

Advising and Supervising Doctoral Students: Lessons I Have Learned

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When I had my first doctoral advisee, I realized very quickly that I didn't know how to be a good advisor. I had the experience of being an advisee and working with an advisor. I had casual, incomplete, unorganized observations of other advisors. There were no models of supervision that I knew about. Advice was anecdotal and incomplete. As with many knowledge work processes, there was an implied assumption that completing a doctoral program and doctoral dissertation qualified a professor to be a good advisor. In fact, as I learned over time, some professors have good advising instincts and naturally do good advising. However, most seem to learn through a trial and error process. Indeed, some never seem to learn to be good at it.

The assumption of this paper is that professors can learn advising skills by following some systematic advising processes. This paper codifies some of my observations from being on well over a hundred doctoral dissertation committees and being the principal advisor for thirty or so doctoral dissertations. I summarize lessons I learned both by mistakes I have made or observed and by successes.

I recognize some difficulties with lessons learned or codified experience. The advice that emerges specifies what should be done (because it has worked) and how it should be done. The advice does not take into account philosophical differences among supervisors or the psychological resistance an advisor may have to normative advice. Like all such codified experience, the lessons learned are a starting point for building good advising skills rather than being a perfect recipe. Because the paper codifies my experience, it does not deal with all conditions (even though I have experienced a wide variety in different countries), but it does provide a good basis for a supervisor to examine his or her advising for possible improvement. I have learned from both good and bad advising experiences. I hope that others will profit from my lessons learned

An Overview of the Advice on Advising

This section clarifies terminology and provides an overview of the advice. Terminology may vary in different countries but the underlying problems are the same. To avoid using multiple terms, I will use the following terms to apply to the dissertation advising function being performed and the objective of the advising process:

- X *Dissertation* and *thesis* are used interchangeably to refer to the doctoral dissertation or doctoral thesis produced and defended by a doctoral candidate. The dissertation results from significantly independent work by a doctoral candidate. It is a "contribution" to knowledge.
- X *Doctoral candidate* historically referred to a person who had demonstrated a readiness to do a doctoral dissertation and was therefore admitted to candidacy (probably after some examination procedure). As will be explained, students in many doctoral programs may be considered doctoral candidates during preparatory work. Although this distinction is important in some systems, from the standpoint of this article, a doctoral candidate is one who is in a doctoral program and is planning a doctoral dissertation.

X *Advisor* is used to refer to the doctoral student advisor or supervisor. The function is assumed to be essentially the same. “Advising” refers to the process of providing guidance, advice, and quality assurance for a doctoral student during two stages of a doctoral program: doing preparatory work prior to a dissertation and doing a dissertation.

The process of building expertise in advising a doctoral student begins with understanding four underlying issues: doctoral program assumptions, motivations for a doctorate, advising styles, and student need for advising. The first issue is the underlying assumptions about a doctoral program: the two major assumptions are an entry-level doctorate or a mid-career doctorate. The second issue is the student or program motivation for a doctorate. These motivations range from recognition or prestige to a career requirement with a number of variations of these two extremes. The third issue is different advising styles. At the extremes, these range from a very strong master/apprentice model to a hands-off model. There are many variations between these extremes. Each advising style has advantages and disadvantages, depending on the student and the problems being studied. The fourth issue is differences in student need for advice and supervision. At the extremes, these needs range from need for very close direction and supervision to need only for general direction and supervision. With basic understanding of these issues, an advisor can begin to develop a preferred personal advising style and can make decisions about variations in advising to suit a particular student or problem.

Given an understanding of the four basic issues of program assumptions, student motivations, advising styles, and student needs, an advisor should be familiar with and apply some basic concepts about doctoral advising and some useful procedures. These concepts and procedures will help in achieving good results. Three basic concepts relate to the definition of contribution required for an acceptable dissertation, advisor competence to supervise a given dissertation, and appropriate methodology. The contribution concept defines the essence of a dissertation. Advisor competence is a quality assurance concept to ensure an advising process that provides quality in supervision and advice, either by operational competence or review competence. The methodology concept relates to whether a methodology is appropriate for the problem and powerful enough to yield a contribution to knowledge.

Understanding underlying issues and concepts about advising are not sufficient for good advising. Good program procedures are needed and an advisor needs to apply good advising procedures. Good advising procedures will tend to help produce good dissertations (assuming the student is receptive to good advising). Some important procedures to be implemented as part of a doctoral program or by doctoral advising are a broad introductory seminar, a student career plan that defines the role of the dissertation in his or her career, a regular workshop for faculty and doctoral students to discuss presentations and papers, and introduction of doctoral program information and doctoral student productivity aids. Other advising procedures such as topic analyses to consider alternative dissertations, a formal dissertation proposal, a dissertation project plan, a formal or informal dissertation proposal defense, and progress documentation are not discussed in this paper because they are described in some detail in a short monograph (Davis and Parker, 1997) on managing the doing of a doctoral dissertation.

Four Underlying Issues Important to Advising Doctoral Students

Not all doctoral programs are the same. Not all dissertations are based on the same assumptions. A dissertation advisor may impose certain values and standards without considering alternatives. From my experience, I have found it helps me to communicate my advising experience if I make sure that ones I am mentoring have a shared understanding with me of four issues that I believe underlie differences in doctoral programs. These are doctoral program assumptions, motivations for a doctorate, different advising styles, and differences in student needs for advice and supervision.

Underlying Issue One: Doctoral Program Assumptions

Discussions of advising often are not productive because the doctoral program assumptions are not surfaced. I was in a doctoral program with one set of assumptions, but I spent time in Europe with doctoral students who were in programs with different assumptions. At the risk of oversimplifying, I found it useful to define two alternative assumptions for the purpose and conduct of a doctoral program. I term these mid-career doctoral program and entry-level doctoral program.

- X A mid-career doctoral program goes back to the historical development of doctoral programs in Europe. A person who had engaged in teaching or research and demonstrated good scholarly abilities, probably including publications, could seek a doctorate as recognition of scholarly attainment. Given this general condition, the focus of the doctoral program is not on preparatory work but on the dissertation. Any preparatory work is based on individualized counseling to fill gaps in knowledge in order to achieve an acceptable dissertation. The dissertation supervisor is critical to this individualized process. The doctoral candidate may not be in residence at the university. The process places significant emphasis on a final quality control with external examiners.

