The Missing Link in Learning in Science Centres

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ABSTRACT


Science centres have been identified as an important resource in encouraging teenagers to choose higher education in science and technology. This is of interest to society, since there seems to be a problem in getting sufficient numbers to do so. And accomplishing this is sometimes described as a fatal question for a nation’s future prosperity and development. Still, there is an international trend where teenagers fail to visit science centres.

Through research, little is known about what is interesting or useful to the public, as well as how to reach those who are ‘unengaged’. Considering teenagers as exponents for what distinguishes today’s society makes their apparent unwillingness to participate in science centres interesting to study with regards to what culture, history and ideology these centres were initially produced. Hence, from this point of view, what is missing in science centres that would make them interesting for the young people of today?

Many studies of learning in science centres have come to focus on visitors who visit voluntarily and how well the embedded messages in the exhibits have been acknowledged by these visitors. This study focuses instead on teenagers who are reluctant to participate in science centres, with their perspective of science centres as the point of departure, specifically what kind of social activities are formed in their encounters with science centre exhibits. This encounter is regarded as an encounter between the two different practices of the science centre and the teenagers. The applied theoretical perspective is mainly assembled from socio-cultural theories of learning.

This research is a microanalytic study of five teenagers who were equipped with video cameras and asked to film a visit to the local science centre, Teknikens Hus. The films were later discussed in a focus-group interview consisting of the teenagers and the researcher. Visual ethnography provided the theoretical framework for this research design.
The results showed that the teenagers want to use exhibits to have the authority of interpretations and the possibilities to contribute to the meaning of the activity. At the same time, they want to use the exhibits in a way that the activities become places for developing social identity. To negotiate the meaning of the exhibits there is a need for an openness that may be constrained by too inflexible and limiting exhibit designs. This pattern is described as two different forms of participation in the exhibits; ignoring or extending the intended meaning of the exhibits. Meaningfulness also demands a closeness created by connections between the exhibit and the user’s personal experiences. This pattern is described as two different ways in which the teenagers identified the exhibits; exhibits which they dissociated from or to which they had an ongoing relationship. Providing a space for negotiation seems crucial to inviting teenagers into opportunities of meaningful experiences, even more significant than any specific physical feature in the exhibit.

The teenagers’ agenda, in which forming practices where they can express themselves and contribute to the meaning seem to be very important, appears not to be greatly enabled by science centre exhibits. In this situation they learn to not participate. Science and technology represented in this matter show a ‘ready-made’ world that they cannot change. The missing link in learning in science centres is here described as the part of the meaning making process where the teenagers get to re-negotiate the meaning of the activities in the centre and use the exhibits as tools to accomplish this.

**Key words:** Science center, learning, artefacts, visual ethnography, socio-cultural theories, meaning making, interactive exhibits, social identity, negotiation of meaning, teenagers
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(There are some issues to be careful with when your advisor and husband carry the same name. Like being cautious with who you are sending SMS to since the two names stand right after each other in the number list integrated in the mobile phone.)

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To my mother Valve and her sister Helgi,
and my father Kaljo and his sister Anne
CONTENTS

INTRODUCTION ................................................................................................. 1

REASONS FOR MY RESEARCH DESIGN ...................................................... 3

DIFFERENT AGENDAS .................................................................................. 4

A participatory perspective ......................................................................... 5

OVERVIEW OF THESIS ................................................................................. 6

THE SCIENCE CENTRES’ AGENDA ............................................................... 9

SCIENCE CENTRES: HISTORY, CULTURE AND IDEOLOGY ..................... 10

Science museums and science centres ...................................................... 11

Science centre exhibits: ‘interactives’ ......................................................... 13

SCIENCE CENTRES IN SWEDEN .............................................................. 15

Teknikens Hus: an introduction to the site of study ..................................... 18

The work of personal enthusiasm ............................................................. 20

Influences and development ...................................................................... 21

THE EXHIBITS IN TEKNIKENS HUS .......................................................... 23

Reality in full scale (as much as possible) ................................................. 25

Small scale models (doing the real ‘thing’) ................................................. 26

Illustrations of the real ‘thing’ .................................................................. 26

Traditional/standard exhibits ................................................................. 27

Unique playful exhibits ............................................................................ 27

ASSUMPTIONS ABOUT COMMUNICATION AND LEARNING ............ 32

Interactivity and authenticity .................................................................... 34

A constructivist-inspired research agenda .............................................. 35

THE SCIENCE CENTRE AGENDA REVISITED .......................................... 36

The science centre goal – contested ground ........................................... 36

Youth development and museum development ....................................... 39

The Minnesota Youth Science Centre ..................................................... 39

‘The myth of the individual user’ ............................................................ 41

AN ALTERNATIVE PERSPECTIVE ............................................................. 42

A new paradigm taking form .................................................................... 44
THE RESEARCHER’S AGENDA ..................................................47

HOW TO MOVE THE RESEARCH AGENDA FORWARD ...........48

SIX FUNDAMENTAL ASPECTS OF LEARNING ..........................50
  Living knowledge .................................................................. 50
  Learning organized as participation ....................................... 51
  Space for learning ................................................................ 52
  Social production of meaning ................................................ 55
  Reality is mediated through artefacts ..................................... 57
  Learning as a matter of becoming ........................................... 59

UNIT OF ANALYSIS AND RESEARCH QUESTIONS ..................63
  Research questions ............................................................... 64

VIDEO DOCUMENTATION AS RESEARCH METHOD ..................64
  Visual ethnography .............................................................. 66
  The features of the present research design .............................. 68
  A participatory perspective .................................................... 71
  Research methods as practice ............................................... 72
  Analytical implications of the research method ....................... 74
  Interpreting visual images ..................................................... 75
  The question of the ‘authentic situation’ ................................ 78

ETHICAL ISSUES ........................................................................80
  Ownership of the interpreted meaning .................................. 82
  Exploitation .......................................................................... 82
  Informed consent ................................................................. 83
  Harm to informants .............................................................. 84

THE TEENAGERS’ AGENDA ..................................................87

FORMS OF PARTICIPATION IN EXHIBITS ..............................89
  Hands-on and the ignorance of the intended meaning .............. 94
  Playing around and the conversion of the intended meaning ...... 94
  Extending the intended meaning – a process over time and across space 96
  Questions of orientation in the activities .................................102

WAYS OF IDENTIFYING EXHIBITS .........................................103
  Exhibits that teenagers dissociate from .................................108
  Exhibits that teenagers have a nostalgic relationship to ..........111
  Exhibits that teenagers have an on-going relationship to .......112
  Questions of orientation in the group interview ......................116

EXHIBITS AS ACTIVE PARTS OF MEANING MAKING .............117
  Negotiation of being a teenager visiting Teknikens Hus ..........117
  Enabling, constraining, and rewarding exhibits .....................120
  Space of negotiability ..........................................................124
Introduction
The Norwegian author Erlend Loe describes life like this:

I regard human life on earth as an endless piece of teamwork. The quest, formulated in the dawn of time, is as follows: Think about what you see around you. Learn how you can organise yourself in the best way and make use of nature. Describe, in your own words, how it is to be a human being. Find out why you are here. Take the time you need.

(From the cover of Expedition L (2003), translated by the author)

This may very well serve as a baseline for the present study, which is about what people do, not only because of who they are, but where and with whom they are. Their motive or agenda is the search for meaningfulness through ‘an endless piece of teamwork’.

Think of what this 15-year old girl is saying about the interactive stationary exhibits at the local science centre, Teknikens Hus:

I think it would be nice if they [Teknikens Hus] could have a lot of things you could invent yourself. Not so controlled, things with which you could do as you liked. That not everything was pre-determined.

It seems that certain things are missing in her search for meaningfulness at the science centre. How can this be better understood? This is one of the fundamental questions which I try to address in this thesis. The quote is taken from the research material of this thesis’ study, a microanalytic study including five 15-year olds in Luleå, Sweden.

During the last decade, I have been involved in Teknikens Hus as a project leader and as a researcher. Over the last 10 years, I have heard and participated in discussions about teenagers’ lack of interest of participating in their local science centre. A survey conducted by me in 2001 (Nöu, 2001) of all teenagers in Luleå who were about to start upper secondary school (in their 16th year) showed the same tendency – they stopped going to Teknikens Hus when they began grade seven in school. Further, a majority of the teenagers had last visited Teknikens Hus during grades 1-6 in the contexts of school trips and with family or friends. The whole survey consisted of 446 informants, with 14 who had never visited Teknikens Hus on a school trip, 39 had never visited with their family and 131 had never visited with friends. One major science centre attraction is the interactive exhibits; in fact, they are an important part of what defines a science centre. Teenagers in the survey also mentioned ‘walking around in the exhibits’ as the primary activity during a visit, leading me to wonder if the lack of
participating interest at science centre, especially with friends, has something to do with the exhibits?

Many studies of learning in science centres focus on visitors who had voluntarily come to visit and how well the embedded message of the exhibits had been acknowledged by these visitors. Interesting challenges arise when you instead try to understand why certain groups of people do not want to visit. Obviously, science centre perspectives of these people may very well indicate a direction for further development in the activities of the science centres. I have come to the conclusions that from a better understanding of the encounters between teenagers in particular and science centre exhibits something important can be learned about the development of future science centres.

If this encounter means a meeting or a clash has to be an empirical question. However, there is evidence indicating that teenagers seem to avoid a meeting by choosing not to visit science centres at all. Does this presuppose a conflict? And if so, a conflict between what?

**REASONS FOR MY RESEARCH DESIGN**

Many more sources of knowledge about science and technology exist in society than school. We are in the midst of a worldwide explosion in museum growth, the majority of which are science museums. The objectives of museums have shifted from emphasising collecting and preserving to one of educating the public (Hein, 1998). New forms of museums (like science centres) and new ways of programming existing museums have evolved. At the same time, there is an increase in museum-going; a study shows 3 of 5 people in the USA visit a museum once a year, compared to 30 years ago when 1 out of 10 went to museums regularly (Falk, 1998). Surveys of museum research (Falk & Dierking, 2000) indicate that it not only has to do with the increased amount of new museums, but also a fundamental shift towards making learning experiences a part of everyday life.

However, an opposite trend seems to indicate that many museums\(^1\) in the western world have a problem attracting youth to come and visit and

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\(^1\) In this thesis, science centres counts as a form of museum.
participate at their institutions\(^2\). In my research, I have tried to give voice to teenagers who are reluctant to participate in science centres by allowing their perspectives to stand out as much as possible. Obviously there is a methodological challenge that arises when you want to study how a certain group acts in an environment they are familiar, but would not normally visit for some reason. Inviting them to visit without any other purpose than to be observed, interviewed, or both would not provide any possibilities for them to represent themselves and make a personal account of their perspective on the science centre.

Hence, to deal with this issue, I provided the teenagers who participated in my study with video cameras and asked them to film a visit that we later watched together. This way the video films became not only an (non-human) agent through which the teenagers could tell their story, the video films also provided a space where the teenagers could elaborate this story and integrate how it related to their social identity. Visual ethnography provided a fruitful theoretical framework for this research design.

**DIFFERENT AGENDAS**

The teenagers’ encounters with science centre exhibits may be regarded as encounters between different practices with different agendas. With its clear educational purposes, the science centre agenda influences and is influenced by a practice with certain assumptions about communication and learning, ideologies concerning how science and technology are constituted and what role these subject areas play in society.

However, there is also the visitors’ agenda. The visiting teenagers construe their own learning institutions in the meaning making process, institutions that are part of the larger learning infrastructure in society, though they function in a certain culture. My point of departure is that this culture dominates during, in this case, a science centre visit, and subsequently resituates the focal point of what to study from the agenda of the museum to that of the visiting teenagers.

\(^2\) Of course, there are exceptions, see for example the Youth Science Centre in Minnesota, USA (Roholt & Steiner, 2005).
I regard the whole situation as youth living their lives, which may influence and become influenced by interacting with science centre exhibits produced with a purpose of making an impact in a specific direction.

It is important to remember that, in terms of the visitor’s lifetime, the museum visit itself is a fleeting event. Visits are measured in minutes and hours, not days. A visit, or even repeated visits to a museum or museums, is but a barely discernable blip on the ECG monitoring an individual’s total learning experience, if you like. To recycle an age-old metaphor, even the longest visit is like a tiny thread woven into the tapestry of the visitor’s other lifetime experiences.

(Rennie & Johnston, 2004, pp S13)

When integrating these things into their lives, the teenagers engage in a process where they construe a relationship with the artefacts. This particular relationship may be one of the keys to better understanding the relationships of teenagers to science centres and their learning from interacting with traditional science centre exhibits. Thus, the present research is about what role science centres play in the lives of teenagers from their own perspective.

A participatory perspective

Researching the teenagers’ agenda is obviously one key feature of this study to accommodate the ambiguous meanings of the exhibits, and consider them as artefacts. Exhibits produced to promote a public understanding of science in science museums and science centres attempt to carefully control the understandings of visitors. Authentic objects have tended to be viewed with some suspicion in these contexts.

For a single-minded mission to explain “the science”, objects are problematic because of their ambiguity and the richness of their associations for the viewer: their meaning and significance are not fixed, and visitors’ reactions to them are difficult to control.

(Bennett, 2000, pp 56)

However, considering science centre exhibits as artefacts, with no fixed meanings, opens up a discussion on their meaning from the visitors’ point of view. Instead of focusing on how much the intended meaning of an exhibit the visitors have understood, it is fruitful to study the multiplicity and richness of response that an exhibit may evoke³. Martin (1994) suggests that less narrowly constrained ways of investigating and talking about the

³ Richness of responses to an exhibit is actually recognized as a positive feature rather than a failure of clarity in recent perspectives on public understanding of science (MacDonald, 2002a).
relationships between science and the public are needed, because when people talk about scientific facts or images, they often do so in ways that ‘create knowledge about a whole range of topics’ (pp 114). Thus, the focus of the present study concerns the teenagers’ encounters with science centre exhibits, not to see how well they have been able to enter the belief system characteristic of the science in question, but in how they choose to participate in the exhibits and make meaning of them.

OVERVIEW OF THESIS

This research basically assumes an idea of regarding the situation when a teenager encounters an exhibit as an encounter between different practices with different agendas. This is also how the thesis is structured. The thesis is organized into four parts, each of them indicating different practices and agendas that intersect in the present study.

Part one deals with the agenda of the science centre, considered on the local level embodied through Teknikens Hus and on a cultural level for the science centre movement as a whole. Sections dealing with the Swedish science centre movement, including Teknikens Hus, are partly built on testimonies from people who can be regarded as exponents for the fundamental ideas assumed in the science centre practice. This is to make this part of the thesis consistent with the third part that is built on the teenagers’ testimonies of the same setting. All are in line with one purpose of the study, to focus on the encounter between teenagers and science centre exhibits regarded as an encounter between two practices, which become visible in human action and the use of cultural tools.

Part two deals with the researcher’s agenda when conducting this research. Both theoretical assumptions and methodological issues are scrutinized and described.

Part three concerns the empirical research material, i.e. an analysis of teenagers’ activities in science centre exhibits from the teenagers’ perspectives.

Part four is actually a cross-reference between parts one, two and three and a discussion about what the results may lead to regarding future research. This indicates the existence of a parallel structure that adds a time dimension to the thesis, with the beginning in the science centre history
and the end in discussions about future science centres via how teenagers represent the science centre of today.

This is the first Swedish thesis regarding learning in science centres. I hope that my study may be of interest and a contribution to the field, especially since this sort of research is in demand by the Swedish science centres themselves (Hagberg & Hultén, 2005). In particular, ‘research on how science centres influence children’s and youths’ learning and understanding in mathematics, technology and natural sciences, both short – and long-term’ (Ibid., pp. 51). The fact that I have chosen to write this thesis in English will also provide opportunities for international readers to take part of this research. After all, it is of a worldwide interest to better understand learning in informal environments, especially regarding the use of artefacts by future generations in their meaning making activities.
Part one

The science centres’ agenda
SCIENCE CENTRES: HISTORY, CULTURE AND IDEOLOGY

The science centre movement is usually described as being derived from the ideas of Francis Bacon (1561-1626), the English philosopher who claimed that experiments were the right way to discover things about nature. He proposed a “museum for discoveries”, though the first science centre, Le Conservatoire National des Arts et Métiers in Paris, did not open until 1794. The movement got a revival during the 1960s in the United States after the Soviet Union won the space-race and became first in space with Sputnik in 1957. From this point on, it became highly important, first in the US and later on in the rest of the western world, to increase the understanding and interest of the public in science and technology to produce more engineers and scientists who could help in the successful development of a country. Science centres were recognized to play an important part in this mission.

In its modern form, the science centre is a creature of Second-World-War American society. Spurred by the Soviet Union’s conquest of space with Sputnik, stimulated by the race to put a man on the moon, and alarmed by increasing public scepticism about the benefits of such scientific blessings as pesticides, nuclear power and genetically altered food, government and industry have supported the science centre as a means of informing the public about science and technology.

(Bradburne, 1998, pp. 121)

From this societal perspective, the science centre may be recognized as an ideological project with political ambitions. The science centre movement greatly expanded during a period (in the 1960s) when many of the nineteenth-century triumphs became challenged. The progress of the nation-state, racial and social hierarchies, seem to have become much less inevitable through the emergence of ethno-nationalist and environmentalist movements and the acceleration of globalization.

These societal tendencies also highlighted the perceived dangers of technology. Hence, the first modern science centres were, at least in part, dedicated to presenting positive visions of scientific potential and achievement to counterbalance these tendencies. Still, many science centres today describe their central activity to enhance the ‘public appreciation of science’ (Lewenstein, 1992). Science centres are clearly situated in a larger
ideological context⁴, and are associated with (reflecting or opposing) wider historically located cultural and political rationalities.

Politics, in other words, lies not just in policy statements and intentions (though these are important) but also in apparently non-political and even ‘minor’ details, such as the architecture of building, the classification and juxtaposition of artefacts in an exhibition [and] the use of glass-cases or interactives.

(MacDonald, 1998, pp. 3)

Science museums and science centres

Museums are defined by the International Council of Museums (ICOM, 2001) as:

A museum is a non-profit making, permanent institution in the service of society and its developments, and open to the public, which acquires, conserves, researches, communicates, and exhibits, for purpose of study, education and enjoyment, material evidence of people and their environment.

In addition to institutions designated as ‘museums’, a whole range of places, including science centres, qualify as museums for the purposes of this definition. In the present study, the term ‘museum’ is used in the same generic manner to include science centres. Science museums and science centres vary in history, content and purpose. MacDonald (1998) describes the historical background, pointing out that science centres and specialized hands-on galleries also have pre – 1960s precedents, like the Children’s Gallery, established in the 1930s in the Science Museum in London. Although the Children’s gallery and similar were often devoted to showing particular applications of science, more recent science centres have concentrated more on relatively abstract scientific principles.

The earliest example of a centre devoted to representing scientific principles through hands-on exhibits was the 1969 opening of the Exploratorium in San Francisco. At this point, the old, established traditional science museums that focused on collections, research, and authoritative information seriously began to remodel their exhibitions to enhance communication with their visitors. They were not only challenged by the new science centres, but also by another form of scientific and technological displays: industrial heritage sites. While there has been debate about

⁴ See MacDonald (1998) for an overview of the transformation of science museums over time from this perspective.
whether industrial heritage and science centres should be regarded as museums of science (Durant, 1992), it is clear that traditional science museums have occasionally sought to borrow strategies from these kinds of institutions. The approaches to science taken by the different forms of display are, however, almost the opposite of one another: ‘the former [industrial heritage] seek to present science entirely contextualized in a “slice of history” in a specific community [5], whereas science centres are more concerned with universal laws and principles which transcend particular times and places’ (MacDonald, 1998, pp. 14).

McManus (1992) chose to describe traditional science museums as ‘the first generation’ museums, museums of science and industry as the second generation and science centres as the ‘third generation’ museums, created by the move from exhibits based around objects to exhibits built on ideas6.

Today’s science centres often house two different forms of exhibits: (1) thematic, but non-object based exhibitions of larger concepts (often travelling displays), and (2) ‘decontextualized scattering of interactive exhibits’ (McManus, 1992, pp. 164), each conceptualized science usually being unrelated to the adjacent exhibits. Science centres may be regarded as very popular, both from the perspective of visitor numbers and the large and increasing number of established science centres8. MacDonald (1998) suggests two reasons for this popularity, namely that there is the clear intention to promote ‘the public understanding of science’ conceptualized in terms of ‘public appreciation of science’ (Lewenstein, 1992), and that another source of appeal lies in their hands-on interactivity – a mode of display that is becoming increasingly common in contemporary exhibitions.

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5 The Swedish open-air museum Skansen (opened 1891) may be seen as a precursor to industrial heritage sites. It attempts to provide a ‘total environment’: artefacts are presented embedded in the worlds of which they were part of, and visitors are invited to enter those worlds and lives.

6 However, Bradburne (1998) suggests that the history of science museums should be regarded as an expression of changes in the history of ideas of science. Third generation museums have yet to come, ‘which will be based on the active process of doing science, rather than on the passive receiving of science as a canon of accepted truths’ (pp. 119).

7 For instance, science centres reach an estimated 39 million school children every year (Retrieved from www.astc.org, August 17, 2005).

8 At the end of 2004, The Association of Science–Technology Centres (ASTC) had 532 members in 40 countries. (Retrieved from www.astc.org, August 17, 2005). ASTC also reports that between 1990-1996, 86 new science centres had opened, more than the entire previous decade. This phenomenon is also shown graphically in Beetlestone, Johnson, Quin & White (1998), as per the 30 per cent increase each decade in the number of science centres.
The first reason, i.e. intention, was clearly stated by the founder of The Exploratorium, Frank Oppenheimer, who thought that the main task of science centres was to present positive visions of scientific potential and achievement. Oppenheimer’s attempt in the Exploratorium was to represent ‘pure’ scientific principles unsullied by the context of their production or of their applications (Hein, 1990), and thereby provide relatively politically ‘safe’ images of science. This has had a great impact on other science centres, which can build their own exhibits with the same concept by using the ‘Exploratorium cookbooks I, II, and III’ printed in 1976, and reprinted in 1980 and 1987.

Science centre exhibits: ‘interactives’

The Nordic Science Centre Network, NSCF⁹, defines science centres in their charter as centres for exhibits and activities with the purpose of popularizing science and learning through interactive objects and demonstrations. Obviously, the interactive component lies in the core of the science centre enterprise.

⁹ Nordisk Science Centre Forbund [www. nordicscience.org].
Barry (1998) overviews the historical background and points out the Exploratorium as the initiator for the modern concept of interactive exhibits. The Children's Gallery (1936-94) at the Science Museum in London, and the Palais de la Découverte in Paris (1937-) influenced the founder, Frank Oppenheimer. He wanted to empower visitors by giving them the opportunity to participate, not only observe, and to experience the process of discovery with all their senses and thus become experimenters (Oppenheimer, 1968). The idea was that the visitor was (and still is) expected to become aware of scientific principles through the use of touch, smell, hearing or the sense of physical effects on their own bodies (Durant, 1992). This is, however, quite different from the way real scientists work, since the scientist's body has become disciplined (Law, 1986), capable of making exact observations, though no longer serving as an experimental instrument in itself. The scientist no longer experiences experimental events; the scientists' instruments record them (Barry, 1995).

The enthusiasm for interactivity spread across the United States following the late-60s example of the Exploratorium, and arrived in Europe in the mid-80s. A veritable 'interactives' movement had emerged with the formation of organisations such as the British Interactives Group (BIG)\textsuperscript{10} and the European Collaborative Science, Industry and Technology Exhibitors (ECSITE)\textsuperscript{11}.

The popularity of interactives has proven to be both beneficial (in terms of large visitor numbers) and problematic. The recognition that visitors came to the interactive science centres to enjoy themselves created a problem of validating the learning that was intended by the exhibit designers. Because of this, science centres have been criticized for promoting fun and enjoyment rather than education in science, first espoused by Champagne (1975). After 6 hours at the Ontario Science Centre in Toronto with his family, he suggested that the science centre had failed to meet its obligations to science in four ways: (1) questions about important problems in the world were obscured by exciting and flashing displays, (2) poorly given explanations, (3) ethical dimensions were ignored, and (4) science was dishonestly portrayed as easy and unproblematic.

To address research that partly supports criticism of this kind (e.g Rennie & Williams, 2002), a new genre of issue-based science exhibitions have

\textsuperscript{10} www.big.uk.com
\textsuperscript{11} www.ecsite.net
emerged, deliberately placing the intersections between science, technology and society at the forefront. Pedretti (2004) describes how two exhibits in this genre (Mine Games and Question of Truth at the Ontario Science Centre) enhanced learning through four factors – they personalized the subject matter, evoked emotion, stimulated dialogue and debate, and promoted reflexivity.

**SCIENCE CENTRES IN SWEDEN**

Many state authorities appear in a historical description of the Swedish science centre movement. To simplify the reading of this chapter for both Swedish and international readers, a list of authorities in the text will be presented first. The translated names will be used consistently in the text and bibliography, fully written in their first appearance and later on with their acronyms (if there is an official one). Even if the authority has changed its name after the referred publications were published, the former names and acronyms will be used in the text as they appear below. The new names can be found below in the inserted footnotes.

- The Swedish Council for the Renewal of Higher Education (Rådet för högre utbildning). URL: rhu.se
- The Swedish Knowledge Foundation (Stiftelsen för kunskaps- och kompetensutveckling [KK-stiftelsen]). URL: www.kks.se
- The Swedish Ministry of Education (Utbildningsdepartementet12). URL: www.regeringen.se
- The Swedish National Agency for Education (Skolverket). URL: www.skolverket.se
- The Swedish National Agency for Higher Education (Högskoleverket [HSV]). URL: www.hsv.se
- The Swedish National Audit Office (Riksrevisionsverket [RRV]13). URL: www.riksrevisionen.se
- The Swedish National Council for Cultural Affairs (Statens kulturråd). URL: www.kulturadet.se
- The Swedish Council for Planning and Coordination of Research (Forskningsrådsnämnden[FRN]). URL: www.vr.se14

12 The Swedish Ministry of Education has changed its name to Ministry of Education, Research and Culture (Utbildnings-och kulturredpartementet)
13 RRV have changed its name to Riksrevisionen.
14 FRN has now been integrated into the Swedish Research Council (Vetenskapsrådet).
An assessment of Swedish science centres (Riis, 1995), proclaimed that science centres play important roles in making the public appreciate science and technology. As noted above, the modern science centre movement began in North America during the 1960s, and thereafter spread worldwide. Even though these early science centres provided much inspiration and influenced the design of the European counterparts (see pictures 2 and 3), the idea was not merely imported, rather transformed (c.f. Latour, 1986) to better suit national differences and rationales. In Sweden, this transformation is influenced by the government’s interest in educating the public, which has resulted in annual grants to Swedish science centres. Another Swedish feature is the way certain science centres have based their stationary exhibits on themes from everyday life or local industries, instead of physics-based phenomena.

*Picture 2*  The wave machine at the Exploratorium
In Sweden, Riis (1995) described the first outcomes of this transformation by classifying Swedish science centres into five categories. (1) *Traditional science centres* have a number of larger exhibit areas relating to a school subject, preferably physics, technology, and chemistry. (2) *Traditional science centres in miniature* are much smaller than those in the former category, with only one person employed and facilities that are not usually theirs. (3) *Small, developing science centres similar to schools* usually have one very dedicated employee, with a lot of experience from school education. (4) *Houses of Attitudes* differ from the three former categories because they do not have many exhibits and artefacts and instead try to popularise physics by attempting to work more with themes. Finally, (5) *theme houses* try to organize their exhibits in themes, e.g. everyday life or industries within the province, where the different subject matters are integrated.

