PREFACE

The Finnish version of this report was developed more than 10 years ago with Annikki Järvinen. The English and Finnish versions are almost same. Our students and researcher colleagues are willing to publish their studies in English, and that's why the translation was necessary.

This book is intended to give a holistic view on research methods. The main contribution is a classification of research approaches presented in an introductory chapter. In order to teach research work there are at least two alternatives. First, to train students in use of one general method, e.g. survey, or secondly, to allow students define their research exercise problems themselves. We chose the latter. The students in a particular research course often select problems requiring different research methods. We then many times got real applications of the most research approaches, altogether five ones (Chapters 2-6). When a researcher or student is aware of many different research approaches she can better evaluate and utilize research reports produced by other researchers.

The number of research methods is large. To this end we cannot give advises in detail. We wish that the book in its present form could help a reader to find the right method and to get references to essential sources with detailed instructions. We also recommend that a reader first fast read the whole book, she then knows its overall content. She can later concentrate in the section she is interested in.

We are willing to improve this third edition of the book, and we therefore wish to receive as many comments, hints etc. as possible.

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CONTENT

# 1. INTRODUCTION

In this chapter we shall present two models of a research process: Jenkins' (1985) and Wallace's (1969) models. They describe two differing views on the most popular research approach, on the empirical theory-testing approach. We like to orient a reader to a research process by demonstrating some phases and tasks belonging to a study. Our aim is not to guide a reader in problem definition, but we assume that a researcher has a certain problem or an idea to be studied. We like to pay the reader's attention to selecting the most suitable research method, because the problem dominates the method selection, not vice versa. We are approaching inductively and we firstly guide a reader to familiarize with practical affairs of a study. The philosophical questions of research are postponed to the end of the report (Chapter 10). By discussing about various purposes of research work in Section 1.2 we try to illustrate motives and aims of researchers. Our classification of research methods in Section 1.3 is firstly a new research result as such, and secondly a guide to select a method class that best fits for the problem under study.

## 1.1 Two models of a research process

Jenkins' (1985) model of the research process contains 8 sequential steps (Figure 1.1). Jenkins says that this kind of model is over-simplification, because the research process often is iterative.

1. idea
2. library research
3. research topic
4. research strategy
5. experimental design
6. data capture
7. data analysis
8. publish results

Figure 1.1 Jenkins' model

The idea starts up a study. In fact, before the idea there is a certain state of affairs occupying our mind, thus a problem or a question we want to find out an answer. What is a suitable-sized and

non-trivial problem to be solved? Teachers in exam state problems by writing examination questions. In a study an identification and definition of a problem are a natural part of the process. A researcher must do it, not an outsider. You have well selected your problem, if both the confirming and falsifying outcome alternatives are interesting. You must, however, relate your problem to your possibilities. Do you have suitable technical research facilities, enough competent assisting staff, necessary data and knowledge bases, and are your own intellectual capabilities sufficient to perform the research task? Concerning the first three factors and their potential deficiency, do you have enough money to purchase them? Concerning your own capabilities, could you see that you can in the proximal zone develop yourself in those areas you still have weaknesses?

From where do research ideas emerge (Step 1)? They are not coming up by order but, for example, by applying some theory to practice and by making observations, or they emerge upon intuition in the course of debating the matters or of reading the results achieved by other researchers. In general, *the gap between the already known and the potential new knowledge* will motivate a researcher. In the literature there can be two opposing perspectives, for example, the tacit and explicit knowledge, and such a new perspective could be tried to find which explains both (cf. Orlikowski 2002). In our society, when many changes are going on, Berthon et al. (2002) recommend replications as an important component of scientific method in that they convert tentative belief to accepted knowledge. They developed a framework within which to systematize the conceptualization of replications; they reviewed and illustrated how some key information systems research fits into the framework and examine the factors that influence the selection of a research strategy. Their framework includes a conceptualization of the relationship among replication, extension, and generation in IS research.

