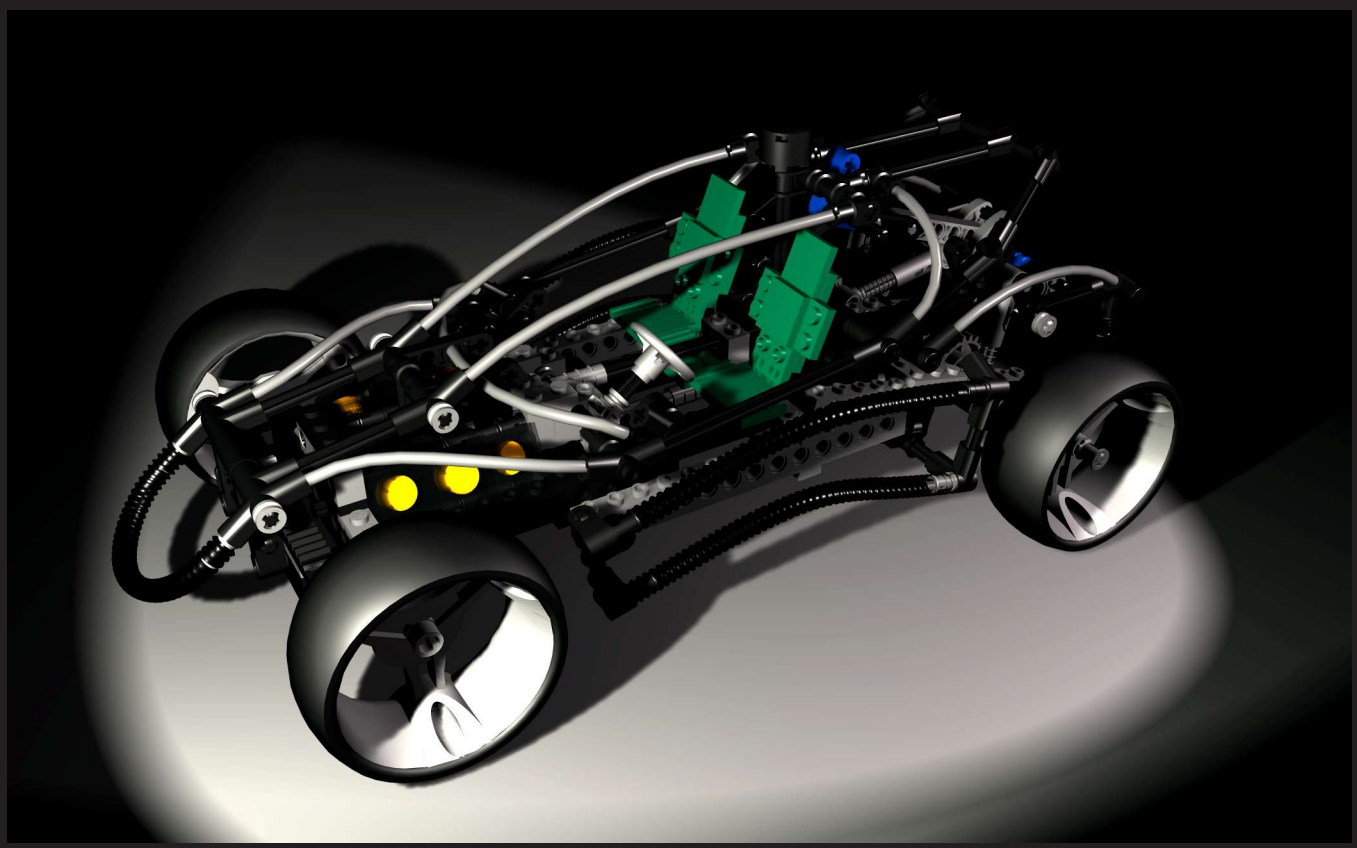


BURNING RUBBER CONCEPT

Thesis of Christoph Bartneck

BURNING RUBBER CONCEPT

Thesis of Christoph Bartneck
In cooperation with LEGO A/S
Billund, 05.09.97

Examining board
Prof. Dr. Ing. Falk Hoehn
Prof. Dr. Dr. Thomas Jaspersen

FH Design & Medien Hannover
Faculity Industrial-Design-Informatik
Herrenhaeuser Str. 8
30419 Hannover
Germany

Content

Content

1. The high concept

1.1. In the tradition of Rubber Duck
keeping basics, while extending the play value of models

In the tradition of Rubber Duck, Burning Rubber will be an in-the-box CD-ROM featuring digital building instructions for LEGO Technic models. Many things about Burning Rubber will be familiar:

- the idea of a **base** of operations where the models are featured and built
- a **tips and tricks** section showing Technic building ideas
- a **catalog** of other Technic products
- a **fact file** of relevant and useful information
- **data screens** displaying information
- and, of course, **building instructions**

Building upon these basics, Burning Rubber will feature "fantasy activities" with the models, including driving in a real-time 3D environment. These activities are framed in a series of goals for the child to achieve, set into the context of an action/adventure story.

