore, two types of motivating aspects to dentists in their work were associated with the extent of technology use (‘craftsmanship’ and ‘immediate results’). This could be due to dentists with higher overall job motivation using more technologies, or to dentists who are motivated specifically by technical aspects or their work, or by seeing immediate results in their work, using more technologies. The
questionnaire study thus opened up questions for further investigation. At the same
time, using a questionnaire also added insights. It enabled an overview of which digital
technologies dentists use, which proportion of dentists used each technology, and how
widespread digital technology use is. It also made it possible to identify opinions dentists
hold about digital dental technologies. Our approach looked at groups of digital dental
technology users. Within these groups, for example among low technology users, there
may be large differences in their approaches to technologies. Other approaches than the
ones used in chapters 3 and 4 would be more suitable to uncovering these differences in
future studies.

I measured technology use as the number of technologies dentists used. After careful
searches of the literature on technology use in (dental) health care, I did not find a consistent
measure of technology use. In most studies on technology use in other fields (e.g. hospital
care, businesses), either the intention to use a technology or whether a technology was
used (often using yes/no questions) was employed as a measure. However, this was usually
used for very specific technologies. Therefore, it became appropriate to develop a measure,
both to investigate an ensemble of technologies used, and to investigate one adapted to
the setting of dental practices. In chapter 3, I tested whether the number of technologies
dentists use could be employed as a measure of technology use. In that chapter, this was
looked at from various angles: whether dentists used a technology, how often they used it,
when they had started using it, how satisfied they were with the technology, and whether
non-users wanted to use it in the future. Aspects such as the frequency of use of technologies
could not be used beyond reporting it per specific technology, because for example, digital
administration would often be used far more often than a CEREC machine. Thus, comparing
how often a technology is used across multiple technologies was not consistent enough.
For these reasons, a sum score for technology use was employed: the number of digital
technologies dentists used. I then used this sum score to develop a categorization into low,
intermediate, and high technology user groups. Subsequently, it was tested whether this
categorization was associated sufficiently with dentists’ own rating of their technology use
compared to others (which was an item included in the questionnaire for this purpose).
The findings indicated that indeed low, intermediate and high technology use based on
the number of technologies, was consistent with whether dentists thought of themselves
as using less, the same amount, or more technologies than other dentists. In future studies,
however, this measure should be further refined, as measuring the sum of technologies
used has the limitation that it does not include information on, for example, frequency or
durability of use.

In chapter 5, a questionnaire study on the use of new technologies was described that
was carried out among dentists in New Zealand. The findings of this study indicated that
characteristics of dentists and dental practices were mostly not associated with technology
use among New Zealand dentists, contrary to the study in the Netherlands described in chapters 3 and 4. One of the main differences between these studies was that in chapter 5, use of specific technologies was studied rather than the total number of technologies. Furthermore, in this study the use of newer, clinical technologies was studied, whereas in chapters 3 and 4 the focus was on digital - administrative as well as clinical - technologies. Chapter 5 furthermore presented an overview of three studies on the use of new technologies by dentists: the one described in chapter 3, the one described in chapter 5, and a previous study in New Zealand which was carried out in 2007. Comparing these showed that digital radiography use appears to have increased substantially, the use of some technologies decreased, and that many other technologies are used to a similar degree. This suggests that studies on adoption of new technologies in dentistry should look not only at increases in use, but that decrease in use can be just as important.

In chapter 6, my perspective shifted from a focus on decision-making around technology use, to a study on what happens when dentists implement digital technologies in dental practices. This study differed from the earlier chapters in other ways as well. It looked specifically at processes in using technologies, and thereby moved away from the more static perspectives of the preceding chapters. In chapter 6, I aimed to reach a closer understanding of how digital dental technology use develops over time. Furthermore, this chapter uses a more theoretical approach than the previous ones, though still employing an explorative and open-ended method. The methods used in this chapter were constructivist grounded theory, combined with semi-structured interviews.