The library research (Step 2) plays a different role in different research approaches. Strauss and Corbin (1990) considered that in the grounded theory approach it is not necessary to perform an exhaustive library research before the start of the study. Jenkins himself wants to emphasize that there is no substitute for library research in refining the initial idea to enable the next step. In theory-testing studies Jenkins wants to encourage a researcher firstly to know what the others have written about that research idea, and then to elaborate the research idea. According to

Webster and Watson (2002) a complete review covers relevant literature on the topic and is not confined to one research methodology, one set of journals, or one geographic region. They recommend a structured approach to determine the source material for the review: (a) The major contributions are likely to be in the leading journals. (b) Go backwards by reviewing the citations for the articles identified in stage (a) to determine prior articles you should consider. (c) Go forward by using http://www.webofscience.com/ or http://isiknowledge.com (the electronic version of the Social Sciences Citation index).

A literature review is concept-centric. Webster and Watson (2002) recommend that you compile a concept matrix as you read each article as the following table.

| Article | | | Concepts | | |
|---|---|---|---|---|---|
| | A | B | C | D | … |
| 1 | | x | x | | x |
| 2 | x | x | | | |
| … | | | x | x | |

Before commencing this stage, take some time to develop a logical approach to grouping and presenting the key concepts you have uncovered. You might need to add a further dimension to the concept matrix to handle the unit of analysis, e.g. by dividing columns to three sub-columns according to organization, group and individual.

In finding out the research topic (Step 3), the sub-process can be broken into three main components: 1) originating question(s), i.e. what you want to know; 2) research rationale, i.e. why you want to know it; and 3) specifying questions, i.e. which particular questions you need to investigate in order to provide the answers to the originating question(s). For research rationales you can think about whether your study will lead to original research findings or a major increment in understanding. You can find new facts or fill gaps in knowledge. You can also test hypotheses or try to establish a relationship between variables or to test the adequacy of models or theories (Clark and Causer 1991). Yin (1989) proposes that Step 2 (library research) and Step 3 (problem-finding) should be combined. Beginning investigators may think that the purpose of a literature review is to determine the answers about what is known on a topic, but Yin emphasizes

that experienced investigators review previous research to develop sharper and more insightful questions about the topic.

The three first steps of the Jenkins' model exist in every research process. Thereafter a researcher selects a certain research strategy(e.g. research method) (Step 4) depending on the research object and the problem. Many research strategies will be considered in Chapters 2 - 6. In Chapter 3 there are examples on experimental design (Step 5). Data capture (Step 6), data analysis (Step 7) publishing results (Step 8) have got own chapters (7, 8 and 9) in this report.

Wallace (1969) has modeled the research process as a cycle:

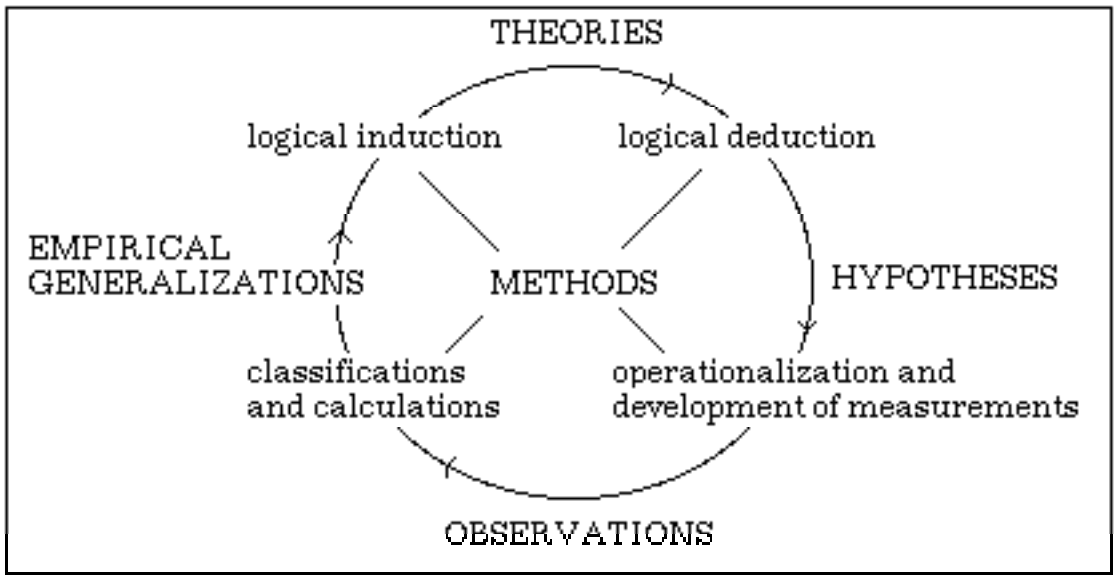


Figure 1.2 Wallace’s model

The cycle is composed as follows: By logical deduction a researcher derives the hypotheses from the chosen theory. In order to test those hypotheses she formulates measurable and observable questions (operationalization, development of measurements), to which she gets observations as answers. She then focuses classification and calculation action on the observations. On the basis of results she considers whether the results are confirming of falsifying the hypotheses. By using results, reasoning, explanation and imagination she gets empirical generalizations from which

she can either decide that the old theory was confirmed or she can by logical induction derive a new theory. Thereafter the cycle continues to the next round.

Wallace (1969) put methods in the middle of the figure. The logical deduction and induction, operationalization, development of measurements, classification and calculations are methods in the Wallace's terminology. To our mind term method is used in a broad sense of the word.

The chapters in this report are in many ways connected with the Wallace's cycle. The theory-testing approaches in Chapter 3 cover the whole cycle. The theory-creating approaches in Chapter 4 only cover a half of the cycle: From the observations to the theory. In an action research (Section 5.3) the cycle may be performed more than one times, because the researchers will immediately give their intermediate results to users. Mathematical research (Chapter 6) with logical deduction proceeds from axioms to propositions, theorems, laws, clauses and lemmas. In the Wallace's cycle 'observations' belong to data gathering techniques (Chapter 7), and 'calculations' to statistical analyses and tests (Chapter 8). Writing (Chapter 9) is needed, when the results will be published. The design-science research (Chapter 5) as a new and different research approach is difficult to locate into the Wallace's cycle.

Both Jenkins' and Wallace's models mainly describe the theory-testing empirical research, hence the same type. Instead of that they are quite different. The Jenkins' model seems to consist of 8 sequential steps almost without any feedback loop; the Wallace's model seems to be a continuous cycle without any begin and end.

The steps 1, 2, 3, 4 and 8 do not explicitly exist in the Wallace's model. The Wallace's operationalization and development of measurements correspond to Jenkins' step 5 (experimental design), Wallece's observations to Jenkins' data capture and Wallace's classification and calculations to Jenkins' data analysis, respectively.

Terms model and theory are often used as synonyms. We can now raise two questions: (1) Which of them, the Jenkins' model or the Wallace's model, is now better? (2) Which of them is profitable to follow? Questions (1) and (2) are examples of problems, when the research process

itself is under study. The answers to questions (1) and (2) are not given in this section, but a reader is in suitable situations encouraged to experiment both, and continually reflect, analyze and develop own working methods. As a thinking experiment a reader could also develop such a model of the research process which covers all the partial sub-tasks in both models.

Jenkins and Wallace did not consider selection of a research object, i.e. a suitable organization, nor how you can be allowed to study it. Buchanan et al. (1988) have in the pleasant way described how they have got in, got on, got out, and got back e.g. to continue a longitudinal study.

### 1.2 A purpose of research work

Every researcher has her own personal motivation to perform a scientific study. You may want to know more. The bodies financing research may have more tangible and instrumental goals. Huczynski and Buchanan (1991, p. 17) have seen four possible purposes of science: 1) to describe, 2) to explain, 3) to predict and 4) to control. When a particular phenomenon of a nature is under study, it is understandable, that research is needed to describe it, to explain its properties and inner relationships. If the latter follow a certain law of nature, it is possible to assume that the same stimulus in the same circumstances also later causes the same reaction. It is then possible to predict that reaction. If a phenomenon occurs or a certain whole behaves predictably, it is easy to control it. Huczynski and Buchanan, however, note that seeking those purposes in human-centered studies will meet a lot of difficulties. We shall in Chapter 6 show that a free will of a human being knocks the bottom out of prediction and control. - The common goal of research work can also be formulated in such a way that some results have been achieved, if they force a researcher to re-consider and change her earlier opinions.