- X An entry-level doctoral program rests on the implied assumption that the doctorate is a credential for beginning a career as a researcher or academic. This is the most common situation in my experience in the USA and other countries. The degree is usually a requirement for entry into an academic career. Students entering a doctoral program may have little or no experience in teaching or research. The doctoral program is designed to prepare them for a career. Therefore, there is a fairly structured set of courses on a range of research methods, discussion of important literature and examples of research in the field of study, and review of important literature and examples of research in one or more underlying disciplines that support research in the field of study. The advising and mentoring process usually includes strong advice to students on seminars to take, specification of assignments that demonstrate progress in a doctoral program, and criteria for examinations or other evidence of readiness to proceed with a dissertation. The program for an individual doctoral candidate is therefore a combination of core subjects and experiences plus individually tailored learning. A typical supervisory arrangement consists of a committee process to evaluate readiness to do a dissertation and a committee of four or five faculty members to evaluate the dissertation. The committee is headed by

an advisor who takes a significant leadership role. It includes three or four other faculty members with diverse backgrounds and skills. The choices of committee members are based on ability to assess the dissertation proposal, give advice, and evaluate the results.

The two assumptions do not hold perfectly in practice. I am familiar with a doctoral program that has all the external appearance of a mid-career program, but many individual advisors in the university essentially establish conditions that fit entry-level students. There is a world-wide trend to entry-level doctoral programs, primarily because they fit the majority of students. However, there are students who fit best with a mid-career program. In my experience and from discussions with graduates, there are significant problems when the student is entry-level and the program is mid-career. As an example, a young student with little business experience and no experience in doing independent scholarly work entered a doctoral program based on a mid-career doctorate. His doctorate did not prepare him well for a scholarly career, and he expressed disappointment with the mismatch between his needs and the doctoral program he chose. On the other hand, I have advised some mid-career persons to not do an entry-level doctorate and to seek a mid-career program. Those who have followed this advice have found it worked very well. For example, a man with a business career in consulting and other advisory activities retired early and started teaching. He used his background to assist him in doing scholarly work, including research. He found a mid-career doctoral program an excellent fit with his background and his ability to work without close supervision.

A related issue is the length of time it takes to complete a doctorate. There are large variations within universities as well as between universities, so my comments of length are calibrated to high quality programs in information systems (or related subjects) in good universities. Ignoring preparatory activities, a typical dissertation takes the equivalent of 12 to 18 months of full-time work. The average time for United States and Canadian doctoral students in entry-level programs (including the dissertation) is between four and five years. In the United States, as reported by the National Science Foundation, this time has been increasing steadily during the past 25 years. There are four reasons for this increase in time: first, the depth and quality of preparation have improved; second, students entering the job market are expected to have evidence of teaching ability; third, students entering the job market are expected to have demonstrated an ability to write and submit articles for publication; and fourth, dissertations must be completed before taking a position. The latter condition means effectively that students who are a few months behind schedule must wait many months before the next academic recruiting period.

Underlying Issue Two: Motivations for a Doctorate

When I started as an academic, I thought that students working on doctorates all had the same motivation, namely to be scholars engaged in teaching and research. I have found that the real reasons for doing a doctorate are varied. I have been on dissertation committees in other disciplines and have found a variety of motivations. They affect the design of doctoral programs in different fields and certainly influence the selection of topics, acceptable research methods,

and advising processes. Even within doctoral programs in a given field or discipline, students may have different motivations. Without trying to look at all motivations, four examples from my experience illustrate this point:

- X Requirement for a scholarly career. Under current and expected academic conditions in academic institutions, a doctorate involving good preparation for a scholarly career is a condition for employment. A well-constructed doctoral program provides preparation that enhances academic career potential. In the doctoral program in information systems at Minnesota, we emphasize this motivation, and the program is built around this assumption.
- X Requirement for career as a practitioner. There are many careers that require a doctorate as a condition of credentials to practice or provide significant economic incentives for those who have doctorates. I worked closely with a woman getting a doctorate in psychology, and her motivation was to be in a private counseling practice. I have been on committees in which the person getting the doctorate will receive an increase in compensation (without regard to the value of the doctorate in the employment).
- X Evidence of intellectual competence. Consultants and those in similar knowledge-work occupations may find their careers enhanced by doctorates because the degree provides evidence of intellectual ability. I was on the dissertation committee of a consultant doing a degree in philosophy. The dissertation was not related to his work career, but it was evidence of his intellectual competence.
- X Evidence of scholarly achievement. Those who have been involved in research and related scholarly activities may wish to obtain a doctorate as evidence of their work. Although there are examples of great scholars who do not have doctorates, I have observed that many wish they had obtained the credential.

The motivation of a scholarly career is the dominant basis for many doctoral programs. For the MIS doctoral program at the University of Minnesota, we clearly make that our objective. An entry-level program is very consistent with this motivation. Other doctoral programs seem to support consulting as a basis for doctoral work. Certain programs in the university have professional qualification as the basis for a doctorate, and it is reflected in the design of the programs. I have observed doctoral programs in departments where program objectives and student motivations are varied. One department prepared students for either scholarly careers or professional careers requiring a doctorate as a credential. The mixed objectives may have been one reason they did not do a good job of either.

Underlying Issue Three: Advising Styles

For the purposes of discussion, it is useful to identify five advising styles. These are illustrative, but I have known advisors I would classify in each of the five styles. The five styles are ordered

from strong, detailed supervision to hands-off *laissez faire* advising. Each style has strengths and weaknesses. An advisor may shift his or her style somewhat depending on the student, but I think it is difficult for an advisor to be equally effective in all styles.

- X **Strong master/apprentice style.** In this style, the advisor is the master. The student works as an apprentice on problems selected by the master (often on research grants obtained by the advisor). Assuming a competent master for dissertation advisor, the advantages are significant reduction in the time for student to formulate a problem, strong guidance and direction in doing the work, and development of specific skills for the type of problem being worked on with the master. Even assuming a competent master, there may be severe disadvantages. The student may be given strong direction but may not develop an ability to formulate research and conduct it independently. The research methods may be limited. The focus on the master's problem may becloud the apprentice student's understanding. The sciences, where the master/apprentice style is very prevalent, routinely expect graduates with doctorates to do post-doctorate appointments. In part, this may be a response to the narrow focus of master/apprentice doctoral training. Of course, the master/apprentice style may be very bad if the master is not a good researcher or is exploitive in his or her handling of doctoral students. On balance, the master/apprentice style fits best the condition of a relatively immature, inexperienced student who needs strong direction. It also fits with well-defined, funded streams of research. This is not my natural style, but I have colleagues who do it very well and train their students well; on the other hand, I have evidence from observing colleagues and from talking with recent graduates that the style can result in exploitation and poorly trained graduates. For example, we interviewed a graduating student who was working on a part of a very interesting funded project. Unfortunately, the student had no understanding of the large project because all his efforts were directed at a small part of the research.

