



Edupark conference in Stockholm 12-14 September 2013

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Amusement parks offer many possibilities to study physics in exciting and enjoyable situations, where the body of the rider is part of the physics investigation. A visit can also be used in interdisciplinary projects involving other subjects including not only math, science and technology, but also e.g. language, art, music, history and geography. Using amusement parks in teaching can be one way to increase interest in future educations in science and technology.

In connection with the Edutainment day in Stockholm 12 September, 21 teachers, teacher educators, curriculum developers and event managers, from Italy, Denmark, Finland and Sweden met to share experiences and ideas and discuss future development and possibilities for dissemination.

We first observed and took part in the Edutainment day, where 3011 students with 248 teachers had exclusive access to the park for three hours. All teachers had taken part in a workshop at the House of Science before the visit, but not necessarily having tried the experiments suggested. Most of the students used worksheets produced in a collaboration between Gröna Lund, the House of Science and the Swedish National Resource Centre for Physics Education.





This year, technology assignments had been added to the worksheet, connecting with the technology table, which demonstrated a lot of common technology solutions as applied in the park, including levers, hydraulics, pneumatics, magnetic brakes. Students could e.g. lift a 1200 kg engine from Eclipse, watch and feel different wheels and the anti-rollback device from Jetline, and try to move the magnetic brake in different directions.

After having observed the Edutainment day in action, the participants gathered in the old Theatre for presentations. After some time to try rides in the open park, participants joined for dinner at Kryddhyllan.

The sessions of the following day took place in the House of Science in Stockholm, where we also had a guest presentation from Maria Hagarth, Vinnova, about the newly released preliminary texts for the Science with and for Society program in Horizon 2020.



Different event formats

The participants represented a number of different formats for events, shaped partly by the opening hours and attendance pattern of different parks - related to geographical conditions. A special situation in Sweden is that schools are not allowed to charge students for curricular activities.

Andreas Theve told about the development of the Edutainment days, where teachers are now required to come to a workshop at the House of Science, where tickets are handed out, and how evaluations have been collected every year, and the responses used as input for the design of next year's edutainment day. Classes outside Stockholm pay 125 SEK for participation.

Ann-Marie told about the restart of Liseberg physics days, where teachers are required to help out at stations and classes are charged 200SEK for one hour exclusive ride time, including wristband for the rest of the day.

Ulrik Lundby Hansen presented activities at Danish parks (Bakken, Tivoli Gardens and BonBonLand), where the parks invited student investigations during regular opening hours with low attendance. In this way a very low price (50DK) could be offered to schools, while parks could increase revenue. Regular park attendants had been trained to provide support and material (like

filling water mugs for drop towers or providing blindfolds for roller coasters). Before the visit, teachers could download workbooks including tasks also e.g. about biology, math and energy.

Giovanni Pezzi and Stefano Alberghi presented their supervised workshop programs at Mirabilandia, where schools pay an additional fee for tutored visits, where special equipment could be brought on rides. They presented a workshop from Science on Stage 2013, on "*Mathematical machines and other measurements devices for science activities at an Amusement Park*". They brought a beautiful collection of mathematical machines for the math programs in the park - and the participants eagerly tried the machines after the presentations. The material has been published in a book "Matebilandia".

Giovanni Pezzi also presented "*Physics days at Mirabilandia. A new format with physics shows, and science centre participation*" sharing experiences from a science event in the park, run in collaboration with the science center Faenza: . In this way, the general public could try out many different experiments.

Teacher roles

Teachers can take on a number of different roles in connection with a visit, as known also from research at science centres. Teachers may leave the class to roam around, possibly agreeing on meeting time, including a snack - a "soda pop visit". Teachers may use the visit as an appetizer to start up an area of work - or as a resource or laboratory providing equipment not found in school. Lessons may be offered by the teacher or as a packet offered by the amusement parks, in which teachers may take part together with the students or choose to be absent. We have seen all these roles taken on by teachers during different forms of amusement park visits. Amusement park visits also invite additional roles, e.g. as "bag guards", as an "equipment center" or "electronics support centre".

Maria Nilsson and Cia Malm-Boode, from Fridaskolan in Vänersborg, showed their interdisciplinary project "Let the force be with you", with a Liseberg visit as a part. Göran Sten showed how students had tried free-fall, collision and other experiments in the classroom and playground before the visit.



Johanna Windestål presented the collaborative work at the Västerhöjds gymnasiet in Skövde, where she started a few years ago, in a highschool who has experimented at Liseberg since 2002.

Lars Gråsjö's presentation "*High-school students at Edutainment Days at Gröna Lund*" was part of the Science-on-Stage exchange with Mirabilandia, following up Science on Stage 2013. He presented the activities at Danderyd Gymnasium, from the first pilot visit with three classes in 2008 and also attempts to measure student learning and long-term retention.

