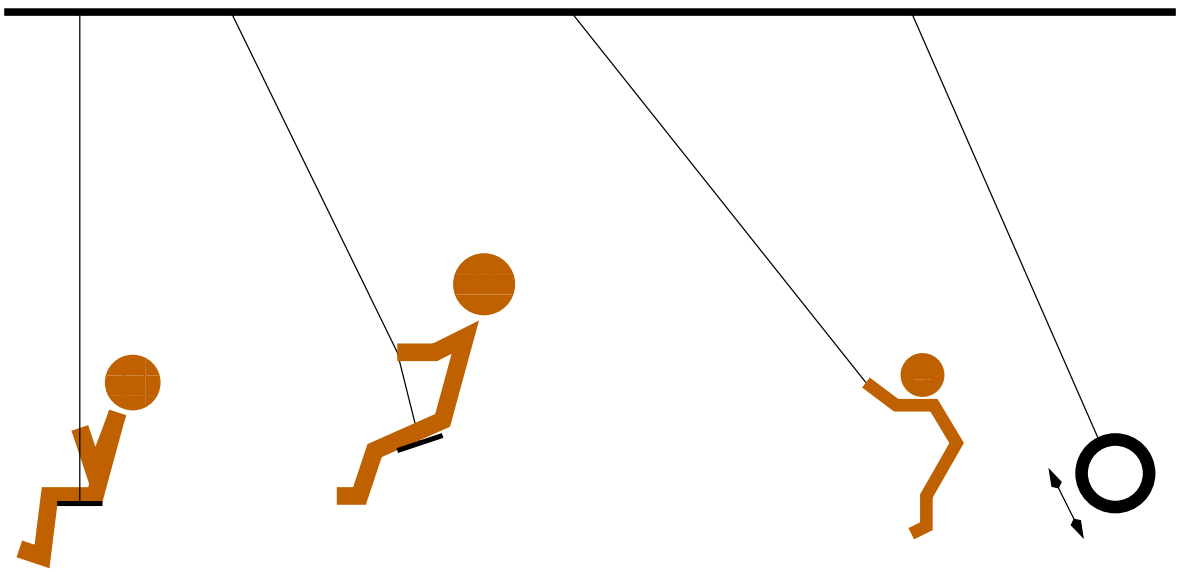
75048 Mathematical modeling 1998

Exercise 5

Modeling seminar

The problem is easily stated. Consider a child on a swing. The child starts from rest and wishes to get as large a swing as possible going as fast as possible. There is no one else around to push, and the swing is too far off the ground for the child to push with the feet. What is a good (or even optimal) strategy for attaining this goal? You may also consider a circus artist hanging by her hands from a trapeze. What is her best strategy for building up and maintaining momentum? Yet another variation to consider is a simple robot, capable of no other movement than moving its center of mass a short distance up or down the rope.

Further questions, if time permits: What role does air resistance play? Consider the extreme case of a very small child on a very large swing. Yet another question is what happens if the child is replaced by a robot undergoing some periodic motion with a fixed frequency. As a result, the swing may undergo some quite irregular motion, maybe even chaotic. Investigate this.



The report. Of course, this is not an industrial problem of great economic or environmental importance, but I want you to pretend that it is. It does not help to have produced a wonderful model if you cannot present it in a way understandable to others!

As far as possible, the report must be written in a non-mathematical language, so that it can be understood by non-mathematicians. However, it should also contain the mathematics used to arrive at your conclusion, so that others can judge on the soundness of your reasoning, and use it as a starting point for further investigations.

Be sure to mention any factors you have ignored, and in what ways they limit the usefulness of your model.

If you tried an attack on the problem that did not work, include a brief description of what you tried and why you think it failed.

Try to keep the report as brief as possible – but not briefer. You may wish to present a summary and your conclusion first, and then go into more technical detail later. That way, the busy child can quickly get to the crux of the matter and get swinging, while the more academically oriented reader can read on. Avoid presenting long and messy calculations. If absolutely necessary, you can move such detail to an appendix. Since I suggested starting

with the conclusion, I think it is good to end the report with a section suggesting some directions for future work. I don't expect a final solution to this problem in such a short time, and you should imagine that someone else might continue what you started. The final section should be aimed at getting those people aimed in the right direction.

The report will be judged on clarity (and brevity) of presentation, as well as the simplicity and effectiveness of your models. A simple model which manages to contain the important factors will be viewed more favourably than an overly complicated one. But a model that is too simple to produce useful insight is of course viewed less favourably.

Do not waste too much time on layout. The contents of the report, and your choice of words and illustrations, is more important than the looks! Use handwriting, a computer, or a mixture to create the report.