The four purposes of science do not cover all the studies. For example, a construction of a new data system considered in Chapter 5, is not any description, explanation, prediction nor control. It is rather to study whether we can or cannot build a new artifact. Behind of this question can be a usage of the system for control purposes, often for striving economic profits. We shall not restrict ourselves to a materialized artifact, but we also accept social innovations. Wynekoop and

Conger (1991) studying CASE (Computer Aided Software Engineering) systems paid attention to the fact that in addition to construction or engineering the purpose of a study can be understanding the system, its re-engineering and evaluation. Those categories are based on Basili's et al. article (1986).

### 1.3 On selection of research approach

In Section 1.1 two models of the research process were presented. They were compared with each other. That comparison can be called a theoretical-conceptual analysis. Every study contains a certain kind of theoretical consideration, either in the beginning or close to the end of the study. To this end we shall in more detail familiarize a reader with theoretical-conceptual approaches in Chapter 2. If you are not only interested in theoretical matters, you must select a suitable empirical research approach. We shall in this section firstly derive our own classification and compare it with two the best challengers, with March and Smith's (1995) and Hevner et al.'s (2004) classifications. Finally we shall shortly describe other chapters of this report.

We present our taxonomy (Figure 1.3) and argument for it. We firstly differentiate other methods from mathematical methods, because they concern formal languages, algebraic units etc., in other words, symbol systems not having any direct reference to objects in reality. From the rest of methods concerning reality we then use research questions in differentiation. Two classes are based on whether research question concerns what is a (part of) reality or does it stress on utility of an innovation. From the former we differentiate conceptual-analytical approaches, i.e. methods for theoretical development, from empirical research approaches. When we empirically study the past and present, we can use theory-testing or theory-creating methods depending on whether we have a theory, model or framework guiding our research or are we developing a new theory grounded on the gathered raw data. This kind of description-driven research uses the perspective of an observer and operates in hindsight. An important pre-supposition behind both theory-testing and theory-creating studies is whether we assume consensus or dissensus (Deetz 1996). Concerning innovations we can either build or evaluate them. The build-part of design-science research uses the perspective of a player and in prevision intervention-outcome logic,

and the outcome is later evaluated. We have above tried to apply the Bunge's (1967a) guidelines to the taxonomy.

