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Solar Energy Exhibits at the Popular Science Park TEKNOLAND

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Abstract - The new Popular Science Park TEKNOLAND in Falun contains a number of interactive solar energy exhibits, including The Solar Heated Chess Board, The Solar Electric Playhouse, The Sudanese Solar Oven, and Solar Collector Optics. The TeknoTrix tutored children activities include solar thermal activities. Some related interactive exhibits are planned to be included during the summer and during coming years.

1. Introduction

The author has a rather long experience of working with interactive exhibitions and with Science Centers. Over a decade ago, he and a colleague built a Solar Energy Traveling Exhibition (Broman and Gustafsson, 1991), that for several years toured Swedish museums, and after many years was permanently put on display at Grönhögen Energy Center on the island of Öland in southern Sweden.

At the time of writing this paper, I am engaged in a new interesting educational project: the creation of the Popular Science Park TEKNOLAND at the Swedish National Ski Stadium Lugnet in Falun. The park, which was inaugurated on 13 May 2000 and will be open daily until 8 September (during the off-ski season!) is planned to be a yearly event and a major tourist attraction of Sweden. The park is inspired by two similar parks that I visited in 1988 (Broman, 1988) and 1999, respectively: Nehru Science Park in Bombay, India, and Clore Garden of Science in Rehovot, Israel.

With its over 100 hands-on and the-whole-body-on (!) exhibits spread over 25 000 m², TEKNOLAND has, as far as I know, become the world's largest popular science park and is unique of its kind in Europe. Information about the park is available in English, German, French, and Swedish at <www.teknoland.se>.

Preliminary results from a recent inquiry study (Broman; see also Appendix), questioning science major students from three different Swedish gymnasium schools (high schools) clearly indicate that students regard previous science center visits as important for their interest in science and technology. I believe that visits to a popular science park like TEKNOLAND may have an even larger impact.

2. Solar Energy Exhibits at Teknoland

TEKNOLAND had a number of interactive solar energy exhibits already at the opening day. Others will be added later on, during the first season and during coming seasons.

2.1 *The Solar Heated Chess Board*

This exhibit consists of 64 40×40 cm² squares, half of them white and half of them black. The squares are made as shallow boxes with top and sides of plastic coated steel sheet, and filled with concrete. Made in this way, the thermal conductivity and capacity of the squares are well balanced, so the temperature difference between black and white surfaces is quite noticeable, but they don't get so hot so they hurt - at least not at Swedish latitudes. It is interesting and enjoyable to note that when the sun is shining, bare-foot players prefer walking on the white squares, while they prefer to walk on the black squares on cloudy days. Both this and the following exhibits are accompanied with an explanatory text.

2.2 *The Solar Electric Playhouse*

This exhibit has a PV panel on its roof and a small radio inside the house. The panel can be covered with a lid in order to simulate night. A small current storage in the form of a bank of high-capacity condensers will be added later - large enough to display the idea behind energy storage but small enough for the impatient visitor to notice the emptying of the storage.

2.3 *The Sudanese Solar Oven*

This 1×1 m² semi-parabolic mirror (Broman and Broman, 1997) consists of ten parallel single-bent aluminum strips on a supporting plywood grid. It is used from time to time for baking Swedish style pancakes and making popcorns, demonstrating the power of the sun.¹

2.4 *Solar Collector Optics*

This slightly elaborated version of an exhibit that has been designed by Kjell Gustafsson will be added in June. A stand has a small roof with the two sides tilted towards north and south. On each side five pieces of absorber strip are attached. One is painted white, one has a pure aluminum surface, and one is painted black; these are not covered. One more is painted black and one has a selective surface; these are covered with a clear plastic glazing.

2.5 *TeknoTrix*

TeknoTrix is a lap type teepee, where daily children have the possibility to experiment, guided by a teacher. In one of the activities, they work with the S(c)olar Collector¹ (Broman and Gustafsson, 1997). This is a small school laboratory solar thermal device. It consists of a 4 dm² Sunstrip[®] absorber connected to an 80 cm³ storage tank in such a way that it works as a thermo siphon. The absorber has one surface painted flat black and one covered with a

¹ The Sudanese Solar Oven and the S(c)olar Collector are manufactured by Orsa Sol- & Energijämnst, Kallmora 3285 B, SE 794 93 Orsa, Phone and Fax +46 525 550 356.

selective coating. It is used by children who design, make, use and compare the performance of their solar thermal systems.