1.2. LEGO Values

The success of Rubber Duck has proven the effectiveness of providing a digital component to LEGO Technic kits. By adding dimensions of fantasy, knowledge, surprise, and reward, the product inspires new levels of exuberance and imagination. The continuing evolution of in-the-box products as developed by SPU-Darwin is intended to develop these essential values to their maximum potential.

1.3. Some key features

Burning Rubber will introduce several exciting features, designed to make the models, and their construction, more engaging.

enhanced building instructions

- a dynamic element lists for each step
- greater control of the step animations
- construction in a "virtual reality" base setting, designed to reinforce the digital/plastic connection between the "real" models and the models in the program
- an element counter to measure the builder's progress
- "QuickTime VR" representations of the models, ideal for visual testing for correct construction

more immersive interface
By reducing the base to a single large room with very basic navigation (virtual head-turning), the environment can become much more immersive, and therefore more engaging. Within this room is the large screen display for the KB9000 base computer, on which is projected building instructions, fact file data, and laboratory results.

driving!
The user will have the opportunity to drive the 'A' and 'B' models at high speeds in a quality real-time environment. This environment will be designed to satisfy the bølle bob in all of us.

interesting characters
Dan Thunder, JOE, and pup are an ensemble cast that will make the child's experience exciting, informative, and fun.

1.4. Target Audience

Burning Rubber is targeted for children Age 9, LEGO Technic Starters.

1.5. Target Platform

PC Windows95
75 MHz Pentium Processor
4X CD-ROM
Midi Compatible Sound Card
Optional Internet Connection
10 Languages

1.6. Technology

The technology behind Burning Rubber is an evolution from Rubber Duck. The multimedia content will be created in self-sufficient bundles available for all types of delivery from CD-ROM to the Internet. The engine that drives the narrative and generates the real-time 3D world will play this multimedia content. By taking this approach we hope to build a system that is able to deliver products and technology to the consumer with out creating a static development cycle that needs to be re-invented with each product. This approach is the next logical step from foundation that Rubber Duck has created.

2. Rubber Duck II

2.1. What we have taken

Several aspects of the original CD-ROM are essential elements to future products of this type. These have been gladly inherited for incorporation into Burning Rubber:

components
- building instructions, of course
- tips and tricks
- fact file
- catalogue

the "base" setting
"data screens" for providing information
attention to detail
- richness of environment
- evocative sounds

2.2. what we've changed or added

It is important that our digital products continue to grow and evolve, continually presenting new ideas and greater excitement to the users. This is the current nature of the "digital revolution," and our products must keep up with increasing expectations.

"fantasy activities" with the models
- applying fictional details and settings
- drive it yourself

a basic story
- providing context, motivation, and reward
- an interesting cast of characters

"user genesis of models"
- a new idea for reinforcing the digital/plastic link
- the user must build the models to exist in the "reality" of the base
- better parallels the table-top environment at home
- opportunity to deconstruct

simplified base and navigation interface
- a single room
- turn to face different work areas
- more immersive = more engaging

an integrated information system
- consolidated "data screens" into one screen
- a recognizable information source

3. user walk-through scenario

introduction
After logging in and choosing a language preference, the program opens with an exciting animation of the Hero in the 'A' model chasing some bad guys. He is not able to catch the first two bad guys and gets more and more frustrated. While chasing the third bad guy, he takes it too far and crashes. The defeated Hero contacts the base, where the user is "stationed," and the presents an initial "mission brief:" to build a better car, fast enough to catch the bad guys.

building
With this goal in mind, the user gets busy. A robot assistant suggests starting with assembling the 'A' Model. The user follows the building instructions on the base computer screen display. At any time, the user can "glance" to the left and see the "virtual model" in the base in the current state of completion. He can also spin the virtual model around to look at it from any angle of view. When the user returns to the building instruction screen, he can click on a highlighted functional unit, which leads him to the relevant Tips and Tricks section. He can find out more about the construction of this LEGO tip, its physical principles and its variations.