- X **Collegial master/apprentice style.** Limited domain advising. This is a less restricted concept than strong master/apprentice. The advisor is willing to advise on problems that are within the scope of his or her research and methods within his or her skill set. The set is not restricted by advisor's current research activity or research funding. The problems may be selected by the students as long as they fit within the general domain of expertise. This style puts more responsibility on the student than the master/apprentice style, but the student dissertation must fit within the existing knowledge of the advisor. I have seen this work well when both the professor and the doctoral student were interested in a problem and the professor had sufficient expertise to provide good guidance.

- X **Collegial development style.** Extended domain advising. This advising style includes not only the domain of the advisor's current or past research but is extended to areas in which the advisor has an interest and is willing to invest in becoming reasonably proficient. There is a joint learning experience; the advisor starts with more experience, but both are learning the details of the dissertation research area. This style fits an advisor who is willing to expand his or her research competence; it fits a student who is willing to

engage in a joint learning experience. It fits very well for a dissertation that opens up a new or fairly new area of research. The stream of group decision support research at Minnesota began by this type of advising. A student had an idea, and an advisor was willing to invest in becoming proficient enough to be a good mentor. I have seen this advising style fail when the advisor was not willing to make the investment to be competent.

- X **Guidance and suggestion style.** General advising over a range of problem domains. Some advisors have good skills at problem identification and problem formulation over a range of problems and research methods. They conceptualize well and are good at “sense making.” This style works best with students who are willing and able to take initiative and take responsibility for learning the research domain and the appropriate research methods. The student gets good general guidance and good evaluation of the dissertation but usually does not get detailed feedback and detailed mentoring of methods. It is not very good for immature students who need more detailed guidance. I have had some very good advising experiences with this style with mature students who took initiative. I was able to apply my comparative advantage in mentoring them, but they took responsibility for learning the research domain and methods. For example, a student did a simulation that examined the effects of design decisions on the life cycle costs of computer systems. I was familiar with simulation and the general principles being applied, so I could offer good suggestions, but the student had much better knowledge of the characteristics being modeled.
- X **Passive hands-off style.** In this laissez faire style, the advisor takes the role of a general quality control reader. The student must take the initiative to define a problem, decide on a research method, develop a research plan, and so forth. The advisor responds to student plans and initiatives with some suggestions, but the responsibility is almost entirely with the student. Given a competent advisor who gives good suggestions in response to student initiatives and plans, the advantages are that the student develops independent skills at formulating problems and planning research. The disadvantages are that the student may meander from problem to problem and take too long to do a dissertation. Under these conditions, a student may not develop good skills and may drop out of the program. For fairly mature students with an ability to take initiative, this style may work well. It has significant danger with a dissertation project for which the student does not have the necessary background for doing a good dissertation or the advisor is unable to do reasonable quality review. For immature students, it is likely to be a disaster. In general, I do not like to operate in this mode.

The five advising styles are summarized in Table 1. The advantages and disadvantages of each are summarized in Table 2. The two extremes of strong master/apprentice style and passive hands-off style have significant risks but may work well under appropriate conditions. The middle three styles are less extreme. Advisors can develop styles that are not at the extremes, based on their preferences, the maturity of students they advise, the availability of funding, and so forth. Probably the extremes should be avoided, but one style does not fit all advisors and one

style does not fit all students. For example, an advisor may use a collegial master/apprentice style with many students but change to a collegial development style for other students. For a very mature student who demonstrates good competence, an advisor who prefers a collegial master/apprentice style of detailed advising within restricted domains may be willing to change advising style to a guidance/suggestion style. In any situation, an advisor should identify his or her own strengths and weaknesses, identify both a preferred style but also alternative styles he or she can do, and evaluate his or her ability to advise different students. For example, as indicated earlier, I prefer a guidance and suggestion style, but I have adapted to situations requiring a collegial master/apprentice style and a collegial development style. I have avoided advising requiring a strong master/apprentice style or a passive hands-off style.

Table 1. Five Advising Styles

Style	Advisor Role and Behavior	Student Role and Behavior
Strong master/apprentice style	Advisor is master. Advisor has a well specified domain of expertise and set of problems within it.	Student is an apprentice working for the advisor. Student works on advisor's problems.
Collegial master/apprentice style	Advisor is expert who limits advising to problems that are within scope of his or her research skill set but will work on student's problem.	Student develops a problem within advisor's domain and skills and works under the advisor to develop the research plan and procedures.
Collegial development style	Advisor is senior colleague who will respond to student research problem and extend his or her advising domain to include new problems and new skills.	Student takes initiative to introduce new problem that requires new skill set and works as a junior colleague with advisor in joint development of new domain.
Guidance and suggestion style	Advisor is a senior colleague who gives good general guidance over a wide range of problems and methods but does not have personal skill in all of them.	Student is an independent, junior colleague who takes initiative for presenting problems and research plans for discussion and guidance. Student develops required skills.
Passive hands-off style	Advisor has quality control role and responds only to requests or documents and performs only general quality control review	Student is an independent researcher who takes initiative for developing problem, developing skills, and presenting research plans for general review and approval.

One reason for classifying advising styles is to help new advisors to understand their own experience and to build upon their own abilities and preferences. It helps in building more confidence in advisors, so that they can better adapt to the needs of the students and the conditions of the academic institution.