More recently established science centres in Sweden, like Universeum in Gothenburg, have started out on a large scale from the beginning with support from the city council, the Knowledge Foundation or both.
In March 2003, 22 science centres in Sweden were registered in the Nordic Science Centre Network, NSCF\textsuperscript{15}, with 1.7 million total visitors in 1999.

**Teknikens Hus: an introduction to the site of study**

The site where the empirical part of this research was carried out is the exhibit area at Teknikens Hus, one of Sweden’s oldest science centres, closely linking it to the introduction of the science centre idea in Sweden. The author knows of few written sources about how the idea of science centres was introduced and established in Sweden\textsuperscript{16}. The following section is mainly based on an interview\textsuperscript{17} with two persons within the leading circle of people who introduced and developed the idea of science centres in Sweden at the local and political levels:

- *AnnMarie Israelsson*, initiator and former Head of Teknikens Hus, who was awarded an honorary doctorate of technology at the Luleå University of Technology in 1991 for her work in launching Teknikens Hus.

The interviewees were given the following questions in advance: What happened before, during, and after the launch of Teknikens Hus (and at the same time the Swedish science centre movement)? What kinds of discussions were held by whom? From where did the ideas come from? Whose interests were behind the ideas and how did they develop?

The following text is supported with quotes from the interview. The initials written within brackets indicate whose statements are quoted, with (AMI) standing for AnnMarie Israelsson and (GJ) for Gunilla Jacobsson.

Teknikens Hus is one of the oldest science centres in Sweden, and the story of its emergence is closely intertwined with that of the Swedish science centre movement. Swedish science centres have received governmental funding through the Swedish Council for Planning and Coordination of

\textsuperscript{15} [www. nordicscience.org.]

\textsuperscript{16} Written resources on the subject can be found in Riis (1995). However, more recent and detailed information can be found in the national audit report of the subsidies given to Swedish science centres. The audit was made in 2001 by RRV.

\textsuperscript{17} The interview was conducted in Stockholm, June 17, 2004.
Research (FRN)\textsuperscript{18} since 1988. Before 1988, FRN supported study tours to North American science centres and projects with the aim to develop interactive science and technology exhibits in existing museums.

AMI worked at Luleå University of Technology as Head of the Information Office when she ‘stumbled upon’ the science centre idea somewhere around 1979. She became interested partly because of ‘the ongoing crisis in recruiting students’ and because of ‘the open atmosphere at the university, it was ok to come up with new ideas --- plus there was also financial support available for a few odd projects like this one’. She applied for money from FRN, and won a scholarship to do a study tour.

I applied for money from FRN and received money to do a study tour in the United States. At that time, some other people from different universities had also done the trip, three persons, all male and Heads of Information Offices. However, I didn’t think that so much useful came out of their trip, so I wanted to see for myself. I made a terribly ambitious program and went to the United States in 1980 --- 18 centres in 14 days. (AMI)

AMI was very impressed by the American science centres and was fond of the sort of activities the exhibits enabled. Although it was ‘very school-like, they tried hard to do natural sciences illustrations as it usually has been represented in schools. You simply blow up the physics experiments into a larger format, and think that it will be funnier that way’ (AMI). The tour resulted in a report, and a couple small exhibit projects displayed within the university. The idea of doing something special with these exhibits, like a science centre, came early and was supported by the university management, which helped AMI to find financial support.

The project ‘Teknikens Hus’, for which AMI was the project leader, was built on a pedagogical idea that the activity should be anchored to reality and not in concretized abstractions from physics. The task became to try to exist somewhere in between the ‘physics-trap’, i.e. experiments with the laws of nature, and some sort of amusement park, while being relevant for visitors.

In 1988, Teknikens Hus was opened, built on the university campus and organized as a foundation funded by Luleå University of Technology, local authorities and organisations, and three major local industries. AMI stayed

\textsuperscript{18} FRN was established 1977. One of the council tasks was/is to promote arrangements aimed/aims to spread research information to especially young people.
as the CEO until 1997. The first year attracted 175,000 visitors, which was the average number of visitors until 2004 when they started to charge an entrance fee, when the number of visitors then dropped to 121,900. From the beginning until 2005, Teknikens Hus had more than 2.4 million visitors.

The work of personal enthusiasm

Many Swedish science centres have started on a small scale, often on the initiative of real enthusiasts. AMI has provided an example of this. Committed administrators, like GJ, have also supported the development of Swedish science centres, whose purposes of this support may have shifted on a political level from being concerned with student recruitment and the development of in-school education to public understanding, depending on who has been the State secretary in the Ministry of Education. However, among the people working with these issues, there seems to be personal convictions or opinions pushing in specific directions.

AMI describes her interest as not only professional, but also personal, as an urge to change the natural sciences education in schools and a personal need to learn to understand more about science and technology in everyday life. The many student-recruitment campaigns in her professional life made her hesitant of the common approach of trying to change the students (especially girls) to better fit into the university, instead of trying to change the way the university dealt with the subject matters. Even though GJ was assigned to work with these issues, she would ‘never have carried on with the NOT project if I hadn’t had a very firm personal opinion about how to address the problem’. Her personal experiences of natural sciences in school were that it did not have so much to do with personal interest, but merely a question of background and family life, i.e. something only for the top-level students. For her, the important issue was to ‘play down the natural sciences in particular and make it available to a much broader group of people’; subsequently, ‘it wasn’t youth who had to change, it was the school system and how you make knowledge available that had to change’.

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19 GJ has for instance been one of the project leaders for a 10 year-project (1992-2003) called Science and Technology (Naturvetenskap och Teknik, NOT), run by the National Agency for Higher Education and the National Agency for Education. The aim was to increase public interest in natural sciences and technology.
Influences and development

In the mid-1990s, many science centres in Sweden developed financial problems. In 1996, AMI, who was at the time Head of Teknikens Hus, and Tomas Ginner, Head of the Centre for School Technology Education (CETIS), called upon the Ministry of Education with an idea regarding long term financial support for science centres. A commission of inquiry was later formed (including both AMI and GJ) at The National Agency for Higher Education, whose task was to identify the financial needs and on what grounds a future grant would be distributed. This resulted in a bill (1997:153) concerning governmental grants to science centres, and the commission of inquiry transformed into a working committee (involving the same people) to prepare decisions regarding the distribution of governmental subsidies to science centres. This distribution was to be administered jointly by the The Swedish National Agency for Higher Education, The National Agency of Education and The Swedish National Council for Cultural Affairs. In 1997, the total amount of the grants was 12 million SKR, increasing to 23.5 million SKR by 2004.

To be eligible for these governmental grants the science centres have to fulfil certain conditions. The basic conditions are: (1) the purpose of the centre is to increase the knowledge and interest in science, technology or both through different kinds of interactive methods, (2) it is available to the public, (3) it is locally connected, and (4) it shows economic stability. The size of the grant is based on how well the centre meets the following quality criteria: the centre has (1) an organized co-operation with university, schools or other cultural institutions, (2) activities that place at the forefront connections between human beings, society, technology and nature, and highlight current issues in society from historical and cultural perspectives, (3) activities that provide a gender perspective on science and technology, and (4) the activities are shaped in many different ways and forms of expressions, thereby paying attention to esthetical dimensions (RVV, 2001).

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20 SKR is the Swedish currency, ‘krona’.
The working committee was assembled with people who knew how the science centre movement in Sweden worked and who shared similar values in these issues. Even though the committee does not have the formal right to decide the distribution of grants, their influence on the development of science centres in Sweden should not be underestimated. After all, they have formulated the criteria that, if fulfilled, produce financial support to the science centres.

Surely, it [the Swedish science centre movement] has changed and developed new branches. Still, the exhibits are the basic activities, but supplementary activities have grown with new forms of expressions, such as dramatizing. I also think that many sites have tried to stimulate a kind of debating societal activity, to bring in a holistic perspective and understanding of science and technology in other contexts than in the exhibits. (Gj)

Since the quality is reviewed every year before the grants are distributed, and the money is distributed in relation to how well the quality is developed --- it has pushed a development in certain areas listed in The Swedish national Agency for Higher Education statistics of how to distribute the funding. (AMI)

This is a unique way of distributing governmental grants in an international context. However, further issues also influence the development of science centres, since Swedish science centres have a Nordic, a European and a worldwide organisation to share ideas with, as well as a need to be sensitive towards visitors and local partners (e.g. industries, schools and so on).

Clearly, today’s science centres are both politically and publicly well established in Sweden, and regarded as sources for increasing the public interest and appreciation of science and technology, in many ways thanks to a rather small circle of enthusiasts (including AMI and Gj). A governmental rationale behind the decision to support science centres on a regular basis seems to be twofold – (1) to recruit more students to these subjects at the university level and (2) increase the public understanding of science (legislation 1997:53). This mission seems to be highly significant today, since Sweden has many empty classes at the university level, though this may be due to the enormous extension of the university system during the last decade. The empty classes may not be because of ‘a decreasing interest by teenagers, but an increasing numbers of things to choose between’ (Gj).
THE EXHIBITS IN TEKNIKENS HUS

Stationary exhibits seem to be an important aspect of the science centre identity. In a survey (Nöu\textsuperscript{21}, 2001) of all Luleå teenagers who were to start upper secondary school (in their 16\textsuperscript{th} year), the majority of the participants associate Teknikens Hus with the stationary exhibits, though they are not mentioned in any connection to natural sciences or technology. Also, they spend most of their time at these exhibits during a visit. Therefore, the exhibit area was chosen as the investigation site in the present study.

Teknikens Hus is, as with all science centres, a place with activities and exhibits whose purpose is to popularize science and technology and to educate in a self-directed manner through interactive objects and demonstrations. But Teknikens Hus focuses on exhibitions based upon the technology common in the northern parts of Sweden and everyday technology. The exhibit area is 2,300 m\textsuperscript{2}.

Exhibits include steelmaking, mining, papermaking, aerodynamics, household technology, space and more. These exhibits provide examples of a holistic concept, where the application of science and technology in the surrounding society are shown. Although many other science centres organize their displays thematically by different science phenomena (light, sound, etc), Teknikens Hus has chosen to focus on technology in its appliance (see www.teknikens-hus.se).

Together with the background information about science centres, in general, and Teknikens Hus, in particular, a closer look at this site’s exhibits may contribute to a fruitful point of departure when examining the practice of teenagers as visualized and analyzed in this study. Following description of the exhibits originate from a tour around Teknikens Hus with the Director of Exhibition Development at Teknikens Hus Mr. Olle Nordberg (ON), on April 24\textsuperscript{th}, 2005.

\textsuperscript{21} The author changed her last name from Nöu to Fors in 2001.
Olle Nordberg has worked for Teknikens Hus since the very beginning in 1988, and may be regarded as one of the leading persons concerning the development of the stationary exhibits, and an exponent of exhibit-building practice at Teknikens Hus.

The interview begins with the historical background and the ideas behind the stationary exhibits, especially those appearing in the research material. After the interview, ON answered a follow-up question regarding how Teknikens Hus exhibits could be categorized, since it became apparent during the first interview that they differ somewhat from traditional science centre exhibits. The categories stated by ON on this occasion provided an overview and insight into how the meaning of the exhibits is constructed in the exhibit-building practice at Teknikens Hus.

Some expressed differences with a traditional science centre became clear during the tour. Whereas a traditional science centre usually begins in the physical or technical phenomena themselves, Teknikens Hus begins in the application of the phenomena. Hence, calling it a technology centre rather than a science centre may be more appropriate, without necessarily defining technology as applied science. Table 1 provides a description of the different categories of exhibits defined by ON. The categories named will also be significant in the coming chapters, where their different qualities will be discussed from an analytical point of view.

Table 1  The different categories of exhibits at Teknikens Hus, formulated by ON.

<table>
<thead>
<tr>
<th>Example exhibits</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mine Drill and Lumber Forwarder</td>
<td>1. ‘Reality’ in full scale (as much as possible)</td>
</tr>
<tr>
<td>Paper Mill</td>
<td>2. Small scale models (doing the ‘real thing’)</td>
</tr>
<tr>
<td>Train</td>
<td>3. Illustrations of the ‘real thing’</td>
</tr>
<tr>
<td>Key and Shadowgraf</td>
<td>4. Traditional/standard exhibits that you can find in other science centres</td>
</tr>
<tr>
<td>Maze and Boats</td>
<td>5. Unique playful exhibits</td>
</tr>
</tbody>
</table>
The categories are more thoroughly understood through the descriptions below of the example exhibits belonging to each category. Background and function information may also provide insight into a) built-in assumptions about the societal role and educational goals of Teknikens Hus together with ideas about communication and learning, and b) how the practice of exhibit building is carried out.

The example exhibits in the table above will be represented here in three ways. Firstly, a written description of the exhibits will clarify their background and intended function, as mainly interpreted from the interview with ON. All quotes originate from this interview. Secondly, the exhibits will be represented in pictures used by Teknikens Hus22 (pp. 28-31), which can also be viewed as reifications that mediate the social practice of Teknikens Hus, since they are used in public presentations of their work. Thirdly, how the teenagers in the present study represented these exhibits can be viewed on the website: http://www.vaike.se The example exhibits chosen will return in later chapters and Appendix A, consisting of a complete list of occurring exhibits in the present thesis used as examples of different aspects of the results of the study.

**Reality in full scale (as much as possible)**

A large mining company that produces, among other things tools used in the mining industry, funded the construction of the whole mining area and specially made the Mine Drill at Teknikens Hus, built in the spring of 1988. The Mine Drill (picture 4, pp. 28) was replaced in the mid-90s, and is not an exact full-scale representation because of the large size of the actual drill. However, it is in principle authentic, with minor adjustments regarding the length, the given possibilities to manoeuvre it (you cannot actually drill, though it sounds like it), and the design of the control room.

The Lumber Forwarder (picture 5, pp. 28) is a part of a larger area with exhibits built in 1991 and sponsored by the forest industry. The idea behind the exhibit area was conceived in a co-operation with an agency representing all sorts of forest industry branches. Teknikens Hus built the area because they wanted to show the public the technology involved in this highly relevant industry of the region, and the forest industry was eager

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22 The pictures is retrieved from Teknikens Hus website and archive, which are printed here with the permission of Teknikens Hus and the photographer Erik Holmstedt.
to show the public an agreeable business that ‘didn’t pour lye into our lakes and not only produced clear-cut areas, but also used wise politics in their decision-making’. The exhibit area is unique in that it is produced together with representatives from a whole industry, from small-scale forest owners to larger companies. The idea with the exhibits in this category is to provide visitors the opportunity to experience authentic machines, manoeuvre large and heavy constructions, and realize how they work, though not necessarily in combination with information about the technique behind it. This information may be displayed at other exhibits close to the machine.

Here, you can enter one of these massive machines and realize that you can actually sit there and master the entire thing. I mean, here, you get to be king over many tons of machinery in some ways. You can suddenly lift logs, which if you are a child would not be able to do otherwise... Well, I reckon it is about socializing with technology in a way, you can get closer to 'science literacy', or 'technical literacy'. (ON)

Small scale models (doing the real ‘thing’)

The Paper Mill (picture 6, pp. 29) was produced in the same context as the Lumber Forwarder. The difference is that this model was built on behalf of Teknikens Hus by a company specialized in manufacturing laboratory machines. What distinguishes this exhibit from most other exhibits at Teknikens Hus is the fact that you actually get something; you can produce a piece of paper from paper pulp that you can take with you, making it very popular. For instance, small girls ‘make paper after paper after paper, build a small cardboard box over here [pointing to another exhibit], fold their papers and put them in the box... When they have done ten small boxes filled with self-made paper, they go to our shop and ask for a bag, in which they bring everything home’. (ON)

Illustrations of the real ‘thing’

From the beginning, the Train (picture 7, pp. 29) was a model railway on a circular track put in motion by pressing a button. During the last renovation and rebuilding of the exhibits, a much larger model railway was installed with the support of a large mining company and Banverket23. The technicians at Teknikens Hus built a train engine cabin from where you

23 Banverket is the authority responsible for rail traffic in Sweden
could manipulate the train. This new model railway physically connects the mining exhibits with the furnace exhibit, symbolizing the situation’s authenticity.

**Traditional/standard exhibits**

The *Key* (picture 8, pp. 30) was produced at Teknikens Hus during the first years. Inspired by another science centre during a study tour to the USA, the key is an enlarged illustration of what happens when you stick a key into a bolt, which is made of Plexiglas to allow the workings of the bolt to be visible.

The ‘recipe’ to the *Shadowgraf* (picture 9, pp. 30) is found in the Exploratorium’s ‘cookbook’. It is a standard exhibit that can be ordered from specialized manufacturers, and was one of three existing exhibits from even before the building of Teknikens Hus. It is an illustration of the physical phenomenon that hot water rises.

**Unique playful exhibits**

The *Boats* (picture 10, pp. 31) in the harbour were constructed as a natural end-point for the system of water running through Teknikens Hus, made as an illustration how water travels from the mountain to the sea. Boats, and the archipelago, are very significant in the culture of the coastal areas in northern Sweden. In the beginning, a notion of navigation was implemented in the exhibit design, but since the visitors ignored this, these special features were taken away. There is still an idea to try and prolong the stopping and manoeuvring distance by making the boats heavier and operate them with half of the required current, to give a feeling of operating an oil tanker.

The *Maze* (picture 11, pp. 31) is a labyrinth game placed close to the Lumber Forwarder to give another, more explicit, example of how things can be operated pneumatically. This is why the controls are installed in a box made of Plexiglas.

The following pictures are of people acting with the exhibits described above. The texts under the pictures are the same texts (in part) as on the labels displayed in the exhibits (if there are any).
Picture 4  Start the drill. Aim at the markings on the wall. Steer with the bars.

Picture 5  A forwarder collects trees felled in the forest. Enter the cabin to load and unload some logs!
Picture 6  In a real paper mill, the wet end, the press section and the dry end are all one part. The paper goes unbroken through the whole machine. Our machine is split into three to help you follow the process.

Picture 7  Train approaching! An iron ore train at full speed needs two and a half kilometres to come to stop!
Press the button! Wait a moment and watch what happens! The heated water rises – warm water is lighter than cold.
The boats.

Photo: Erik Holmstedt

The maze.

Photo: Erik Holmstedt
There is a somewhat striking difference between the typical Teknikens Hus exhibits and traditional science centre exhibits. The authenticity in the objects displayed at Teknikens Hus places them in a somewhat different position in relation to the visitors’ prior experiences. For instance, a lumber forwarder with an authentic control panel and functions is something a visitor may very well have seen or even used in contexts other than the science centre, while the shadowgraf is not. The invested meaning of the lumber forwarder will hereby be even more unpredictable, which lies at the very core of authentic objects displayed in museums (MacDonald, 1998). This makes Teknikens Hus slightly harder to categorize, since it has positioned itself somewhere in between a traditional science centre, an industrial heritage site and a children’s museum. However, looking at the intended purpose of the activities, as defined by the staff, there is no question that Teknikens Hus belongs to the branch of science museums called science centres.

ASSUMPTIONS ABOUT COMMUNICATION AND LEARNING

The major goal of the science centre movement is apparently to inform the public, not only young people, even though the question of how this will be achieved has been contested. It is no longer obvious that ‘informing’ means the public should be offered exhibits simply presenting scientific facts. Bradburne (1998) argues that the public should instead learn to use science, whereas Rennie (2001) suggests that science centres should teach science to develop an appreciation and awareness for the scientific enterprise. Still, they agree on the educational purpose of science centres.

The science centre movement has been criticized for having pedagogical goals without being able to describe any theoretical underpinnings for these goals (for example, Anderson, Lucas & Ginns, 2003; Salmi, 1993; Dierking & Falk, 1992). However, Hein (1998) argues in favour of ‘The Constructivist Museum’, based primarily on Jean Piaget’s perspective on learning.

Constructivism provides the most comprehensive and elegant theory to consider how visitors can both use their previous beliefs and knowledge to construct new meanings and how they can actively carry out this process.

(Hein, 1998, pp. 154)
‘The Constructivist Museum’ is based on three basic ideas as concluded by Hein (1998) in three questions to be addressed by each museum when implementing a constructivist agenda:

- What is done to acknowledge that knowledge is constructed in the mind of the learner?
- How is learning itself made active? What is done to engage the visitor?
- How is the situation designed to make it accessible – physically, socially, and intellectually – to the visitor?

The constructivist idea of learning belongs to a philosophical perspective called rationalism in which learning is considered to take place within the individual’s mind. These ideas were also the dominating learning theories in the US during the launch of The Exploratorium (Fors, 2001). Learning and development become the same as to mature and develop internal innate abilities and skills. A fundamental position is the idea of an individual learning about an external world by making internal representations of it in their mind. These representations, sometimes called frameworks, are our memories, and are sometimes described as a depiction or a copy of the external representation (Säljö, 2005).

Subsequently, it is through these frameworks that the individual deals with and interprets the external world. Given the opportunity to interact with the external world, the individual may extend or re-model the already existing internal representations and thereby construct a new understanding of the represented issue. Greeno, Collins, & Resnick (1996) describe this point of departure as a cognitive perspective on learning.

Research on learning from a cognitive perspective focuses on what impact learning in one situation has on other situations, so called transfer (Greeno et. al., 1996). Accordingly, if something is learned in situation A, it may be also useful in situation B, depending on the qualities of the external representation in situation A. In other words, from this perspective, if situation A is construed to resemble situation B, transfer is more likely to occur24.

The constructivist idea of learning emphasizes that the individual has to be active in the process of explaining and solving problems. Accordingly, it becomes crucial to design ‘the constructivist museum’ to be easier for the

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24 See Linderoth, 2004, for a critical examination what impact the cognitive perspective on learning has had on research on interaction with computer games.
visitor to make connections with familiar references, objects, ideas, and activities, all to enable the visitor to engage with the represented issue, because:

--- unless the new can be incorporated, either because the visitor already knows enough about the subject to simply include the new into existing frameworks or because the visitor has sufficient other frameworks so that the new can be accommodated by adjusting what is in the mind, the new will be rejected or not observed.

(Hein, 1998, pp. 153)

These theoretical underpinnings are well in line with two assumptions about typical science centre exhibit characterizations, *interactivity* and *authenticity*, which seem to underpin the science centre agenda and mediate assumptions about communication and learning (Barry, 1998).

**Interactivity and authenticity**

Interactivity is historically described as part of the core of the science centre enterprise. The importance of interactivity is also stressed in the development of Swedish science centres, since it is one of the basic conditions to be eligible for governmental grants. From a cognitive perspective, it gives the individual user the ability to operate or manipulate an object (external representation) and therefore the opportunity to actively construct mental representations of the object or develop already existing mental frameworks.

As an example from the exhibits at Teknikens Hus, interacting with the key (picture 8, pp. 30) may, from this perspective, develop and expand an already existing mental representation of the situation when you lock a door with a key. Obviously, the Key exhibit is designed in line with cognitive assumptions that choosing a familiar situation and making it possible to realistically interact with make it easier for the visitor to connect this external representation with an already existing mental representation in their mind. Since the Key exhibit is designed to provide more information about how a lock works, it is intended that the visitor will develop their mental representation of the issue (learn). Logically, according to this theory, the visitor will then be able to use this new and developed mental representation in other situations involving keys and locks (transfer).

The importance of creating opportunities for visitors to somehow connect mentally with the exhibits has advanced a development of exhibits (and
science centres) in Sweden that includes making them as ‘realistic’ as possible. It began with AnnMarie Israelsson’s decision to anchor the activities at Teknikens Hus to common and everyday technology, instead of traditionally building exhibits that concretized abstractions from physics. Subsequently, this decision seems to have contributed to the way the Swedish science centres were categorized by Riis (1995), i.e. either based on school subjects, or themes from everyday life or industries in the province. This is also how the Head of Exhibit Development at Teknikens Hus chose to categorise the exhibits at Teknikens Hus, i.e. how well they resemble the ‘real’ thing.

This analytical perspective of the history, culture and ideology of the science centre agenda from a pedagogical point of view indicates built-in assumptions about learning and communication in the exhibits that goes in line with constructivist ideas from a cognitive perspective.

Another example is making paper in the Paper Mill (picture 6, pp. 29) at Teknikens Hus, which is assumed to give the visitor the opportunity to construe a better understanding of the paper making procedure in a real paper mill and the technology involved. This is because it is (1) designed to resemble the real paper production procedure (only modified to increase the interactive component), (2) the paper mill is an industry found in the region and is thus familiar to many of the local visitors, and (3) how it is placed connects it to surrounding exhibits through their ‘external’ representations (the industries these exhibits represent are connected to the paper mill industry in this region).

**A constructivist-inspired research agenda**

With the cognitive perspective, the rather traditional science centre exhibit design may also be regarded as having behaviouristic overtones, providing visitors a certain *stimulus* (e.g. a button to press) to achieve the ‘right’ *response*, i.e. learn what the museum intended them to learn. These influences may have their origin in the philosophical context in which The Exploratorium was built, in the transition period between the behaviouristic culture and the American cognitive revolution of the 1950s (Fors, 2001).

Even though recent researchers maintain this line of thinking and discuss constructs like an exhibit’s ‘attracting power’ or ‘holding power’ (cf. Sandifer, 2003), there has been a recent change of focus in research. At the
beginning of the 90s, Falk & Dierking (1992) described how *many* (not only the ‘stimulus’ provided by the exhibit) interacting variables comprised the museum experience and resulted in learning. From their point of view three contexts, namely the personal, social, and physical, interact to produce the nature and outcomes of the visitor’s museum experience. This was a reaction ‘to the prevailing behaviourist models of museum learning’ (Falk, 2004, pp. S84) and resulted in the ‘constructivist-inspired Contextual Model of Learning’ (Ibid., pp. S86)\(^\text{25}\). Dierking & Falk (2001) describe this change:

\[
\text{Gone is the old idea of learning as an isolated experience, a predetermined response to a specific stimulus. Instead, a picture of learning is emerging as a series of related and overlapping processes, an evolutionary adaption that permits a continuing dialogue between individuals and the physical/sociocultural world they inhabit. To understand the process, new studies suggest, we must consider not only what is being learned at any given moment, but also how that learning experience fits into the overall scheme of what the individuals already knows, believes, feels or is capable of doing. (pp. 4)}
\]

Many researchers now use theories of learning based on constructivist ideas in the museum context (e.g. Anderson, Lucas & Ginns, 2003). Research from this perspective often takes an interest in the influences of prior knowledge and experience (Roschelle, 1995) and the role of prior interest (Falk & Adelman, 2003) on an individual basis.

**THE SCIENCE CENTRE AGENDA REVISITED**

To better understand learning in science centres from an analytical perspective, it may be fruitful to revisit the existing assumptions about a) the science centre goal and b) the ideas about learning and communication embedded in the science centre practice, as noted above.