base activities
When the user has completed the model, he then has a number of choices for what to do next. He can take it directly for a drive, move it to the lab area, or tear the model apart and build a new one. In the lab area, he can pursue the mission brief by modifying some "fictional" aspects of the car such as frame material or the type of fuel. These adjustments will affect the cars driving performance on the test track. While in the Lab, the user can also run some cool diagnostic tests to learn more about how the modified car will perform.

research
At any time, the user may want to learn more about what he is doing. For example, while running the "shock drop" test, he may click on the reference button. The knowledge base then fills him in with relevant help information. Looking around a bit more in the knowledge base, he finds a wealth of background information to the story and mission, such as the criminal records of the bad guys. From here he can navigate on to "top secret" technical reports of their vehicles, as compiled by Planet Technic's intelligence services.

driving
When the user feels ready for a drive, he can take the car out his choice of three test tracks. After finishing the third lap, the car stops and the picture fades out and brings the user back into the base. On the base computer display, he can view time and speed results from the test run. If the user has adjusted the vehicle properly and driven well enough, then he has met the mission goals. The robot helper may suggest he contact the Hero character to tell him that the car is ready to rumble.

the story continues
In another exciting animation the user watches as the Hero catches the first bad guy. The Hero returns to the base with new secret information and building instructions for the enemies' second vehicle, and asks the user to adjust the model again (either A or B) to be able to catch up with this vehicle. The user then enters another cycle of activity – building, adjusting, testing, and driving – to create a vehicle to meet the second performance benchmark. Having achieved this goal, the user is rewarded with another animated chase scene where the Hero catches another vehicle, seizing new information and presenting yet another mission update.

the conclusion
When the third and final benchmark has been met, the story continues in an unexpected way: the Hero is unable to complete his mission and the user's character must take his place. A final animated chase scene leads the user's character to the enemies' hideout, and in a final climax he destroys their headquarters.

The story concludes with a special audience with the Planet's High Commander, who expresses his gratitude to the user for his skill and bravery, rewarding him with ownership and command of the base. The user is then free to play in the base for all eternity.

4. User activities in Burning Rubber

Burning Rubber is not intended to be a "computer game," as so many current CD-ROM products on the market are promoted. Because it will come inside a box of LEGO elements, its main purpose is to involve the user in LEGO activities and in some way "enhance" the plastic. Therefore, all the user activities featured in Burning Rubber are related in some way to the Technic models. The story, with its series of goals and rewards, is provided to give the user personal meaning and motivation to try all aspects of the product.

4.1. Building

When the user first starts the program, the base will be empty of models. The mission statement will make it clear to the user that he is responsible for building the models, and that no further fun can be had until he has gone through a building instruction for either the 'A' model or the 'B' model. This is intended to make the connection between the real model on the child's table and the virtual model in the imaginary base -- making the digital-to-plastic connection.

To reinforce this illusion, the model in the virtual base progresses just as the real model on the table progresses. As a step is completed in the building instructions (as shown on the KB9000 screen), the model in the virtual base will be shown completed to the same level. This serves as a confirmation of the child's progress and also as a visual test for correctness (especially if the partially built virtual model can be turned around at milestone steps).

The parallel "existence" of the virtual model with the real model is made even more clear by requiring the child to take both the real and the virtual models apart before building the next model. It has long been Technic's goal to encourage children to take their models apart, but they are sometimes reluctant to do so. In the base, this will be an especially fun task: with the press of a button, the virtual model will literally explode into hundreds of elements.

Mostly for reasons of economy, the C models cannot "exist" in the virtual base. They will, however, be featured prominently in the story animations, and their building instructions will be made available in the same style as the 'A' and 'B' models' instructions. These instructions are offered as "rewards" for building the first two models.

4.2. Playing in the Base

Once having built a virtual model in the base, the user will be able to choose a "fantasy activity" to do with the model – testing, adjusting, or driving. The child will not be required to perform any single activity first or to do them in any order. The base, then, is intended to be a world of "free play" with the model he has built. The robot assistant may provide gentle reminders and suggestions for achieving the mission goal, although the child will remain free to play as he wishes.

