



Notes on designing Roller Coasters

Important information required before starting a design:

- Type of coaster ride in question
- Area where the ride is going to be operated (area plan)
- Area restrictions, position of station, position of main elements
- Local and national codes, height restrictions, earthquake factors etc.
- Customers budget
- Special Customer wishes, track length, lay-out or THRC (capacity)

With this kind of information it is possible to start a design, even if not all factors are completely established.

In general the process starts as follows:

Feed all the relevant information into the computer using a CAD program. Sometimes area plans are available as electronic files, sometimes the area including buildings, levels and other obstacles have to be reconstructed into a computer area plan drawing that can be used for laying out the track.

Often a couple of rough hand sketches showing a top view of the track are made at this stage to show the possible solutions within the constraints. These sketches can be used too for making a pre selection together with the Customer. The one that is selected will be used to position all the key elements roughly in the right place as a computer model overlaying the area plan drawing.

This drawing showing the top view of the track in the area can also be used to roughly calculate the track length. It is also useful to position all the required zones in the ride and to make sure that there is sufficient track length in the ride for brake zones or transfer and storage tracks.

At this time the rough shape of the track in the top view is ready and can be used to start developing the matching profile. It is also useful to obtain a rough indication on track length, lift height and capacity of the ride. Some Clients require special adaptation to the trains, like the integration of an audio system or a complete new vehicle body with special facilities for boarding. At this stage it is determined whether this could be a minor change to the existing standard vehicles or if a new train has to be designed.

Before entering the next phase it is very important that the rough design is discussed with the Customer to avoid too many re-designs in the future. Often a ride takes up more space than expected, or high-thrill elements end up at the wrong level or have dimensions that clash with the area or expected viewing points from within the Park. Sometimes the station or other parts of the track end up at an unexpected level, a solution could be using trenches or tunnels, or track flies high in the air over buildings or structures for which permission of the Park or other authorities is required. Sound is often a restriction too, which could lead to re positioning of high thrill elements to less harmful areas or sound deafening of columns or even track in the future. If everybody is happy with the early design than the next phase is entered.

During this phase the track profile is designed. This profile generates future vehicle velocities, G-forces, exact track elevations, but should also allow enough space between tracks, future columns and existing area obstacles. It is clear that understanding these limitations to the track lay out in an early stage could save a lot of re design work. If the profile line is ready than the G-



forces, zone timing, velocities can be calculated. The results are used to fine tune the profile and the top view in an iterative process until all of the criteria are met. At the end of this process the exact position and elevations of all the critical elements are fixed. This process is quite time consuming but required before moving on to the next step in the design. If new vehicles have to be designed than this is the time to start this activity with the parameters for track gauge, vehicle speed, G-forces and timing retrieved from the above track design.

A 3D-model of the track can now be generated showing the ride in a 3-dimensional space in the future area including existing buildings area levels or other obstacles. With this model and within the restrictions of the input data it is possible to generate life-like computer animations that give the impression that the ride is already in operation. An even better feel for the effect of the ride can also be obtained from simulating a train on the 3D track running at real speed through Loops, Horseshoe elements tunnels or inside buildings.

These movie files are put on a CD, which can be played by the Customer to get a good feel for the ride and to forward any comments towards the final proposal. If an agreement is reached on the design than the final design stage is entered in which numerous static and dynamic calculations are performed to determine the size and shape of all the necessary components. For standard rides this could be pretty straightforward procedure, because a lot of parts are already known, for custom design type of coasters however this could take many hours of engineering including prototype building of seats, harnesses or even entire new vehicles. For some special elements like Launch-tracks or Seesaw elements a full-scale test program is set up to ensure maximum reliability and safety later on. In rare cases even the entire track is build as a prototype ride preferably together with the future Customer to allow extended testing before opening to the public. If in future you happen to be near this coaster, enjoy the ride!

Frequently asked question.

Q: What makes an attraction enjoyable, exciting, or interesting?

A: Basic ingredients for an Amusement Ride are: Speed, height, variation of movement, light- and sound effects, the element of surprise, optical illusions, illusion of fear and danger. Long time experience shows that "real" effect i.e. high g-forces on a roller coaster or fast changing movements on a carousel type of ride still beat optical simulation such as 3D movies or Simulator Rides. People expect a ride to be safe in the end but still want to be scared beyond imagination, this explains somehow the need for faster, higher, more freedom aboard a ride.

Q: What is the recipe / what are ingredients for a successful attraction?

A: There is no specific recipe. The goal is to find a new combination of possibilities that result into a new, or more often a re-introduction of a ride. Trying to improve an existing ride by ever increasing the key elements on which the popularity of a ride is based is not always successful. A ride's popularity is also based on the balance between costs and capacity; it often happens that a very attractive ride has a too low capacity and is as not popular with the proprietors.

Q: Which are the hidden / forbidden effects, what are the maximum values for g-loads, without exceeding the limits?



A: Hidden effects include unexpected changes in direction or deceiving visual- and sound effects. Maximal allowances for g-forces depend on the direction, time, change of direction and seating arrangement. For Roller Coasters a vertical load of up to 7 G's is acceptable as long as all involved factors are satisfied, however it is not necessarily better or preferable to expose people to G-forces of this level. In many cases restricting the maximum G-level to 5 is adequate. Advantages to do so are lower risk factors on people's health and a longer life expectancy or less maintenance on the ride.

Q: How are the limits determined, measured in terms of what the human body can endure?

A: Acceptable load levels in the past were mainly obtained by field experience. A small ride with perfectly acceptable G-loads would be increased in size, speed and effect until it was regarded to be unacceptable, after testing. From these trial runs and experiences norms and specifications were developed. Nowadays the possibilities are there to test effects or expected loading in production facilities or institutes for Human Resources. These institutes employ medical doctors and researchers that can help in conjunction with a ride manufacturer to develop a new and safe ride.

Q: Which were the most successful rides for Vekoma?

A: Roller coasters are the most well known products of Vekoma. In particular two specific types of rides have been proven to be very popular: The Boomerang coaster and the Suspended Looping Coaster.