We discussed the importance teachers trying out the experiments in order to be able to discuss with students. Mirabilandia offers free teachers workshops as preparation for class visits. In Sweden, introductions to amusement park physics have been given at many teacher conferences. In addition, teachers have been invited to take part as observers at Liseberg before coming with a class of their own. Possibly next year's workshop for teachers could be run at Gröna Lund. Attempts in the early days had relatively low attendance, but that was before workshop participation was mandatory. We

also discussed possibilities to offer special teacher workshops at selected rides during an Edutainment day.

For large-scale edutainment days, it is also important that teachers are given opportunity to appreciate the fact that what they do with their class impact the experience of other classes and vice versa . E.g. the capacity of the popular Free fall ride does not allow for 3000 students to ride it during three hours. Teachers participating in Gröna Lunds science days are therefore strongly encouraged to use worksheets that involve a larger number of rides, and this has been found to give considerably smoother operations during the Edutainment days.

Development of additional activities

As part of the conference, the participants were asked to consider possible additional activities.

Katrin Lindwall, from the Linnæus university, showed the app Coaster Physics (<https://itunes.apple.com/us/app/coaster-physics/id393340142>) where you can see both speed and forces during different parts of a roller coaster ride, which could be used as preparation for a visit.

Mattias Davidsson demonstrated Air Space App (<https://airspace.leapmotion.com>) using the body to run e.g. Google Earth, flying into close-ups of Top Thrill Dragster at Cedar Point and the Insane roller coaster at Gröna Lund. They had also started a Google hangout, showing how it can be used to share photos and videos from an event. They emphasized that we should aim to develop a standard for tagging documents to be shared and have a place for collaborative development of lesson plans.



Giovanni told about a competition for students to produce www-pages after a Mirabilandia trip.

Ulrik and Giovanni suggested that it would be useful to produce an Amusement park education app, that combine many tools useful in parks. It was suggested that we start by collecting a number of different useful apps. An app tutorial could probably be appreciated by many teachers.

Ulrik showed how Bakken had mounted a speed meter permanently in a roller coaster, and also allowed a glass with water to stay in a pendulum ride during the whole Natur&Fag week.

Johanna Windestål, Västerhöjdsgymnasiet, Skövde rode the Insane, using a measurement vest with a WDSS sensor, and added a mobile phone simultaneously recording a video through the transparent cover. The results can be synchronized using e.g. Logger Pro. She suggested that Gröna Lund might have some approved vests with the Gröna Lund logotype for sale, or to rent during visits.



Mirabilandia offers the classes a second day at no extra cost. Ulrik mentioned that they had discussed (but not implemented) giving out free entrance ticket for participants in Faglige Dage.

We also discussed possible "Teacher play day" (Ulrik) and company kick-offs and other events (Andreas). We had a short discussion of guided tours behind the stage e.g., which are offered by some parks on www pages, on other parks only on request.

Queueing areas are unused opportunities for information and learning. QRCs or Aurasmas could be used much more, in addition to sign in the waiting areas.

Safety questions.

Although many observations and investigations can be done from the ground, or using the experience of the body in different rides, a combination with different types of measuring devices and experimental equipment taken on the rides can provide a wider range of representation and contribute to deeper insights. Still, safety considerations must always come first.

Tutored visits offer the largest possibilities to deviate from rules during ordinary visits. The tours in Mirabilandia have included a bouncing ball on a string in drop towers and a vertical accelerometer in a plastic tube from Vernier, that many parks are likely to be concerned about allowing during regular operations.



Similarly, bringing a water mug into a drop tower is a wonderful experiment, found to work well also with unprepared students. Only very little water (less than 1cm) is needed for the observation, but mugs with too much water may provide a safety risk if dropped. Teachers may be tempted to add more water for their students for larger effects. Thus, mugs and the amount of water require monitoring. In Mirabilandia, tutors bring the mugs and fill them. In Tivoli gardens, the guards fill the mug. At Gröna Lund, supervisors from the House of Science or participating teachers fill mugs during the Edutainment days.

Material, planning and finance

Amusement park physics activities involve many actors with complementary interests and motivations. Parks obviously need to make sufficient money to cover the cost of operation, as well as possible losses visitors who would otherwise have paid the full fee.

Schools have very different ability to pay for activities outside school. Swedish schools are not allowed to charge anything from the students for mandatory curricular activities, so the money has to be taken from the school budget. At the same time, a too low price risks to cause the visit to be taken less seriously.

Balancing the price to bring income to the park, while enabling schools to pay the fee (in addition to bus rides and other costs) is a delicate task, and the price point depends on many local conditions.

Development of high-quality educational material and programmes take time, and many paths can be used and combined for best results. Teachers and teacher educators have an interest in developing material for their students. University researchers and lecturers are used to open access,

making their work freely available - the main reward is "citations", but salaries for the development typically come directly from the university, or as support for specific projects. School teachers usually do not share material - but it would be important to find and develop ways to encourage their sharing in a supporting format. Some generic tasks may be easily adapted, since the same rides are found in many parks. Detailed assignments, e.g. particular involving roller coasters, are best created with good knowledge of individual parks and rides.