Testing

With the car in the Lab area of the base, the user can run a series of tests on the car to measure its abilities. There is a shock-strength test, a speed test, a balance/weight test, a power test, and a wind test. For each test, the Lab morphs in really cool, entertaining ways. The results of the tests (and the meaning of these results) are posted on the KB9000 computer screen. (see Appendix B)

Adjusting

Also while the car is in the Lab, the user can quickly make some adjustments to the vehicle to change its abilities, affecting the test results accordingly. Since the "real" model itself cannot change much, the changes in the virtual Lab are "fantasy-oriented" and do not change the actual construction of the model. For instance, the user can choose a different frame material, different tire types, different shock types, and different fuel types. The first two would be represented by color and texture changes to the virtual model; the other two are not visible at all. A final adjustment does remain true to the "real" model, and that is frame position: both the 'A' and 'B' models can be set in a raised or lowered position. (see Appendix B)

Driving

At any time after a model has been built, the kid can take it for a simulation test-drive on one of three track circuits. At the "go" signal, the user can drive three laps as quickly as possible. The user will accelerate, brake, and steer the vehicle through a series of gates. The point of view will be above and behind the vehicle.

On one level, this activity is intended to satisfy the bolle-bob in just about every Technic kid, actually taking their model out on the road with all the thrills and spills. At another level, the driving activity is one more test of the vehicle, a road-test verification of the results of the Lab tests. If the vehicle adjustments are satisfactory, and the road-test results good enough, then the user will have met the mission goals and the story/animation can proceed.

Research

Also at any time while in the base, the user can look to the KB9000 database for further information on several subjects. There is a detailed and cross-referenced tips and tricks section explaining the structure, principles, and variations of various Technic constructions. The user can also learn more about the various vehicle principles involved in the adjusting and testing process. Under "Top Secret," the child can find background information on the base, the characters, the mission, and even Planet Technic, information that would be too costly to tell in the animated story sequences. Finally, the user can preview other Technic products in the catalog section.

4.3. Participating in a story

In order to give meaning, purpose, and direction to this building and to the other activities, a story has been developed. The story is a classic tale of good against evil, and features action, adventure, and suspense. Much of the story is shown through a series of animated sequences taking place outside of the base, involving the hero-character in feats of daring and skill. The user will be made to feel like a necessary contributor to the success of the hero-character by his responsibilities at the base.

The user's role in the story will be communicated by the robot helper in the base and by the hero-character via telecommunications. The mission goals, successes, and failures will all be communicated to the user in this manner.

As the user succeeds in meeting these goals, he will be rewarded with the next chapter of the story and a supplemental building instruction for one of the enemy's vehicles. When the final goal is met, the concluding animation featuring extra surprises will be shown. Back in the base after this climax, the user will be presented with a final reward – ownership and unlimited usage of the base.

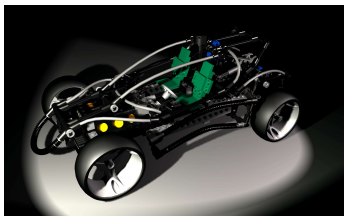
5. Elements of Burning Rubber

5.1. Models

The Technic model designs are the heart and soul of this product, the entire raison d'etre for the CD-ROM. The goal is that the player will build each featured model and have a rewarding play experience with them once built. Their style serves as inspiration for the game and environment.
The model designs are very attractive, but have sacrificed some degree of flexibility for this reason. Because the models cannot be quickly or easily reconstructed, the fantasy digital world has added some fictional interpretation to the vehicles. By working with ideas such as material or component variations, the child will have more play opportunities in the digital universe.

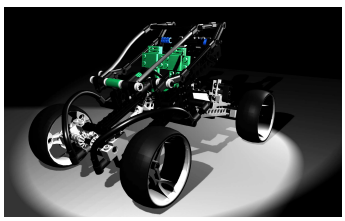
5.1.1. The 'A' model – the cruiser

The 'A' model is the primary model, the one featured on the front of the box. It is the largest of all included model designs (it uses every single element), and has the most features. It is this model that the consumer purchases.



In the fantasy created on the CD-ROM, the 'A' model is the fastest and most powerful of all models. It is most likely the first model constructed by the user. However, for the purposes of the story, the original built design is not the best the car can be; in the opening animation, it is shown to fail. By adjusting such fictional aspects as material and fuel type, etc. in the Lab, the car can perform even better.

5.1.2. The 'B' model – the buggy



The 'B' model is similar to the 'A' model, but not as large. It also uses a different suspension system, so in the story it is featured as the more maneuverable and rugged vehicle, but not as fast as the 'A' model. For these reasons it is not suitable for apprehending the first bad guy, it may work for the second (winding road) with optimal adjustments, and it is necessary for catching the third, off-road, vehicle.