Table 2. Advantages and Disadvantages of Different Advising Styles

Advising Style	Advantages	Disadvantages
Strong master/apprentice style	Advisor is heavily involved and gives expert direction for research activities. Student learns how to do research within advisor's domain.	Student works on advisor's problems and within advisor expertise and may not develop independence.
Collegial master/apprentice style	Advisor knows the research domain and research methods and can give expert advice on them. Student can take initiative in formulating problem and working with advisor.	Student is limited to advisor research domain and advisor research skills. Student may do work that is not within his or her long term research plan.
Collegial development style	Advisor and student develop together to explore new domain and new research methods. Student develops independence within relationship.	Risk of exploring new research area that does not work. Risk that necessary development of both advisor and student does not occur or occurs unevenly.
Guidance and suggestion style	Student is able to develop independent research and research management skills while receiving guidance and suggestions. The student may research a broad range of topics and employ broad range of methods.	Student may not get expert advice from advisor on many issues, so student must search for expert advice. Student has significant responsibility for research quality and management of process.
Passive hands-off style	Student is able to act independently with little interference from advisor. Student can work on problems of his or her choosing.	Student may make serious mistakes because of lack of advice and suggestions. Student may flounder and not complete on timely basis.

As coordinator of the information systems doctoral program for a number of years, I have heard from students who were frustrated with a master/apprentice advising style because they were not given enough freedom develop themselves; I have observed other students who had hands-off advisors who complained that they couldn't get any advice or direction; other students were very happy with the same advisors. This suggests an advisor can do two things to be more effective: one is to develop a preferred advising style and communicate this to prospective advisees; the second is to adapt somewhat to the different needs of students.

Advising styles that an advisor is able to employ effectively may change during the course of an academic, advising career. I have certainly become more aware of the effect of my advising style and the range of advising styles that I am willing to employ. Experience with different styles and different student needs may assist an advisor in drawing clear boundaries to discuss with potential advisees. One very good advisor says that she has a clear, detailed session with any potential advisee in which she explains her philosophy and approach to advising. For example, she believes a major part of the advisor's work is to help the student in formulating and

writing a good dissertation proposal. She does not want to work with a student who is not willing to develop a detailed proposal. A student who works with her understands the advising relationship and is expected to work within the guidelines provided.

Students also need to understand preferred advising styles of potential advisors. Students can evaluate their maturity and level of skill. They can evaluate their need for close monitoring and supervision versus fairly loose monitoring. Such self examination can lead to a useful dialog with potential advisors. It can lead to clarity relative to expectations by both student and advisor.

Underlying Issue Four: Different Student Needs for Advice and Supervision

There are significant differences in the maturity and confidence of doctoral students relative to the process of selecting a dissertation topic, selecting a research design and research method, and managing the process of research and write up. To illustrate the range of students needs for advice and supervision, three archetypes will be described.

- Immature, unconfident student. Although the student may have requisite tools and skills to do research, the ability to work independently is not well developed. The student looks to the advisor for a problem, strong mentoring, and strong, detailed supervision. The student views the advisor as “big daddy.”
- Somewhat mature, somewhat confident student. Preparatory work leading to the dissertation has helped the student be somewhat confident, but the student still needs moderately detailed direction to get going and moderate supervision during the process. The student views the advisor as a “mentoring” colleague.
- Very mature, confident student. Preparatory work and experience leading to the dissertation has prepared the student to be quite independent. Student recognizes need for guidance and supervision, but the need is at a fairly general level. The student can take general guidance and apply it well. The student views the advisor as a “senior” colleague.

Understanding how students differ in their needs may help a potential advisor to not accept supervisor assignments that he or she cannot do well. It may help an advisor to modify a preferred advising style to fit the needs of a student. Table 3 summarizes the likely fit and outcomes from advising styles for the three different student archetypes. The table does not account for adjustment and compensating behaviors by students and advisors. . The table does not suggest outcomes that must occur but suggests outcomes that are likely in the absence of adjustments and compensating behaviors (from students and advisors). In other words, students and advisors may adjust for the apparent lack of fit and compensate in various ways to achieve satisfactory results.

Table 3. Advising styles and likely outcomes for student archetypes.

Advising Style	Likely Fit with Student Archetypes
Strong master/apprentice style	<p>Good fit with immature, unconfident student. “Do what I do” provides clear direction.</p> <p>Possible good fit with somewhat mature, somewhat confident student, but the style creates some stress between heavy direction of advisor and initiative and independence of somewhat mature student.</p> <p>Likely stress and conflict between this style and the independence of a very mature, confident student</p>
Collegial master/apprentice style	<p>Some stress but a workable fit with immature, unconfident student because some initiative is required.</p> <p>Fairly good fit with somewhat mature, somewhat confident student because it provides boundaries for what is expected and allows some independence.</p> <p>Some stress from this style for mature, confident student because of constraints on what can be done by student.</p>
Collegial development style	<p>Stressful for immature, unconfident student because of need for significant student initiative.</p> <p>Good fit with somewhat mature, somewhat confident student because it builds confidence through development interactions.</p> <p>Reasonable fit and reasonably low stress for very mature, confident student if advisor and student are compatible relative to problems and methods.</p>
Guidance and suggestion style	<p>Very stressful for immature, unconfident student because of vagueness of process and need for initiative that may exceed capacity of novice.</p> <p>Stressful but workable relationship for somewhat mature, somewhat confident student because of high initiative required from student.</p> <p>Good fit and reasonably low stress fit for very mature, confident student who is given much freedom and good feedback.</p>
Passive hands-off style	<p>Likely disaster for advising relationship with immature, unconfident student because not sufficient guidance.</p> <p>Stressful relationship between advisor with this style and somewhat mature, somewhat confident student because of insufficient feedback.</p> <p>This style may work for a very mature, confident student but introduces risks because of lack of clarity in expectations.</p>

Basic Concepts for Dissertation Advising

There are a number of concepts that are important in dissertation advising. Three that are especially significant are the concepts of contribution of a doctoral dissertation, advisor competence to supervise, and dissertation research methodology.

Contribution Required for a Doctoral Dissertation

One of the important roles of an advisor is to work with the student to define the dissertation to meet university requirements. There are significant variations within a university and among universities specifications for an acceptable dissertation. However, there are some reasonable general guidelines. Individual departments or fields of study may make the general guidelines more specific.

- X Contribution to knowledge. The role of university research is to create knowledge. A dissertation should contribute to this role. The contribution to knowledge may be modest or profound, but this is the important test of a dissertation. Some possible ways to think about contribution are given later in this section.
- X Demonstrates independent scholarly ability of student. A student receiving a doctorate should have reasonable ability as a scholar. The dissertation should therefore demonstrate this ability. It should not be just the ability to do what an advisor says but ability to take initiative and be reasonably independent. For some research, the contribution to knowledge of the dissertation itself may be modest, but the research process demonstrated in the dissertation indicates development of a capable, independent scholar.
- X Demonstrates quality in use of appropriate research methods. There is quality if accepted methods are used appropriately. Methodology may sometimes be used as a contribution to knowledge if new methods are applied and demonstrated to be useful.
- X Communicates the problem or objectives, process, results, and meaning of the research. The dissertation should communicate clearly to a reader with an appropriate scholarly background. The reader should be able to assess the quality of the research by reading the dissertation.