**The science centre goal – contested ground**

Firstly, one political goal for maintaining science centres seems to be the concern of governments and scientific lobbies about public **illiteracy** in science and technology (Lindqvist, 2000). In Sweden, this concern regarding the public (mis)understanding of science has led to governmental measures to try and increase the understanding of science, especially that of

\[\text{25 The Contextual Model of Learning is presented in Falk & Dierking (2000).}\]
An analytical perspective of the exhibit building practice at Teknikens Hus indicates a historically and locally located cultural logic and a political rationale behind the chosen exhibit content. Building exhibits based upon technology common in northern Sweden, and sponsored by the local industries, provide an ideologically grounded representation of what this region consists of, how it can be developed and what about it is important to know. Basically, there seems to be an interest in getting visitors to acknowledge industrial production as one key feature of the region, and subsequently recruit young people to work in these industries and enter this particular belief system. This belief system also seems to influence the exhibits that focus on everyday life where the technology is presented as a neutral agent in the pursuit of improved lifestyles for the human race in general.

Secondly, this concern about the public (mis)understanding of science is also directed towards youth and their choice of career. The concern for the presumed lack of interest by youths for science and technology is highly relevant in Sweden today. The Swedish National Agency for Education declared in a 2003 national survey report about attitudes in schools that: ‘natural sciences are not acknowledged as either fun or important in the eyes of the pupils’, and ‘one of the reasons to the fact that fewer and fewer pupils choose to study natural scientific subjects on a university level may be that pupils find these subjects boring’ (2004:243).

This may, however, be a qualified truth. A debate article in a Swedish newspaper revealed that one chapter in the report, written by Professor Ingrid Carlgren, was rejected before publication. This chapter took an opposite standpoint in the discussions about the attitudes of youths towards natural science subjects in school based on the fact that 59% of the 13-15 year olds in the survey thought these subjects were fun. Natural sciences ranked in third place after Physical Education and English. At the same time, enrollment to natural scientific and technological university degrees in Sweden has increased from 36,000 students (1990) to 89,000 (2000). The debaters proclaimed that ‘The Swedish National Agency for Education propagate myths’ (Carlgren & Hultén, May 27, 2004).
One of the debaters points was that a decreasing interest in science and technology is a tendency in society, rather than a tendency regarding the education in these subjects in schools. This also concurs with the conclusions of the Science and Scientists (SAS) study, which indicates a problem in science and technology with its public image in many developed countries. The problem is not a low public understanding of science caused by bad teaching and a low or negative profile in the media. Instead,

It may be seen as an indication that many young people have a rather well informed skeptical attitude towards certain aspects of modern society. Maybe their doubts are based on real fears about an unknown feature that scientists may lead them into?

(Sjöberg, 2003, pp 28)

Sjödin (2001) makes similar conclusions in his report about how Swedish research on youth culture informs and addresses the issues dealt with in the NOT-project. What is youth like? What is needed to get them interested in natural sciences and technology? One of his conclusions regards learning in informal settings. Today’s youth retrieve knowledge about the world from many different sources, and the old authorities (the school or the parent) are no longer the only possible information channels. A large part of learning about the world takes place via media and the Internet, occasionally resulting in distrust towards all authorities – the physician, the scientist and the teacher.

Teachers (or other more informal information channels) who carry traditional views of how natural science should bring forward ‘the truth’ through scientific inquiry, encounter youth in the classroom (or the museum) who are more or less convinced that there are different truths, that truth is relative. This may result in conflicts or resignation, more likely the latter since youths are dependent on good grades; hence, one of the possible reasons not enough teenagers choose to study natural sciences or technology.

Looking at science centres from these somewhat more varied perspectives than that served by the notion of ‘the public (mis)understanding of science’ renews a discussion about the role science centres may play in society. One example is the increasingly vibrant movement in museums to bring young people into museums and science centres and thus new displays.
Youth development and museum development

Youths are recognized as vital sources of museum visitors, whose numbers constitute the visitor counts needed for the core and programme funding proposals to government, to trusts, to corporations and to the public at large. A practical concern is how to best do this for the young person, the museums and the larger community. Baizerman & Hildreth (2000) suggest that the answer lies in how young people are theorized and understood. By thinking of teenagers as well informed about science and technology (instead of the opposite), interested and accustomed to handling informal sources of information, the museum could be spaces for youth development.

Youth development is here seen as a process ‘in which young people are invited into safe spaces where, with appropriate adult consultation, they can craft themselves – i.e. explore different ways of being-in-the-world, while also finding ways to meaningfully engage larger societal concerns’ (VeLure Roholt, Baizerman & Steiner, 2002, pp. 48). Delgado (2002) contextualizes museums as a ‘new frontier’ site for youth development, especially museums that subscribe to ‘active learning’ models with activities emphasizing physical interaction. However, to accomplish this and fully realize the potential of this setting for the field of youth development, the museum goal has to be re-examined. Museums have to be seen ‘as being in a “social”, service-oriented category, rather than one that is “enlightening”. Young people themselves must be prepared to think of museums as places they can visit, learn in, have fun, and work’ (Ibid. pp. 181-182).

The Minnesota Youth Science Centre

VeLure Roholt et. al. (2002) describe The Youth Science Centre in The Science Museum of Minnesota as a site for youth development. The project originated from concerns about why young people had stopped visiting the centre when they entered junior high school, only to return when they had children of their own. This local observation correlated with national trends, and the question of what would attract more 13 – 17 –year olds to the museum arose.

In this science centre, today’s teenagers participate in the ongoing work of the museum with a dual purpose – to get museum work done and provide possibilities for young people to build skills while learning about a subject.
Through the co-creation of projects and activities, young people feel connected and stay connected to the museum, which has their support and that of their parents in its larger efforts to serve the entire region’s children, young people, and families. The notion of participation is conceptualized through Hart’s (1997) ‘ladder of participation’, where enhanced involvement is characterized to be authentic, viable and meaningful to young people on their own terms (contrary to participation conceived as manipulation, decoration or tokenism). In the youth initiatives of the Science Museum of Minnesota, youth development and museum development are reciprocal; ‘when the museum invites young people into the work of the museum, it benefits young people, museums, and the whole community’ (VeLure Roholt et al, 2002, pp. 55).

VeLure Roholt & Steiner (2005) describe how this project began as a part of a national initiative launched by the Association of Science-Technology Centres (ASTC), called ‘YouthALIVE!’26. They conclude their evaluation of the project that ‘engaging young people in the work of the museum creates an internal culture that values young people as more than visitors and builds an experience of the institution as a place of relationship and knowledge’ (pp. 155).

This example of a science centre that has re-examined their goals and the outcome of this process may also suggest a need to re-examine the assumptions about learning and communication, from where the activities are based upon. From Hein’s (1998) constructivist perspective, the approach towards young people described above may be seen as a way to provide additional means for youth to ‘associate with the museum by allowing them to see the human quality of the museum itself’ (pp. 178). In other words, improve the museum’s impact on young visitors.

From a cognitive perspective, learning occurs when the individual develops already existing or constructs new mental structures in their mind. Participating in the construction of an exhibit could be seen as a way to make viable connections to the visitor’s mental schemes and the exhibit itself may have a greater impact on the visitor. There may, however, be another possible way of interpreting the situation, based on alternative assumptions about communication and learning.

26 YouthALIVE stand for: Youth Achievement through Learning, Involvement, Volunteering, and Employment.
The youth program developed at the Youth Science Centre in Minnesota may surely be seen as a project that facilitates this kind of process. But the emphasis on youth participation in museum practice and how the museum will benefit from this work indicates somewhat different assumptions about what the desirable learning qualities are than the cognitive perspective focuses on. From an analytical perspective there seems to be a shift from emphasizing individual learning experiences towards more collective benefits, and the metaphor ‘exhibits impact on visitors’ has to be changed to ‘visitors’ impact on exhibits’. Situations when the meaning of (in this case) the exhibit is negotiated in a social situation assumingly supports learning from this alternative perspective. From a cognitive perspective an important feature of an exhibit’s meaning seems instead to be how well the visitor may be supported to re-construct the same representation of reality into their mental structures (so it can be used in another similar situation).

‘The myth of the individual user’

More recent research on interactivity in science centre exhibits also provides another perspective on the subject that is not included within the cognitive tradition. For instance, Heath & vom Lehm (2003) argue that the term interactive is misleading, since it encompasses an extraordinary range of tools, technologies and artefacts designed to create interactivity in museums and galleries. However, these different ‘interactives’ engender very different forms of interaction and provide highly variable opportunities for co-participation and collaboration. Interaction, historically derived from the cybernetic notion of interaction between human beings and machines, does not include human social interaction. Even though human social interaction, i.e. interaction between visitors, is increasingly recognized as critical to how the museum is experienced (e.g. Paris, 2002), this is not always what the exhibits are designed for.

However, ‘interactives’ are rarely designed to support or enhance social interaction; rather in most cases they are principally concerned to provide individual users with the ability to operate or manipulate a system or object--- The ‘myth of the individual user’, as Jo Graham suggests, continues to pervade the design and development of ‘interactives' in museums and galleries – a general reflection perhaps not only of the provenance of the term, but more worryingly, of the prevailing curatorial and educational concept of the visitor.

(Heath & vom Lehm, 2003, pp. 11)
‘The myth of the individual user’ may be seen as an exponent of the underlying assumptions of the visitor, as constructing mental representations of the exhibits’ meaning when manipulating them based on a cognitive perspective on learning. This has recently been critically reviewed. Adams, Luke & Moussouri (2004) suggest cautiousness and awareness when developing new interactive devices in museums and urge museum curators to look beyond how interactive exhibits have traditionally been designed, and instead focus on the purpose of the exhibits. Falk, Scott, Dierking, Rennie & Jones (2004) have also addressed the question of the differential impacts interactive exhibits may not only have on the learning experiences of visitors, but also in different contexts.

Finally, there are two other overarching features science centre exhibits have in common that are neglected from a constructivist viewpoint. The exhibits are situated in the science centre context (Walton, 2000) and are artificial in that they have not been constructed to change the world in some way (i.e. the normal characteristics of other technical artefacts), but rather change the visitors’ view of the world. Clearly, this is why they only exist in the science centre culture and context.

These concerns of the concept of the visitor as someone who manipulates the exhibits and discovers individually in order to duplicate external representations into their personal mental structures and schemes may also bee seen as an argument to not perceive learning as merely a single-handed and private endeavour.

AN ALTERNATIVE PERSPECTIVE

Recently these concerns have entailed the development of alternative research perspectives about learning in the museum context (see an overview how the research area has evolved in Hooper-Greenhill & Moussouri, 2002). One example is the sociologically directed studies that depart from a critical theory, and are proven by the interest for the contemporary consumption society, literacy and questions of power (Fyfe & Ross, 1996; Macdonald, 2002b). Another example is a perspective that

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27 The ‘artifice’ (Walton 2000) of the exhibits lies in how they are organized in such a way as to promote a feeling of individual discovery in the mind of the learner – the so called Aha! experience.
takes its point of departure in assuming learning to be socially and culturally situated, a *sociocultural perspective*.

This perspective emphasizes the idea where meaning emerges in the interplay between individuals acting in social contexts and the mediators – tools, talk, activity structures, signs, and symbol systems – existing in that context. In 1997, Shauble, Leinhardt, and Martin published a framework for organizing a research agenda on the processes of learning in museums, as guided by the sociocultural theory. The framework was developed to organize the common work of Museum Learning Collaborative members (MLC). Six years later, Leinhardt, Knutson and Crowley (2003) conclude the work of the MLC to provide a feasibility proof for using sociocultural theory for understanding learning in museums, with a special emphasis on learning regarded as participation in conversation.

Sociocultural theory focuses on processes of learning, not simply its outcomes — [and it] foregrounds how people’s thinking changes as they make meaning of their experiences. Museums are places of signs, symbols, culturally significant artefacts, tools, and activities; it is difficult to think of institutions that more self-consciously foreground and value a meaning-based conceptualization of learning.

(From the MLC website²⁸)

The sociocultural viewpoint of learning has since influenced parts of the international research agenda, e.g. in research on family learning in museums (Ellenbogen, Luke & Dierking, 2004). It was also recognized in a policy statement by an Informal Science Education Ad Hoc committee (established by the Board of the National Association of Research in Science Teaching, NARST), whose task was to define this area of research. One aspect of learning requiring consideration in research on learning in informal settings was identified as:

…learning is strongly socioculturally mediated, so research design need to offer opportunities to explore social and cultural mediating factors including the role conversations, social learning networks, cultural dimensions and the use of groups, as well as individuals, as the unit of analysis.

(Dierking, Falk, Rennie, Anderson & Ellenbogen, 2003, pp 110)

A new paradigm taking form

Even though the constructivist and the sociocultural perspectives have been identified as striving towards the same goal, i.e. a more ‘holistic view’ of the learning situation in museums that recognizes ‘the importance of the myriad details and complex interactions of individuals, settings, and situations’ (Falk, 2004), some fundamental differences exist between the two approaches.

Firstly, one important difference is what to study if you are interested in learning. The cognitive assumption of the existence of some sort of mental representations in a person’s mind, regarded as the ‘content’ of thinking, is hard to accept from a sociocultural perspective (Säljö, 2005). Thinking from this perspective is instead assumed to be a part of human action and activities, not a separate phenomenon to be studied in itself. Therefore, the focus lies on the visible and audible part of the relationship between people and artefacts, i.e. communication. Communication (talking, writing, gestures, body language, etc.) is a constitutive element in the coordination of human perspectives, and unlike individual consciousness, it is accessible for study. To accomplish this, one has to go beyond the isolated individual. This means to not go behind by making inferences to what is going in the ‘mind’ of the individual, because ‘people’s activities are the way their minds work and are not merely imperfect reflections of the postulated secret processes which were supposed to be the workings of minds’ (Ryle, 1949/2000, p 56).

Secondly, both perspectives entail different views on the meaning of artefacts, e.g. science centre exhibits. A cognitive perspective might assume the exhibits to have a certain meaning to be presented in a way that facilitates the visitors’ possibilities to connect to and construct a mental representation of it. The information is there to be retrieved, in a way already defined and thought out, and the task is to effectively transmit this into the mental structures of the mind.

From a sociocultural point of view, the exhibits cannot contain existing information to be retrieved. Instead, the visitor reads a meaning into the exhibit. They become tools for the visitors to use and create a meaningful

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29 Dewey & Bentely (1949/1991) even consider ‘mind’ as redundant, since ‘the living, behaving, knowing organism is present. To add a “mind” to him is to try to double him up. It is double-talk; and double-talk doubles no facts’ (pp. 124).
situation; the visitors re-construct the meaning of their activities using the exhibit, i.e. the exhibits gain sense in social activities. This is one crucial aspect of how socioculturally grounded theory challenges the constructivist perspective on learning. Hence, it is not the notion of interactivity or authenticity regarding the exhibits design, but rather the forms of enabled activities that influence the learning situation the most.

The present study begins in a sociocultural perspective on learning, basically because it may be fruitful to contrast the science centre practice (especially the exhibit building practice) by conducting an inquiry based on assumptions about communication and learning other than the built-in ones. Another reason is because research in this tradition has proven to be helpful in advancing the research agenda in the area. However, this research is also influenced by sociologically oriented research, since it has an interest in exploring the societal belief systems and political ambitions associated with science centres. The County Administrative Board of Norrbotten (northern Sweden) has launched a growth program for 2004-2007, presenting the basic industries as very important for increasing growth in the region. In a speech held by the County Governor in October 2004, new ventures into the basic industries of mining and steel production in Norrbotten were described as something that will ‘create a very positive development in the whole region as well as possibilities for development at universities and different research centres. Furthermore, it will form the foundation for new and exciting lines of business in the future’.

Teknikens Hus may be seen as a contributor and participant in the political discussion regarding the importance of industrial development in the region, especially with its focus on increasing public knowledge about the significance of certain industries. Apparently, Teknikens Hus reflects these political ambitions with an interest in getting visitors to acknowledge industrial production as one key feature of the region, and subsequently to recruit young people to work in these industries. This example not only gives an understanding of the role of science centres in society, but also the implications on discussions about what role science centres may have in the future.

30 In Sweden, each county has an Administrative Board, a governmental body working in direct and continuous contact with the people it serves. The County Administrative Board is a link between people and municipalities on the one hand, and the government and central authorities on the other. The work of the County Administrative Board is lead by the County Governor.

31 Which are represented through the exhibits at Teknikens Hus
Part two

The researcher’s agenda
This second part of the present thesis is dedicated to the theoretical perspectives and assumptions that have guided the researcher/author, beginning with a theoretical perspective as a guide of what to pay attention to.

**HOW TO MOVE THE RESEARCH AGENDA FORWARD**

As noted at the end of part one, the chosen perspective for this research is inspired by a sociocultural tradition due to an attempt to challenge the cognitive perspective that seems to dominate the assumptions of communication and learning which the science centre agenda is partly based on. However, this contribution is also an attempt to move the research agenda forward. Rennie & Johnston (2004) conclude that the last decade of research has progressed the understanding of how institutions like museums affect people’s lives considerably. However, much remains to be done. They bring to the forefront three characteristics of learning considered especially critical when investigating the impact museums have on people’s lives; (1) its personal nature, (2) it is contextualized, and (3) it takes time. To move the research agenda forward, a fruitful research design has to deal with all these dimensions. A sociocultural perspective on learning is recognized to integrate all these aspects in out-of-school contexts (Rennie, Feher, Dierking & Falk, 2003).

Firstly, the personal nature of learning focuses on the learner as an individual with a unique visit experience, i.e. the research has to recognize the visitor’s perspective and capture multiple learning outcomes. For instance, Rennie & Williams (2002) built their survey about scientific literacy on focus group discussions with visitors, enabling them to structure the items using words and phrases likely to be familiar to visitors. To not only consider cognitive outcomes, like knowledge gained through the visit, Burns, O’Connor & Stocklmayer (2003) argue for a broader view of what may be evidence of science communication during a visit. They suggest any relevant change in awareness, enjoyment, interest, opinion, or understanding to represent a personal learning outcome. Emphasizing the uniqueness of the visitors’ learning experience does not mean that no research possibilities exist into overall trends. The work of the Museum Learning Collaborative (MLC) may serve as an example of this. Leinhardt, Knutson & Crowley (2003) describe how the research carried out in the MLC project provided
a foundation for a model of learning like ‘conversational elaboration’, which orchestrates a deep qualitative exploration of ‘who the visitors are and what they are engaged with in the museum’ (pp 30).

Secondly, the recognition of how the context has to be accounted for is a rather recent feature in research. Much earlier research did not acknowledge how the personal, social and physical contexts shaped the learning experience.

Designing hypothesis-testing research that attempted to control variables inevitably led to contrived settings and hence decontextualizing of the visit experience. Where the research question concerned exhibit evaluation this was not usually a serious flaw, but when visitor outcomes were the focus, the flaw could be fatal. Only a partial view of the outcomes could be realized. Visitors come with their own agenda, often a social one, and they are active agents in the visit experience.


This approach may acquire a mixed-method research design, i.e. employing a range of methods of inquiry, to produce complementary results that provide a better understanding of the complex research situation.

Finally, allowing time for learning to occur means that the impact investigation has to be flexible, broad ranging and on going, i.e. the data collection has to be done in longitudinally. Ellenbogen’s (2003) research provides an example how this can be carried out. The families in the study were not only followed during their museum visits, but also before and after these visits. Instead of studying one hour of a family’s life, the research design provided the opportunity to follow a whole sequence. Subsequently, it revealed how the different family activities were interconnected.

Hooper-Greenhill & Moussouri (2002) emphasize a lack of studies ‘that would attempt an open-ended exploration rather than confirming what we expect’ (pp. 18), with certain groups of visitors not being included in the body of research.

Most of the [reviewed] research was carried out with traditional science museum visitors that is, school and family groups. There are only a few studies of teenage or adult visitors while there are no studies of other visitor groups, including virtual visitors. Since different visitors use museums for different reasons and have different needs, it is hard to deduce evidence about visitors in general using findings from studies of children and adults in specific social groups.

(Ibid., pp. 18)
In a recent overview, Insulander (2004) proposes, among other things, that future research initiatives should address questions of a museum’s identity, the development of methods for studies of learning in museums, and studies of communication through exhibitions.

These suggested features to advance the research agenda have provided the basis for the following assumptions about learning and communication that have guided this research.

SIX FUNDAMENTAL ASPECTS OF LEARNING

As in all research, different theoretical assumptions reduce the complexity of social life. Human beings are regarded as fundamentally social and historical creatures in this research. This theoretical assumption organizes social life on a cultural and social level of description. In the present study, learning is seen as an emergent property of being involved in practices, and is a natural part of engaging in joint action. Actually, it is impossible to not learn (Wenger, 1998). Because learning cannot be fully captured through one single approach, different research perspectives focus on its different aspects. The research perspective applied here deals mainly with the following six aspects of learning.

Living knowledge

To some extent, the research perspective used in the present study does not make use of the notion of ‘theoretical learning’, i.e. the foundation of inquiry in modern science that includes the idea of one understanding nature intellectually, without any other goal than to understand32. Molander (2000) notes how the birth of this theoretical knowledge tradition has provided a border with ‘practical’ traditions involving people’s conduct and active life.

Since long before the advent of science, people have learned from and elaborated their experiences in order to live as well as they can under various circumstances. These practical traditions of knowledge are rooted in the whole range of life’s activities: accusation and preparation of food, birth and upbringing, exploitation of the soil and

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32 The natural philosopher Thales (in ancient Greece) is usually hailed as the first in our Western philosophical and thereby scientific tradition; for example, see von Wright (1987).
land, handicap, art, magic and morality – to indicate only their breadth. Practical understanding reveals itself at once in action and in how practices are carried on. (Molander, 2000, pp 32)

To best acknowledge practical knowledge traditions, knowledge should be perceived as living knowledge, i.e. knowledge-in-use, anchored in people’s lives and carried on by people who ask questions, who try to answer them and who conduct tasks as well as possible. From this point of view, knowledge is always in the world, embedded in culture. It is not the subject’s knowledge about any object distinct from the subject; it is embodied knowledge in action. Accordingly, it blurs any distinction between knowledge and understanding, since living knowledge is living understanding of how best to go further (James, 1907/1978).

**Learning organized as participation**

Learning in practical knowledge traditions can be organized as intent participation (Rogoff, Paradise, Arauz, Correa-Chavez, & Angelillo, 2003). In this tradition learning is explained as a transformation of participation in ongoing cultural activities, and affects all the participators in that practice. In contrast to other educational philosophies where learning is seen as accretion of information or skills, this brings across a boundary from the external world to the mind of the learner (Rogoff, 2003).

When contrasting intent participation with other ways of organizing learning, the distinction is not in the subjects or settings, but rather the form of involvement (Rogoff et al., 2003). Engagement in this kind of practice involves a collaborative, horizontal participation that is motivated by obvious importance and interest in the activity, and communication that employs words to provide or discuss needed information during shared endeavours, i.e. talk is used ‘in the service’ of engaging in the activity (not as a substitute for involvement). Finally, assessing intent participation includes the interest and voluntary willingness of individuals to be involved as important aspects of learning (Rogoff, Goodman Turkanis & Bartlett, 2001).

This tradition is prominent in many indigenous American communities and can also be seen in interactive museums (Rogoff et al. 2003). In the official information leaflet for the Teknikens Hus science centre, the director

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33 Teknikens Hus is the site where the present study is carried out.
expresses similar features as with intent participation, regarding how the learning experience at the centre is organized.

We live and learn. Where people meet and communicate, where they seek answers together or on their own, where inventiveness and imagination are allowed to run free – that’s where knowledge is formed. Teknikens Hus, the House of Technology in Luleå, is a unique place where people and technology meet. Here, students and professors, preschoolers and seniors, tourists and teenagers, school children and teachers experience the joy of discovery on a journey of exploration through an exciting range of exhibits. (from Teknikens Hus official information leaflet: Curious about Teknikens Hus, 2001)

This is also mediated through the way Teknikens Hus has chosen to shape their interior.

**Space for learning**

The shape of the interior also fundamentally shapes our experience of how to act in it to make it meaningful. To be in a new place can be a frightening experience, where one can find oneself in a rather arbitrary position, something people want to avoid. Instead, people want to change this arbitrary feeling to something more meaningful, in a way inhabit the room to feel safe (Bollnow, 1963/1994). To achieve this ‘homely’ feeling, people need to have the opportunity to experience the interior with their bodies and actions. A geometric interior is not the same as the space we are experiencing, where everything is dependent on the different experiences people get from different spaces. Hence, different interiors, organized in different manners, give different opportunities to provide a safe environment. This is fundamental for all human activity, including learning.

At the top of the next page is a painting by the Swedish artist Peter Tillberg called ‘Will you be profitable, little friend?’ It illustrates a Swedish classroom in the beginning of the 1970s. This may serve as an example of a space where people (pupils in this case) cannot inhabit a space with their body and action, considered crucial in the process of appreciating a space as described above.
Picture 12  An example of how physical interiors can be organized in different ways.

Photo: Erik Holmstedt

Printed with the permission of the Modern Museum, Stockholm
Bengtsson (2003) suggests that ordinary classrooms do not appreciate the essential urge in people to inhabit a space, i.e. transform it from a physical geometric room to a live space. The classroom does not take its point of departure from the unaffected and complex way of experiencing space of children. Instead, the ordering of the furniture, the lack of space to move around and the lack of things to pay attention to (except the teacher) reduce the children’s bodies into heads.

Lower on the same page is an interior picture of Teknikens Hus in Luleå, illustrating a striking difference in how the two rooms are organized. Here, many alternative objects are found for the visitor to pay attention to interactively, including all senses and the whole body. Everything is to help the visitor voluntarily build a personal relationship with the objects, and what they represent.

At the same time, many common features exist between this ‘voluntary’ learning and the learning that takes place in school. For instance, there are certain similarities between the exhibits and the construction of the school textbook.

In both of them, the curators/authors are supposed to choose what is to be presented from a certain material and how to present it. When the visitor comes to the museum, a certain selection has thus already been made, and from this selection the visitor may then choose what he wants to see.

(Insulander, 2004, pp. 30)

However, Selander (2003) emphasizes that it is something else to learn from a textbook than through hands-on activities. For instance, in a textbook, the students have to read all the pages assigned by the teacher, whereas in an exhibit, the user can choose to do whatever they like, even to not participate. Falk (2001) argues that this qualifies it as ‘free-choice’ learning, with the issue being that the learner perceives the available learning choices and possesses the freedom to select or not to select from among those choices. However, whether or not this notion of ‘perceived freedom’ is acknowledged by the visitors remains an empirical question.
Social production of meaning

The sections above deal with a certain aspect of how to understand human life and learning, namely a focus on the experience of meaningfulness. This section will develop this further through the notion of practice. People experience meaningfulness through engaging in the pursuit of enterprises of all kinds.

As we define these enterprises and engage in their pursuit together, we interact with each other with the world and we tune our relations with each other and with the world accordingly. In other words, we learn. Over time, this collective learning results in practices that reflect both the pursuit of our enterprises and the attendant relations. (Wenger 1998, p 45)

Therefore, practice (as an analytical term) is used here to contextualize the learning process in which people experience the world and their engagement with it as meaningful. Lave (1988) even considers social practice as a key factor in grasping the actual complexity of human thought as it takes place in real life.

Practice is inherently social, since acting turns people towards or away from other people. An action is influenced by how it is received by others, and cannot even be considered as performed before this happens (Molander, 1996). Another perspective of the sociality of practice is that ‘any episode of human action must occur in a specific cultural, historical, and institutional context, and this influences how such action is carried out’ (Wertsch, 2000, pp 18). Thus, social practice connotes doing, but not doing in and of itself; ‘It is doing in a historical and social context that gives structure and meaning to what we do’ (Wenger, 1998, pp 47). From this perspective, learning is not merely an individual process best separated from the rest of our activities and something you can be good or bad at realizing. Instead, learning is best perceived as natural as sleeping and eating and in fact, inevitable.

