LEGO is developing a 3D building application for children – please see the current version on www.lego.com/ldd. We are now looking for possibilities to improve performances and functionality of the application.

Classical LEGO bricks are building blocks which connect to each other in well-defined manner, and allow for making rigid structures of arbitrary shape (see Figure 1).
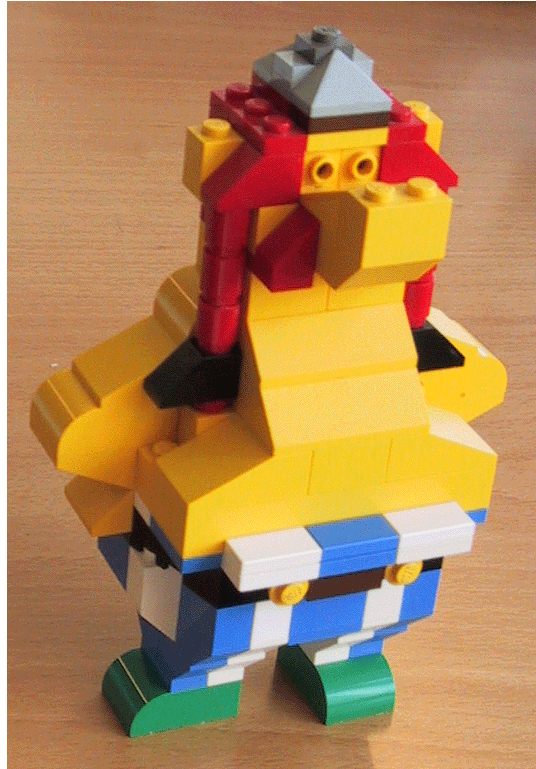

Figure 1. Typical rigidly-connected LEGO model

Recent development added different types of joints to bricks assortment (see Figure 2). So a typical LEGO construction consists of several rigidly connected blocks, connected together via different types of joints. (see Figure 3).
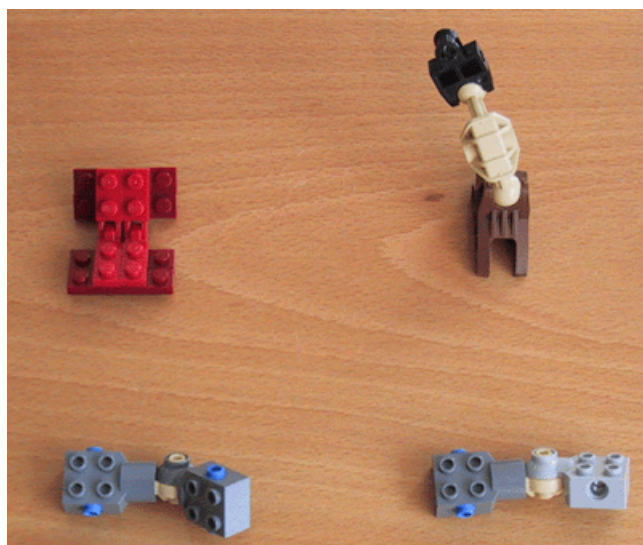

Figure 2. Typical LEGO joints

Figure 3. Typical construction with several rigidly connected parts connected via joints
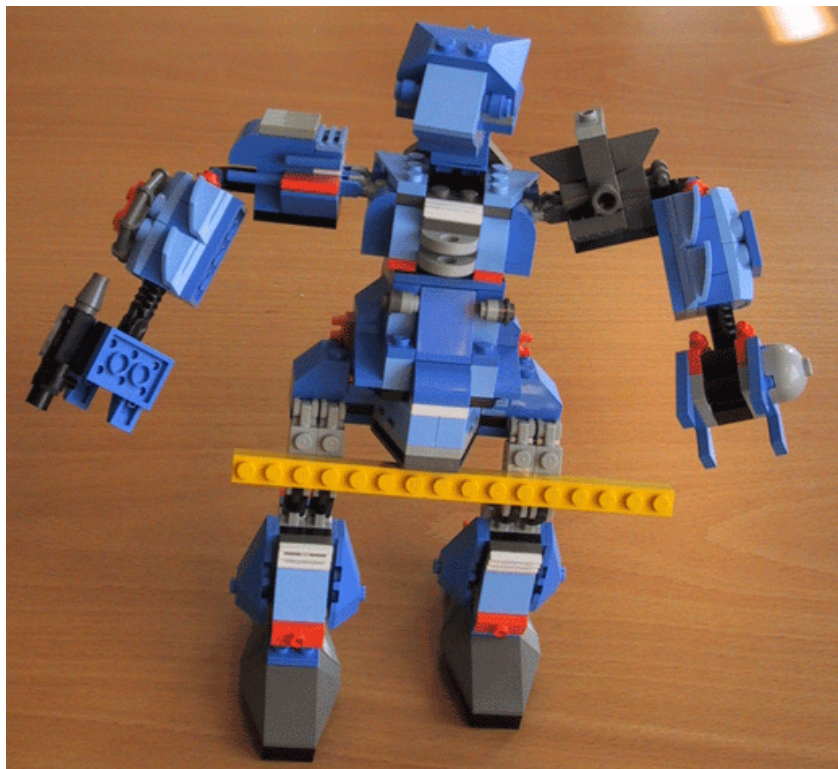

Figure 4. Changing kinematical structure of the previous model by adding a single brick

Unfortunately, as the construction is a result of a child's imagination, it is impossible to say anything about its structure – kinematically, it could be anything, including both open chains and

closed loops. Moreover, adding or deleting a single brick to a structure could completely change kinematical properties of the construction, as illustrated on Figure 4. The added/deleted brick could be very far from the joint itself, and not directly connected to any of the bricks forming the joint.