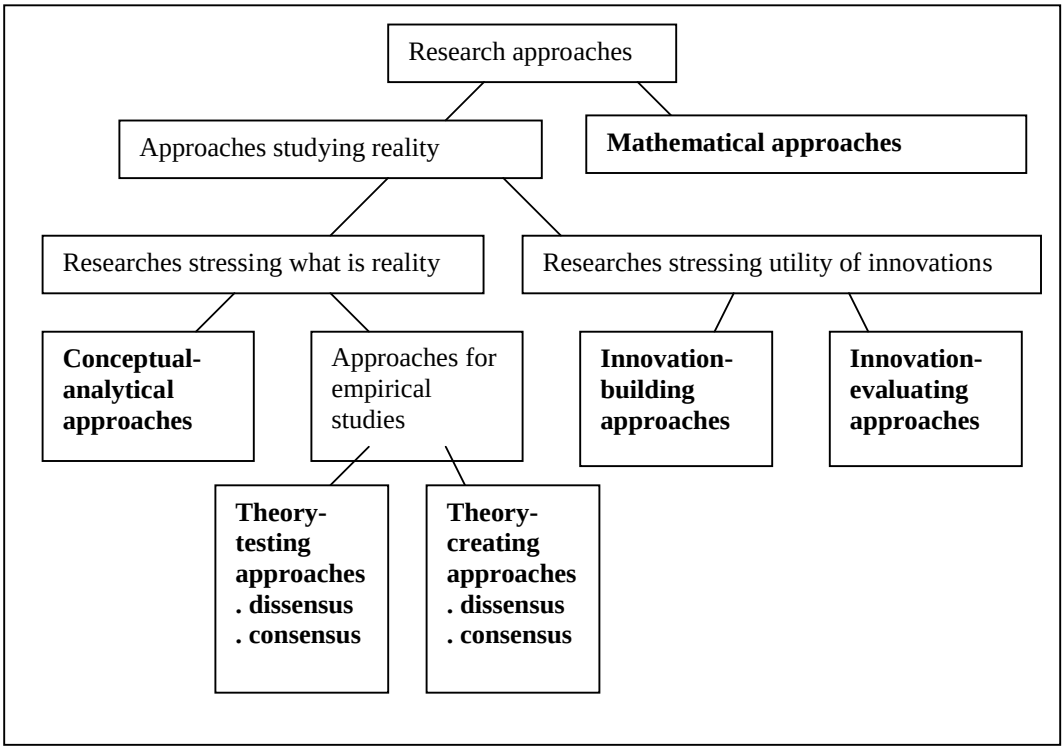


Figure 1.3 Järvinen & Järvinen's taxonomy of research methods

To give a more concrete view on our classes we enumerate research strategies in mathematical approaches, conceptual-analytical approaches, theory-testing and theory-creating approaches, building and evaluation of innovations.

In *mathematical* studies a certain theorem, lemma or assertion is proved to be true.

In *conceptual-analytical* studies basic assumptions behind constructs are first analyzed; theories, models and frameworks used in previous empirical studies are identified, and logical reasoning is thereafter applied.

In the *theory-testing* studies such methods as laboratory experiment, survey, field study, field test etc. are used. Lee (1989) presented a particular version of the case study, which should be classified to theory testing approaches. Some longitudinal study methods belong to this category. In the study where the theory-testing method is used the theory, model or framework is either selected from the literature after competition or developed or refined for that study. In the selected theory either consensus or dissensus is explicitly or implicitly assumed. In the dissensus case a critical study is performed.

To the *theory-creating* approach we include "normal" case study (Yin 1989, Eisenhardt 1989), ethnographic method, grounded theory (Strauss and Corbin 1990), phenomenography, contextualism (Pettigrew 1985), discourse analysis, some longitudinal study methods, phenomenological study, hermeneutics etc.

In *building* a new innovation utility aspects are striven and a particular (information systems) development method is applied. In *evaluation* of the innovation, e.g. an information system, the realized final state is compared with the desired goal state, and maybe some criteria are used and some measurements performed.

We wish that our examples in Chapters 2 – 6 will help both to find a suitable method for herself and to identify a research approach used in a certain article and on that account to evaluate its content. The large number of different categories makes a scientific debate more understandable, and we hope that the researcher using research methods of a certain category could better tolerate those researchers using methods from another category.

To evaluate our result, especially our tree-like taxonomy of research approaches, we shall take the two best possible other classifications we know, namely March and Smith's (1995) framework (Figure 1.4.) and Hevner et al.’s framework (Figure 1.5). In Fig. 1.4 March and Smith have four principles of classification. First, columns are divided by natural science and design science. Secondly, March and Smith differentiate theorize and justify in the natural science, and thirdly, build and evaluate in the design science. Fourthly, 4 types of design science products

(constructs, models, methods and instantiations) are identified. Prof. Salvatore March was one of the authors in both those papers (March and Smith, 1995; Hevner et al. 2004).

| | | Design science Research | | Natural science Activities | |
|---|---|---|---|---|---|
| | | Build | Evaluate | Theorize | Justify |
| Research Outputs | Constructs | | | | |
| | Model | | | | |
| | Method | | | | |
| | Instantiation | | | | |

Figure 1.4. A research framework (March and Smith 1995)

Both papers concern the same topic and the contents of two papers are therefore overlapping. The two most important weaknesses of both papers are: 1. The authors forget mathematical approaches, 2. They consider people as regularly and predictably behaving objects who do not have free will. March and Smith's theorizing and justifying correspond to our theory-creating and theory-testing approaches. Both they and we have the Build and Evaluate research activities in the design science.