A view of learning as a social production of meaning that is influenced by both the individual’s situated experience and the ‘cultural, historical, and institutional context’ in which it occurs, cannot accept a dichotomy between the individual and society. Instead, the individual and society are connected through a reciprocal relationship. In other words, this theory of learning can be located somewhere in between theories of social structure,
which view human action as mere realizations of underlying structures\textsuperscript{34} (cultural systems, discourses, history), and opposing theories of situated experience, which emphasize the interactive relations of people with their environment\textsuperscript{35}.

This reciprocal view of what constitutes a learning process makes it possible to state that human beings not only produce practices, they \textit{re}-produce practices.

\textit{/\ldots/individual action and development must be viewed in relation to the collective practices in which they are embedded. But we also have to look at matters in the opposite direction. To act is to contribute to the continuous production and reproduction of social practices that, when viewed in their totality, make up society and social order.} (Säljö, 2001, pp 109)

Engagement in practices, even when the practices are well known by the individuals, always produce new situations that extend, redirect, dismiss, modify or confirm the histories of meanings of which they are a part. In this sense, ‘living is a constant process of \textit{negotiating of meaning}’ (Wenger, 1998, pp 53), and it is accomplished by two complementary processes, \textit{participation} and \textit{reification}.

To take part in a social community is a process of participating and relating to others; it shapes the experience as well as the community. Reification literally means to make something or someone into a thing, and in this context does not only denote the creation of physical artefacts. Rather, it is ‘things’ that give form to experience; reification is a process that creates points of focus around which the negotiation of meaning becomes organized. Any practice produces abstractions, tools, symbols, stories, terms, and concepts that reify something of that practice in congealed form, e.g. the exhibits in science centres. However, words and concepts in spoken language are probably the most frequent reifications of daily life. Yet, nonverbal behaviours, such as gazing, positioning, or gesturing, also constitute conversational meaning-making (Crowder & Newman, 1993).

\textsuperscript{34} See for example, Lévi-Strauss (1958/1963).

\textsuperscript{35} For example, ecological approaches to psychology, in which the environment is viewed as offering specific possibilities for actions (affordances) (Gibson, 1979).
Reality is mediated through artefacts

The exhibits at Teknikens Hus reify the culture, history, and ideology of science centre-practice in congealed form. From this perspective, the exhibits are not simply concrete material objects, but rather artefacts reflecting practice, i.e. the exhibit building practice at Teknikens Hus. Consequently, science centres not only illustrate science and technology in their exhibits, they create representations of these subject matters.

In other words, one effect of science museums is to pronounce certain practices and artefacts belonging to the proper realm of “science”, and as being science that an educated public ought to know about.

(MacDonald, 1998, p 2)

Interacting with a science centre exhibit becomes more than manipulating an object, it can be considered as an encounter with the representations of reality mediated by the exhibit.

Wertsch (2000) suggests that an artefact, and an individual interacting with it, ‘provides a mechanism for analyzing the relationship between individual and socio-cultural setting’ (pp 18). This is possible because the artefacts embody and mediate (from the German ‘Vermittlung’) culture, history and ideology of the sociocultural setting where it was produced. The focus on cultural tools (either intellectual or physical) as mediational means distinguishes sociocultural theory from other theoretical traditions. Artefacts mediate the reality for humans in concrete situations. In fact, we never meet reality as it is, but how it is mediated through cultural tools.

The relationship between individuals and artefacts is contextualised through the social practice, not in the sense that the context actually makes things happen, but rather the social practice creates the context. This context provides a baseline to understand the situated meaning of the artefacts in that specific situation.

However, one crucial point is that the artefact does not only have one fixed meaning when being created, but also how when it is being used, i.e. the tool can occur in situations when it is not used according to its original

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36 Wertsch (1998) uses the concepts ‘mediational means’ and ‘cultural tools’ as equal terms. I will use the concepts artefacts and tools to signify the same thing.

37 Compared with the concept of activity, which in its simplest terms is defined in human contexts as mediated through the use of culturally established tools. As per Vygotskij (1978), this is labelled tool mediated activity.
purpose (Wertsch, 1998). This means that artefacts should not be viewed as a determining action in some kind of static, mechanistic way.

/…/mediation is best thought of as a process involving the potential of cultural tools to shape action, on the one hand, and the unique use of these tools, on the other. (Wertsch et. al., 1995, pp 22)

For instance, a saucepan is usually regarded as a round metal container used for cooking, usually with one long handle and a lid. It is usually used to cook food in on a stove; at least through the daily practice of using it this way, it has become habit. This use constitutes the meaning of the artefact in the specific situation. It is not given beforehand; rather, it is something people have learned to do. However, doing whatever we want with the saucepan is not possible. For example, it would be considered very impolite at a party to serve coffee in a saucepan instead of cups, even though it would be physically possible. Hence, how the artefact is expected to be used is socially constituted and certain customs of use are more legitimate than others.

The meaning of an artefact can be changed by people’s activities. A four-year old child would certainly be able to find alternative ways of using a saucepan – turn it upside down and it could be a drum. From the parent’s perspective it would still be a saucepan, but from the child’s perspective the meaning of the artefact is something else. Hence, the same artefact can be used for different purposes in different situations, and its meaning changes depending on the users’ activities when using it. This is true for saucepans, but it is also true for other kinds of artefacts, such as science centre exhibits. The meaning of an artefact is not a physical object with one possible predetermined use. The possible meanings are constituted by the users’ way of handling it in specific situations.

In other words, these assumptions provide possibilities to understand the co-existence of different meaning-potentials in science centre exhibits, and how they are situated in an intermediary position between the practices of both the science centre and teenagers. In this intermediary position, teenagers interact with the exhibits to gain meaning to their activities. Therefore, learning cannot be studied by itself; learning is always to do something with an artefact.
Eventually, the exhibits’ characters are not only reified in their form, but they should also be understood in the context provided by the processes in which they are integrated into this practice. Building on these theoretical propositions, the science centre exhibits are best perceived as a ‘situated activity system’ (Goodwin & Goodwin, 1996), consisting of a web of interactions involving people, artefacts, and tools.

**Learning as a matter of becoming**

Learning transforms who people are and what they can do. They obtain an increasing familiarity with the situated use of certain kinds of cultural tools. Bakhtin (1981) distinguishes between appropriation of a cultural tool (making it one’s own) and the mastery of a cultural tool, i.e. simply knowing how to use it. Mastery and appropriation of course relate to each other, higher levels of mastery are usually positively correlated with appropriation. However, this need not be the case.

> Indeed, some very interesting forms of mediated action are characterized by the mastery, but not by the appropriation of, a cultural tool. In such instances of mediated action, the agent may use a cultural tool but does so with a feeling of conflict or resistance. When such a conflict or resistance grows sufficiently strong, an agent may refuse to use the cultural tool altogether. In such instances, we might say that agents do not view that cultural tool as belonging to them.

(Wertsch, 1998, pp 56)

Thus, the formation of a practice is not only about negotiating meaning, but also negotiating identities, since appropriation is an activity of identity (Rogoff, 2003; Wertsch, 1998).

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38 Cf. Vygotskijs (1978) notion of tool mediated activity
Identity is an ongoing process of becoming\(^{39}\) and a way of being in the world\(^{40}\), and is constructed and reconstructed through participation in the ongoing process of negotiating meaning. This process has become increasingly complicated and crucial to individuals in the open, manifold and unpredictable globalized society of today (Nilsson, 2003).

Questions about how you want to live your life, what you want to look like and who you want to be play important roles in peoples’ lives today, not the least of which in the lives of young people. To form identities, to become a human being in relation to other people, takes the form in late modern society of a so called ‘reflective project’. In this case, ‘reflective’ refers to that individuals’ experiences of self as well as the individual feeling of how they are perceived by others, is formed in dialogue with other people. (Ibid. pp 115. Translated by author)

Talking about identity in social terms, i.e. social identity, presents an opportunity to renegotiate the relationship between the individual and the community. Instead of regarding these units as opposites, both become involved in the process of their mutual constitution. Practice and social identity present mirror images of each other (Eckert, 1989; Wenger, 1998).

Molander (1996) emphasizes the issue of how human action depends on other people and their acknowledgement of the action. This is a cornerstone in human co-existence; the practices deal with the profound issue of how to be a human being.

Eckert (1989) describes this reciprocal, social form of identity as a social structure that is not ‘simply the context for learning [in schools], it is part of what is learned. What a student learns in the classroom is indeed a very small other part’ (pp. 179). One conclusion of this is ‘the social forms and dynamics that students engage in outside the classroom and their strategies for coping with the school are a major part of what they learn in school’ (Ibid. pp. 179-180). The connection between learning and social identity is also argued as crucial by Eckert, Goldman & Wenger (1997), when learning cannot be studied as an endeavour in itself, but rather as a means to build social identities and engage in meaningful activity. This social dimension of learning has to be taken seriously, because ‘no amount of clever delivery of

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\(^{39}\) Even though different theoretical traditions concerned with the concept of identity exist, they seem to agree upon the fact that identity is not a static condition (Nilsson, 2003).

\(^{40}\) This resembles Heidegger’s notion of being-in-the-world (1927/1962). However, the difference is that the abstract notion of being is not the point of departure for the process of negotiation of meaning and identity. Instead, this process produces our being by making our living in the world meaningful.
subject matter will capture the imaginations and energies of students who feel that their opportunities for social development lie elsewhere’ (pp. 2).

Social identities contextualize the meaning making process, and make it personal. Furthermore, social identities determine what, of all potentially significant things that happen in a practice, actually become significant learning, i.e. social identity defines which meaning matters to the individual. Hence, individuals learn in the interests of participating in communities that matter to them, to know how to gain access to valued forms of community participation. The reward is ‘seeing their contribution, knowing that others recognize their contribution, and forging an ever changing sense of themselves’ (Eckert, Goldman & Wenger, 1997, pp. 2).41

We accumulate skills and information, not in the abstract as end in themselves, but in the service of an identity. It is in that formation of an identity that learning can become a source of meaningfulness and of personal and social energy.

(Wenger, 1998, pp 215)

An empirical example of this is Ellenbogen’s (2003) research on science centre-going families and what happened at the local level with regards to how the learning was mediated through family interaction (both at home and at the science centre). The conclusions states that the families co-opted exhibit content to interactionally establish family identity (c.f social identity).

The families did not just manipulate their experiences in the museums; they manipulated the very meaning of the experience. In this instance, the families themselves functioned as learning institutions, drawing upon science museums as one of many tools they had to build family identity — in this way, the families’ science learning focused not just on the doing of science, but on positioning themselves as doers of science

(Ibid. pp. 138)

41 Obviously, this feeling of meaningful participation in communities does not always entail learning from a constructive point of view. Learning to handle tools like syringes has different consequences for the individual depending if the person is studying to be a nurse or joining a community of drug addicts.
Social identity forms around practices and the practices form around social identities. However, identity is also defined by the practices people choose to \textit{not} engage in or are \textit{excluded} from, i.e. forms of non-participation are as much a source of social identity as participation. This puts the notion of negotiability into the foreground. If identification defines which meanings matter to people, negotiability determines their ability to negotiate these meanings. When people create identities of participation, \textit{both} processes need to be addressed, and there have to be possibilities to adopt both and contribute to the negotiated meaning in the practice.

Building on the assumption of the possibility of co-existing meanings of artefacts, one aim of this study is to open up questions about contribution and adoption of meaning in exhibits. The production and intentions of exhibits is important, though, the starting-point has to be their actual use, since the meaning of the exhibit is constituted in this process.

Beginning with these six fundamental aspects of learning provide a point of departure for constructing an alternative, and a more flexible way of looking at learning in free-choice settings (like a science centre) other than more dominating perspectives that focus on the cognitive development in the individual’s mind. All too often, measurement instruments produced for quite different learning practices have been used in former museums studies of learning, producing misleading results. These results subsequently misinform what the desired outcomes of a science centre visit may be (Wertsch, 2002).
UNIT OF ANALYSIS AND RESEARCH QUESTIONS

The purpose of the present study is to examine teenagers’ *encounters* with science centre exhibits; this is the point of departure. The applied theoretical perspective on learning described above considers certain aspects of this encounter:

1. The exhibits are artefacts produced in a social practice.
2. The teenagers form practices around their usage of the exhibits to make it meaningful to them. This practice contextualizes the negotiation of meaning in the exhibits in relation to the formation of their social identity in the science centre.
3. The encounter is organized through the teenagers’ actions and becomes visible through their communication.
4. The exhibits gain sense through the teenagers’ social activities. This formation of socially constructed meaning indicates what is learned in science centres, from the teenagers’ perspective.

What become visible in the encounter are the forms of participation and social identity that can be related to how the meaning of the exhibits is constituted by the teenagers through their social activities. These activities constitute, therefore, the object of inquiry in this research.

The theory of co-existing meanings of artefacts described above places human action in social practice and the interrelationships between them at the forefront. To address this reciprocal view the unit of analysis is placed ‘in the middle’; in this case, it is constructed as teenagers-acting-with-science centre exhibits. This indicates an encounter between two practices, (1) teenagers-visiting-science centre and (2) science centre-building-exhibits\(^\text{42}\).

To find out more about how these meanings matter to the users, the present study has taken advantage of the properties of another practice, namely a group interview.

\(^{42}\) Actually, there are three practices involved, since both the teenagers’ and the science centre’s practices are mediated through a researcher’s practice in the present thesis.
Research questions

The focus on the mediational processes provide results in terms of how the artefacts are used and what people learn during this process, compared to, but not defined by, the intended use and learning outcomes. When regarding learning as situated in a cultural activity, it becomes interesting to study functional aspects of the interaction between and among individuals and artefacts.

The main purpose of this research is to study how teenagers encounter science centre exhibits. The unit of analysis is teenagers-acting-with-science centre-exhibits and the object of inquiry is the social activities formed in this interaction. In discussing the area of interest for this study in connection to the chosen theoretical perspective, the following research questions have emerged:

- What kinds of social activities are formed in the encounter between teenagers and science centre exhibits?
- How do these activities constitute the role science centre exhibits play in the lives of the teenagers?

VIDEO DOCUMENTATION AS RESEARCH METHOD

The present study is based on an assumption that learning is a ubiquitous and basic human activity, and a fundamentally social phenomenon. Meaning43 is ultimately what learning is to produce, and is negotiated when individuals participate in practices. Another aspect of participation in practices is that it deals with the profound issue of how to be a human being; through learning people change who they are in the process of forming a social identity.

43 'Meaning' is used here to describe our ability to experience the world and our engagement with it as meaningful.
The term ‘social identity’ is here used as the perspective on the world developed in practices, i.e. a tendency to come up with certain interpretations, to value certain experiences and to engage in certain actions. An equivalent term, though with stronger analytical connotations, is ‘culture’. The resemblance between the two terms is here seen mainly because of how they can be used to describe the same phenomena. This is not something one can go out and observe; it is a way of rendering the researchers accounts.

Were culture something one could observe first-hand, all any ethnographer would have to do is observe and record human interaction and bring back a detailed account of what have been observed. But culture is not “there” waiting to be observed, and no ethnographer can ever hope to catch so much of a glimpse of it.

(Wolcott, 1999, pp. 79)

In his accounts for the ethnographer’s mission, Wolcott (1999) continues to describe culture as nothing someone can belong to anymore than one can belong to a language; culture and languages are ways of doing things, not something one joins. Ethnography becomes descriptions of what people in particular places usually do, and the meanings they ascribe to what they do under ordinary or particular circumstances. The descriptions are presented in a manner that focuses on the regularities implicating cultural process. This is how ‘culture’ and ‘social identity’ resemble each other as analytical tools.

To learn more about the relationship of teenagers to science centre exhibits from this perspective calls for a research design that is sensitive to the possibilities of co-existing meanings and the formation of practices and culture. This not only informs the analysis of the research material, but the research material itself. It is by definition ‘material’. Therefore, the meanings of the research material are as arbitrary as those of other objects of culture; the research material gets new uses and meanings as it moves into different contexts. An important task of the analysis is to reveal how this process may take form.

Studying teenagers’ actions with science centre exhibits is an ambiguous task. However, the point of departure in the present study is the teenagers’ perspective; hence, the main purpose of the study design was to provide a situation where teenagers had the opportunity to assign meaning to the exhibits on their own terms.
Visual ethnography

To study the unit of analysis in the present study from a cultural and social perspective, ethnography is being used, concentrating on visual ethnography (Pink, 2001; Banks, 2001). Here, this approach has entailed the production of video documentation.

The assumption of reality as mediated through cultural tools also has consequences on what the present study claims about the object of inquiry. Pink (2001) approaches the matter by acknowledging the inherent partiality of visual ethnography, since ‘reality cannot necessarily be observed visually. Therefore, rather than recording reality on video tape or camera film, the most one can expect is to represent those aspects of experience that are visible. Moreover, these visible elements of experience will be given different meanings as different people use their own subjective knowledge to interpret them’ (Pink, 2001, pp 24).

Visual research methods have been used since the 1960s\(^4\), and have developed to varying degrees depending on different theoretical underpinnings. During the 60s and 70s, a strict observational technique was developed, which was informed by the will to collect objective research material. The camera was used with the purpose of ‘visual note taking’, to support the researcher’s observations in social sciences. Answering the critique that the use of visual was too subjective, unrepresentative and unsystematic, Collier & Collier (1986) responded that under the right controls, the visual could contribute to a positivist social science as an objective recording method. This tradition builds on the assumption that reality is visible, observable and recordable in video or photography. Today, this tradition is brought forward by researchers like Emmison & Smith (2000), who have specialized in ‘unobtrusive’, observational research. In Sweden, Sahlström (1999) has tried to answer the question of what actually happens in Swedish classrooms, by documenting pupils with microphones and video cameras. Building on this assumption the analysis of the visual has to be very strict and ‘close’ to the content of the images, and an advanced code system is used when transcribing the material.

However, the present study has its start in another research tradition, developed by Clifford (1986) as a critique against the realist assumptions

\(^4\) An overview over the history of visual anthropology and ethnography can be found in Pink (2001).
made in the visual research described above. Instead of trying to report as closely as possible to the ‘whole’ view of a situation, Clifford suggests that ethnographies themselves are constructed narratives and cannot reveal or report on complete or whole accounts of reality; ‘etnographic truths --- are inherently partial – committed and incomplete’ (Ibid., pp. 7). This approach build on an assumption of the world as experienced; things become visible because of how we see them rather than simply because they are observable. Reality cannot necessarily be observed visually, and ‘the most one can expect [from a video tape] is to represent those aspects of experience that are visible’ (Pink, 2001, pp. 24). Moreover, those visible elements of experience will be assigned different meanings by different people, since looking is ‘embodied’ – undertaken by someone with an identity (Lister & Wells, 2000). Banks (2001) argues that to ‘read’ images we need to attend to both their content, i.e. ‘its internal narrative - if you will’, and its ‘external narrative’, i.e. ‘the social context that produced the image and the social relations within which the image is embedded at any moment of viewing’ (Ibid., pp. 11). Visual meanings are thus both personal and framed by the wider context in which the image was produced.

Following this notion of the ambiguity of meaning in images, the status of the visual as a form of knowledge on its own has to be recognized. Transcribing the visual into written words without describing the reasons for doing so, would be ‘to impose a single verbal meaning upon appearances and thus to inhibit or deny their own language’ (Berger & Mohr, 1982, pp. 133).

Photographs can be used to create critical representations in ways written words cannot. This is not to say that one medium is superior to the other, but to seek the most appropriate way to represent different aspects of ethnographic experience and theoretical and critical ideas, and, perhaps most importantly, being prepared to explore how photography can be a significant contribution to this.

(Pink, 2001, pp. 135)

In the present thesis teenagers get to partially represent themselves. In doing so, the thesis tries to make full use of images and words, and combine them in a text with the aim to represent how the teenagers spoke about, showed and experienced their science center visit. Hence, the pictures do not merely function as illustrations to the texts; they also bring another dimension to the discussed issues. This will include written theoretical narratives and narratives combining images and words to represent the research materials and experience.
There is also a connected website where video clips produced by the teenagers are available for viewing. Holliday (2000) argues that when video clips are used in academic presentations, ‘respondent empowerment and emotional engagement is made available through visual/verbal representation – through their greater presence’ (pp. 519), and that even if her informants did not fully agree with her interpretations ‘they do get to represent themselves with minimal interference at least’ (pp. 519).

The photographs and video clips appearing in this thesis should be regarded as more than merely captioned illustrations of examples referred to in the written text. The video clips, represented in this thesis as both still pictures and ‘live’, have a dual role, as both a reflexive device and a medium representing examples of the diverse practices, opinions and experiences forming part of teenagers’ encounters with science centre exhibits. They become a link between the fieldwork and representation, here used to explore and represent ethnographic experiences and self-representations of the informants.

The captions to the pictures are formulated not solely in relation to the visual content of the images, but to make it comprehensible in terms of the researcher’s analysis experiences and the understanding of the images and the science centre exhibits by the informants. The captions situate the images more deeply in the research context (cf. Pink, 2004b).

**The features of the present research design**

During the spring 2002, five teenagers from Luleå, studying in the same class and their last semester in secondary school, were asked to go to Teknikens Hus and film their own visit. They were contacted by the researcher during a visit to their school together with a letter, which described the research project as an ‘opportunity to learn more about what Teknikens Hus actually can mean to people in your age’.

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45 www.vaike.se
46 These teenagers where picked out as ‘collaborative’ by their teachers. Another criterion was that they had lived in Luleå during the past 10 years, and that they were familiar with Teknikens Hus.
47 In Sweden, this means that they were all on their 16th year.
The letter described how the study was to be carried out, and they had the opportunity to ask questions during the first visit to their school. During this discussion it became clear that all of them had frequently visited Teknikens Hus during their childhood, but only went there now if they had to, e.g. on school-trips. They asked about how they were supposed to think about bringing the video-camera:

Researcher: Think of it as just a way to describe a visit to Teknikens Hus in your own terms.

Informant: Oh, like a video diary?

Researcher thinking of how to answer for a moment. Then answering after deciding it is best that they define the conditions on their own terms.

Researcher: Yes, something like that.

Informant: Ok, then we know. We have seen 'PS' on TV.

They also decided in what constellations they wanted to come and visit Teknikens Hus. They came in two groups, i.e. two girls in one group (Rebecka and Emelie) and three boys (Emil, Kim and Simon) in the other group. After both of the groups had made their visits, they were summoned to a combined video session – group interview, where the videos were watched together. The informants were asked to stop the video at any point to discuss the content more thoroughly. The researcher participated by feeding the discussion with questions, mainly focusing on what they were doing in the video films. In all, the informants created a conversational space through the video films, where they had the opportunity to represent themselves, and the role of the interactive exhibits was mutually examined in the co-construction of what it may mean to visit Teknikens Hus for a teenager in Luleå.

48 By all means, this will not be enough to respond to Rennie & Johnston’s demand for longitudinally performed studies. However, it addresses the time dimension, since the teenagers relationship to Teknikens Hus clearly has been built up over a rather long period of time.

49 'PS' was a youth programme on Swedish TV that during 2002 showed, among other things, different teenagers’ video diaries presenting certain aspects of their lives and identities.

50 However, Simon could not come on the day of the visit. He was present later in the group interview.
This procedure formed the base for the production of the primary data in this study, mainly used in the account of the study results.

Table 2  The primary produced and developed in this research.

<table>
<thead>
<tr>
<th>Production of data</th>
<th>Description of data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two video films produced by the teenagers during a visit to Teknikens Hus</td>
<td>Video film 1 lasts 17 minutes, distributed on 25 different scenes. These scenes show activities in 22 different exhibits. Video film 2 lasts 19 minutes, distributed on 29 different scenes. These scenes show activities in 29 different exhibits. The films are digitally stored.</td>
</tr>
<tr>
<td>One video film showing the video session with the teenagers viewing and commenting their video films. The discussions were transcribed.</td>
<td>The video film is 75 min long and the transcription consists of 37 pages of text. The film is digitally stored.</td>
</tr>
</tbody>
</table>

However, during this research, secondary data was also produced which has been accounted for in part one of the thesis. It has been used primarily in part one of the thesis as a part of the background to the research.

Table 3  The secondary data produced and developed in this research.

<table>
<thead>
<tr>
<th>Production of data</th>
<th>Description of data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recorded interview with Olle Nordberg, Head of Exhibit Development at Teknikens Hus in Luleå.</td>
<td>The interview was one hour long and was partly transcribed. The whole interview is digitally stored.</td>
</tr>
<tr>
<td>Recorded interview with AnnMarie Israelsson and Gunilla Jacobsson.</td>
<td>The interview was two hours long. The interview is transcribed into 15 pages of text and digitally stored.</td>
</tr>
</tbody>
</table>
A participatory perspective

To reach the recommended open-ended, personalized, contextualized and longitudinal dimensions of research in this area (described at the beginning of this part of the thesis) in the relationship between the teenagers and science centre exhibits, the research used a collaborative approach. This is recommended by Rennie & Johnston (2004), since ‘seeing through the eyes of the visitor means that, at some stage, data must be collected from the visitor and this requires self-report data, or recording what visitors both say and do’ (pp. S8).

However, the present research design goes one step further. Collaboration suggests (1) working with informants and attempt to understand and represent their points of view and experiences, as well as (2) acknowledging aspects of experiences and knowledge that are not merely observable, and recognizing how the visible experiences will have different meaning to different people (Pink, 2001). The task became to design a study in which teenagers could personalize a science centre visit, and give them the opportunity to assign meaning to it. Since meaning is seen as constructed socially in this research, the design had to permit these steps to be taken in groups, not individually.

Another important reason to choose a collaborative approach instead of observations was the fact that teenagers very seldom, if ever, visited Teknikens Hus on their own initiative (see part one). Instead, the teenagers in this study were asked to come to Teknikens Hus by the researcher, possibly seen as problematic, since it interfered with the notion of the ‘authentical science centre experience’. However, it may also provide a unique possibility to study those who usually do not visit a science centre, an area in need of research (Rennie & Stocklmayer, 2003).

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51 This notion is dealt with later in the present thesis.
This is a micro-analytic case study, with theoretical underpinnings and a research design similar to Rahm’s (2003) study of meaning making among a group of teenagers visiting a science centre. She also acknowledges detailed case studies as fruitful, to ask the kinds of pertinent questions in the present study. However, her use of video in the research process as merely ‘a note-taking tool’ with complementing field notes made by an observer to make the record more complete produced findings suffering from a lack of the teenagers perspective on the situation. Although ‘how that learning experience [at the science centre] then comes to be integrated into old and new ways of knowing is also unpredictable’ (Ibid., pp. 243), an account of the situation made by the teenagers could have indicated what was significant to them of all the things that happened during their visit.

**Research methods as practice**

Since this study is about studying practices, the design can actually be seen as a compound of two practices, both connected through the site of the production of the video-films titled Teknikens Hus.