Computer game we are developing tries to mimic as faithfully as possible the process of building in real world.

What concerns us most is a data structure and set of algorithms that would allow us to update the structure of the digital model as fast as possible on-line – i.e. a data structure that would allow for efficient adding/deleting a brick on-line (or with minimal delay for the user for the case of more complicated models) and would describe correct kinematical model at each moment – as the child could decide at any moment that the model is finished, and then start adjusting joint positions, then continue building again, and so on. We would like to be able to build digital models with 200-500 bricks (current application significantly slows down at about 50 bricks).

Screen shot from existing application together with an example of a digital construction with several joints is on Figure 5.
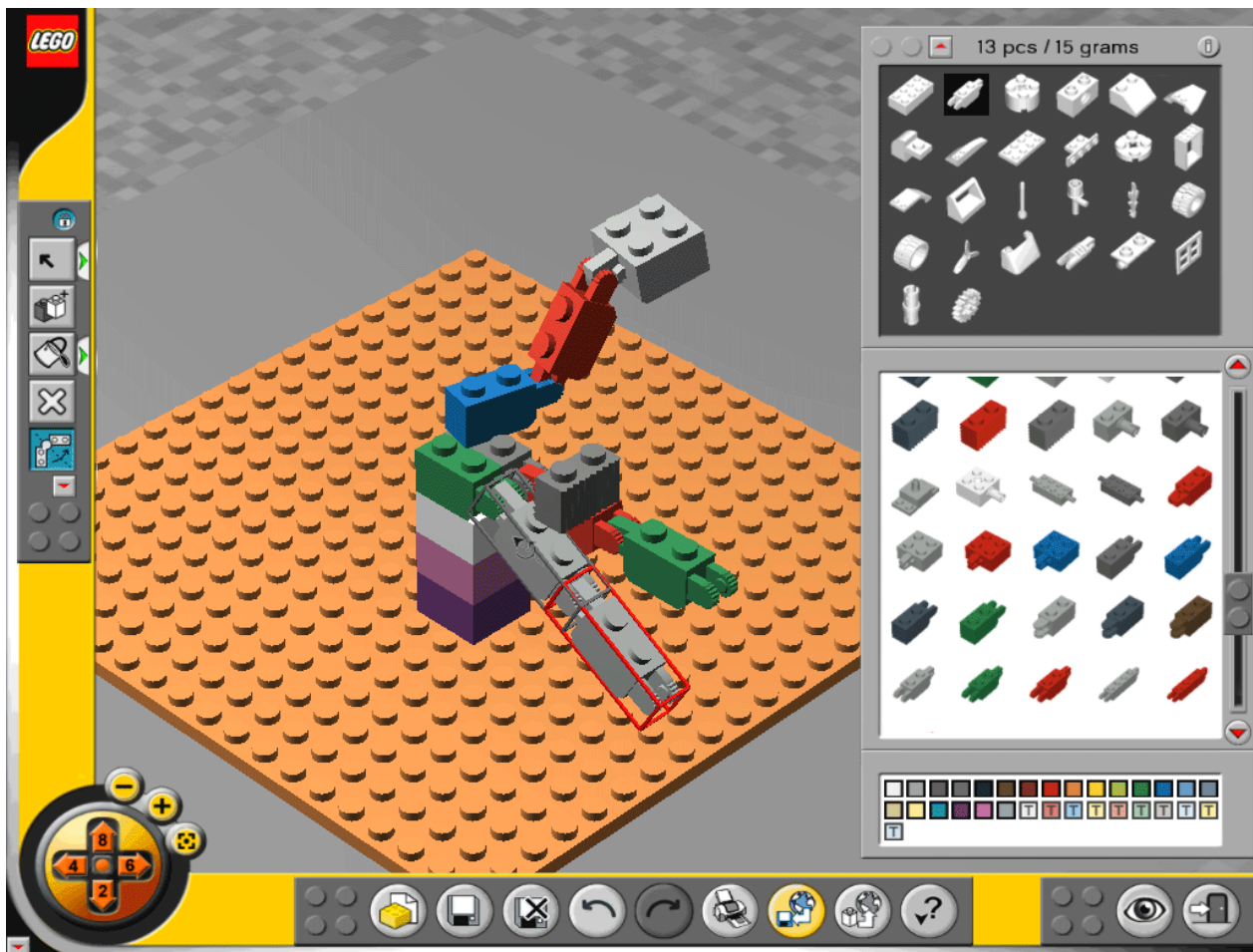

Figure 5. Screen shot of the current application – open chains work fine, but there are some problems with parallel hinges