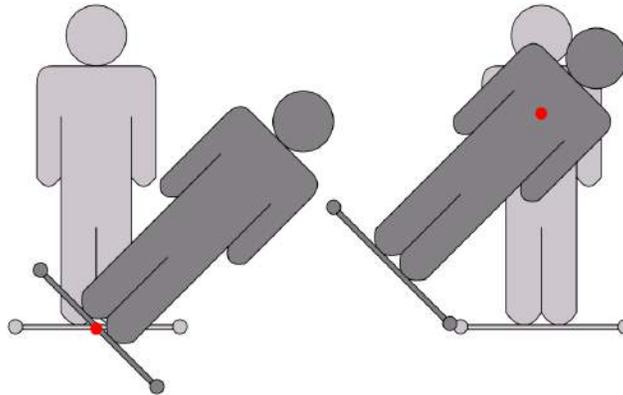


### Heartlining and Track Shaping

#### Heartlining

- Possibly the single most important modern design technique invented. It is what allows steel coasters to have fast, smooth banking transitions.
- The idea was invented by roller coaster design god Werner Stengel in the 1970s and became prominent in the 1990s with the rise of B&M and Intamin AG (and fall of Arrow Dynamics)
- The idea concerns how to rotate track during a banking transition. Previously, banking transitions would rotate around the center of the track (see the left figure below). Heartlining rotates the track around the rider's center of mass (see the right picture). The name comes from the fact that the heart is near the center of mass of most people.



(thanks Wikipedia!)

- Why does this help? The head and upper body in general is more annoyed by large, quick motions than things like your feet. Notice the head displacement in the two figures above. The left one involves massive head movement, which would make quick transitions hard to achieve. The right one has a much smaller head movement, not to mention less jostling of the internal organs.
- Today, coaster designers will design coasters as heartline paths, calculating forces along the path. Later, after the coaster is complete, they calculate the track position relative to the path (all you need is the heartline height and the banking).
- The height of the heartline depends on the ride. Coasters where you sit down have lower heartlines than rides where you stand up. Inverted coasters have negative heartline height.
- You can actually have some freedom with placement of the heartline. Some coasters use heartlines through the rider's head ("headlining"). I've heard that the barrel rolls on Outlaw Run are headlined.
- Modern designers like B&M and Intamin use heartlining in all their coasters. Arrow didn't use heartlining, and some attribute that to why they went to the wayside once the other two came on the scene.

- Wooden coasters are generally NOT heartlined. If they are, it is with partial heartlines. This is because wooden coasters want that feeling of being thrown around. There are exceptions though, like El Toro at Six Flags Great Adventure.

### Track Shaping

There isn't a full set of notes on track shaping, but there are two main 'schools' of track shaping: classic and modern

- Classic track shaping uses equations of basic geometric shapes (mostly circles and lines) to achieve the elements desired. Calculations are performed to achieve desired forces, as discussed last week in Coaster Physics. Classic track shaping has the advantage of creating more astatically pleasing designs with more control over such things as the footprint of the ride, but has a disadvantage of having forces be the secondary goal. Pretty much all coasters are classically shaped, even major modern coasters like Millennium Force and Intimidator 305.
- Modern track shaping uses a technique called FVDs (force vector designs) which involve a designer defining a track based on the desired forces and banking over time. With this information (and lateral forces, which are usually 0), the full equation for the track in xyz space is defined. By focusing on forces, designers can create strange and exciting elements (eg wave turns, zero-G stalls) while knowing forces are going to be comfortable on the riders. However, this comes at the cost of being able to do things like achieve perfect curves. This technique began as a curiosity among the No Limits community, but has in the last 3 years made its way into modern coaster design, and has been observed on coasters designed by S&S and Rocky Mountain Construction.