Firstly, there is the practice of producing the video-films. This was of course situated in the Teknikens Hus context, and the stationary exhibits became points of focus for the teenagers’ acting. However, bringing the video camera gave the teenagers agency to produce an account of the exhibits and how they can be used, from their own perspective52. The making of the video-films essentially became a practice through which the meanings and possible uses of the exhibits were negotiated and performed. Therefore, the video-films cannot be seen as a product of this research, but rather a process where the video camera ‘becomes a (non-human) agent in the process by which knowledge is produced’ (Pink, 2004a, pp. 63). This may allow for possibilities to gain better insight into their ‘visual cultures and into what is important to them as individuals’ (Pink, 2004b, pp. 399), and how they choose to re-produce the science centre practice through interacting with the exhibits.

52 cf. Holliday’s (2000) case study in which she asked her respondents to make ‘video diaries’ with camcorders that would ‘demonstrate visually and talk about the ways in which they managed or represented their identities in different settings in their everyday life’ (pp 509)
Secondly, to provide the teenagers an opportunity to assign meaning to their participation in the video-films, this research took advantage of another practice – a group interview. This group interview had similarities to a ‘focus group’, with the researcher participating as a guide. The researcher’s voice is present to guide the group so it stays ‘on task’, provide the agenda, and choose how to compose the results.

Wilkinson (1998) found that the imposition of meaning by researchers is diminished in focus groups compared with individual interviews, because participants tend to take control of the topic of conversation. This practice allows the participants, in interaction with each other, to speak for themselves by using their own language in the context of their own experience. Bergin, Talley & Hamer (2003) conclude that the adolescent’s perceptions are much more at the forefront through focus groups than in most forms of research.

Though not natural settings themselves, focus groups provide arenas in which youth can reflect on and describe behaviors they have observed in their own natural settings – their classrooms, playgrounds, and homes. The focus group approach allowed us to enter into the interpersonal world of young adolescents.

(Ibid., pp. 15)

Thus, the teenagers got to contextualize their video-films from Teknikens Hus, by negotiating what their actions on the videos meant to them as a collective, i.e. formatting their social identity as teenagers at Teknikens Hus. The videos were not used to ‘elicit’ knowledge about facts that are somehow embedded in the videos. Rather, the interest here lies in how the teenagers used the content of the video-films as ‘vessels in which to invest meanings and through which to produce and represent their knowledge, self-identities, experiences and emotions’ (Pink, 2001, pp. 68).

Harper (1998) suggests that the ambiguity of the meaning of photographs may be used as a reference point through which the researcher and informant discuss their different understandings of images, thus collaborating to determine each other’s views. Following this way of reasoning, the video-films were a reference point through which the teenagers represented aspects of his or her reality to the researcher and vice versa. The video-session may then serve as an example of Harper’s suggestion of how photo-elicitation combined with the ‘new ethnography’ is ‘a model of collaboration in research’ (Ibid., pp. 35).
Analytical implications of the research method

Anthropologist Janet Hoskins (1998) discovered how the Kodi people (of the Island of Sumba, Eastern Indonesia) used objects to produce more personal, intimate accounts of their lives than if she had asked them to talk about people. Pink (2004a) suggests that this may also provide a way of thinking about the relationship between narratives of informants regarding objects, spaces and places and their narratives of self in modern western cultures. Thus, visuality in this research represents a way to produce more personal and intimate accounts of teenagers’ relationships to science centre exhibits. The performances made with the video camera are seen as another way of communicating what may create a space for negotiating the meanings of the exhibits in a more complex way.

This does not mean simply that they temper their performances with regard for the camera, but that they perform to the camera by using it as a medium through which to communicate with one another. Thus the camera is used to both reveal and conceal, it may be seen as offering opportunities to both show and hide more. The camera is simultaneously a catalyst for forms of communication not normally developed in [for example] tape-recorded interviews.

(Pink, 2004a, pp. 64)

However, in these different ‘revealing and concealing’ practices, the teenagers may certainly direct their attention towards other activities not related to the object of inquiry in this research. Obviously, this has analytical implications. In the film making practice, the participation in different exhibits may become more of a background to a more primary wish from the teenagers to produce a narrative about something else, i.e. the primary social activity in that case establishes the teenagers more likely as ‘film producers’ than ‘science centre visitors’. The analysis of this material has had to be sensitive to what the teenagers direct their interest towards regarding this issue. In line with this reasoning, the staff at Teknikens Hus was also asked to watch the video clips to obtain a ‘second opinion’ on the results.

This may also be regarded as a form of pragmatic validation (Kvale, 1997), i.e. if the knowledge the researcher claims, based on an analysis of the video clips in this study, is supported by the staff, the video clips receive a more effective status. In an invitation to the staff the task of watching the video clips was explained as follows:
I would like one of you who has worked a long time at Teknikens Hus, and has spent a lot of time out among the visitors, to look at these video clips before our meeting. Think about if you recognize the situations in the films. Do teenagers talk this way when they visit Teknikens Hus? Do they touch things as in the films? In short, are the films credible; is this the way teenagers act when they visit Teknikens Hus?

(Part of invitation from the researcher to staff to discuss the video clips)

This session was held May 13, 2005 and included eight staff members and the researcher, with the results of this meeting to be discussed in part three of the thesis.

The other situation, the group interview, has similar analytical implications as the film making process. As acknowledged by Eckert (2005), ‘adolescent peer groups --- [as] primary loci for jointly viewing the social world and assessing one’s place in it – participants situate themselves as a group with respect to other specific communities of practice’ (pp. 95). In this case, data analysis from the group interview has to be sensitive towards what the conversation is oriented, and if the informants primarily situate themselves within the research situation or their action in the video clips.

Interpreting visual images

Rose (2001) advocates an approach to interpreting visual images that ‘thinks about the visual in terms of the cultural significance, social practices and effects of its viewing, and reflects on the specificity of that viewing by various audiences’ (Ibid. pp. 32). She proposes a three tier analysis to perhaps focus on one or more sites where the meanings of images are made: the site of production, the image itself, and what she refers to as audiencing, i.e. ‘the process by which a visual image has its meanings re-negotiated’ (Ibid. pp. 25).

Within these three sites Rose identifies three different modalities, i.e. the technological, the compositional and the social. Technological aspects deal with questions of how the image was made, what kinds of visual effects were used and how the images were displayed and circulated; compositional aspects deal with genres, composition and what viewing positions were offered; and the social aspects refer to the institutions and practices surrounding an image and through which it is seen and used.
Different research methods have their own analytical assumptions and thus their own empirical focus on visuality. Heikkilä & Sahlström (2003) may serve as an example of how the chosen site of production and modality may inform the research questions and research design. Their article describes thirteen Swedish doctoral theses, all using video documentation as the research method. The question Heikkilä & Sahlström brings forward is how the researchers have handled the camera and microphones. This is presented as crucial because, depending on the purpose of the study sometimes a ‘camera fixed on a stand with a microphone on the camera does well; sometimes maybe a handheld camcorder with wireless microphones does better. These decisions are critical for how the data is produced, thus making it crucial for how the analysis can be performed’ (Ibid., pp. 38).

The emphasis on the technological modality of the site of production may be suitable for certain studies, though not for all. The issue at stake may not be what kind of camera was used and how it was used (from a technological perspective53), but what is considered important to understand the image.

Theoretical debates about how to interpret images can be understood as debates over which of these sites and modalities is most important for understanding the image. (Rose, 2001, pp. 32)

Rose argues that the ‘social’ aspects of visual meanings deserve more attention, something long argued by anthropologists (Pink, 2003). As Banks (2001) insists, the social relationships of images are key to understanding their meanings, since they are products of human action and entangled in human social relations. The present study deals with, in using Rose’s terms, the ‘social modality’ in all three production sites of meaning of the video clips. This also provides the structure of the visual analysis in the present study.

The social aspects in the site of production concern how and why the researcher collaborated with the informants to produce knowledge through video documentation. This is mainly dealt with in the present part of the thesis.

The social aspects in the site of the image itself concern how the researcher interpreted the video films. After cutting the video films into video clips at the same points as the informants had cut to move on to the next ‘scene’,

53 Another perspective is offered by Pink (2001), who gave examples of how considering local visual or video cultures can inform the use of video as a research method, i.e. from a social perspective.
the clips were organized into groups. Each group represented a certain way of acting with the exhibits, which were later analyzed to distinguish qualitative differences.

The social aspects in the site of audiencing concern how the films were commented on by the informants during the video session and group interview. After this event, the video clips were gathered with the comments from the informants. This procedure provided opportunities to reflect upon how the informants used the exhibits to represent themselves in the practice of doing a science centre visit, and how they used the video clips to construct what that practice consisted of. The different ways they described the exhibits in this process were analyzed to distinguish qualitative differences.

The social aspects of each meaning-making site provided the basis for an understanding of the encounter between teenagers and science centre exhibits. Since the present study is based upon a theory of co-existing meanings of artefacts, the visual meanings of the video clips lie in the intersection of these different areas of interpretation, rather than being ‘revealed’ by just one approach.

![Figure 1](image)

**Figure 1** The structure of the analysis in the present study brings forward social aspects of the different sites where the meanings of the video clips were made. The results lie in the intersection of the different sites of understanding the video clips according to the research design.
Figure 1 shows how the different meanings of the video clips are linked, but analytically separable, countering an argument assuming that ‘reading’ an image implies reading a message within the visual image; ‘that it is speaking to us and that all we have to do is listen’ (Banks, 2001).

An example of how this analysis model has been used is the video clip ‘Wave machine’, represented in picture 15 (pp. 99) as still images. The image itself shows a picture of two boys having fun at a somewhat traditional science centre exhibit, ‘play’ fishing in the water basin. This is perhaps a slightly odd activity, since the exhibit is supposed to represent the abstract notion of wave motion, but they seem to at least have fun. In the audiencing procedure, another picture develops where the boys identify the exhibit as boring and too simple and add that ‘we usually don’t stand here and fish in that thing’. The staff also gives feedback on the video clip as something teenagers would not normally do during a visit. It seems that the site of production and the fact that they have brought a video camera during this particular visit is an important aspect of what the teenagers are directed towards in their activity. Hence, the situation of ‘having fun’ revealed in the image itself developed through the analysis procedure into a situation of ‘making fun’ of the exhibit.

The question of the ‘authentic situation’

Rennie & Johnston (2004) conclude their discussion about research design and measurements with a question: ‘How does one collect data in ways that do not change the behaviour of the visitor?’ (pp. S12). This question arises from concerns about how research involving people may have the potential for reactivity in the process of measurements and influence their subsequent behaviour.

Post-visit interviews, particularly with stimulated recall through photographs or video recordings, have the potential to change the impact of the visitors’ experience by requesting visitors to think and talk about the experience in ways they might not otherwise do.

(Ibid., pp S13)

The answer to their well-founded question is somewhat philosophical, because it has to be answered on a philosophical level. Is there an authentic situation, in a sense that it is more authentic than other situations? The

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54 It can be viewed in action at www.vaike.se
The purpose of this research is not to examine a situation as if the researcher was not present. Instead, the focus was on what the teenagers said, did and showed, and what both the researcher and the informants experienced when audiencing the research material.

Interest not only lies in the content of the research material, but also in how all these activities co-construct the teenagers’ relationship to science centre exhibits. The distinction that observational video documentation should show more about what people actually do than other collaborative approaches presented in this study (like the teenagers’ own videos and the group interview) where informants say what they do, is too clear cut.

According to the speech act theory (Austin, 1965), saying and doing may be seen as performances and not altogether distinct from one another (talking is certainly a form of doing). For example, if someone says, ‘I promise to take a taxi home’, the speaker is actually making a promise rather than just describing one. Hence, saying should not be studied solely as a rule-governed form of behaviour, but also as an action with consequences. Otherwise, ‘it would be as if baseball were studied only as a formal system of rules and not as a game.” (Searle, 1969, pp. 17).

Since reflecting on one’s life is an integral part of living it, ‘performances staged for the camera may have affinities with those people put on for themselves – and the performers may be no less true to themselves for it’ (Taylor, 1998, pp. 5). More important in this case is to stay sensitive towards what the teenagers are orientated to in their ‘revealing and concealing’ ‘performances’ as discussed in previous sections.

However, the intention here is not to argue that either observational or collaborative methods are ‘better’, but rather to note that one should chose a method according to context, circumstances and theoretical perspectives.
ETHICAL ISSUES

A Swedish bill (2003:460) dealing with vetting the ethics of research involving human beings has been law since January 1, 2004. This law represents an attempt to develop ethical guidelines and codes of practice that researchers should follow to avoid unethical behaviour. The present research does not fall under the categories of research concerned with this law\(^55\), but even if it did, the notion of one superior ethical code might be problematic. Ethics is more than simply the ethical conduct of the researcher, it is also demands the researcher to develop an understanding of the ethical contexts of their research.

In our judgement there are dangers in treating particular procedures as if they were intrinsically ethical and desirable, whether this is ensuring fully informed consent, giving people control over data relating to them, feeding back information about the research findings to them, or publishing information on the basis of ‘the public’s right to know’. What is appropriate and inappropriate depends on the context to a large extent, and sometimes actions that are motivated by ethical ideals can cause severe problems, not just for the researchers but for the people they are studying as well.

(Hammersley & Atkinson, 1995, pp. 278-279)

The present research not only involves ethical issues in the relationship between the researcher and the informants, but a need to construct an ethical code between Teknikens Hus and the researcher that intersects with the ethical conduct of the research. Different codes of ethics have to be acknowledged so that they fit with this particular research, and decisions referring to these codes have been co-constructed\(^56\) in different situations ‘along the way’. Table 4 below describes these situations as activities. Any form of consent given by the informants is described further down in the text.

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\(^{55}\) This research has not the purpose to intervene in peoples’ lives and influence the individual either physically or mentally.

\(^{56}\) Giving agency to the participants goes in line with the theoretical underpinnings to the present study.
Table 4  Activities performed during the present research, including both the informants and staff at Teknikens Hus.

<table>
<thead>
<tr>
<th>Activities concerning the informants:</th>
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<tbody>
<tr>
<td>May 16, 2002</td>
</tr>
<tr>
<td>June 5-6, 2002</td>
</tr>
<tr>
<td>June 11, 2002</td>
</tr>
<tr>
<td>October 3, 2002</td>
</tr>
<tr>
<td>May 21, 2004</td>
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</table>

<table>
<thead>
<tr>
<th>Activities concerning the staff at Teknikens Hus:</th>
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<tbody>
<tr>
<td>2001-2005</td>
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<tr>
<td>October 14, 2002</td>
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<tr>
<td>April 25, 2005</td>
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<tr>
<td>May 13, 2005</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Activities concerning the interview with Gunilla Jacobsson and Ann-Marie Israelsson:</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 17, 2004</td>
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</tbody>
</table>
Ownership of the interpreted meaning

The present research has its point of departure in an assumption of reality as experienced and experience of meaning as negotiated. This does also include the production and interpretation of research material. In the group interview conducted during the video session, knowledge was not ‘elicited’, but rather negotiated in a process with the researcher as a co-constructor. The interview is supposed to be what happens between different views – inter views – knowledge is built through the exchange of views (Kvale, 1999). In this context it is important to state that the interpretations of this co-construction are those of the researcher, and do not reveal the informants ‘true’ meanings. Edger & Fingerson (2002) argue that researchers can and should attempt to empower their respondents, particularly in research involving young people, even though the researcher holds the final power because it is they who do the interpretation and presentation of the data. To respond to the power differential between the researcher and the informants (and between adult and child), the informants in the present study got to represent themselves in their own words and actions through the enclosed video clips as much as possible. Therefore, the ownership of meaning is shared through the research design, though the researcher’s interpretations set the tone in the organisation of findings. However, this will of course be re-arranged and re-negotiated by the readers.

Once visual and other representations of ethnographic work have been produced and disseminated publicly neither author nor subjects of the work can control the ways in which these representations are interpreted and given meanings by the readers, viewers or audiences.

(Pink, 2001, pp. 43)

However, the use of the video clips in other contexts than this thesis is strictly forbidden.

Exploitation

All research is more or less exploitive in some sense, e.g. this research is a part of the researcher’s agenda to earn a doctoral degree. Sometimes it is recommended that researchers should give something back, that participants should be somehow empowered through the research or that the research should be directed towards the powerful not the powerless (Hammersley & Atkinson, 1995). However, the notion of giving something back depends on the idea of research as a ‘hit and run’ act, neglecting the interplay
between the informants and the researcher. The collaboration between the researcher and the teenagers participating in this study lasted for two years, and the collaboration with the staff at Teknikens Hus has been an on-going relationship. Although this approach does not remove the inequalities of research, merely trying to make it less exploitive may shift the ethical agenda. Ethnography is here seen as a process of collaboration and negotiation with informants, through which ‘they too stand to achieve their own objectives, rather than as an act of taking information away from them’ (Pink, 2001, pp. 44). The teenagers got the opportunity to represent themselves both in the production of the video films and in the group interview, the staff at Teknikens Hus got the opportunity to address a well known problem in the activities which they wanted to come to terms with, and the researcher got the opportunity to use the video clips as research material.

**Informed consent**

Research falling under the new Swedish law of ethical research involving human beings has to be conducted with informed consent from the informants. The informants should be informed, among other things, about the purpose of the research, the methods to be used, and the possible consequences and risks of the research. However, this may cause some problems for an ethnographer, since at least in the initial point of negotiating access, the researcher does not know in any detail the course the work will take. In this situation getting an *informed* consent from the informants will be very hard (Ryen, 2004). Thorne (1998) recommends the researcher to instead ask for ‘process consent’, i.e. consent to be involved in a research process, as is the case here with the consent given by the teenagers. Initially, consent was given by their parents and only included consent to participate in the project, without having to reveal the informants’ identities. However, the research developed to a point where the video clips became an essential part of how the findings could be represented. Actually, it was one of the informants who influenced the research into this direction. In connection to the video session the informants were again informed about the films not going to be published to secure their anonymity. At this point, one of the informants spontaneously replied that it would be more fun if they were, and the others agreed, thus becoming one of the strongest influences to shift the research agenda towards trying to use the full potential of visuality as a form of knowledge.
Harm to informants

The whole process of collaborating with the teenagers in this research was also a conscious decision to not produce a feeling with the informants that research was done to them. That feeling may certainly have consequences, since ‘being researched can sometimes create anxiety or worsen it’ (Hammersley & Atkinson, 1995, pp. 268). Certain features of how the informants were approached were used to give control and authority to them, such as how the letters were formulated.

In this study, I would like to hear how you, who are around 15 years old, talk about a visit to Teknikens Hus with peers of your same age. I would like to join this conversation, but it is up to you to direct it. For your help, you will begin by doing a video film about a visit to Teknikens Hus, which we will look at later. You will then get the opportunity to talk about the content of the films.

(from the first letter sent to the teenagers from the researcher)

During the video session the researcher was especially attentive to situations and comments that appeared to offend the informants. Pink (2001) suggests that research, harm and anxiety have to be understood from the informant’s perspective in the research context, instead of using a universal method of preventing harm. In visual ethnography, what a researcher needs to prevent harm from being caused is ‘a good understanding of local notions of harm and anxiety, how these may be experienced and how they relate to images’ (pp. 42).

The informants showed a relaxed attitude towards watching their performances in the videos, and instead seemed to enjoy the session and sometimes laughed and joked about what they saw. At some point, it seemed like one group had previously talked about a specific happening in their film as particularly funny, because when this specific scene appeared, one of the teenagers cried out, “Oh, look there she is!” All the others laughed at this situation in which a small girl asked how a door worked, and the informant on the video answered in a rather funny way. This situation may serve as an example of the teenagers actually feeling an ownership of the video, and the lack of anxiety in the presence of video images. This also indicates that the informants did not consider these films as mere research material, but rather as a way of expressing themselves as a mate in front of peers.
The notion of harm in the present research does not only refer to the informants, but also to Teknikens Hus. From the very beginning of this research project, Teknikens Hus was been anonymous as the place where this study was carried out. In fact, both the head of Teknikens Hus and her staff were forthcoming and interested in a better understanding of why teenagers in Luleå fail to visit. However, there may be ethical problems involved in research where institutions are pointed out. Oliver (2003) describes situations in which institutions suddenly have noticed that their portrait as depicted by the researcher does not appear positive throughout. This can cause mistrust against the researcher’s results. To prevent this from happening, the researcher took a collaborative approach towards the staff, both to inform how the research develops and to get useful feedback to findings and ideas. They were also invited to give a ‘second opinion’ on the video-clips, as described above.

This co-operation has made the staff conscious of how the research develops and eager to use findings in upcoming developments of exhibits. It is no secret that teenagers fail to visit, not only Teknikens Hus, but science centres as a whole. The staff reasoned that this is why it should not be a secret that someone is trying to investigate this issue. Here, this may actually produce good publicity for Teknikens Hus, since they want to collaborate with a researcher who wants to better understand the relationships of teenagers with science centres, a research question with bearing on their problem. Teknikens Hus seems to be an active institution that wants to develop and deal with their problems.

Where Teknikens Hus’ agenda and the researcher’s work meet, an ethical code has developed through collaboration and openness about the ethical issues. This code admits the researcher’s ownership of the research and freedom of speech. However, through collaboration during the research project, the staff has been able to benefit from the researcher’s work.
Part three

The teenagers’ agenda
This part will follow the same structure as the chosen perspective of how we experience the world and our engagement in it as meaningful, by the process of negotiating meaning and thus the formation of social identity. A central focal point is how this process of negotiation is distributed between reification and participation, where different mixes become differentially productive of meaning. Since they come as a pair, they form a unity in their duality.

Given one, it is useful heuristic to wonder where the other is. To understand one, it is necessary to understand the other. To enable one, it is necessary to enable the other. They come about through each other, but they cannot replace each other. It is through their various combinations that they give rise to a variety of experiences of meaning. (Wenger, 1998, p 62)

The findings from the present research will be presented below in three chapters: Forms of participation in exhibits, Ways of identifying exhibits, and Exhibits as active parts of meaning making. ‘Forms of participation in exhibits’ focuses on the actions of the teenagers in the exhibits during their visit and involves their practice and different forms of participation in exhibits as shown by them in the video-clips. In other words, their relationship to Teknikens Hus was demonstrated in the video-clips. An important feature of this analysis is that it is based on the researcher’s interpretation of the teenagers’ activities on the video clips that is grounded in the chosen theoretical perspective.

‘Ways of identifying exhibits’ involves the practice of the teenagers during the video session after their visit and how it dealt with the on-going formation of social identity. How the teenagers identified the exhibits during the group discussion contextualized their relationship to the science centre, and how they identified the exhibits is here regarded as reifications of their science centre-visiting practice. This part of the results is crucial in establishing the participatory approach taken in this research, since it is based on the teenagers’ perspective on their activities.
Finally, ‘Exhibits as active parts of meaning making’ deals with how the exhibits invite the teenagers into a negotiation of meaning in their practice. The results basically consist of a cross-reference between the findings presented in the two earlier chapters and therefore provide an integration of the two represented perspectives. This integration enumerates how research material gains new uses and meaning as it evolves into different contexts. This integrating analysis of the results from the first two chapters makes use of this process to provide a better understanding of teenagers’ encounter with science centre exhibits.

An overview of the findings indicates that a meaningful relationship between the teenagers and the exhibits may be characterized in terms of openness and closeness. To negotiate the meaning of the exhibits, an openness that may be constrained by too inflexible and limiting exhibit designs is needed. At the same time, meaningfulness demands a closeness created by connections between the exhibit and the user’s personal experiences. Exhibit activities that are open to personal interpretations and offer personal experiences create a space of negotiation. In this space, teenagers have the authority to contribute to the meaning of their activities through the use of the exhibits as tools. Providing this space seems to be crucial to inviting visitors into opportunities for meaningful experiences, even more significant than any specific physical feature in the exhibit.

**FORMS OF PARTICIPATION IN EXHIBITS**

This first part of the video clip analysis regards the ‘image itself’ and how the researcher interprets the performed activities. The different forms of participation demonstrated by the teenagers in the video clips show several qualities of how open the enabled activities are towards negotiating the meaning of the exhibit. These forms of participation inform the process of transforming knowledge and meaning-making in different ways.
Participation shapes the experiences of practice, as well as the practice itself, e.g. when the teenagers approach a drinking fountain in the video film (picture 13). The teenagers revealed during the video session discussion that they thought the drinking fountain was an exhibit.

Rebecka: We didn’t understand this one either.

Kim: You are supposed to drink from it.

Rebecka: Oh yeah? (laughing) I thought it was one of those see-things!

Seemingly, one aspect of the teenagers’ science centre practice is to automatically confront objects with buttons as if they were exhibits. This form of participation was used due to their practice at the science centre, though it makes them consider the drinking fountain as an (incomprehensible) exhibit.

In this way, their participation both shapes their practice and their experience of practice; it becomes a constituent of meaning. Another important aspect of their participation experience is their ability (or inability) to shape their practice. However, this was only one example of the different ways the teenagers participated in the exhibits.
The following is a complete list of the different forms of participation represented in the video clips, as interpreted from the researcher’s perspective. The ‘modalities’ describe different distinguishing activities occurring in the forms of participation. Visual accounts are given in pictures 14 – 17, along with examples of each form of participation. Furthermore, the ‘example exhibits’ presented in Table 5 can be viewed ‘in action’ on the website: http://www.vaike.se

Table 5 Different forms of participation, their different modalities and examples of the teenagers’ action in exhibits in the different modalities

<table>
<thead>
<tr>
<th>Forms of participation</th>
<th>Modalities</th>
<th>Example exhibits</th>
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<tbody>
<tr>
<td><strong>Hands-on</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teenagers moving directly to</td>
<td>Button Pressing</td>
<td>Photo booth Shadowgraph</td>
</tr>
<tr>
<td>the exhibit controls and</td>
<td>Body Using</td>
<td>Seesaw Bike</td>
</tr>
<tr>
<td>more or less ignoring the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>intended meaning of the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>exhibit</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Playing around</strong></td>
<td>Game Playing</td>
<td>Car Boats</td>
</tr>
<tr>
<td>Teenagers converting</td>
<td>Fun Making</td>
<td>Mine drill Wave machine</td>
</tr>
<tr>
<td>exhibits into something</td>
<td>Fault Finding</td>
<td>Gold washing Cock-pit line</td>
</tr>
<tr>
<td>other than intended</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Process over time and cross space</strong></td>
<td>Back Tracking</td>
<td>Lumber forwarder Key</td>
</tr>
<tr>
<td>Teenagers extending the</td>
<td>External</td>
<td>Paper mill 1 Circuit card</td>
</tr>
<tr>
<td>intended meaning of</td>
<td>Elaboration</td>
<td>Paper mill 2</td>
</tr>
<tr>
<td>exhibits</td>
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</tbody>
</table>

These different forms of participation can be seen as connected to how the teenagers were able to negotiate the meaning of the exhibits in their activities. In some cases involving ‘hands-on’ and ‘playing around’ participation, this becomes a form of non-participation, especially in the modalities Button Pressing, Fun making, and Fault Finding. It seems like the communicative activity of exhibits depends on how the work of negotiation of meaning is distributed between the artefact and the participation in the exhibit. Different mixes become differentially productive of meaning and subsequently depend on what degree the exhibit invites negotiation of meaning.
The following figures and text will try to explain this process further. The exhibits are here drawn as squares with the varying thickness of the border depending on the degree the meaning of the exhibit is closed or open for negotiation in the teenagers’ activities; closed is marked as a solid line and open is subsequently marked as a dashed line. The persons drawn in the figures are either turned towards or away from the exhibit. This does not simply indicate a physical movement of the teenagers in the video clips, but how they turn to or from the exhibit in a figurative sense, i.e. emotionally, cognitively, and with their bodies and senses.