It is simpler and more meaningful to discuss some general concepts that define contribution rather than making rules that measure contribution. Some general ideas are the following:

- Based on significant question, problem, or hypothesis. The dissertation should tackle an interesting problem (that is amenable to research). It should be an original work that explains, solves, or adds proof or disproof to the question, problem, or hypothesis. The focus of the contribution may be data analysis, interpretation, design, or concept development.
- Based on and guided by meaningful concepts or theory. Theory may come from the field of information systems, but theory may also come from other fields.

- Provides new or improved evidence. Existing beliefs may be weakly supported by evidence or argument. There may be conflicting opinions and beliefs. The existing evidence may be contradictory. The dissertation makes a contribution if it adds evidence, helps resolve conflicting beliefs, or strengthens the reasoning either supporting or disproving beliefs.
- Employs new or improved methodology to do analysis or interpretation. Existing analysis may be incomplete. New or improved analysis includes improved or more complete data, comparative analysis, longitudinal analysis, or application of new or different analytical methods. The new or improved methodologies should be shown to add to knowledge.
- Develops new or improved concepts or theories. Existing concepts or theories for a problem may be weak. A dissertation that explains and supports a new or improved concept or theory makes a contribution.
- Develops and demonstrates new or improved design of conceptual or physical artifact. This is often termed “design science.” The contribution may be demonstrated by reasoning, proof of concept, proof of value added, or proof of acceptance and use.

An advisor should also provide practical guidance to the student in evaluating dissertation topics. The research should be interesting, theory-based, and make a contribution to knowledge. It should also meet feasibility and career criteria. These are discussed in further detail in Davis and Parker, 1997.

I have had potential students, who have just completed a challenging, interesting project in industry or government, ask if that project could be a dissertation. After discussing the contribution to knowledge, theory that could be applied in an analysis of the case, and similar questions, they have not pursued the project as a dissertation. Perhaps a development project can be a dissertation, but very few projects are suitable. The reasons they are not suitable is generally because they do not make a contribution to knowledge other than actually doing something that everyone knows can be done and at least conceptually how to do it. An example from my consulting career was a project to design and program a computer model to assist in planning a finance subsidiary for a company. The model could be done easily today with a spreadsheet processor (such as Excel), but in 1961 it required significant work to formulate and program the set of statements to examine the alternatives in the planning model. In other words, the project implemented something that was conceptually well understood. It took significant effort and the results were useful, but there was no conceptual contribution. It did not add to our knowledge of planning or evaluating projects. Note, however, that the project could have become the basis for interesting investigation about human-computer model interaction in a planning process, and this might have become a doctoral dissertation.

Advisor Competence for a Specific Dissertation Topic

An advisor should give good advice, give good direction, and be able to judge the quality of work being performed for a dissertation. That means that advisors are constrained in the problems and methods they can supervise well. It may be useful to distinguish between operational competence and review competence.

- Operational competence means the advisor can do well everything the student has to do. A master/apprentice or master/colleague type advisor needs good operational competence, especially with immature students.
- Review competence means the advisor can understand (or develop understanding) sufficient to give good advice and make good judgments about the dissertation. Some advisors have a broad perspective and are very good at review competence; given a dissertation proposal and research plan, they can do a very good job of evaluating the project and making good suggestions. They may not be good with operational advice. Note again the need for matching advisor competence (operational and/or review) with the maturity level of the student.

My personal view is that review competence is sufficient for good advising. An advisor does not always have to be an expert when presented with a proposal where his or her competence is not strong. In such cases, an advisor who is collegial and open to learning new skills should be willing to invest in learning in order to work with a doctoral student. In one case I observed, a faculty member choose to invest in a new area of research in order to be a good, collegial advisor. The result was very good for the student and allowed the faculty member to mentor a number of students in the same area of research. The question in such cases is the commitment of the faculty member to invest.

Advisor competence may be an important factor in student selection of a research area and a dissertation topic. Unless a student has good skills and confidence, the tendency is to gravitate to the advisor who can provide adequate mentoring and quality assurance. In one case, a student did dissertation research in an area outside of her long term interest because of the lack of advisor competence in her department for the area of her interest.

The question of advisor competence to advise a student for a problem may have different outcomes depending on whether there is a single advisor model or a committee. The traditional mid-career doctorate typically has one advisor. These places significant responsibilities on the advisor to either not advise on problems where his or her competence is insufficient or to make a strong commitment to build competence. Because the traditional mid-career doctorate places the quality control on external examiners after the dissertation is completed, an advisor with insufficient competence may lead a student to do a dissertation that will not be accepted.

The committee model common with entry-level doctoral programs provides a basis for good advising without relying on a single advisor. There are still conditions for success. The committee must have a good mix of appropriate skills and be willing to provide good advice and mentoring. The advisor must invest enough to make sure the committee structure provides the

requisite guidance and advice. Another advantage of the committee structure is the ability to have a collegial contract (not a legal contract) based on a dissertation proposal. Weaknesses can be spotted early and appropriate advice given.

Dissertation Research Methodology

There are a number of alternative research methodologies that may be applied. Jenkins (1985), at the 1984 Manchester Conference by IFIP 8.2 defined thirteen methodologies (ranging from strongest to weakest in terms of hypothesis testing):

- Math modeling
- Experimental simulation
- Laboratory experiment
- Free simulation
- Field experiment
- Adaptive experiment
- Field study
- Group feedback analysis
- Opinion research
- Participative research (action research)
- Case study
- Archival research
- Philosophical research

The thirteen methodologies focus on obtaining data and interpreting the results. Many dissertations take a different approach that has been termed design science. In design science research the researcher builds an artifact (algorithm, computer program, analytical method, prototype, theory or set of concepts, etc.). The artifact is a contribution if it adds to knowledge. The issue with design science artifacts as contributions is how to evaluate them. In some fields, the artifacts may be evaluated in terms of simplicity and/or elegance of design; in other fields, the artifacts must be supported by evidence that they yield improved results, are deemed useful by those who apply them, etc. Two references that explain the nature of design science, especially within the context of information systems are March and Smith (1995) and Hevner, March, Park, and Ram (2004).