Hevner et al. (2004) in their framework (Figure 1.5) supplement March and Smith’s one as follows: “The environment defines the problem space (Simon 1996) in which reside the phenomena of interest. For IS research, it is composed of people, (business) organizations, and their existing or planned technologies. In it are the goals, tasks, problems, and opportunities that define business needs as they are perceived by people within the organization. Such perceptions are shaped by the roles, capabilities, and characteristics of people within the organization. Business needs are assessed and evaluated within the context of organizational strategies,

structure, culture, and existing business processes. They are positioned relative to existing technology infrastructure, applications, communication architectures, and development capabilities."

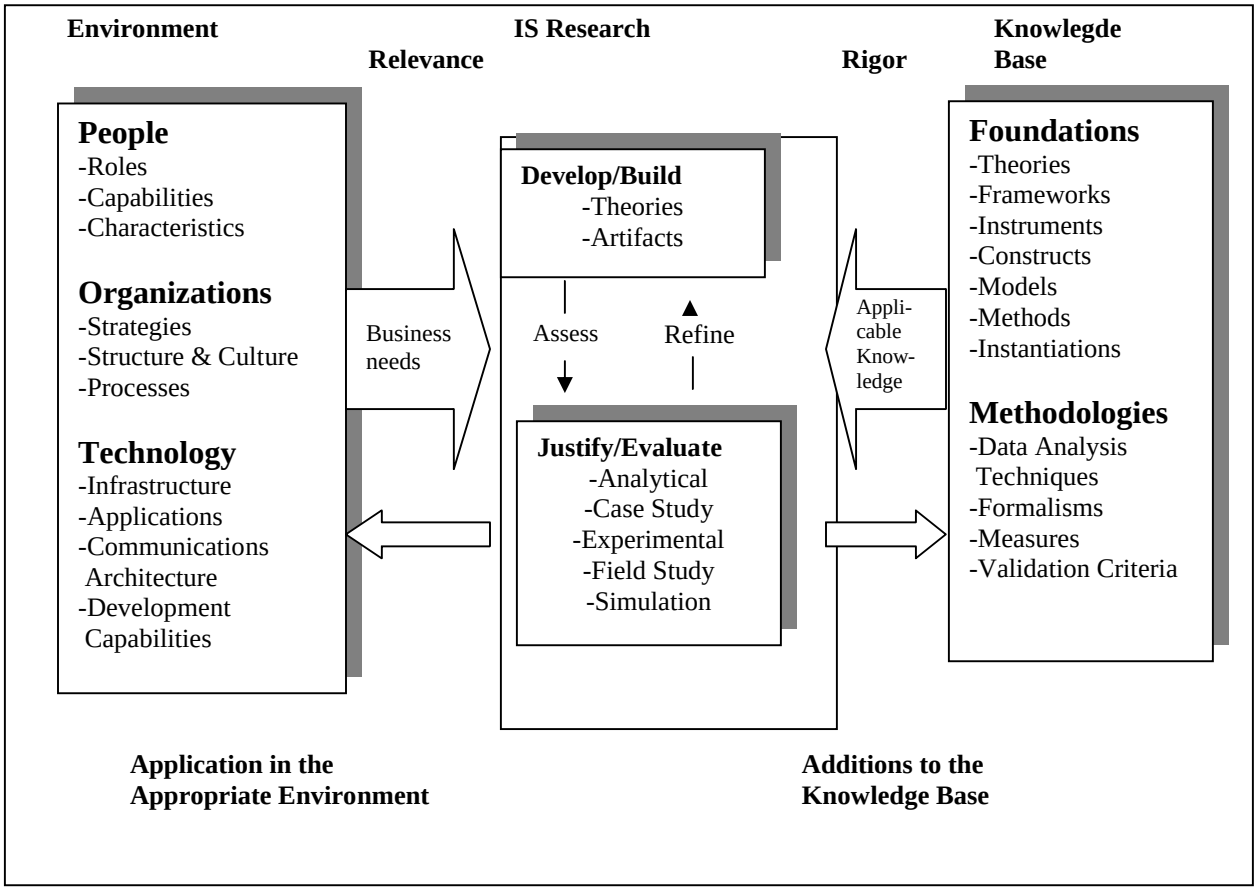


Figure 1.5 Information systems research framework Hevner et al. 2004)