For instance, in ‘hands-on’, the represented exhibits often reify the whole intended meaning-making process, where all you have to do is ‘press the button and see what happens’. As a user, you cannot affect the outcome. The afforded activities are rather inflexible and create but a small space for negotiation of the intended meaning. Hence, the teenagers simply ignored it.

![Figure 2](image)

**Figure 2** The ‘hands-on’ exhibits are closed for negotiation of meaning in the afforded activities

In contrast, the lumber forwarder in ‘process over time and across space’ is installed so that the teenagers can use it with real lumber, with the next step of action being up to the user to decide. In these cases, the teenagers extended the intended meaning.
In ‘playing around’, the intended meaning of the exhibit was converted into something completely different. The exhibits are not used as active parts of science centre related activities.

Figures 2 and 3 show how the possibilities to re-negotiate the meaning in the exhibits vary, depending on how closed or open (in terms of flexibility) the afforded activities are in relation to this process. Figure 4 shows how the ‘playing around’ form of participation differs from the other two figures.
The teenagers do not primarily use the exhibit as an active part of the meaning of the activity, but instead are the activities oriented toward the video camera.

The following describes the connections between the form of participation and the situated meaning of the artefacts created in these activities, analytically extracted from the research material.

**Hands-on and the ignorance of the intended meaning**

‘Hands-on’ represents a closed and rather inflexible form of participation in the exhibit, i.e. the teenagers do what they are supposed to do, technically speaking, but no more, no less (or sometimes less). Thus, the intended meaning of the exhibit is more or less ignored; the main focus is on how to master the exhibit that becomes the negotiated meaning in that context. Clearly, not participating is also a way to participate, which in this category becomes evident at the exhibits where the effect of button-pressing is delayed (picture 14).

The more ‘body-on’ exhibits like the seesaw or the ‘whisper dishes’ are more rewarding, i.e. they give immediate feedback to your actions. Still, they are similar to the ‘hands-on’ exhibits in how they are closed for re-negotiation of the intended meaning and do not afford any flexibility in the activities.

**Playing around and the conversion of the intended meaning**

In ‘playing around’, the intended meaning of the exhibit is converted into something else. The actions of the teenagers in the exhibits are not only about mastering what you are supposed to do; they are also about doing something completely different. In other words, the exhibit is not so closed for negotiation that there is some space for one’s own initiatives regarding what you can do (picture 15).

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57 ‘Body-on’ is a travesty on the concept of ‘hands-on’, used here to describe the exhibits that invite the user to use their whole body in the activities.
In this form of participation, the teenagers’ action seems to be most dependent on the presence of the video camera. The teenagers later describe during the video-session how they usually do not act like this in the exhibits, ‘if we wouldn’t have had the video camera with us on this visit, we probably wouldn’t have played in the cockpit, for instance’. Even though the meaning of the activity seems to be more oriented towards producing a film than participating in a science centre exhibit, it does say something of how a teenager can act during a visit.

Rennie & McClafferty (2002) suggest that all play in a science centre is not learning, though much learning is associated with play. Their suggestion is based on Hutt’s taxonomy of play (Hutt, 1981). Play is classified into two major divisions: epistemic (child acquires information) and ludic behaviour (child engages in self-amusement). The implicit question in the child’s mind during epistemic play is ‘What can this object do?’, whereas in ludic play it is ‘What can I do with this object?’. Rennie & McClafferty paraphrase these two questions as ‘What can this exhibit do?’ and ‘What can I do with this exhibit?’, as a useful way of thinking about children’s interactions with exhibits. They suggest that epistemic behaviour is more likely to be associated with learning, and ludic behaviour with self-amusement.

The teenagers’ play in this category correlates with ludic behaviour, echoing how they played at the exhibits when they were smaller or making fun of the exhibits through comments and actions considered ironic, irrelevant or both58.

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58 From the science centre’s perspective.
Extending the intended meaning – a process over time and across space

In ‘process over time and across space’ the intended meaning of the exhibit is absorbed and extended by the teenagers. When acting in these exhibits, how they tend to organize the meaning making process is not limited by time or space. Instead, the event becomes part of a learning trajectory integrated in the practice of actually extending the meaning, and hence becomes meaningful not only in this specific activity, but also to whom they are. In addition, the intended meaning behind the exhibit seems to fit more easily into this process and become a point of interest and a point of departure when negotiating how it can be important and meaningful together with other contexts (picture 16).

The learning may seem unpredictable, with the results indicating that the learning opportunities supported by these exhibits had as much to do with the way the teenagers participated, as it had with the exhibits themselves.

Furthermore, how that learning experience then comes to be integrated into new and old ways of knowing is also unpredictable, yet very much at the heart of the matter if we perceive learning as a continuous process of becoming rather than the mere accumulation of facts.

(Rahm, 2003, p 243)

However, the forms of participation that support the extension of the intended meaning are concerned with how open they are for negotiating the meaning. In other words, the degree teenagers use the exhibits as active parts in the negotiation of meaning of the activity is closely linked to how they find themselves enabled to do more than what is possible at a first glance (picture 17).
- And now…?
- OK.

- What’s happening?

- Come on, let’s go.

Picture 13  The meaning of an artefact is not a physical object with one predetermined use. The teenagers approached the drinking fountain as if it was an exhibit. They pushed the button, looked at what happened and then moved on; one way of participating in exhibits that partly shape their science centre-going practice.
(Walks up straight to the exhibit and pushes the button)

- Boring. (Turning away)

- No wait. Look.
(A hasty look and then turns away anyway.)

Picture 14: An example of how the intended meaning is ignored. The meaning of an exhibit may be negotiated on different levels; the issue dealt with through the exhibit or the issue of how to deal with the actual exhibit. The ‘hands-on’ participation afforded in certain exhibit may sometimes become the main issue, and if this way of participation fails to give an immediate effect the participation transforms into a sort of non-participation (the user leaves without investigating the exhibit any further).
- Do you get any fish, Emil?
- No, it’s not going that well.
- What kind of bait do you use?

- I think it is too cruel for the worms, so I don’t have any bait.
- Ok.

- Now I got some fish! Oh no, it got away.

Picture 15  An example of how the intended meaning is converted. Bringing a video-camera made the teenagers look for alternative ways of using the exhibits, expanding and converting the meaning. These ways of participation are probably not what they would usually do in the exhibits, but it give examples of what may happen if another artefact (the video camera) is brought into the practice, changing the conditions for the setting.
- (giggle) You always did this when you were small.

- Aha, is that why it sounds like that when you put in the key?
- Yeah.

- I have never realized that.

Picture 16  An example of how the intended meaning is extended over time. One of the girls describes how this specific exhibit fits into her previous experiences of Teknikens Hus (in a significant way) and provides a context for the other girl to (1) recognize it as relevant and (2) acknowledge what can be learnt through its use.
- I want to do paper. Press!

- A lot of paper must be wasted here.
- Yes, people just throw away their papers.

- This is the funniest part.
- Should we try and fold it and press a flower in it?
- Yeah, clever idea.

Picture 17  An example of how the intended meaning is extended. The Paper Mill offers possibilities to contribute to the meaning of participation in it, since it includes manufacturing features, i.e. ways of expressing an individual account for it. In this way, it opens up for both connections to other issues (the paper-waste) and extension of the meaning (flower-pressing).
Questions of orientation in the activities

This analysis of the video clips has divided the research material into three qualitatively different categories, all related to the issue of the possibilities to form activities in which the situated meaning of the artefact is negotiable. In this section, the issues of what effect the site of production may have had on these results are discussed.

![Diagram](Image)

Figure 5 The results of the image analysis are connected to the site of production in the analytical structure used in this study. Compared with the figure showing the analytic structure as a whole.

As previously discussed, this analysis has had to be sensitive toward what the teenagers are oriented when filming their activities at the science centre. Note that in the above results, the category 'playing around' provides examples of certain exhibit activities where the teenagers are more oriented towards establishing themselves as 'film producers' rather than 'science centre visitors'. This conclusion was also supported by the staff at Teknikens Hus, who singled out the following video clips as showing activities not normally performed by visiting teenagers: The Car, The Wave Machine and The Erosion Table. The researcher already categorized these three video clips as belonging to the 'playing around' category.

Since this study is concerned with teenagers’ relationships to science centre exhibits, it was determined that the category ‘playing around’ did not support the purpose of the research based on the researcher’s interpretations and staff comments.
WAYS OF IDENTIFYING EXHIBITS

This second part of the video clip analysis regards the ‘audiencing’ of the video clips during the group interview attended by the researcher and all the informants. While the former part of the results concerned the researcher’s perspective on the video clips, this part concentrates more on the informants’ perspective.

The video session and group interview held with the teenagers after their visit to Teknikens Hus provided possibilities to better understand what the exhibits meant to them as a collective. In this practice, they communicated themselves as science centre-goers, using the video clips to represent their social identity in relation to Teknikens Hus. Audiencing the video-clips co-constructed the social identities, as well as contextualized and personalized the meaning making given form in the different ways they participated in the exhibits. The following extract is taken from a situation during the group interview, while viewing a video clip showing staff and a group of small children when they interacted with an exhibit together. The clip is taken from a rather long distance, and it is obvious that the filming teenagers did not join the closer audience.

[Talking about the Rocket Launch]

Kim: This one is striking. Something happens. You can do something yourself.

Emelie: I don’t think it’s good. You realize what is going to happen.

Kim: But small children don’t understand, they think it’s great. They get curious about what is going to happen.

Simon: I think they understand what is going to happen, but they think it is funny anyway.

It seems that to know beforehand what is going to happen can be fun for small children, but not enough for the teenagers. They discuss features (‘something happens’ and ‘you can do something yourself’) that provide small children with excitement and interest in this exhibit, though their own relationship to it is a bit more distant. This is also mediated in how they positioned themselves while filming the event. They seem to agree
upon the fact that this exhibit (the Rocket Launch) is ‘striking’, though it is not relevant for them because ‘you realize what is going to happen’. This discussion contextualizes Kim’s somewhat appreciating opening comments about the exhibit, suggesting that as exciting as the exhibit may be, it will not capture the interest of the teenagers. It simply does not provide a site for social development. In this negotiation of social identity, the teenagers define which meaning matters to them and constitutes the context in which they define their membership in this practice, their identity of participation.

The analysis results of the communication during the video session arrange the teenagers’ discussion of their actions in the exhibits in terms of how they identified them. In this identifying process, they position themselves in relation to the exhibits, i.e. ‘childish exhibits’ are not generally childish, but merely indicate exhibits perceived as childish by the teenagers in the present study. Certain exhibits are co-constructed and agreed upon as ‘childish’, with others being, for example, ‘exciting’. In other words, the teenagers formulated how they identified themselves as a collective through the exhibits. Specifically, it may or may not be the actual exhibit (like the Dummy) that is childish. However, there is something about the Dummy that this group of teenagers probably does not accept as a site for social development. These relationships, expressed as ways of identifying the exhibits, position the teenagers at a certain distance to the exhibits, described in Table 6 as ‘forms of relationships’.

Table 6 Different forms of relationships, different ways of identifying the exhibits and examples of teenagers acting in exhibits described in these ways

<table>
<thead>
<tr>
<th>Forms of relationships</th>
<th>Ways of identifying exhibits</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exhibits that teenagers dissociate from</td>
<td>Boring</td>
<td>Wave machine</td>
</tr>
<tr>
<td></td>
<td>Childish</td>
<td>Dummy</td>
</tr>
<tr>
<td></td>
<td>Too simple</td>
<td>Platform New Zealand</td>
</tr>
<tr>
<td></td>
<td>Mechanical</td>
<td>Cock-pit</td>
</tr>
<tr>
<td></td>
<td>Incomprehensible</td>
<td>Remote-controlled mine drill</td>
</tr>
</tbody>
</table>
Consumed Boats
Traditional Car
Improvable Lumber forwarder

Exhibits that teenagers have an on-going relationship to

<table>
<thead>
<tr>
<th>Exciting</th>
<th>Maze</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensible</td>
<td>Key Paper mill</td>
</tr>
<tr>
<td>Realistic</td>
<td>Lumber forwarder</td>
</tr>
<tr>
<td>Affectable</td>
<td>Paper mill</td>
</tr>
<tr>
<td>Connectable</td>
<td>Paper mill Stone cave</td>
</tr>
</tbody>
</table>

How the teenagers identified the exhibits is here regarded as reifications of their practice during the video session, i.e. focusing on which negotiation of meaning becomes organized. The reifications show different qualities regarding the distance the teenagers put between themselves and the exhibits.

The following figures and text will try to explain this process further. The exhibits are here drawn as squares. The persons in the figures are drawn as either turned towards or away from the exhibit from a certain distance. This does not simply indicate the physical distance and movement of the teenagers in the video clips, but how they turn to or from the exhibit from a certain distance in a figurative sense, i.e. emotionally, cognitively, and with their bodies and senses.
The distance to the exhibits created by the teenagers when positioning themselves towards them during the video session is linked to how much the exhibit matters to them as a collective.

![Diagram](image)

*Figure 6* The exhibits that the teenagers dissociated from are here identified as boring, childish, too simple, mechanical or incomprehensible. Through these descriptions the teenagers positioned themselves at a distance from the discussed exhibits.

The exhibits characterized by ‘complete dissociation’ seem to have little relevance to the teenagers, in contrast to the exhibits where they experienced an ‘on-going’ relationship.

![Diagram](image)

*Figure 7* The exhibits to which the teenagers had an ‘on-going’ relationship are here described as comprehensible, realistic, affectable and connectable. These descriptions established the teenagers as using the exhibits as active parts in the meaning making activities.

An on-going relationship indicates some sort of process; hence, these exhibits provided a place or a context where they could identify themselves as *participating* learners. In other words, the distance the teenagers literally put between themselves and the exhibits is closely linked to how they are able to identify themselves as a collective participating in the exhibits.
The third category of exhibits, to which the teenagers expressed a ‘nostalgic’ relationship, differs somewhat from the other two. A nostalgic relationship seems to somehow connect to things they have previously done with the exhibits, though this is described in the past tense; their past is disconnected from the constitution of their participation today. In a way the teenagers are not even remotely present (as is the case of the ‘dissociating’ category). They talk about and describe the exhibits, not what they do today and why in the first place, but rather assess the roles of the exhibits as they used to be. This positions the teenagers in a distant distance towards the exhibits, since they do not describe their actual activities in the video clips as such.

![Exhibit]

Figure 8 The exhibits to which the teenagers had an ‘nostalgic’ relationship are here described as consumed, traditional and improvable. In this case the teenagers position themselves in a ‘distant distance’ toward the exhibits, talking about them in the past tense, like things you used to do.

These descriptions are described in more detail below, with special attention given to how they relate to the negotiation of social identity.
Exhibits that teenagers dissociate from

Dissociation from the exhibits describes a kind of expressed non-relationship to the exhibits, based on an understanding of the intended meaning of the exhibits as something that is not available or desirable to the teenagers for a certain reason. In these exhibits, the teenagers acknowledge an intended meaning, though they ignore it in different ways. They occasionally assign other meanings to their activities. In boring exhibits, there seems to be no point in doing what you are supposed to do:

[Talking about the Wave Machine]

Emil: Here, we’re playing. We usually don’t stand here and fish in that thing. It’s one of those ‘wave things’.

Kim: We stopped here because it looked so fun with a float. Otherwise, this one is also boring; you just stand here and make waves.

Rebecka: We were only wondering why there was a float there, we thought it was strange.

Emil: After, we tried to make waves as big as possible, and splash people walking by.

The dissociation with the exhibits also includes descriptions of experiences more closely linked to the teenagers expressed self-images. For instance, childish exhibits reveal the notion of Teknikens Hus as something for younger children:

[Talking about the Dummy]

Kim: She is not moving her lips; that is unreal.

Researcher: Is this one dorky?

Rebecka: Yes, it is a bit dorky.

Kim: When we went there for the first time, she [the dummy] said ‘hi’ like this, and then something else. We wanted to put this on film. So, we were just supposed to walk by and when she said ‘hi’, Emil was going to say ‘hi’ back directly to her. But then she said something else, and we were taken a little aback.
Emil: I think it is a good thing instead of having an explanation text; it is actually a good way of grabbing peoples attention. Something to focus your eyes on.

Rebecka: I don’t think it is more dorky than anything else, I mean not in Teknikens Hus. It feels like everything is adapted to 8-9 year olds.

Too simple exhibits are described in a somewhat similar way, even though the focal point is directed more towards the (lack of) complexity in the exhibits.

[Talking about the Platform New Zealand]

Rebecka: Well, you were supposed to place yourself behind the earth globe, but we didn’t bother.

Emelie: You were supposed to direct that thing and tune in a picture on the TV screen. That was what we tried to do.

Rebecka: It said that you had to stand, like, behind the earth globe.

Emelie: Yes, because there were some kind of video camera placed there.

Rebecka: But we didn’t bother.

Researcher: Why didn’t you bother, what was it that didn’t make you want to be there?

Rebecka: I suppose you understood that you were going to see yourself [on the TV screen]; there was nothing more to it.
This group of reifications also includes exhibits whose intended meaning is experienced as unavailable due to technical features, such as the mechanical exhibits that simply require you to manipulate different sorts of controls, without any possibilities to make it personal.

[Talking about the Cockpit]

Emil: The cockpit is a quite good feature, but it would be nice if you could do something for yourself. Because it is merely just about pushing buttons that flash. There is nothing really more to it.

Simon: Yes, something should happen when you pull those [levers], you know!

Some exhibits are not only identified as mechanical, but also as incomprehensible exhibits. The technical features are described as something you have to manipulate, even though (or maybe just because) you do not understand why.

[Talking about the Remote-Controlled Mine Drill]

Rebecka: We didn’t understand anything of this one.

Researcher: What do you do there?

Emelie: I don’t know what it was.

Rebecka: There were a lot of buttons.

Emelie: But what was it about? I haven’t got a clue.

Rebecka: It was something you were supposed to steer. It was like one of these exhibits you don’t understand, and there was a lot of text that you couldn’t be bothered to read. If you understand right away from looking at it, then you will stay and look.

Researcher: However, you stood and watched quite a long time?

Rebecka: That was because there were a lot of buttons to push. You have to try them all.
Eckert, Goldman & Wenger (1997) argue that the social dimensions of learning have to be taken seriously, because ‘no amount of clever delivery of subject matter will capture the imaginations and energies of students who feel that their opportunities for social development lie elsewhere’ (pp. 2). Maybe it is simply due to the lack of possibilities for social development, like the teenagers at the wave machine who think it is boring because ‘you just stand here and make waves’, that makes them dissociate from the exhibits described above. The feeling that ‘everything is adapted to 8-9 year olds’ probably reinforces the experiences of dissociation.

### Exhibits that teenagers have a nostalgic relationship to

‘Nostalgia’ describes a relationship to the exhibits based on the frequent childhood visits to Teknikens Hus by these teenagers. Understanding the meaning of these exhibits is formed through a process over time, involving a relationship with nostalgic qualities. In the consumed exhibits, these qualities were described by the teenagers as something they could better appreciate when they were younger.

[Talking about the Boats]

Rebecka: I always go to the boats. When you were smaller, they were the funniest. Usually, there are so many people there, so you don’t...

Kim: We used to race with the boats.

Emil: I think they were faster before. Or maybe it was me who was smaller.

The nostalgic qualities were also described as the main reason to go to certain exhibits, here called traditional exhibits.

[Talking about the Car]

Researcher: Why did you go to the car?

Emil: It is rather funny.

Kim: To sit in the car is a classic.
*Improvable exhibits* have similarities with those consumed and traditional, but the difference lies in the way the teenagers describe how these exhibits can be improved.

[Talking about the Lumber Forwarder]

Simon: But you should be able to actually do something too. Usually, you can pile logs up or...

Emelie: So that you get a little bit challenged.

Emil: Or put a tennis ball into a tube using a tractor.

Simon: Yes and then you can pile up the tree stubs.

Emelie: It is a bit boring just moving logs around.

The exhibits in this group may serve as examples of how the teenagers establish themselves as visitors at Teknikens Hus. They describe themselves as visitors in the past tense, e.g. certain exhibits ‘were’ the funniest, while describing how they ‘always’ go to certain exhibits even though they are now perceived as a ‘bit boring’.

**Exhibits that teenagers have an on-going relationship to**

A ‘present’ relationship to the exhibits might be characterized as something on-going. Common to the examples below are the way they indicate a process, indeed linked to the teenagers’ negotiated experience of self during their encounters with the exhibits. These exhibits are mainly characterized as providing teenagers the possibilities to somehow personally represent themselves. Their descriptions of these exhibits are not formed around an intended meaning as something you do not want to deal with, as in the first category (where they dissociated from the exhibits). Instead, they seem to feel that they are able to use the exhibits to form meaningful activities, such as the *exciting exhibits* that are identified as something you can actually be good at (which is also identified as the meaning of the activity).

[Talking about the Maze]

Emil: This one is good.

Rebecka: This is also one of those where you can do something for yourself; those are the funny ones.
Researcher: What do you mean 'do something for yourself'? Is there a difference between this and the paper mill?

Emil: This is like sport.

Rebecka: It is your own actions that have to carry it out.

Researcher: You said it is like sport?

Emil: Yes, it becomes like that, it becomes a game. As a matter a fact, it is a game. Therefore, it is fun. You can compete.

Comprehensible exhibits are identified as places where you can actually see how things work and therefore support an understanding about the issues the exhibits are intended to illustrate.

[Talking about the Key]

Emil: There is a bit of nostalgia in this thing. You always go there.

Researcher: Have you played with this one before?

Rebecka: You always go there. You always have.

Emil: It’s good, because here you can see what to do. In this exhibit, I once realized why it sounds like that when you put the key in...

[Talking about the Paper Mill]

Researcher: Is this exhibit good?

Rebecka: Yes.

Emil: It is extravagant.

Rebecka: And you get to do things yourself. You really see how it works. Actually, I think that it is very good. It’s among the funniest.

Researcher: Why is this one funny?

Simon: I think it takes too much time.

Rebecka: See, here everything gets done, it becomes paper.
To get the opportunity to try and improve in something in a rather open and playful manner (not constrained by the exhibit design) is a process supported in realistic exhibits.

[Talking about the Lumber Forwarder]

Emil: Here, you also get the opportunity to do something.
Kim: You have to play.
Emil: Playing and learning. It is always like that. And it is fun too because it is so realistic. It is not a controlled process. You get to do what you want to do. You can be good at it. Get to learn.

The identification of realistic exhibits touches on the subject of authencity. This is further elaborated in the affectable exhibits, where the teenagers address the possibility to make a unique, personal contribution to the meaning of the exhibit. This process creates an experience of engagement.

[Talking about the Paper Mill]

Researcher: What is it that creates engagement?
Kim: That something happens. That you can control what happens.
Researcher: What does it mean to do things?
Rebecka: Something happens through you own actions.
Emil: This [the Paper mill] is more real. It wouldn’t be so much fun to make paper if you press a button and than see what happens on a TV screen.
Kim: Nope. Like a simulator.
Emil: We never looked at the logs in the saw mill.
Rebecka: What happens there is very much the same, regardless of who is doing everything. It has to be more personalized.
Kim: Different outcomes every time.
‘Exhibits that teenagers have an on-going relationship to’ all indicate some kind of process involved in the descriptions. For instance, the process of personalizing is to have ‘different outcomes every time’ and that it ‘is your own actions that has to carry it out’. Or a manufacturing process where ‘everything gets done’, and other processes where you can improve and ‘be good at’ something.

The connectable exhibits differ somewhat from the others in how the teenagers integrate them in their lives and build up connections both across space and over time.

[Talking about the Paper Mill]

Rebecka: We went to a paper mill on a field trip in school. They had much larger machines. They told us about everything, and it is the same thing here.

Researcher: Why did you go there [to the paper mill exhibit]?

Emelie: Because it is fun, and because you’ve always gone there.

Researcher: You said before that you have a routine that you do. Is it the same routine every year?

Emelie: Yes, it has almost become that way.

Emil: It is quite fun to get something that you have done for yourself.

Kim: My mother has a picture in her room that I did on this kind of Teknikens Hus-paper. Before, it was brown.

[Talking about the Stone Cave]

Rebecka: Yes, here we are looking for magnetite. To our magnet. But we didn’t find it.

Researcher: Why did you look for magnetite?

Emelie: We were supposed to report on magnets and stuff [in school]. Because of that, it is fun to see.
Individuals learn in the interest of participating in communities that matter to them, to gain access to valued forms of community participation. These latter exhibits may be sites for this process due to the experienced possibilities for personal contribution, ‘like something happens through your own action’. The Lumber forwarder seems to reward by allowing the teenagers to see their contribution (‘it is not a controlled process, you get to do what you want to do’), to know that others recognize their contribution (‘you can be good at it’) and to forge a changing sense of themselves (‘get to learn’). Other ways of representing themselves are given by competitive features (the Maze), manufacturing features (the Paper Mill) and exhibits they deliberately select because of personal motives they want to express (the Stone Cave).

The different forms of participation analysed by the researcher in the previous chapter relate to the process of forming social identity as verbalized by the teenagers, which appears more evident in this chapter.

**Questions of orientation in the group interview**

An analysis of the communication in the group interview has divided the research material into three qualitatively different categories, all related to the issue of identifying the exhibits in relation to teenagers’ social identity and how they position themselves in certain exhibits. This section contains many issues of what effect the site of production may have had on the discussed results (based on the same principles as the first chapter of the results).

As previously discussed, the analysis has had to be sensitive to not only what the teenagers are oriented towards when filming their activities at the science centre, but also to what they are oriented towards when discussing the video clips in the group interview. The results above highlight that the category ‘nostalgic relationship’ provides examples of discussions in which the teenagers do not position themselves as either using the exhibits in ongoing activities or dissociate from them. Instead, they place a ‘distant distance’ between themselves and the activities in the exhibits by discussing them in the past tense. This way of describing these exhibits and their activities indicates an orientation in the discussion towards something other than the actual activities happening in the video clips. The informants initially seem to situate themselves with respect to the research situation in this case, and not the action in the video clips.
Since this study is concerned with teenagers’ relationship to the science centre exhibits, it was decided that the category ‘nostalgic relationship’ did not primarily support the research purpose based on the researcher’s interpretations.

EXHIBITS AS ACTIVE PARTS OF MEANING MAKING

The last section of the findings deals with how the exhibits support the teenagers’ practice. The different forms of participation showed how the teenagers extended the meaning in certain exhibits and not at all in others. During the video session the teenagers identified a present and on-going relationship to some of the exhibits, and completely dissociated from others. Clearly, some characteristics to an exhibit in action are more desired than others. The findings emphasize the importance of a present and on-going relationship as a provider of context, promoting participation that appears meaningful to the teenagers.

Negotiation of being a teenager visiting Teknikens Hus

Evidently, the teenagers’ practice during the group discussion is mainly organized around descriptions of the exhibits, providing a sense of what matters to them in their social identity as youth visiting Teknikens Hus. The negotiation of their social identity experiences becomes noticeable in the interplay between the teenagers and the researcher.

[Talking about the creativity]

Researcher: Some of you said before that technology is when you construct something and when you are creative in some way. What do you say – is that something you do at Teknikens Hus?

Emil: I think you are rather passive.

Kim: If we didn’t have had the camera with us during this visit, we wouldn’t have been playing in the cockpit, for example.