5.1.3. The 'C' models – the accelerator, the dart, and the wombat

The 'C' models are a special case for several reasons. For one, their building instructions will be available only on the CD-ROM. They are also much smaller, and their designs are much more exotic.
Even though the instructions are available in the knowledge base, the 'C' models will not appear in the construction area and therefore are not available for tests or driving, nor are they required to advance the story. The 'C' models have been designed with the story in mind. As the bad guys' vehicles, they are therefore are very specialized for the three driving challenges: one for speed, one for maneuverability, and one for ruggedness. The designers also kept potential Tips and Tricks in mind when developing these designs.

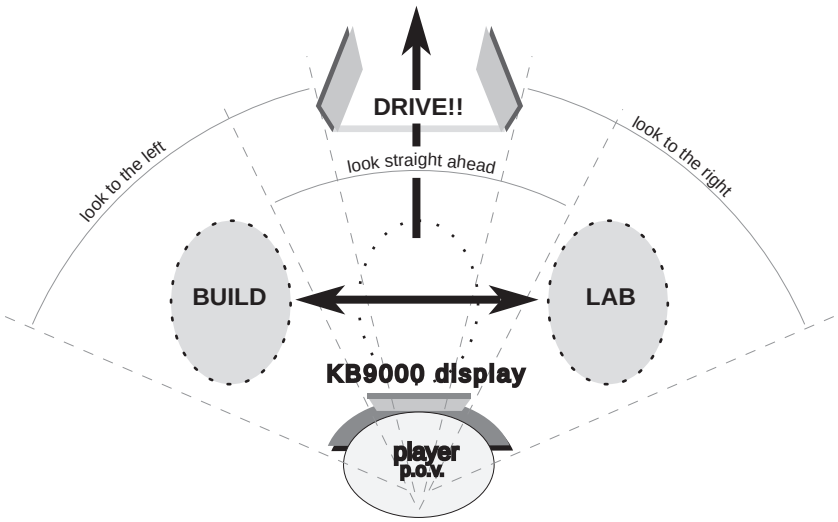
5.2. The Environment

Many digital products, as a part of the "fantasy" experience they create, include places that do not, or even cannot, exist in reality. The technology allows for the construction of detailed "virtual realities" for the user to become immersed in, to navigate and explore. Rubber Duck featured a fine example of such a virtual environment. This product should have an environment of at least equal quality.

5.2.1. The Base

The base is where most of the user-activity will take place. It is a single large room with different functional areas. The user will occupy a fixed position in the room and control all activities from that position. To perform a certain activity, the user must simply "face" that direction (pans his view) and the program mode will adjust for that activity. To the left is the building area, to the right the Lab, and straight-ahead is the base computer display – the "KB9000." These three views combine into a sort of "extended field of vision" of the entire base area.

Burning Rubber
base layout - diagram



building area

To the user's left is the building area, where the virtual vehicles are assembled and disassembled. Initially, this area is empty but as the user goes through the building instructions, a virtual model appears. (This happens for only the 'A' and 'B' models.) A little visual trickery makes this possible: to advance the building instructions, the user must be looking at the KB9000 display and not at the building area. As the instruction animation plays, audio cues signify that something is happening in the building area. Between instruction steps, the user may look back to the building area, and there will lie the partially built virtual model. The user may "spin" this virtual model to check it against his own real model, for correctness.

When the instructions are completed, the user can move the model (see "console") to the Lab or drive it. Likewise, the user can move a finished model back into the building area and demolish it with the push of a button. In fact, this deconstruction step is necessary before construction on a new model can proceed.

lab area
The lab area is to the user's right. While the model is here, the user can adjust various aspects of the model that may affect its performance. The menu of adjustments is available on the KB9000, so again the user will hear but not see the changes made. Looking back to the right after making a selection, the user will see the result only.

At any time that a model is in the Lab, the user can run a series of tests on it. This time, he may watch the model as the test is run – the Lab will morph to arrange the testing apparatus, and the test begins automatically. Once running, there isn't much to see on the model directly; on the KB9000 screen, though, the test data results are shown.

The base computer display – the KB9000
In the center of the user's extended field of vision is the display for the base computer system, the KB9000. From this single screen, a simple "head turn" away from the building area and the Lab, every piece of information that the user may need is quickly available, whether building instructions, tips and tricks, testing suggestions, tutorial help, even background to the mission.