Event managers can catalyze collaboration between many different actors, and help create win-win situations.

Learning and impact

Impact can be assessed at different levels. In a long-term perspective, there is a hope for increased recruitment into educations involving science and technology. A number of participating teachers have told how student interest, as well as performance on national tests, have improved significantly in connection with amusement park visits. Measuring effects on a larger scale, taking into account methodological difficulties, including unbiased selections, confounding variables and statistical significance could be a suitable project for one or more PhD students.

Organizers, could monitor to what extent teachers come back next year - and possibly try to follow up those who don't, asking e.g. about the importance of funding and perceived learning outcomes in connection with the visit. From experiences with post-visit questionnaires, we believe that this would have to be done by assigning a person to perform phone interviews.

In connection with "Physics Bridge" visits between Swedish high-school and university teachers, we have also discussed the development of tests that could be administered before and after the visit. These would obviously have to be developed in different versions for different age groups.

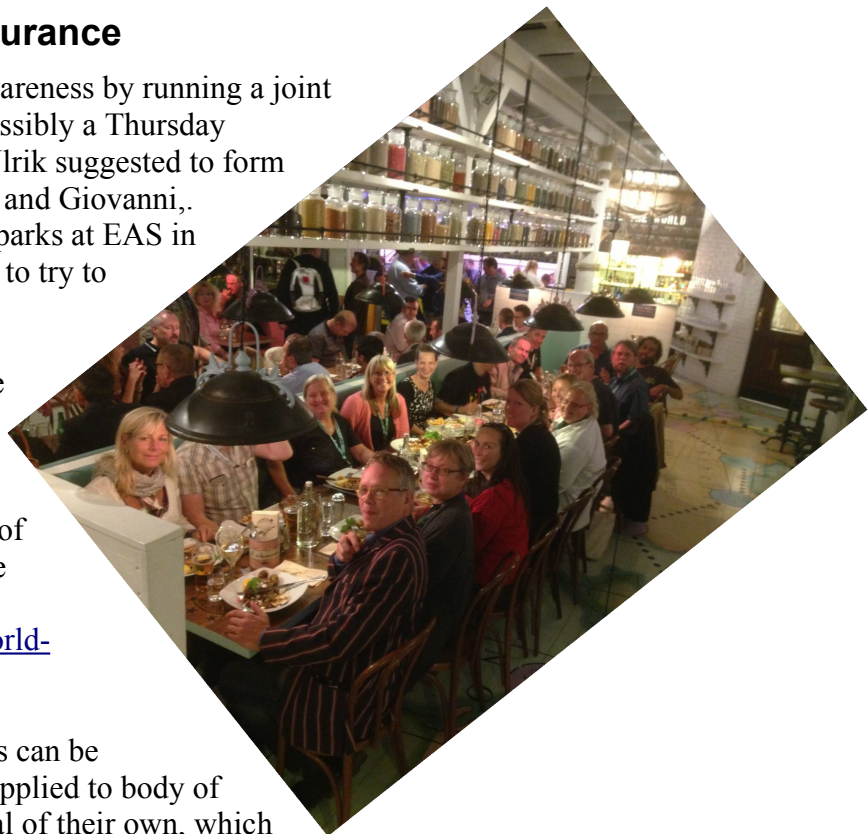
Dissemination and Quality Assurance

We also discussed the possibility to raise awareness by running a joint European Amusement Park Science Day, possibly a Thursday afternoon in the second half of May 2015. Ulrik suggested to form a small committee together with Ann-Marie and Giovanni,. Ulrik will discuss the possibility with other parks at EAS in Paris 18-20 Sept 2013, and also volunteered to try to find sponsors.

We will also keep our eyes open for possible collaborators for an EU proposal for the Science with and for Society, when the criteria are known. We will try to identify and contact other parks with different types of education programmes, as a follow-up of the article in FunWorld

(<http://www.iaapa.org/news/funworld/funworld-magazine/new-way-of-learning>).

The physics of roller coasters and other rides can be challenging. Physics seems different when applied to body of the rider. Some parks have produced material of their own, which



adds to well-known difficulties and misunderstandings. On the other hand, material developed by physicists alone does not necessarily work directly for all teachers. The materials produced in the collaborations in the Edupark networks have been developed in design cycles, involving formative evaluation including teacher responses.

How can other parks benefit from this development? The university researchers in this collaboration would be happy to review material for correctness, and to share some basic, well-tested, safe experiment assignments. We also suggest to create a list of data to be provided by parks for different rides, to facilitate for teachers who want to use the rides in education.

Professional event managers can complement the generic resources by adapting them to specific parks and build events that suit the local conditions. They may also e.g. help raise funding for different events.