Researcher: What would you have been doing instead?

Kim: Nothing.
Emil: Sitting on a bench waiting for the time to end.

Researcher: Is that right? You become passive?

Emil: I think it is the small children who are active and run around. But in a rather short while, you have done all the things a couple of times. Like when I was small, then I could run around for hours there.

Kim: Everyone had their favourites there.

Rebecka: When you were small you maybe looked at all the exhibits, but you played around in the centre even more. Hide-and-seek, rode the elevator, hanged on the edge of the mine lift. Things like that; used the exhibits to play other things, you know.

This practice not only seems to be about making meaning out of the issues handled in the exhibits, it is also about negotiating how Teknikens Hus fits into their world. A social identity does not mean that all members of a community look at the world in the same way. Nonetheless, it does manifest itself in a tendency to lead to certain interpretations, to engage in certain actions, to make certain choices, to value certain experiences – all by virtue of participating in certain enterprises (Wenger, 1998).

If the setting does not support the formation of social identity, it becomes meaningless, and you find yourself ‘sitting on a bench waiting for the time to end’. Small children are instead supported in their social enterprise, as in playing hide-and-seek (something they do in other contexts too). Teknikens Hus provides a setting for them where they can continue doing (and developing) what they usually do – in this case, playing games. Indeed, playing is an important site for social development, especially for smaller children. Apparently, Teknikens Hus does not provide a suitable setting for what teenagers would normally do, except if they bring along a video camera.

Researcher: What’s the point of visiting, if you have a certain routine you always do?

Kim: I would never voluntarily visit Teknikens Hus just to visit. To me, it feels like there is no point going there anymore.

Rebecka: You know that routine.

Emil: You don’t go there just for fun.
Rebecka: You would never go there in your free time. If you are forced to go, you do what you always do.

Emelie: But if you come across new things, you try them too. Then it becomes a little bit new anyway.

A certain understanding of each exhibit is formed in the group discussion, which then becomes a focus and a context for the on-going negotiation of meaning that is then integrated into the teenagers’ practices when participating in these science centre exhibits. For instance, what constitutes a ‘boring exhibit’ is always defined regarding specific forms of participation that contextualize its meaning. An exhibit identified as ‘boring’ in a form of participation ignoring the intended meaning differs from a ‘boring’ exhibit in another form of participation supporting the conversion of the intended meaning (e.g. how the teenagers’ actions in the hovercraft and the wave machine differ in the research material). This is an example of how participation and reification accomplish the process of making the world appear meaningful and how the researcher’s and the teenagers’ perspectives on the content of the video clips may be integrated in the results analysis of this study.

Figure 9 The structure of the analysis performed in this study suggests an integration of the different perspectives from the video clips. These are provided by the research situation (site of production), the researcher’s perspective on the image itself, and the teenagers’ perspective verbalized when audiencing the video clips.
The exhibits simultaneously described as ‘hands-on’ (in the first section) and ‘exhibits that teenagers dissociate from’ (in section two) will not support any form of participation, but will more likely contribute to the development of an identity of non-participation. However, the exhibits analysed as belonging to the category ‘process over time and across space’ in the first section as well as ‘exhibits that teenagers have a present relationship to’ in the second section seem to have a greater potential to be somewhat significant to the teenagers, which is one important part of supporting learning processes. This integration of the different forms of participation in the video clips, as interpreted by the researcher, and the teenagers’ perspectives on what the exhibits mean to them from the group interview analysis is further elaborated in the next section.

How the site of production has influenced the analysis of the results was dealt with in previous sections regarding the orientation of the activities in the video clips and the group interview. In short, this has resulted on only two of the three categories regarding the analysed forms of participation in exhibits and the ways of identifying exhibits being emphasised upon. Hence, it has been suggested that the ‘playing around’ form of participation and the ‘nostalgic’ way of identifying exhibits do not support the present analysis based on the proposed research purpose, and are therefore temporarily left aside.

Enabling, constraining, and rewarding exhibits

The intersection of the results from the video clips and the audiencing yields a) activities described by the researcher as oriented towards the intended meaning of the exhibits that are either ignored or extended, and b) activities identified by the teenagers in relation to how they find them meaningful. Their relationship to these exhibits is characterized as something on-going or by complete dissociation.

Ten exhibits organized in a system of co-ordinates are presented in Figure 10. The horizontal axis represents these two forms of relationships to the described exhibits (Table 6, pp. 104-105) and the vertical axis represents the two forms of participation and handling of the meaning of the exhibits (see Table 5, pp. 91). The system of co-ordinates allows for these two analytical findings to be cross-referenced to find out what kind of exhibits fall under the different combinations of qualities. The bracketed numbers indicate how each exhibit is classified according to the classification scheme.
constructed by the Head of Exhibit Development at Teknikens Hus (see Table 1, pp. 24). This way, each combination of qualities (captured in the different quadrants) distinguishes the exhibits in terms of how the teenagers described them and acted in them. After the exhibits in the different quadrants were analysed, they were characterized as enabling, rewarding or constraining. Some of these exhibits are more extensively elaborated in part one of the present thesis. All exhibits are described in Appendix A and can be viewed in action at the website: http://www.vaike.se

Figure 10  Different exhibits (and the actions they represent in the present study) are organized in a system of co-ordinates. Each quadrant represents the different qualities to support the teenagers’ meaning-making practice. The bracketed number indicates which type of exhibit according to the classification scheme created by the Head of Development at Teknikens Hus.

Figure 10 suggests four different exhibit characterizations developed in the intersection between a) the different forms of participation and therefore negotiating the meaning in the exhibits, and b) how the teenagers used the video clips to identify their relationships to the exhibits. All relate to how the teenagers found themselves supported in their fundamental quest of making sense of the situation.
To begin with, no exhibits completely dissociated from by the teenagers while supporting the extension of meaning were found. Of course, this seems logical since the process of identification provides the context to what is significant to the members of a practice. If no intention to relate to an object exists, the object will not contribute to a context that supports a sense of significance or relevance. Also, the classification scheme presented here does not resemble that provided by the Head of Development at Teknikens Hus. For instance, exhibits classified as ‘reality in full scale’ (1) can be found in all the used quadrants.

This classification scheme is mainly construed as to what degree the exhibit resembles the machine it represents, i.e. if it is an authentic device or an illustration. This does not seem to matter in the classification scheme presented in Figure 10. For instance, the exhibits classified as enabling resemble the things they represent in different ways, i.e. as authentic machines, as illustrations of machines and as more traditional science centre exhibits.

They do not resemble each other in more concrete ways, i.e. in the Paper Mill you produce paper from paper pulp, using your hands to move the pulp between the machines, and in the maze you steer a ball through a maze, using two levers.

In this study, the characterizations of exhibits are instead classified as follows:

**Enabling exhibits** seem to be open enough to fit more easily into the teenagers’ practice in a way that they actually enable the development of personal meaning-making.

In **constraining** and **rewarding** exhibits the form of participation is the same. The exhibits are dealt with rather inflexibly; there seems to be few alternative ways to manipulate them and hence, few possible outcomes. Still, the difference is that the rewarding exhibits were identified as exciting, where there was a personal and affective reason to participate in the exhibit. Constraining exhibits, however, were identified as boring, childish, too simple, mechanical, incomprehensible, or a combination thereof. Together with how they acted in them, these exhibits appear to be rather controlled, closed and limited.
This could certainly be recognized as a normative classification of good and bad exhibits. However, there are some important issues to address regarding this somewhat hasty conclusion. It all depends on how the objectives of the science centre are perceived.

Rowe (2002) has argued that there are at least two different ways of looking at the educational purpose of an exhibit in a science museum (equally applicable to the science centre). Should science museums use (1) their objects to transmit accurate information or to (2) transfer authority for interpretation to visitors?

The rewarding exhibits work better than the constraining exhibits from the perspective of the first function. Even though they are built to transmit some kind of information rather inflexibly, they do this in a rewarding manner. The possibility for alternative interpretations that are somewhat supported in the enabling exhibits may be seen as a defect in terms of the first function. However, in terms of the second function, this is the most important characteristic of the object.

Thus, the most functional aspect of an exhibit, from the science centre’s point of view, is clearly defined by what purpose the exhibit was built for. Still, the primary purpose of present study is to describe the situation starting from the teenagers’ agenda, even though the issue of built-in purpose and assumptions about communication and learning will be further addressed in the next part of this thesis.

Juxtaposing the opposites, the enabling and the constraining exhibits, gives an empirical overview of their differences concerning forms of participation and identification. This overview is presented in Appendix B.
The features belonging to the enabling exhibits describe on a basic level what characterizes engagement in practice in an exhibit. Allen (2004) suggests that successful exhibits should be immediately apprehendable, conceptually coherent, and cater for a diversity of learners. One teenager, Emelie, stresses the importance of immediate apprehension when she discusses Rebecka’s action in the Shadowgraf exhibit:

- Rebecka said “Let’s go” when she didn’t see the results at once. As soon as she went, things started to happen.

Another teenager, Emil, explains that the Paper Mill is good because of its coherency:

- And you are allowed to do it yourself. You really see how it works. It is among the funniest [exhibits] --- See, everything gets done, it becomes a paper.

Research also confirms that the visitors’ understanding of the science behind the concepts or phenomena displayed depends upon how the phenomena are modelled and the range of experimentation and explanation possible (Gilbert, 2001). Kim, yet another teenager, comments on the value of experimentation when he concludes the exhibit called the Maze:

- This is also one of those where you can do something yourself, those are the funny ones.

**Space of negotiability**

However, there seems to be one overarching characterization that is more or less present in the different exhibits (more in the enabling and rewarding exhibits and less in the constraining), and in the teenagers’ actions in them. It is something crucial in creating an exhibit that supports identity, and subsequently learning processes, namely a space of negotiability. The negotiation of meaning and the negotiation of experience of self require open space, where the adoption of and contribution to meaning must be negotiated equally, if it is to be regarded as meaningful.
The constraining exhibits show very little or no possibility for the teenagers to contribute to or negotiate the meaning of the exhibit. On the contrary, the teenagers’ action in the enabling exhibits shows forms of participation and identification that include different ways of contributing to the meaning of the exhibits. The teenagers’ actions in the exhibits indicate a space of negotiability that brings engagement and interest into the practice. For example, in the Paper Mill where both groups stayed for a longer period than in other exhibits, making several papers. One group even attempted new methods of application when trying to press a piece of a plant into the paper pulp before drying it.

In the discussion afterwards, at least two different meanings of the artefact were negotiated:

Rebecka: We went to a paper mill on a school field trip. They had much larger machines. They told us about everything, and it is like the same thing here.

Researcher: Why did you go there [to the paper mill exhibit]?

Emelie: Because it is fun, and because you always have gone there.

Researcher: You said before that you have a routine that you do. Is it the same routine every year?

Emelie: Yes, it has almost become that way.

Emil: It is quite fun to get something that you have done yourself.

Kim: My mother has a picture in her room that I did on this kind of Teknikens Hus-paper. Before, it was brown.

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59 Compare ‘interest’ with the original Latin words ‘inter’ and ‘esse’. To be interested is to find a space ‘in between’, to which you have access.
Because it is hard to tell the exact learning outcomes from a science centre visit, as a matter of content or skills, it may be more appropriate to discuss whether the exhibits support learning, whatever that may include. The theoretical perspective in this study looks upon learning as an on-going negotiation of meaning and a process of becoming. These meanings have to matter to us, if we are to engage in the meaning-making process. This is discussed in section three related to the process of identification. Yet, this is not the whole story; negotiability is also required to make the practice not only engaging, but also meaningful.

Processes of identification define which meaning matters to us, but do not in themselves determine our ability to negotiate these meanings. Another aspect of identity, therefore, is the issue of negotiability.

(Wenger, 1998, p 197)

The teenagers’ action in the Paper Mill may serve as an example of such a process. The meaning of the Paper Mill seems to matter, since “you always go there”, and discussing it reveals that it matters in different ways, that there is a space of negotiability involved in the action. Is it merely a demonstration of a process in the paper-making industry, or is it a machine where you can make your own paper for your own purposes? Maybe you can describe the exhibit as a place to develop your own creative ideas (considering the way the teenagers decorated their paper with plants)? Either way, it includes handling a technological artefact in a productive way that may very well be the educational purpose of visiting a science centre.

What is a productive way from the teenagers’ point of view? Since their own words declare the importance of getting to do something unique for themselves, it is not so farfetched to suggest that the enabling exhibits best serve their agenda that includes the generation of personal meaning. This appears to be the main difference between the constraining and rewarding exhibits and the enabling.
Part four

Discussion
The whole issue of failing to visit science centres does not seem to be simply a matter of resistance or conflict (considering the question asked in the introduction of the present thesis). Rather, the findings indicate more of an act of resignation due to experiences of non-participation, i.e. teenagers do not want to identify themselves with exhibits (or other practices) that are not open for negotiation of both meaning and identity. Choosing not to visit is a resigned way of calmly accepting a situation that cannot be changed. This resignation may be due to aspects of how technology in a science centre is represented, including a) unequal ownership of meaning of technology, and b) a lack of vitality of the represented knowledge. In short, an unbalanced equation between the object, the way it is represented and the way it enables a re-negotiation of meaning, i.e. one important link enabling the possibilities for visiting teenagers to make sense of the exhibits is missing. This will be elaborated further in this last part of this thesis from a historical and societal perspective. The question is: Do these results reflect a change in society to which museums and science centres must adjust?

However, first some comments on the focus of the present research on the visitors’ agenda (the teenagers’ perspective).

**THE CREDIBILITY OF THE AGENDAS**

To make this research credible, the fieldwork, data and representation are produced to provide as much a perspective on the social world from the subject situated within it as possible. The ‘accuracy’ of data is redirected towards the data’s ability to accomplish this perspective (Holliday, 2001), turning the attention towards the researcher’s reflexivity in the project. Here, it is regarded more than simply a question of validity or an understanding of where the researcher is coming from and what impact this has on the knowledge produced. Instead, the purpose of reflexivity has been that it should be integrated fully into processes of fieldwork and visual or written representation in ways that do not simply explain the researcher’s approach but reveal the very processes by which the positionality of researcher and informant were constituted and through which knowledge was produced during the fieldwork.

(Pink, 2003, pp. 189)
Therefore, special attention has been given to how the theory of co-existing meanings of artefacts has influenced the data analysis. Special attention has also been given to the collaborative approach of informants and ethical issues regarding the production of knowledge. These issues concern the agendas of the researcher and the teenagers in this study.

The findings take the notion of the ‘visitor’s agenda’ one step further than, for example, Ellenbogen et al. (2004), who put forward research focusing on the family’s agenda to better understand the complex motivations underlying the family’s practices in the museum. The studied families that voluntarily visited the museums already thought that a museum might provide a place to develop social identity. The teenagers in this study seemingly did not. Thus, the findings indicate that the visitors’ agenda of developing social identity is not only important to consider as a starting point in research about learning in museums, it is absolutely crucial for visitors to find a visit meaningful.

Regarding validity, the researcher’s aim has been to validate the research findings ‘along the way’, i.e. from a pragmatic perspective (Kvale, 1999), mainly through a dialogue with the informants and staff at Teknikens Hus, and continuing discussions within the research community (especially at international conferences and meetings). Pragmatic validation of the findings is concerned with action performed by readers of the research, e.g. the staff at Teknikens Hus validates the findings through their ability to use them to improve their activities (from their point of view). The following extract is part of an e-mail from one staff member after a seminar about the research findings:

It is really a giant move forward when we can stop focusing on ourselves and think about things from another person’s perspective! I myself have quite a lot to think about regarding how we should build our new climate and energy exhibit.

The usefulness of a socio-cultural perspective

Another important aspect of validating the researcher’s agenda is the usefulness of the chosen theoretical perspective. In discussions about a useful research agenda regarding science learning in out-of-school, free-choice environments,
some might argue that a socio-cultural perspective on learning does not cover all issues specific to science learning (Rennie et al., 2003). Although true, this does not mean that it is irrelevant for research on learning in specifically science. The focus on learning as making meaning seems well suited to the science centre environment, since the notion that people visit because they want to be educated and gain knowledge about specific subject matters is not always true. However, it is fair to assume that by considering meaning making as an integral part of everything we do, this process also takes place during a visit to a museum. The socio-cultural perspective in this study has provided new insights into how teenagers relate to science centres from their perspective and may also inform learning theories based on studies of learning in, for instance, schools and classrooms (including learning in science).

The present study focuses on the importance of participation and the authority to negotiate meaning, as well as the importance of sense of personal meaning and the autobiographical context of experience in science centres with naturally occurring learning opportunities. These findings may certainly be valuable for other settings such as more regulated learning environments in schools (cf. Eckert’s (1989) study of how social formation among teenagers in schools influences what is learnt). In fact, the ‘export’ of learning theories in informal settings to more formal settings may emphasize the synergy among different learning contexts and the benefits of studying how contexts influence learning. This potential is often over-looked.

However, research has hardly scratched the surface of the potential of informal environments to inform theories of learning. Instead formal and informal environments are often contrasted as opposite ends of a continuum rather than complementary, interactive, or blended places for first-hand experiences with objects.

(Paris & Ash, 2000, pp. 199)

After all, school is also just a part of the learning infrastructure in which the science centre is another part.

Sjödin (2001) points out how the encounter between young people and natural sciences education in schools may cause a conflict, since today’s young people demand recognition of alternative truths. This conflict may cause resignation among students who want to earn good grades. Choosing not to participate in school is not possible for the students, as in the case of science centres. Still, the problem is the same. The value of the space to re-negotiate
the represented meaning is neglected. This space is crucial to provide a feeling of ‘belonging’ and importance for social development.

**Playing with a camera – both strength and weakness**

To better understand the teenagers’ perspective, video cameras were used, as described in part one. This may be both the strength and weakness of the research method. Bringing a video camera into the teenagers’ visiting practice made the visit more meaningful to them. Of note is that these teenagers did not usually have a reason to visit the science centre. Inviting them to visit without any other purpose than to be observed, interviewed, or both would not provide them with the possibilities to represent themselves and make a personal account of their perspective on the science centre. The video films not only became a (non-human) agent through which they could tell their story, they also provided a space where they could elaborate this story and integrate how it connected to their social identity.

However, the narrative they chose to use in the production of the film may cover the concerns of the research. This issue was dealt with in collaboration with staff who gave feedback on the films, commenting on which video clips they thought said more about the teenagers relationship to the video camera than their relationship towards Teknikens Hus.

Another point of interest was how the teenagers sometimes used established audio-visual narratives, e.g. when filming the paper mill:

**Researcher:** Why did you want him to explain the process [to the camera]?

**Emil:** He wanted to do a factual film. You have to show some seriousness!

This could be a point of departure for further research interests.
A MATTER OF GENERATIONS

This research has come to focus on the issue of what makes teenagers not want to be involved in their local science centre. This is of specific interest in discussions about future science centres, since young people may be seen as representative of the next generation.

Youth is maybe the most inquiring phase in our lives, and therefore have young people of our century been seismographs in the cultural landscape – not only in the underground. (Drotner, 1996, pp 9-10)

Maybe the teenagers’ lack of interest signals a need for change? If so, which direction? The following discussion will focus the results from this study on development and change.

McManus (1992) proclaims science centres to be the third generation of science museums, based on how the exhibits have evolved from being objects to being built on ideas. However, Bradburne (1998) has criticized this classification and suggests that the history of science museums should be regarded as an expression of changes in the history of science ideas. From this point of view, the third generation of science museums is yet to come.

The different features of exhibits pointed out by McManus still mediate the same idea of transmitting science as a canon of accepted truths. The next generation of science museums should instead be based on the process of doing science, moving from a form of accounting for science as ready-made to science-in-the-making (cf. Latour, 1987). Science-in-the-making is more than an issue of method; it encompasses (1) scientific knowledge, (2) knowledge about how we came to know, and (3) why we believe what we know (Shapin, 1992).

This shift in the ideas of science calls attention to how the meaning of science and technology is formed through negotiation between different social practices with different intentions. The processes preceding ‘ready-made science’ are focused upon, demonstrating how social context and technical content are essential for a proper understanding of scientific activity (Latour, 1987).
However, when the struggle is decided, and technology is finally shaped, its meaning will eventually be re-negotiated in its use. Without knowing how and why it was produced, users have but limited possibilities to contribute to its meaning.

At Teknikens Hus, there seems to be a primary wish to show science and technology as close to reality as possible in terms of physical authenticity. The Head of Exhibit Development distinguished the exhibits by how close they represent the actual situation where the technology is used. In Latour’s terms, the exhibits mediate a ready-made-science that is not uncommon in the science centre community (Walton, 2000).

In fact, this is one of the key features of a science centre exhibit – they ‘invoke the universal processes of science’ and ‘do not illustrate the history of science’, and instead ‘strive to awaken curiosity and to inculcate a spirit of scientific inquiry in their visitors’ (Hein, 2000, pp 26). In Bradburne’s terms, visitors to these kinds of science centres become receivers, not users, and it seems that Teknikens Hus is no exception. What questions need to be addressed to move on to the next generation of science museums? The empirical findings in this study indicate that this has to do with who has the authority of interpreting the meaning of the exhibits.
It is not usually difficult to grasp what the intended activities are in science centre exhibits. In fact, comprehensibility is sometimes used as a measure of how successful an exhibit is, namely if the user uses it as intended. However, focusing on the teenager’s perspective in this study brings the use of exhibits into another light. What do the teenagers want to use the exhibits for? The results presented here indicate that they want to use the exhibits for two main reasons:

- To have the authority of interpretations and the possibilities to contribute to the meaning of the activity. The exhibits have to enable a process over time and across space in which the teenagers can extend the intended meaning.
- To develop social identity in the activities. The teenagers have to be able to identify themselves as participants in the exhibits.

Together, these different aspects of exhibit activities create a space of negotiability that seems to be crucial for a meaningful experience from the teenagers’ point of view. Furthermore, the results show the kinds of relationships between the exhibits and the teenagers and what features of the exhibits’ design support these desirable aspects of the activities (see Table 7).

Table 7: An open and on-going relationship to the exhibits creates a space of negotiability that the teenagers need to develop meaningful activities. Certain exhibits’ features and activities enable these kinds of relationships.

<table>
<thead>
<tr>
<th>Relationships that enable a space of negotiability in the exhibit activities</th>
<th>Enabling exhibit features</th>
<th>Examples of involving activities in and identification of exhibits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open relationship based on possibilities for the user to contribute to the meaning of the activity.</td>
<td>Unlimited exhibit designs that afford personal interpretations.</td>
<td>Backtracking</td>
</tr>
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<td></td>
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<td>External connection</td>
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<td></td>
<td></td>
<td>Exhibit elaboration</td>
</tr>
<tr>
<td>Close and on-going relationship based on possibilities for the users to identify the exhibits as places for social development.</td>
<td>Exhibit designs which offer personal experiences.</td>
<td>Exciting</td>
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</table>
In interpreting these results, it is important to note that it is not merely a question of exhibit design. Basically, exhibit design should be viewed upon as consequences of certain assumptions about communication and learning made in the exhibit building practice. To shift perspective and glance at the next generations of science museums, discussing these assumptions before design questions become relevant is vital. This will be further elaborated in the next section.

**WHY DO TEENAGERS FAIL SCIENCE CENTRES?**

Even though the results show some of the exhibits to own a certain amount of negotiability (like the enabling ones) when teenagers act upon them, the degree of this characteristic can vary. It is not like the exhibit either inhibits this or not, but rather like there is more or less of it. This has as much to do with the participants and their interactions with the exhibit and each other, as it has to do with the exhibit itself. A close examination of another group of visitors would probably tell another story (see the results presented in Rahm, 2003).

Consequently, the findings in the present study also need to operate on a level other than the basic exhibit characterizations of specific exhibits. Rather, it is a matter of what assumptions about education and communication in the science centre practice are compatible with the teenagers’ practice. The stimulated but not forced pedagogical accent of the modern science centre based on free will and the learner’s own activity is recognized by the teenagers.

**Kim:** The good thing about Teknikens Hus is that you do things yourself, whenever you want, and however you like.

Nevertheless, achieving this may require a shift of perspectives to comply with the demands of meaningful, appropriate and authentic involvement from the teenagers’ point of view. Surely, the teenagers enjoyed some of the exhibits very much.
Still, certain comments made by the teenagers during the video session indicate something more fundamental to learn concerning the space of negotiability in not only the exhibits, but in the science centre as such.

**Emelie:** I think it would be nice if they could have a lot of things you could invent yourself. Not so controlled, things with which you could do as you liked. That not everything was pre-determined.

**Are visitors contributors?**

It may be easy to say that the teenagers in this study do not understand the exhibits by ignoring or converting the intended meaning. However, this way of reasoning follows the assumption about a linear scale of understanding that is organized around the *intended* meaning of the exhibits, i.e. from the science centres perspective (cf. Borun, Chambers & Cleghorn, 1996). However, the teenagers may understand the exhibits all *too well*, depending on how one looks at the situation and the status of the teenagers’ meaning in relation to the intended meaning. Paradoxically, the teenagers master the exhibits on a high level, though they have not appropriated it. For some reason, they do not view the exhibits as ‘belonging’ to them (c.f. Wertsch, 1998).

During the 1980s and early 1990s, strong arguments were put forward in favour of an increased public understanding of science (PUS). This has since greatly changed, mainly because of criticism against a model (like PUS) where any difficulties in the relationship between science and society are due entirely to misunderstanding and ignorance on the part of the public (for example Wynne, 1993). PUS is today an outdated concept, but there is a focus on public *engagement* in science. However, as Rennie & Stocklmayer state, ‘it is hard to avoid the old, top-down connotations of PUS because the idea of “engagement” still seems to place responsibility on the public to make overtures to learn more about science and technology’ (2003, p. 768). They continue their argument by offering the notion of ‘science and technology’s engagement with the public’ as a better way to move forward.
With this notion in mind, it is rather obvious that the teenagers clearly lack an engagement of science and technology, as a collective, at the science centre.

Kim: You have been so many times to Teknikens Hus that you have become fed up with it.

Emil: The boats have been the one of the funniest things because it’s a bit like playing. It is pretty much like playing, but now you don’t have the time to wait.

Rebecka: Even if new things come, it is the same kind of things. It is always like … you know pretty much what to expect. No surprises.

Playing is described as something important and fun; in play it is certain that everything is negotiable. Still, this is different today, because ‘you don’t have the time to wait’. Molander (2000) describes living knowledge as something anchored in the lives of people, in contrast to theoretical knowledge that is focused on verbal questioning and answering. The focus on the latter cuts away the vitality of knowledge.

Only if the question springs from real concerns or real curiosity can they be real driving forces. By ‘real’ I mean here that the individual person wants to know and proceed further. This is not normally hard in the activities we pursue voluntarily. It is, however, problematic in education and in campaigns to ‘enlighten’ people.

A situation where ‘everything is fixed and nothing can be changed’ does not correspond to real concerns or real curiosity, as when a new exhibit is produced, since ‘you know pretty much what to expect’.

The question of what and how they want to learn is not raised, or how their knowledge can be of any value to the meaning of the exhibits. In fact, you could ask if the whole notion of visitors as contributors to the meaning of the exhibits is something that is embraced or excluded by the very core of the science centre movement, especially the part dealing with interactive exhibits.
Do the exhibits involve the visitors’ lives?