The IS program at Minnesota has had a few design science dissertations. The evaluation usually centers on proof of concept and evidence of usefulness. The differences of opinion on evaluation of design science research are illustrated by a dissertation I chaired on an IS development methodology. The methodology had good conceptual foundations (a necessity). For evaluation, I insisted on a proof of concept and some test of usability. The student therefore taught the methodology to a group, had them use it, evaluated their performance, and collected their reactions. Members of the dissertation committee, in the final oral, focused on a different method of evaluation. They wanted evidence from peer review of the methodology by means of articles submitted to conferences and/or journals and accepted for publication. I prefer proof of

concept and evidence of usability, but others may prefer peer acceptance of innovation, elegance, or other attributes.

Another dissertation committee on which I served was for a student in Philosophy. The proposed dissertation was a code of ethics for computer consultants (based on Aristotle's ethical reasoning). The student was building an artifact (a code of ethics) based on a body of knowledge (theory) about ethics. The question was how to evaluate the results. The Philosophy Department was satisfied with an evaluation based on the quality of reasoning employed to build the code. I argued for a test of feasibility (could a small sample of consultants understand the code and evaluate it as useful in practice).

Minnesota information systems doctorates have had a higher frequency of experiments and field studies than the average for these types of studies in the field of information systems. Our approach has tended to emphasize hypothesis testing based on data. Case studies have tended to be used for insight into the problem domain and for understanding of data. For example, I always urge researchers who are collecting data using questionnaires or other instruments to do a small number of in-depth interviews to get insight into how respondents understood the questions, the issues, and why they responded the way they did. These interviews aid the researcher in interpreting the quantitative results.

Conceptually, the question of methodology is simple. The methodology should fit the problem, so that a contribution is achieved. But problems may be amenable to different research approaches and different methodologies. The concept of methodology choice can involve several criteria. These are the role of methodology in achieving a contribution, methodology choice relative to a long term research career, fit with student skills and interests, and fit with advisor skills and interests.

- Methodology and contribution. The research methods should be powerful enough to support a contribution to knowledge.
- Methodology choice relative to a long term research career. If all things were equal, it would make sense for a student to use positivist, hypothesis testing methods early in a career in order to develop skill and familiarity with traditional methods of data collection and analysis. These skills support advising, reviewing, and evaluation in a research career. Interpretive methods tend to require more maturity and therefore are often best done at a second stage of research in a research stream. Of course, all things are not equal, so the objectives of learning both positivist and post positivist methods may need to be achieved in a different way.
- Fit with student skills and interests. Some methods depend on specialized skills or strong backgrounds in economics, mathematics, statistics, etc.
- Fit with advisor skills and interests. An advisor can usually develop adequate skill to evaluate almost any methodology, but to give expert advice may be difficult.

Four Procedures for a Good Doctoral Program and Good Advising

The paper has focused on my observations and my experiences. I have organized the results into advice, but I have also explained conceptually why I believe the advice will be useful. I could have focused on concepts and not given procedures or practices, but I believe that both conceptual understanding and good advising procedures are required.

This section will emphasize four procedures that I believe are vital to a good doctoral program and good advising: an introductory IS research seminar, a student career plan as part of the seminar, a regular workshop for discussion of research papers, and providing students with resources on doctoral programs and doctoral student productivity aids. I believe these procedures are among the most important things a group of faculty members can do to improve the general climate for good advising. This is especially true of the career plan and the regular discussion workshops. They have evolved from suggestions from faculty members, my own experience, and my observation of good practice. Note that two of these procedures, an introductory research seminar and a regular workshop depend to a great extent on the doctoral program; the other two procedures, a student career plan and productivity aids, may work best in the context of a seminar but they can be implemented by an advisor without participation by other faculty members.

Introductory Information Systems Seminar for Entering Doctoral Students

I found in the early days of the Minnesota doctoral program in information systems that faculty members did not generally favor an introductory seminar that surveyed the field and its research. They felt that such seminars lacked depth and focus. After several attempts, I was able to establish an introductory seminar that was highly rated by the students and supported by the faculty.

The format of the seminar evolved to cover three objectives:

1. Introduce students to the domain of information systems as an academic discipline and have them read and discuss a sampling of classic literature and articles that summarized important topic areas. Since subsequent seminars were more specialized, this was the best opportunity to discuss research frameworks, classic articles, history, and summaries of areas not covered by other seminars.
2. Introduce students to the research interests and areas of competence of the faculty members with whom they might have an opportunity to work. The faculty members were presented as potential advisors and committee members. Each faculty member assigned readings from his or her own research and perhaps classic readings from the topic area. This feature of the seminar helped the students to become acquainted with

faculty members in the first semester of their doctoral studies and faculty members to get acquainted with the new students in the context of their research. The format was important in gaining faculty support for the course.

3. Start the students in a process of developing a 10-year research plan to become a world class scholar. Of course, not every student will become a world class scholar, but the planning process is designed to help them plan for it. This has had a very important impact on students in helping them to clarify their interests and identify their dissertation topic. Because of its importance, the plan will be discussed in more detail.

Use of Student Career Plan to Provide Clarity about Research Interests and Dissertation Topic

Most students have an interest in a broad field. As they investigate research in the broad field, they may find many topics of interest. They have difficulty in narrowing their focus. A second problem is selection of a dissertation topic. Students often select a topic without considering the implications of the topic for a career. For students with a motivation that requires only a dissertation and no further research, the failure to consider long-term implications is not a problem. For those who choose a research or scholarly career, failure to consider the dissertation as a part of a career plan may have serious consequences. My use of a career plan to provide clarity about research interests and the role of the dissertation in a scholarly, research career has emerged through experience in assisting students to make choices fairly early in their doctoral studies. Although the career plan is presented as a basis for achieving academic tenure, I have found the plan is useful in clarifying research objectives and dissertation research questions without being motivated by tenure. For example, I participated in a discussion of a research proposal by a student who was having difficulty. The discussion with the student emphasized his lack of a clear research question. His response was, "I know that, but I don't know how to do it." I took a different tact and carried him through a planning scenario that emphasized his interest in a general research area and the interesting research questions associated with the general area. I then led him to consider how the project he had proposed fit into the research stream and should therefore provide evidence and answers to some of the questions. This planning approach seemed to get him out of the difficulty he was having in formulating the research question.