2.6 Other related exhibits

Some related exhibits will be added later. These include: The existing Elvis Ström's Electric Workshop with dozens of low-voltage electric experiments to do; this will become completely powered by a stand-alone PV system. The Large Sun Dial that by taking the equation of time into account always in clear sunshine shows the correct time. The Day & Night Globe that by being lined up with the real earth shows where on the earth the sun at the instance of observation is above or below the horizon - providing it is clear weather. And, finally, the vacuum tube collector Solar Espresso Cooker.

3. Concluding Remarks

Solar scientists visiting Scandinavia in the summer are invited to a different and active day at TEKNOLAND, experiencing these and many other interactive science and technology exhibits. The author would appreciate communications regarding solar energy exhibits, both such that presently exist in Science Centers and such that so far exist only in your imagination!

References

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Appendix

Preliminary Results from an Inquiry Study in Science Major Classes at Three Swedish Gymnasium Schools

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An inquiry study regarding gymnasium (senior high school) students majoring in science was carried out in the spring 1999. 552 students from three schools participated. All science major students, who were present during the lessons when the inquiry was done, answered.

(1) Haraldsbogymnasiet in the small town Falun. 101 female and 104 male students answered. Out of them, 95 female and 93 male students had visited a science center at least once. 77 female and 83 male students had visited a planetarium at least once.

(2) Frölundagymnasiet in the large city Göteborg. Here, the inquiry study was carried out in grades 2 and 3, only. 43 female and 77 male students answered, out of which 28 female and 51 male students had visited a science center at least once, while 17 female and 36 male students had visited a planetarium at least once.

(3) Gymnasiet in Lerum, a Göteborg suburb. 68 female and 159 male students answered, out of which 53 female and 132 male students had visited a science center at least once, while 55 female and 110 male students had visited a planetarium at least once.

Presently, results from answers to two of the questions have been analyzed in some detail:

Question A: Do you believe that your visit/visits to a science center has increased your interest in science and technology?

Question B: Do you believe that your visit/visits to a planetarium has increased your interest in astronomy?

The students answered by marking a box for one of four alternative answers: *Yes, much. Yes, a little. Maybe. No.*

A majority of the students seem to have the opinion that their visits have had a positive effect on their interest. The 438 students who had visited a science center (and indicated how many times) responded so to *Question A*: 49 *Yes, much*. 185 *Yes, a little*. 135 *Maybe*. 69 *No*. The 378 students who had visited a planetarium responded so to *Question B*: 42 *Yes, much*. 143 *Yes, a little*. 108 *Maybe*. 85 *No*.

In order to be able to quantify the results, a score has been given to each answer: *Yes, much* is given 3 points. *Yes, a little* is given 2 points. *Maybe* is given 1 point. *No* is given 0 points. Quantified in this way, the answers to *Question A* scored an average 1.49, while the answers to *Question B* scored an average 1.38. The difference is not large, but might indicate that science center visits may, on the average, be somewhat more important in raising interest than planetarium visits.

There is however a gender difference. On Question A, female student answers scored 1.38 and male student answers 1.54, while on Question B, female student answers scored 1.45 and male student answers 1.32. If these differences are interpreted as something more than statistical variations, it may be concluded that the world view science *astronomy* attracts female students more than male, while maybe the technological part of *science and technology* attracts male students more.

The students were also asked how many times they had visited science centers and planetariums. There is a very clear correspondence between number of science center visits and the *Question A* answer scores: One visit gives on the average 1.17 points, two visits 1.50 points, 3-4 visits 1.54 points, 5-9 visits 1.79 points and ten or more visits 2.03 points. The correspondence between number of planetarium visits and *Question B* answer scores varies more, but while one visit scores an average 1.11, two or more visits scores 1.57. A teacher who wants her students to become interested in these subjects should obviously visit science centers and planetariums not just once, but several times.

The present study and the analysis done so far favors the notion that science centers and planetariums are important institutions for making young people interested in science and technology. Other preliminary studies (by Ann-Marie Israelsson and Klas Fresk, both unpublished) indicate that the establishment of Teknikens Hus in Luleå and Tom Tits Experiment in Södertälje, respectively, have helped increase the number of science major students at gymnasiums in these two towns.

Finally, even if it is not possible to draw any definite conclusions from this study alone, it is maybe noteworthy that Haraldsboskolan with highest percentage of female science major students (49 %) also has the highest percentage of students that has visited a science center at least once (92 %).

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