This chapter aimed to gain insight into the second and third question posed in the introduction: (2) Which changes impacting on the dental workforce can be expected to develop alongside the increasing role of digital techniques in the field of dentistry? And (3) How do dentists and dental practices adapt to these changes, and what are the consequences of these adjustments? Regarding question two, this study showed that core ideas which dentists held about their profession were pivotal in how they adapted to the consequences that using technologies had. Incorporation of technology use in these core ideas about the profession differed between older technologies, which were included in what dentists considered the core of their profession, and newer digital technologies, which were kept at a distance from this core. Regarding question three, this study showed that two types of processes are happening in dentists’ use of digital technologies. The first of these was fitting technologies into dental practicing, which involves the work required to align skills, the team working in a practice, and material and social contexts. This took place while dentists were not certain what to expect from technologies. The second was expectations for dental practice in the future. This involves the finding that dentists’ expectations - about their profession and about technologies - were a basis for how technology use was experienced, which opinions were formed about it, and which actions dentists took.
The grounded theory study described in chapter 6 gave a more fine-grained analysis than the preceding chapters. The findings of this study indicated that costs, benefits, and consequences of using technologies were often not straightforward or predictable. While during interviews held for this study, such costs and benefits were often initially talked about in straightforward ways, when looking more closely and following up on what was said – in interviews and in analysing these - it became clear that certainty about these was actually lacking. The consequences of using technologies for quality of care, in particular, were negotiated individually and contingent on circumstances in the dental practice.

Using this analysis made it possible to take a closer look at the opinions dentists gave about using technologies (discussed in chapter 4) and see how anticipated advantages and disadvantages of adopting technologies in dental practice developed when dentists implemented technologies. Furthermore, using grounded theory allowed me to examine and further develop insights into the consequences technology use had for professionalization in dentistry. This showed that dentists’ expectations about the consequences of technology use for professionalization often influenced how they acted. Thereby, such expectations had a strong impact on how using technologies in dental practices developed over time. Thus, the methods used in chapter 6 allowed for a closer look at some of the processes that may underlie the opinions and general tendencies described in the preceding chapters, and added invaluable ideas to this thesis.

Reflections
At the start of the research I have described in this thesis, one of the guiding questions was why dentists do or do not use new, digital technologies. After the study described in chapter 3, it became clear that in dental practices many digital technologies are in use. Although not all innovations become used, in fact the use of innovations in dental practices is fairly extensive. This led to a shift in focus from the question why innovations are used or not used, to a focus on how dentists use digital technologies. This led to a perspective aimed at investigating the changes taking place around the use of technologies in dental practices (as described in chapter 6). Thus, the research became more about what using technologies means for dental professionalization, and what it could entail for oral health care and its outcomes.

The trajectory that this thesis is a product of was also one of reaching for words that are able to travel across disciplines. At the start of the project described in this thesis, I was often fazed by the concepts, measurable precision, and practical knowledge (in the sense of embodied knowledge, knowhow in doing) that came up in conversations with dentists, and my own words, concepts, and more abstract connections which often seemed not to make any sense at all to another person. This taught me to be more precise, and above all, to question more abstract concepts that had become part of the academic language I was
used to in the social science disciplines. I might add that part of this was my own confusion working at the intersection of rather different fields of inquiry I could not yet get a grasp on, and on a topic that in the initial phases I could not quite get an overview of. Placing concepts in quotation marks, the use of first-person pronouns, sentences that were half a paragraph long, and a range of terms such as contingent, context, process, or micro and macro levels of analysis, would invariably invoke questions. Explaining many of these terms became challenges like that of explaining to someone how to ride a bicycle, without having a bicycle at hand to demonstrate it. The initial part of this journey was one of exercises in breaking down words and meanings into their component parts, and throwing many of them away, to the point where I wondered which tools – except for methods – could still be transferred into writing. These tools remained important, though, and more precise ones came later. The later stages of this dissertation project involved bringing them back in, much more sparsely, and much more thought through, which you will see reflected in the first and sixth chapter of this thesis, and in this discussion.

Though I mustered some very basic knowledge of what practicing dentistry was about, many of the details of how its tools worked, or even what a dentist would see in mouths, teeth, and tools to investigate and treat these, eluded me. This made asking about basics and what seemed self-evident to some I interviewed less of an artefact of the interviewing itself, and more about genuinely asking for explanations. This approach often illuminated parts of the topic I investigated which I might otherwise have found harder to question. Being outside of the discipline myself, thus, opened up many possibilities for asking questions, and for probing things I might otherwise not have been in a position to question. What, then, were the differences and similarities I experienced between a sociological gaze and a dental professional gaze? One of the main differences was in perspective: one based on providing oral health care, seeing into the mouth, and all that goes on around it, all that is somehow connected to it – but all viewed in connection to that part of the body. Whereas in sociology, the perspective is often more abstract, and the particular is seen through the general, that is: general concepts such as self, identity, professionalism, are viewed as they play out in specific fields studied. In this thesis, I was led by both of these perspectives – one, that of the sociologist, more familiar to me, while the other – that of the dentist – perhaps more familiar to some readers, and infusing this work through engaging with it from a more outside perspective.