Hevner et al. (2004) continue that "given such an articulated business need, IS research is conducted in two complementary phases. Behavioral science addresses research through the *development* and *justification* of theories that explain or predict phenomena related to the identified business need. Design science addresses research through the *building* and *evaluation*

of artifacts designed to meet the identified business need. The goal of behavioral-science research is truth. The goal of design-science research is utility.

Knowledge base provides the raw materials from and through which IS research is accomplished. The knowledge base is composed of foundations and methodologies. Prior IS research and results from reference disciplines provide foundational theories, frameworks, instruments, constructs, models, methods, and instantiations used in the develop/build phase of a research study. Methodologies provide guidelines used in justify/evaluate phase."

Hevner et al. (2004) write that "the contributions of behavioral science and design science in IS research are assessed as they are applied to the business need in an appropriate environment and as they add to the content of the knowledge base for further research and practice. … The key differentiator between routine design and design research is the clear identification of a contribution to the archival knowledge base of foundations and methodologies."

*On the rest of the report*

We use term '*research approach* ' as a general expression of the similar research methods presented in a certain chapter (2 … 6). The *research method* itself refers to a set and sequence of steps a researcher carries in her singular study. We do not regard interviews and participant observation as research methods but as *techniques* to gather data (cf. Chapter 7). Note too that the same data gathering technique can be used in different methods.

At the beginnings of Chapters 2 – 5 we shall present research questions answered by those methods in a particular chapter. Examples are taken from the field of human-computer interaction. We wish that the questions and examples could help a researcher to locate a suitable chapter for her study. At the end of the same chapters we present our proposals for disposition of the study report. Although our proposal is not always applicable to, it can hopefully help the beginner. We try to also give some guidelines how to perform a good research.

The rest of our report is structured as follows: In Chapter 2 we shall by using some examples consider conceptual research. The way that research has performed in physics has long dominated our view on scientific research. We expect that certain kinds of laws or invariance can be found in phenomena under study. If the laws or invariance are not explicitly included into the theory, they are assumed to be derived from the theory. A particular empirical study, was it a controlled study or field study or any other theory-testing study, may either confirm or falsify the theory, as will be shown in Chapter 3.

A new theory may be needed (Chapter 4), if there is no previous knowledge about a matter or phenomenon, or if we assume, that we have a special, unique case or situation. A researcher may then want to see or penetrate behind direct observations, and try to find constructs and relationships for mastering the matter or phenomenon.

Chapter 5 is structured into three parts: building, evaluation and action research. In the building process, there are two possibilities: 1) the desired state is already specified or 2) it should be first determined. For the first alternative our research problem is how to proceed from the initial state to the desired one? For the second alternative a researcher must first specify the desired goal state together with all the interested parties. The use of the built innovations can also be evaluated. The building and evaluation processes are combined in action research.

Mathematics has developed as such, and it has been applied in exact sciences. Our examples in Chapter 6 illustrate how it can be applied into systems, which may have analogies in reality. Some algorithm is also analyzed.

In the empirical research approaches presented in Chapters 3 - 5 raw data must be gathered from reality. Different data gathering techniques and measurement problems will be shown in Chapter 7.

In the theory-testing approaches statistical analyses and tests (Chapter 8) are used to support statistical generalizations of results, confirmation or falsification of the theory.

The result of the study must be published, and as high forum as possible must be used. In Chapter 9 some instructions are given how to structure the report and some of its constituents.

Some research approaches differ from others, because they have different ontological and epistemological pre-assumptions. Those philosophical aspects will be considered in Chapter 10.