Learning (may it be constructive or destructive) develops when people join in practices united by a common enterprise. Here, people come to develop ways of doing things, ways of talking, beliefs and values, in short living knowledge (Molander, 2000). But do the science centre exhibits provide opportunities to involve visitors in meaningful practices as participants?

The results indicate a need for both openness and closeness in relation to the exhibit to enable a meaningful encounter. An openness that creates a space for alternative ways of participation in the exhibit, and a closeness regarding the relationship the participant is able to construe towards it. Paris & Mercer (2002) call this relationship an ‘autobiographical connection’, and is presented as crucial in making exhibits more poignant, emotional, and memorable.

We believe that museum visitors understand objects that they encounter in relation to their own histories and anticipated futures — looking forward and backward in one’s life shapes the meanings attached to objects and experiences.


The present study focuses on situations where this autobiographical connection is not enabled and may be better understood through the notion of learning trajectory (Wenger, 1998). The relationship between the teenager and the exhibit is in this sense a place where the identity of participation is defined. As a trajectory, such an identity must incorporate a past and a future, i.e. encounters with exhibits will become places of identity and subsequently learning to the extent they make trajectories possible — ‘that is, to the extent they offer a past and a future that can be experienced as a personal trajectory’ (Wenger, 1998, pp. 215). Thus, learning entails both the process of transforming knowledge as well as a place where the identity of participation may take form. Examining the results of this study raises questions about the organization of contexts in which such a negotiation of identity may take place. The forms of relationships between the teenagers and the exhibits presented in the results do not seem to enable learning trajectories that connect the exhibits with the teenagers’ pasts and futures. Surely, a nostalgic relationship should seem to somehow connect to things previously done by them with the exhibits, though it is described in the past tense; their past is disconnected from the constitution of their participation today. However, a closer relationship does indicate something on-going with relevance to who
they are in connection to what they do at the science centre today. However, the teenagers do not discuss these experiences as something relevant to their future. In this sense, all three of the described relationships in the results are distant to the teenagers, and rather than integrate technology into the lives of the teenagers and change their view of the world, the exhibits separate them from the represented technology. The teenagers in this study did not use the exhibits as cultural tools with which they could re-negotiate the meaning of the represented technology.

What makes information knowledge – what makes it empowering – is the way in which it can be integrated within an identity of participation. When information does not build up to an identity of participation, it remains alien, literal, fragmented, unegotiable. It is not just that it is disconnected from other pieces of relevant information, but that it fails to translate into a way of being in the world coherent enough to be enacted in practice.

(Wenger, 1998, pp. 220)

Technological artefacts, like the paper mill, once changed the world and opened it towards new possibilities. The region of Norrbotten (where Teknikens Hus is located) was actually once inhabited and developed mainly because of technological innovations from industries that refined the raw material supplied by the region. Paradoxically, science centre representations of technological artefacts tend to close the object by simply redirecting the visitors’ view of the world into pre-determined directions. The ambition of Teknikens Hus to make visitors acknowledge industrial production as a key feature of the region today without addressing the socio-cultural history of the technological artefacts they represent seems to narrow down the potential these artefacts once had.

Through research, we know very little about what is interesting or useful to the public, and we know nothing about how to reach those who are ‘unengaged’ (like the teenagers in this study). Still, the results in this study indicate that as long as there is a gulf between what is presented and those who are supposed to learn from it, i.e. a distance that is not negotiable, reaching those who are currently indifferent will be very hard. This gulf will remain ‘unless scientists are brought into the discussion as players, not captains in the debate. In this regard there is as yet no explicit recognition of the public’s knowledge being of any value to scientists’ (Rennie & Stocklmayer, 2003, p 770).
The missing link

Macdonald (1998) declared that ‘to move towards a more thorough understanding of the potentials, difficulties and consequences of putting science on display we need to look analytically at the contents of exhibitions in relation to their production, contexts and reception’ (pp. 2). Exhibitions tend to be presented to the public as unequivocal statements rather than as the outcomes of particular processes and contexts, processes that are indeed negotiations with many different actors such as educators, technicians, sponsors and so forth (Macdonald, 2002b).

In fact, this negotiation seems to be so overwhelming that the link between the exhibit and how it is received and re-negotiated in relation to this is often overlooked and underestimated in both research and exhibit building practices. The intellectual, aesthetic and practical details of making an exhibit receives so much attention, it is easy to forget the visitors and what role they ought to play in the meaning-making process.

Exhibitions, therefore, tend to be presented as ‘glass-cased’ – ‘that is, as objects there to be gazed upon, admired, and understood only in relation to themselves’ (Macdonald, 1998, pp. 2). The different links in personal meaning-making of represented objects in science centres is illustrated in the figure below. The results of this study suggest that too much focus on the first link, which includes the negotiation of meaning in the exhibit building practice, contributes to an unequal ownership of meaning between the visitor and the science centre. Subsequently, it disturbs the process of personal meaning-making.
The disconnection of the last link of the meaning-making process also disconnects the vitality of the embodied knowledge represented through the object. Instead, the object simply becomes a good piece of craftsmanship to be admired.

[Talking about the Train]

Rebecka: This is like fun to drive a train, but there is nothing more to it. Like ‘So what?’ It is nicely done, but it isn’t so fun, it doesn’t give anything.

Emil: It is but a small development of what was there before, when a button made it go around the mine.

Thus, the representation of the authentic object becomes merely a negotiation between the science centre and the things they represent in their exhibits, leaving the visitor unaffected and disconnected, like a resigned observer of something ready-made.
An opposing illustration of this unbalanced equation may be the project of installing ‘ready-mades’ by the artist Marcel Duchamp, in which he withdrew the hand of the artist from the process of making art. He simply substituted manufactured articles for articles made by the artist, resulting in works of art without any pretence of artifice. From Duchamp’s point of view, art occurs at the juncture of the artist’s intention and the observer’s response, making the observer a kind of co-partner in the meaning-making process. With the ready-mades, Duchamp focuses his work on engaging the observer in the meaning-making process and enabling personal and unpredictable reactions to his artwork.

![The bottlerack (1914). The original version of this Readymade was not modified in anyway, thus deserving the categorization of pure Readymade. The Bottle Rack's primary function is, of course, to dry bottles.](Replica_1964©MarcelDuchamp)

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60 He created twenty-one of them, all between 1915–1923.
A large space for re-negotiating the intended meaning of the artefact even included from Duchamp’s perspective disallowing the original function of the artefact. Duchamp may not have created this bottle rack, but he did displace it and disallow it to function. With his almost overwhelming focus on the observer’s re-negotiation of meaning, he wanted to engage the mind instead of the eye and thereby provoke the observer to participate and think. This may serve as an example of an opposite perspective on the meaning-making process compared to the one enabled by science centre exhibits, whose focus instead lies on the second link in the personal meaning-making process illustrated in Figure 10.

WHAT IS LEARNED?

The present study assumes learning to be as organized as participation, with co-existing meanings in artefacts. The negotiation of these meanings is fundamental to our being in the world; living is a constant process of negotiation of meaning. It characterizes the process by which we experience the world and our engagement in it as meaningful. When someone is always producing meanings, as in certain exhibit designs, and the visitors have to always adopt meaning, there is an uneven ownership of meaning. Visitors whose contributions are never adopted develop an identity of non-participation that progressively marginalizes them until they become unable to engage.

How science centres are situated in the social system and lives of teenagers is not simply the context of learning in the science centre, it is part of what is learned. The purpose of this research is not to investigate the teenagers’ relationship towards science and technology as subjects, but science centres as learning institutions. Hence, the findings do not indicate if the teenagers fail to visit science centres because of their lack of interest in science and technology.
However, the strategies developed by teenagers to function in the science centre environment are part of the knowledge that they take with them into adulthood. These acquired and developed strategies for learning in institutions like science centres, where they may have been marginalized by exhibit designs that are too constraining to which they cannot connect personally, may also marginalize them elsewhere (cf. Eckert, 1989). Thus, if this issue is not taken seriously, the museum will not become a fruitful site for youth development, as it is outlined by for instance Delgado (2002), and through this benefit young people, museums and the whole community.

Exhibits do not always afford engaging forms of participation

It is hard to expect teenagers to learn about the subject matters represented in an environment where they are isolated from the rest of their lives, since they do not seem to be willing at all to visit the science centre and participate in the exhibits. After all, interest and voluntary involvement are important aspects of learning from this perspective. Why are the teenagers not willing to participate, even though the intention and design of a science centre is above all to place interaction at the forefront?

Eckert, Goldman and Wenger (1997) describe how schools may also fail as settings for learning. One reason is that schools offer no opportunity for teenagers to (1) build meaningful lives around schoolwork and (2) to express themselves through participation in school learning.

---knowledge gained in collecting and trading baseball cards, stamps, or records, becoming a “Deadhead”, playing double dutch, Dungeons and Dragons, videogames, high performance Monopoly; playing in a garage band, or working on cars, tends to stay with people the rest of their lives. Adults tend to view friendships, games, romance, collections, popular music, as attractive nuisances that prevent learning. But if the learning energy that goes into these activities went into maths or social studies, we would have a nation of academic geniuses. (pp. 2)

However, the answer is not that learning institutions should build their curriculum around rock music or computer games, or that teenagers need to be cajoled or entertained into learning. Learning institutions have to provide the same participative opportunities that are offered in families,
neighbourhoods, clubs and other communities within the teenagers’ lives. This way of reasoning may very well serve as an important aspect of why teenagers fail science centres and implicates two issues of great concern for the science centre movement, viz. interactivity and the science centre objectives.

**Interactivity does not always mean social activities**

As Heath & vom Lehm (2003) suggest, ‘interactives’ are rarely designed to support or enhance social interaction; they are more often designed according to the ‘myth of the individual user’. This creates problems if the intention is to invite visitors to create practices characterized by participation, engagement, contribution, experimentation, inquiry reflections, i.e. learning through *intert* participation. Oppenheimer’s fundamental message with the interactive exhibits at the Exploratorium was one of *democratic empowerment* (Barry, 1998); the public would be empowered through being able to *interact* with objects as an experimental scientist does in the natural world of the laboratory. This is hard to achieve in exhibits where you cannot participate together with others, since democratic empowerment is a *social* endeavour (Dewey, 1916).

In fact, Oppenheimer recreated what has been known as John Dewey’s core concept, the idea of ‘learning by doing’, which became the hands-on principle in his work (Oppenheimer, 1968). However, science centre educators have oversimplified such concepts, and ‘relied on the practical and common-sense application of loosely formulated pedagogy’ (Salmi, 1993, pp. 57). This is not unique for educators in science centre settings, where one-sided accounts of Dewey’s educational theories are also common in pedagogical discussions elsewhere (Alexandersson, 2000). Of interest here, is Dewey’s focus on ‘shared experience’ and ‘shared interest’, such as fundamental aspects of societal development, and the main task for education to subsequently have its point of departure in social life.

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The world as ‘ready-made’

The objectives of the science centre have to be further scrutinized. The different goals existing side-by-side within science centres (Rowe, 2002) appear to be more or less useful in providing a suitable context for the formation of social practices around the exhibits. Should a science centre use their exhibits to transmit accurate information or transfer authority for interpretation to visitors? The transmitting metaphor seems inappropriate in the free-choice setting and instead becomes counter-productive. In this situation they learn not to participate, and subsequently, that they have nothing to contribute with this matter and that their knowledge is not valued. Science and technology represented in this matter show a ‘ready-made’ world that they cannot change.

Emil: I don’t think there are so many experiments at Teknikens Hus. It is more like an assembly line.

Rebecka: To me, it is more like pushing a button and look what happens.

Kim: Everything happens in such a controlled form, it is not like you can break anything.

Simon: Yes you can!

Rebecka: But everything is like...everything is fixed and nothing can be changed.

The other possible definition of the science centre objectives may instead provide a space to the teenagers where heterogeneous, even conflicting, interpretations meet on the field of their participation in the exhibits. This corresponds better to teenagers interested in alternative truths (Sjödin, 2001). The teenagers’ agenda, in which forming practices where they can express themselves and contribute to the meaning seem to be very important, appears to not be compatible with some sort of ‘enlightening’ science centre ‘mission’.

This is also emphasized by VeLure Roholt & Steiner (2005), who introduce to teenagers the science centre in Minnesota as a site for social development with a goal to ‘engage young people in science learning through real, meaningful and authentic museum work’ (pp. 146). It seems as if the Youth Science
Centre in Minnesota has become a place where they see themselves contributing to the activity of the whole museum, and to the community: ‘what makes this job remarkable to them is that they are asked to do work unusual for young people but typical for adult, full-time, trained and paid professionals’ (pp. 149); hence, they ‘belong’ to the science museum. This sense of belonging may be described in terms of the results of this study. Exhibits described in the results as open (Figure 3, pp. 93) are indeed open towards inviting the visitors to participate, as the teenagers in Minnesota are invited to participate, develop, re-negotiate and influence the museum practice.

**SCIENCE CENTRES – WHAT’S NEXT?**

This last section of the thesis briefly comments on the issue of museums and science centres in the future that I basically discuss with the findings combined with general reflections as a point of departure. The findings suggest that the teenagers do acknowledge a need to move to the next generation of science centres where people use science and can contribute to the meaning of the enabled activities (cf. Bradburne, 1998). My intention is to put this into a societal perspective, and how the science centre may take part of a future society.

Having now entered its last phase, museums and science centres were created in an era when Western countries were industrialized and structured as national states. However, these national states have lost their old importance through globalization and new ways of organizing social communities have emerged via the virtual reality of the Internet. Called cybernations or micronations62, these communities have nothing to do with geographical or social patterns and are built by communities of people connected through the Internet with similar interests and values.

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62They are entities that resemble independent nations but for the most part exist only on paper, on the Internet, or in the minds of their creators.
At the same time, the information and knowledge society has replaced the industrial society, even though this is sometimes only considered as a transitional phase. Since the focus has changed from simply using virtual resources to considering what the virtuality should consist of, some researchers suggest that we are entering a new society based on storytelling; the Dream Society (Jensen, 1999). My point is that if the era that produced museums and science centres is about to end, the next generation of museums has to relate to the conditions of the new era.

This way of reasoning agrees with recent discussions of no longer comparing museums with universities or libraries, with the goal to spread knowledge. Instead, a shift from knowledge to meaning requires new metaphors for the museum practice, e.g. the ‘market place’; ‘Museums hold the possibility of restoring public spaces for people to gather, to play, to tell stories, and to learn about their heritage’ (Roberts, 1997, pp. 148). This museum perspective allows the variation of both meaning and interaction between presenters and participants.

From my point of view, this also questions the use of cognitive perspectives and assumptions about learning when studying learning in science centres. From a cognitive perspective an important feature of an exhibit’s meaning seems to be how well the visitor may be supported to reconstruct (or even copy) the same representation into the person’s mental structures (to be used in another similar situation). This view on learning is difficult to apply in situations when negotiation and contribution are identified as keys to providing meaningful activities, like the results in this study indicate. With the meaning of the exhibits shifting perspectives from the intended meaning and how well it is transmitted to the visitor’s use of the exhibits to provide meaningful activities, a shift in assumptions about learning may have to follow.

This research contributes to understanding the importance of space for negotiating the meaning to make participation in science centre exhibits engaging. Furthermore, it emphasizes the need of space to negotiate and express social identity to make it meaningful. This connects to the idea of the Dream Society, where people gather around mutual storytelling (cf. the immense popularity of virtual meeting places whose people join to simply talk to each other. A Swedish example is www.habbohotel.se).
Another example of what seems to fit into the Dream Society and the interests of young people is live role-plays. One of Sweden’s largest youth organizations is Sverok, an organization for people who play different sorts of role-plays and strategy games with over 90,000 members. The idea of role-plays is that you play a role in a fictional story, which you experience as real (even though you know it is not real). The game leader gives the conditions of the role-play and the characters, but it is the participants who develop the story. Everyone contributes to the meaning of the activities and the participants themselves often manufacture the tools used as authentically objects (for instance, in medieval role-plays).

The authority of interpreting the meaning of the activities is evenly distributed between the participators. They enter the role-play and create their own stories based on a historical era (for instance, the Vikings) or fictional figures (like vampires), and the role-play becomes a place to develop social identity. An active role-player describes how this process is connected to learning in a daily newspaper interview article:

You can’t get a better school. You use your creativity and engage, learn to take responsibility and work in a group. There are 16 year old boys who plan and go through with their own role plays, while other boys who play ice hockey are driven by their parent to already prepared rinks.

(Larsson, January 3, 2006)

The results in this study indicate that if the setting does not enable negotiation of meaning as well as social identity, then it will not appear as meaningful. Role-play seems to provide both and the missing link in the science centre exhibits is instead well addressed.
Adjusting to the future

Smeds (2004) suggests that it is time for museums to move on from their old role as preserving and being educational institutions, and acknowledge their role as a societal commentator and interpreter of the age in which we are living, i.e. become a medium not an institution. There is also a need to adjust to the virtual reality.

Do we need the authentic things? How? We, the people of the ‘industrial era’ need them, authenticity is important to us, but is it important for our grand children, grown up in multiple realities, some of them wholly virtual? Grown up in a Matrix? For them maybe the reconstructions, the copies, are more important?

(Smeds, 2004, pp. 8)

Smeds (2004) also warns of reducing museums to educational centres. People do not often come to the museum to be educated, and might not even know why they go, but they are searching for something. The museum should provide them with alternatives, both in thoughts and in realities.

Mithell (2000) gives examples of how the global digital network may influence architecture, e.g. cities will not only be created as sustainable, but will make economical, social, and cultural sense in an electronically interconnected and global world. Virtual museums already exist (see a directory at www.museumlink.com/virtual.htm). The interesting question is how this new technology is used, by both creators and visitors.

Therefore, I would like to suggest that it may be appropriate to readdress the three myths about learning in museums presented by Rennie (in press); (1) playing and learning cannot occur at the same time, (2) if learning occurs, it must happen at the museum, and (3) that what people learn is predictable and therefore easily measurable. There may be a point in developing the demolishing of the third myth: ‘because outcomes are personal and diverse, they are unpredictable and very difficult to measure’ (pp. 18). Hence, it acknowledges that outcomes have to be personal and appropriate in the visitors’ social practices to be meaningful (if they are not, the visitors will probably not have the motivation to visit). It may be even appropriate to instead add a fourth myth; learning is all about science in science museums, and it is something the visitor either does or does not do well.
New technologies and new forms of creating communities may indeed provide new forms of interactions and encounters in museums and science centres. However, even though the room, the form and structure of these encounters may change, they will always include individuals who use artefacts in specific ways, and that mediate certain assumptions about learning and communication.

People have always used and developed artefacts and have subsequently learned to do new things. Developing these artefacts has developed new practices and reinforced new forms of learning processes. How these learning processes develop has to be understood in relation to our society, what it demands of us, what tools it supplies us with and what kinds of socio-cultural experiences we do. I suggest that the newborn focus on the visual and audible in the ‘virtual culture’ and the verbal and narrative in the ‘storytelling culture’ must be seriously considered as artefacts that influence and develop new forms of learning processes. This study highlights one possible aspect of these processes that seems to be underestimated so far in the science centre exhibits (‘the missing link’), namely the space of negotiability that provides possibilities to the visitor to contribute to and develop the meaning of these activities.

The discussion about how to create future museums is obviously not only about specific physical features of these artefacts, the discussion have to be keenly aware of ideological, societal, and historical aspects of how and what to communicate and what forms of participation and activities should be enabled to fit into a changing society. This is probably a good starting point in future studies of what the next generation of museums may consist of.
REFERENCES


155


Curious about Teknikens Hus. (2001). Teknikens Hus, SE-971 87 Luleå


Following table shows where to find the different exhibits in the thesis, and how they are presented. All the exhibits can be viewed ‘in action’ at [www.vaike.se](http://www.vaike.se). What the markings in the different columns means is described below.

**Cat:** Categories construed by the Head of Exhibit Development at Teknikens Hus; (1) Exhibits showing reality in full scale, (2) exhibits showing small scale models, doing the real ‘thing’, (3) exhibits that are illustrations of the real ‘thing’, (4) traditional/standard exhibits which can be found in other science centres, and (5) unique playful exhibits.

**A:** Exhibits presented in Table 1 (pp. 24), 5 (pp. 91), and/or 6 (pp. 104-105). The numbers indicate in which table the specific exhibit can be found.

**B:** Exhibits commented by the teenagers, the numbers indicate page numbers in thesis.

**C:** Exhibits commented by the researcher, the numbers indicate page numbers in thesis.

**D:** Exhibits shown in pictures, the numbers indicate page numbers in thesis.

**E:** Marked exhibits are presented in Figure 10 (pp. 121), in which they are organized in a system of co-ordinates. This exhibits are also further discussed in Appendix B.

<table>
<thead>
<tr>
<th>Exhibit</th>
<th>Brief description of function</th>
<th>Cat</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
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</thead>
<tbody>
<tr>
<td>Bike</td>
<td>Two bikes connected to a computer which makes it possible to race against each other, following the race on the computer screen.</td>
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<td>Boats</td>
<td>Thoroughly described in thesis (pp. 27)</td>
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<td>111</td>
<td>139</td>
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<tr>
<td>Car</td>
<td>An authentic car, with possibilities to look into the engine both from the top and the bottom.</td>
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<td>113</td>
<td>102</td>
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<tr>
<td>Circuit Card</td>
<td>Displayed circuit cards from computers.</td>
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## Exhibit

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<tr>
<th>Exhibit</th>
<th>Brief description of function</th>
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</thead>
<tbody>
<tr>
<td><strong>Cock-pit</strong></td>
<td>An authentic cock-pit, installed with video screens. By following audible instructions and handle the manoeuvre panel, the visitor may follow a start and and landing on the screen which is installed in the place of the wind shields.</td>
<td>3</td>
<td>5</td>
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<td>110</td>
<td>117</td>
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<tr>
<td><strong>Dummy</strong></td>
<td>A tailor’s dummy dressed up as a miner. When the visitor come near it starts to ‘talk’.</td>
<td>4</td>
<td>6</td>
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<td>108</td>
<td>104</td>
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<tr>
<td><strong>Erosion Table</strong></td>
<td>A slightly leaning table with sand and running water and different tools to play with.</td>
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<tr>
<td><strong>Goldwashing</strong></td>
<td>A basin filled with water and sand with possibilities to pan for gold.</td>
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<tr>
<td><strong>Hovercraft</strong></td>
<td>A platform on which the visitor can stand on and move around, which works like a hovercraft.</td>
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<tr>
<td><strong>Key</strong></td>
<td>Thoroughly described in thesis (pp. 27)</td>
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<td>100</td>
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<td><strong>Lumber Forwarder</strong></td>
<td>Thoroughly described in thesis (pp. 25)</td>
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<td><strong>Maze</strong></td>
<td>Thoroughly described in thesis (pp. 27)</td>
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<td><strong>Mine Drill</strong></td>
<td>Thoroughly described in thesis (pp. 25)</td>
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<td><strong>Mine Truck</strong></td>
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<td><strong>Paper Mill</strong></td>
<td>Thoroughly described in thesis (pp. 26)</td>
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<td><strong>Photobooth</strong></td>
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<tr>
<td><strong>Platform New Zealand</strong></td>
<td>An illustration of how you can send images around the globe via satellite.</td>
<td>3</td>
<td>6</td>
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<td>109</td>
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</table>
| Exhibit                                | Cat | A  | B     | C  | D  | E
|---------------------------------------|-----|----|-------|----|----|----
| Remote-Controlled Mine Drill          | 3   | 6  | 110   |    |    |    
| A mine drill manoeuvre panel connected to a video screen which shows how the actual mine drill can be moved. |
| Rocket Launch                         | 4   | 103 | 104   |    |    |    
| A rocket made of a PET bottle which is launched with the help of science centre staff. |
| See Saw                               | 4   | 5  | 94    |    |    |    
| An actual see saw with the extended possibility to move the point of balance back and forth on the sitting board. |
| Shadowgraf                            | 4   | 1  | 124   | 32 | 94 | 98 |
| Thoroughly described in thesis (pp. 27)  |
| Stone Cave                            | 4   | 6  | 115   | 116 |    |    
| An exhibition of glass-cased rock and mineral samples. |
| Train                                 | 3   | 1  | 143   | 143 | 29 |    
| Thoroughly described in thesis (pp. 26)  |
| Wave machine                          | 4   | 5  | 108   | 78 | 17 | 99 |
| A basin filled with water and sand, and the possibility to make waves with a shovel connected to one end of the basin. |
| Whisper Dishes                        | 4   | 94 |    |    |    |    
| Two satellite dishes installed towards each other on the opposite side of the exhibit hall, with the possibility to send spoken messages between them. |

Many comments from the teenagers about the Paper Mill are used in different parts in the thesis. This is due to the way the teenagers addressed especially this exhibit as something that is 'typical' for Teknikens Hus. This makes it interesting to scrutinize further.
The table below shows an empirical overview of the example exhibits analytically defined as constraining and enabling exhibits respectively in figure 10 on page 121. These example exhibits were chosen with regard to the exhibit classification scheme made by the Head of Exhibit Development at Teknikens Hus:

1. Exhibits showing reality in full scale
2. Exhibits showing small scale models, doing the real ‘thing’
3. Exhibits that are illustrations of the real ‘thing’
4. Traditional/standard exhibits which can be found in other science centres
5. Unique playful exhibits

What category each of the example exhibits belong to according to the scheme above is shown within brackets. This way of choosing and organizing example exhibits make it possible to further scrutinize if and how the exhibits within each category can differ from each other. For instance the Mine Drill and the Lumber Forwarder, both belonging to category one, still the former is identified as boring and the latter as exciting. The same difference may be seen in category five, here represented by the Boats and the Maze even though in this case the difference is not as striking as between the example exhibits in category 1. Yet, the combination of empirical qualities in each of those example exhibits gives that the Boats are closer to what characterizes a constraining exhibit and the Maze is instead closer to what characterizes an enabling exhibit.
### Appendix B

#### Examples of constraining exhibits

<table>
<thead>
<tr>
<th></th>
<th>Forms of participation in the exhibit</th>
<th>Ways of identifying the exhibit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mine Drill (1)</td>
<td>Fun Making</td>
<td>Boring</td>
</tr>
<tr>
<td>Train (3)</td>
<td>Button Pressing</td>
<td>Mechanical Childish</td>
</tr>
<tr>
<td>Shadowgraf (4)</td>
<td>Button Pressing</td>
<td>Too simple Mechanical</td>
</tr>
<tr>
<td>Boats (5)</td>
<td>Button Pressing Game Playing Fault Finding</td>
<td>Boring Traditional Consumed Improvable</td>
</tr>
</tbody>
</table>

#### Examples of enabling exhibits

<table>
<thead>
<tr>
<th></th>
<th>Forms of participation in the exhibit</th>
<th>Ways of identifying the exhibit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lumber Forwarder (1)</td>
<td>Back Tracking</td>
<td>Affectable Realistic Exciting</td>
</tr>
<tr>
<td>Paper Mill (2)</td>
<td>External Connection Exhibit Elaboration Back Tracking Button Pressing</td>
<td>Comprehensible Affectable Connectable Realistic</td>
</tr>
<tr>
<td>Key (4)</td>
<td>Back Tracking External Connection</td>
<td>Traditional Comprehensible</td>
</tr>
<tr>
<td>Maze (5)</td>
<td>Back Tracking Game Playing</td>
<td>Affectable Exciting Consumed</td>
</tr>
</tbody>
</table>