**Recommendations**

The studies described in this thesis suggest a number of ways in which the use of technologies in dental practices can be understood and facilitated. In this section, I will outline recommendations for implementation of digital technologies. As described above, predicting developments in technology use in dental practices is difficult. However, a
number of processes that may influence technology use in the future have been described in this thesis. In what follows, I will base a number of recommendations on these processes that take place in dental practices when digital technologies are used, that may influence technology use in the future. I will focus here on recommendations for dental practitioners and other oral health professionals, universities and other dental educators, and professional organizations. This is aimed at facilitating the integration of technologies, when they are used, in the quality of care provided, in the management of dental practices, and in the development of the dental profession. I thereby focus not on ways of increasing technology use – as technologies are already used to a substantial degree in dental practices – but on pointing to ways in which outcomes of using technologies can be improved. As described in chapter 6, implementing digital technologies was for most dentists not uncomplicated. In the following paragraphs I will try to shed some light on ways in which such complications can be eased or surpassed.

In chapters 2, 3 and 4, it was shown that there are a number of differences in motivations to use digital dental technologies among dentists who use a lower, an intermediate, and a higher number of technologies. The first recommendation, based on this, is therefore, that educators, dentists, and representatives of the dental industry who deal with the diffusion of digital technologies take such differences into account. Especially the extent to which dentists think digital technologies add value to their work, and their focus on innovativeness, form important parts of these differences. Thus, when making efforts at diffusing digital dental technologies, dentists who use few technologies should be approached in different ways than dentists who are high technology users. The size and setting of the dental practice, especially, seem to play a role in the extent of technology use (as described in chapters 3, and 4), as well as in the ways in which technologies are implemented (as described in chapters 2 and 6). In addition, dentists who use more technologies perceive these as closer to the core of their work than dentists who use fewer technologies. Thereby, they may differ in their motivations to use technologies and in efforts they make when implementing them (as described in chapters 2 and 6). In providing courses on or support around digital dental technologies, then, different approaches may be work best for dentists who use fewer or more digital dental technologies.

Changes in the dental workforce, in education, in the size and organization of dental practices, and in financial and juridical measures, furthermore, might change the ways in which and extent to which, digital technologies are taken up by dentists. As described in chapter 6, for example, many younger dentists described that a wish to be in a ‘modern’ practice with many digital means was important in choosing which practice to work in, or in choices made when starting a practice. This appeared to be linked to familiarity with digital technologies through education, but also to a wish to remain up-to-date. In this study, some younger dentists expected that they would remain innovative and more likely to use new
technologies throughout their career, while others thought their use of digital technologies was more a result of this being familiar to them and known throughout their education and working lives, and that they will not innovate more in the future. Thus, it remains somewhat unclear whether greater innovativeness or cohort effects (rather than age effects) explained the higher technology use by younger dentists found in chapters 2 and 3. Notwithstanding the explanation, though, for dentists who were educated more recently, using digital technologies was often an inseparable part of dental professionalization. Therefore, dental education is likely to have played a role in making dentists more likely to adopt digital technologies, and to see these as part and parcel of dental professionalism. Reasons for this should be investigated in future studies.

The findings presented in this thesis show that implementing digital technologies in dental practices requires concerting various aspects of practice management, communication with the technology provider, and interactions between oral health professionals. In chapter 6, this was described as the process of *fitting technologies in dental practicing*. This often proved successful where many coordination activities were invested into fitting technologies in a dental practice. This required a targeted strategy, consciousness of the changes that implementation requires, and checking expectations about digital technologies. Over a longer period of time, this was more successful when team efforts were concerted in a dental practice, attuned to desired and undesired changes by, for example, planning which technology to implement when. Such planned efforts were most likely to lead to continued use of technologies. Therefore, support in realizing these efforts, from professional organizations or suppliers of digital dental technologies, can contribute to constructive use of digital technologies in dental practices.

When consequences of using digital technologies for the dental practice or the dentist remained obscure, implementation often became difficult or was halted. For example, changes in workflow, required materials or cooperation with other parties outside of the dental practice, when remaining unknown in advance of using a technology, often led dentists away from continuing to make efforts at implementing a technology. In particular, explicit information about the consequences that using a digital technology may have in a dental practice was desired by many dentists. Clear communication about these, then, can prevent the halting of efforts to implement a technology, and provide dentists with the means to check its effects on the quality of care they provide. This was a central concern for many, and thus should be addressed and supported when technologies are offered. Concerting the requirements of providing oral care, and those of running a dental practice, becomes more likely to succeed when the changes that implementing technologies might bring are made explicit and known. In this thesis I have aimed to contribute some ingredients to this.