The basic academic career reasoning that motivates this procedure is somewhat based on the typical tenure process in North American universities, but the reasoning can be generalized to a broad range of systems. The career reasoning is:

- When a person with a new doctorate takes a university position, there is a period of essentially five years in which to demonstrate scholarly research abilities. Tenure decisions take place typically during the sixth year, but the record that is presented is work that has been done through the fifth year. Published work is given a higher priority than articles in review or work in progress. A faculty member with a new doctorate therefore needs to move rapidly to establish a good research and publication record.

- If a person in a scholarly research track waits until the completion of the dissertation to decide on future research, it is difficult to complete sufficient research and have sufficient publications to have a good record for promotion.
- Given an entry level doctoral program of four to five years and time to promotion decision of five years, it makes sense to create a ten-year career plan to build research skills, build a network of colleagues, and build a record of presentations and publications.
- With a ten-year plan, the dissertation becomes a major milestone in the plan. It is one of several related research projects. Together, the projects demonstrate research ability and establish a record in a given research topic area. There is synergy in the projects. There is reuse of methods. Projects can build upon prior projects in the research stream.
- With a ten-year plan, a researcher can plan appropriate related study and development of appropriate, useful research skills. The investment is not just for the dissertation; it is for the research stream.

Students have difficulty thinking about a ten-year plan, but as they do iterations of the plan, they become more focused and the plan makes sense to them. In our introductory course, we found that a minimum of three iterations with feedback after each plan are required to get the student to appreciate the value of planning. The biggest objection they have to the planning is that they may change their mind, and the plan will not fit. No problem; they know how to create a new plan. The process of planning has four distinct results:

1. Statement of broad area of interest.

In working with students, they often name their interests very narrowly. I try to get them to think of narrow interests as instances of a topic area or research stream. As they do so, they see an area of interest emerging. If they name a very broad interest, I ask them to identify some broad streams of research within it. Three examples illustrate broad streams of research.

- Example a: Information system development
- Example b: Information system management
- Example c: Electronic commerce

2. Selection of a research stream that is a subset of the broad area of interest.

Within a broad area of interest, a student should be able to define several research streams and select one.

- Example a: Within the broad area of system development, a research stream might be

information requirements determination

- Example b: Within the broad area of information systems management, a research stream might be information system planning
- Example c: Within the broad area of electronic commerce, a research stream might be information systems for conducting e-commerce

3. A set of research topics with one defined as the dissertation.

Ideally, several related topics should be identified with one being identified as a proposed dissertation. The other topics will follow soon after. There is an expectation that the topics will build on each other and that there will be synergy in doing the research.

- Example a: A set of topics within information requirements determination might focus on eliciting methods. Within the topics on eliciting methods, a dissertation topic might be the effect of eliciting methods in achieving correct and complete requirements or perhaps the effect of analyst domain expertise in eliciting correct and complete requirements.
- Example b: Within the set of topics on information system planning, dissertation research might focus on alignment of business plan and information systems plan. The specific dissertation research might be on the effect of type of business on plan alignment or effect of proposals from the information systems group on the business plan.
- Example c: Within the set of topics in the research stream on information systems for conducting e-commerce, dissertation research might focus on economic evaluation of applications for conducting e-commerce. For example, a dissertation might choose to focus on the economic effect of web site characteristics or perhaps the economic effects of being a first mover, follower, etc.

4. A plan for achieving appropriate preparation for the research stream and dissertation.

This plan includes readings, seminars, small projects, research methods courses, etc. There should be general preparation to be a broad-based scholar and specific preparation for the type of research to be done. For example, a student with a plan that emphasizes economic models should develop good skills in modeling. A student who plans to study human behavior in the arena of information systems should develop skills in the design of experiments, and a student who plans to collect data about the behavior of management personnel should develop interviewing and survey skills.

In the introductory seminar I have taught in the first semester of the first year of doctoral studies, the students prepare a ten-year plan. Rob Kauffman, who is taking over the seminar, had added refinements. The students do three iterations. They get detailed feedback and advice on how to distinguish between instances of research and streams of research. The results have been excellent. The students use the plan to guide them in selecting supporting fields, selecting

projects in seminars, and writing papers.

The plan also allows for good advising in the case of significant changes in student objectives. If the research stream changes, the preparation needs to be reviewed. Looking back on one of my advising situations in which I was not satisfied with the outcome, the poor result was my failure to recognize that the student changed expectations for the research stream he intended to pursue. The change should have been accompanied by additional coursework and other preparation. Not making these adjustments meant the student entered the job market working on a research stream for which he was not well prepared.

Providing Candidates with Opportunities to Interact with Established Scholars and Other Students

In addition to providing both general and specific sources of knowledge and advice, a doctoral student should be provided with opportunities to listen to research presentations by established scholars and other students. They should have an opportunity to present their papers and get comments on content, methods, result, and presentation. A regular workshop or colloquium in which research papers are presented is invaluable. The procedure we (and some others) follow in our 70-minute weekly IS workshop is to distribute the paper in advance (post on a website). Those who attend are expected to have read the paper. The presenter makes formal remarks for about 20 minutes. This allows about 50 minutes for questions, responses, and discussion. The tone of the session is critical but positive and supportive. In a typical academic year with 27 workshop sessions, there will be about one-third Minnesota faculty, one-third faculty visitors from other schools, and one-third Minnesota IS doctoral students. This means that, during a doctoral program in IS at Minnesota, a doctoral student will attend well over 100 workshops with a broad cross section of research topics and research methods being discussed. A typical student will have an opportunity to present his or her work more than once.

The idea of the weekly workshop is well known but generally not well defined. The format of the IS workshop at Minnesota has benefited from a variety of inputs. We started the regular weekly workshops when Dennis Severance was a faculty member at Minnesota. Features of the workshop were modeled after a very successful workshop series in accounting at Ohio State University. I believe a regular workshop is vital, so I often discuss it when I talk with doctoral students in visiting other schools or in doctoral consortia. When I discuss the advantages of a weekly workshop, faculty members ask about the difficulty of doing it, and students usually indicate they do not do it at their school. The fundamental problem is getting commitment and making it regular. Both faculty and doctoral students benefit, but doctoral students have the most to gain. Therefore, it may require initiative by doctoral students to get it going and keep it going, in cooperation with those faculty members who are willing to join in the project.

