

## How to select an appropriate research method in ergonomic studies?

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### **Introduction**

Our starting point here is that a research question is in a dominant position compared with a research method. To our mind, this is valid independent on whether we are performing quantitative or qualitative measurements. Concerning the latter Tesch [1] even presented a collection with 27 qualitative research methods. The number of different research methods is rather large. It is therefore reasonable to limit the number of categories of methods in one way or other. In addition to a research question as a factor of categorisation we use differentiation between abstract and real research object, and concerning the latter we use a division between natural and design sciences.

In the development of our taxonomy [2] the top-down principle is applied, i.e. all the research approaches is first divided into two classes, one or both are then divided again into two sub-classes etc. (Figure 1). At the beginning we differentiate other methods from mathematical methods, because they concern formal languages, algebraic units etc., in other words, symbol systems without having any direct reference to objects in reality. From the rest of methods concerning reality we then use research questions in differentiation [3]. Two classes are based on whether the research question refers to what is a (part of) reality or does it stress on utility of an innovation, usually an artefact (something made by human beings). From the former we differentiate conceptual-analytical approaches, i.e. methods for theoretical development, from empirical research approaches. When the past and present are empirically studied, we differentiate the theory-testing or theory-creating methods depending on whether there is a theory, model or framework guiding the study or is a researcher developing a new theory grounded on the gathered raw data. Regarding innovations or artefacts we propose a differentiation between to build and to evaluate them.

During normal circumstances half a population in industrialised countries belong to the working force. Considering the normal day of the person employed and the period he is waken, he is a half of this period at work. In addition, work plays a central role in the development of the personal identity. Work and its arrangements must be safe. To this end

ergonomics is important. We then emphasise both a researcher's and practitioner's view. We shall show that both professionals need a good knowledge of research approaches.

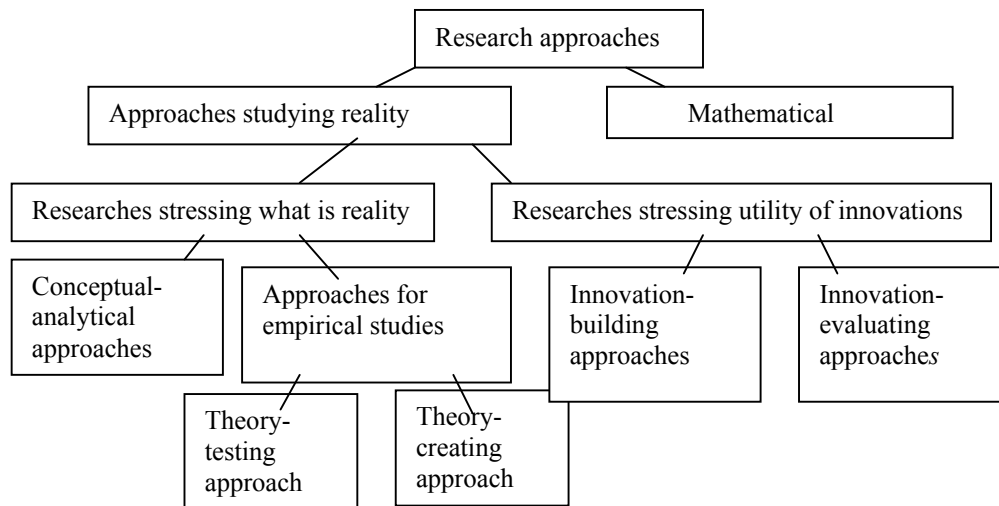


Figure 1. Jarvinen's taxonomy of research methods

We can now state our research question as follows: How to select an appropriate research method in ergonomic studies by using the Jarvinen's taxonomy?

### Method

To analyze our research question we can apply our taxonomy (Figure 1) to the question above and find that the question concerns a research work, i.e. a part of reality. In the further more detailed analysis of our research question we find that term 'appropriate' refers to utility, and hence we can decide that our research question concerns either innovation building or innovation evaluation. We do not yet have anything to evaluate, but we must build it, in this case we must build some method, procedure or algorithm to select an appropriate research method.

To present our algorithm we use some pseudo-language with if-then-else and go to; and describe our algorithm step by step. As we did above we can first state:

- Step 1. If your research question concerns an abstract world of symbols then select mathematical research approaches else go to step 2.
- Step 2. If your research question concerns utility (improvement, efficiency, effectiveness, speed etc.) then go to step 3 else go to step 4.
- Step 3. If your research question concerns building an innovation then use methods to construct, formulate or build the innovation (model, method or instantiation) else evaluate the existing innovation by using the given criteria.

- Step 4. If your research question concerns a theoretical understanding a reality then use some conceptual-analytical approaches else go to step 5.
- Step 5. If you have some theoretical pre-understanding on a research domain then test your theoretical framework else observe your research domain and create a tentative theoretical framework based on your observations.

## Results

In the previous section we wrote out our Figure 1 and described it as the algorithm with five steps. Based on our experiences our taxonomy is not easily applied to. To alleviate the learning and understanding process we like to describe it in third way, i.e. by giving some exemplary research questions (Table 1).

Table 1. Research approaches and research questions

<b><i>Research approach</i></b>	<b>Exemplary research questions (generalised)</b>
Mathematical	To which system class will this subsystem belong? Does a certain aspect, e.g. virtuality, cause changes in the classification of dynamic systems, and which kind properties can be proved to exist in that class?
Innovation-building	Could we improve a certain normative method? Can we build a certain innovation with specific goals?
Innovation-evaluating	How good is a certain innovation measured by particular criteria?
Conceptual-analytical	How a certain new aspect will change components or relations in a particular theory, model or framework? Are some components or relations lacking or useless in a particular theory, model or framework?
Theory-testing	Do observations confirm or falsify a particular theory, model or framework?
Theory-creating	What does a certain action mean for you? Which kind is your action? Which kind is a certain action?

In addition, we still give some examples, which known methods belong to certain categories. Mathematical methods like proofs are used in mathematics, general systems theory, formal languages etc. The building process can concern a model, method and instantiation [3], and they contain some goals to be reached. Two typical approaches are based either on consecutive phases or on evolutionary cycles. The controlled experiment, survey and case study can be used to evaluate an innovation. Note, that certain criteria (not a structure and action) are the measured. A new theoretical framework of a part of reality can be derived from assumption and axioms (deductive approach) or be generalized at the basis of earlier results (inductive approach). The controlled experiment, survey and case study are applicable to test whether a certain theory describes a structure and action of a particular part of reality. The grounded theory, ethnography, case study etc. can be used to create a new theory based on observations of the problem domain.

## Discussion

We can now ask, are all those research categories valid for ergonomics. To our mind they are. Aulin [4] has nicely demonstrated how his theory of dynamic systems with and without rest point has important applications. For example, a self-steering system seems to the best mathematical model of human being. It has an important property that the same state never returns. We often violate this property, when we are performing repetitive experiments.

People proposing and implementing ergonomic innovations are building and evaluating a new artefact or arrangement. Those building and evaluation processes can be performed in a scientific way. The ideas referred above can then be utilised.

Although a researcher or practitioner in ergonomics mainly works with building and evaluation processes, she or he must also know how to study a part of reality. The research object can be novel for him or her, and to this end she or he must study its structure and action. This means that she or he must either test a certain theoretical framework or create a new one. The latter can happen by theoretical derivations or collecting observations and then grounding a new theory on them. – We have demonstrated that a researcher and a practitioner in ergonomics will need to know all the approaches presented above. We have elsewhere [2] shown that our taxonomy is better than the best known [3] this far.

## References

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