Another valuable opportunity for student development is provided by doctoral consortia. These may be organized by conferences, scholarly organizations, sets of universities, etc. The basic idea is to have students present their work at various stages of development and get

feedback from both senior researchers and other students.

Providing PhD Students with Materials on Doctoral Work and Productivity Aids

In preparatory seminars and personal advising, I have found it very important and valuable to discuss resources that will help PhD students be productive. Each supervisor probably has some sources that he or she considers useful. Some examples of general knowledge and advice for PhD students that might be useful are the following. The “starter list” contains both general sources of information to understand doctoral programs and productivity aids for doctoral students, such as endnotes. The productivity aids are very important to introduce early in the advising process, because the benefits tend to be cumulative.

- Re-envisioning the PhD. This is a website from a project to re-examine the PhD and to assemble best practices and best concepts. The site includes interesting or promising practices and resources. Website is: <http://www.grad.washington.edu/envision/>
- Tomorrow’s Professor Listserv. Sponsored by the Stanford University Center for Teaching and Learning. It posts short articles. Although there is a science orientation in many of the articles, there is thoughtful material on being a doctoral student, entering the job market, etc. The articles are organized under five headings including “Tomorrow’s Graduate Students and Postdocs” and “Tomorrow’s Academic Careers.” The website for more information and for subscribing is: <http://ctl.stanford.edu/Tomprof/>.
- ISWorld resources. A very useful source of information and advice is found on www.isworld.net (select ISWORLD button). Examples under this service include a repository of experimental tasks, working papers, research ethics, endnotes, resources for doctoral students, etc. Two pages illustrate these resources and advice: <http://www.isworld.org/#research> and <http://www.isworld.org/phd/phd.htm>.
- Manual of style. Adopting a style for layout of papers (headings, footnotes, etc.) is a good investment. It reduces effort required immediately and in the future. There are a small number of well-regarded manuals. Examples are *Chicago Manual of Style* and *APA Publication Manual*, but there are other good ones. The main point is to select one and use it consistently.
- System for making and filing notes (using a computer)
- Reference documentation (end note) software. Use the software to record references for use in articles and books. The software will format references in any of the major styles. There are also end note libraries for many topics. ISworld.net contains end note libraries that may be useful for researchers in information systems (about 30 at this time): <http://www.isworld.org/endnote/index.asp>.

Summary of Some Other Useful Procedures to Promote Completion and Quality

An advisor can promote completion and quality for a dissertation by encouraging students to employ some simple methods such as the following (described and illustrated in Davis and Parker, 1997):

- Topic analyses to promote early evaluation of ideas for dissertations
- Dissertation proposal
- Dissertation proposal defense (either formal or informal)
- Project time schedule and budget
- Agendas, summaries of meetings, memos on significant decisions, cover memos for chapters, etc.

An advisor may be invaluable in helping students to maintain momentum and to overcome discouragement and delays. Prompt return of drafts with helpful comments, regular meetings, providing deadlines, and having the student turn in intermediate products for review are all important. A professor close to retirement who received a doctorate from Minnesota shared with me some notes from his personal history about his advisor (not me in this case). “Much of my success in completing it (the dissertation) so quickly was because of his (advisor) efforts to give me fast turn around on rough drafts with helpful critical ideas.”

An advisor can help a student maintain perspective. Spouse and family should not be sacrificed for the sake of a dissertation. I had a student drop out of the doctoral program because he felt he could not maintain a good marriage and be a good student. It prompted me to consider the need to discuss the issue and help students to place boundaries on their academic activities. An advisor may help a student to block out dedicated times for spouse or family and to maintain some balance in his or her life. (Probably setting a good example helps also.)

Summary

Based on my experience, my advice to a new advisor (as explained in the chapter) can be summarized as a set of ten recommendations.

1. Clarify in your mind the assumptions governing the doctoral program at your school. Clarify if they are stable or in a process of change. Decide which assumptions you wish to challenge and which you are willing to accept.
2. Clarify in your mind the most important motivations for doctorates among the students who enter your doctoral program. Clarify which of these motivations can be well served within the program.
3. Clarify in your mind the advising style that is most natural to you (and figure out the one that your advisor applied to you). Clarify in your mind the range of advising styles you can do well.

4. Clarify in your mind the needs that students in your program might present to you as an advisor. Ponder what kinds of students you can work with best and which kinds you might have difficulty working with.
5. Define the advantages you have relative to advising and relative disadvantages. Clarify in your mind the limits of your knowledge and skill in advising on different methods and on different topics. Consider the limits on your ability to invest in topics or methods in order to advise on a dissertation outside your current limits.
6. Encourage your school (department) to have a good introductory seminar that prepares students to be scholars. Participate actively in such a seminar.
7. Participate actively in a regular doctoral student/faculty workshop.
8. Learn and teach procedures to help students manage their dissertation research. Examples to teach your advisees are topic analyses to consider alternative dissertations, a formal dissertation proposal, a dissertation project plan, a formal or informal dissertation proposal defense, and progress documentation
9. Be supportive of students in helping them to develop a 10-year plan to be a world class scholar. Do a retrospective plan for yourself and update it to understand the benefits and limits of such a plan.
10. Develop an advising approach and style that recognizes individual differences and establishes a collegial environment in which you are not only a mentor to your advisees but a friend who gives good counsel to advisees who are trying to become good scholars and yet still “have a life.”

References

APA Publication Manual, 5th ed., American Psychological Association, 2001.

Chicago Manual of Style, 15th Edition, University of Chicago Press, 2003

Davis, Gordon B. and Clyde A. Parker, *Writing the Doctoral Dissertation*, Barrons Educational Series, Second Edition, 1997.

Hevner, A. R., S. T. March, J. Park, and S. Ram, “Design Science in Information Systems Research,” *MIS Quarterly*, 28:1, March 2004, pp. 75-105.

Jenkins, Milton, “Research Methodologies and MIS Research” in E. Mumford, R. Hirschheim, G. Fitzgerald, and T. Wood-Harper (eds), *Research Methods in Information Systems*, North-Holland, 1985, pp. 103-117. This is the proceedings of a landmark conference on research by IFIP Working Group 8.2, held in Manchester, England in 1984.

March, S. T. and G. Smith, “Design and Natural Science Research on Information Technology,” *Decision Support Systems*, 15:4, December 1995, pp. 251-266.