Under normal use, the KB9000 will be "context-sensitive." That is, the user will choose his next activity from the much-simpler console buttons, and the KB9000 will display the appropriate data screen. For example, if the user chooses "build" from the console, the display will present the "model viewer" showing models with available building instructions. Likewise, if the user chooses "lab," the model will be moved to the Lab and the display will present adjustment options. If the user chooses a test to perform, whether from the console or the display (an option in the "adjust" menu), the appropriate test results will be displayed.

However, this will not help the user who wants to know more about something while in the process of building or testing. Whatever mode the display is in should have links to relevant help and/or tips information, and be able to return to where the user left off when he started. The user should also have the option to enter the entire knowledge base from a top-level, regardless of context.

The KB9000 display and interface will be very flat and 2-dimensional in appearance. Although the current trend in interface graphics is towards an "embossed" 3D look, we believe that we should emphasize the differences between the "reality" of the base as shown on the user's computer screen and the virtual, data-rich, content of the KB9000.

foreground console
In the foreground of the user's point of view, "within reach," is a desk-type console, upon which several buttons will always be present. Generally, these buttons will control basic functions and modes of the base, such as moving the car about, demolishing a model, morphing the Lab for a test, and opening the door to the outside. The KB9000, by contrast, is primarily an information source, though some overlap between console buttons and KB9000 selections may be useful. These buttons will be placed on the console in positions appropriate to their function (e.g. the "explode" button will be on the left side, in front of the building area).

As the user's "workspace," the console can be the setting for several humorous details, such as a silly coffee mug, scattered papers, etc. Such everyday messiness will help bring life and levity to the base.

door to test track
On one wall of the base (not yet decided), there will be a garage door that opens to the test track outside. By pressing the "drive" button on the console, the car will be positioned, the door will open, and the user (in the form of a Technic figure proxy) will hop into the driver's seat. A transition from the base interior to the starting line of the test track will then occur.

5.2.2. The desert setting

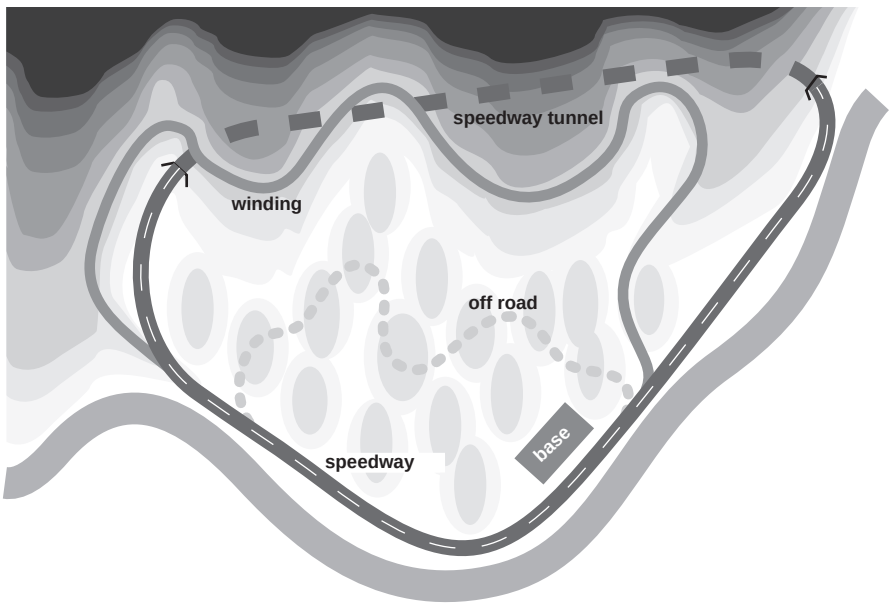
The story takes place in a desert, and the car is the ultimate inspiration for this location. The 'A' model looks built for high-speed cruising, and a desert, with long straight roads in brilliant sunlight, is the best place for this. The story that has been developed for this project is well suited for a desert setting. The idea is that the hero is trying to chase down smugglers – the desert is often where smugglers can be found, being remote and hard to keep under surveillance. The story also requires multiple driving situations – straight and smooth, winding, and off-road – a desert can logically satisfy all three better than most other places. Finally, deserts are barren and by lacking lots of up-close detail are better suited to animation technology.

While the open desert is well suited to the story, the base has a couple of different requirements. It is a top-secret hideaway, and should be a place with limited access – enclosed to an extent. We believe the base should be located at the bottom of a canyon, fitting to the desert location and its secret existence.

5.2.3. The test tracks

To simplify the production of this product, we are proposing that a single real-time driving environment be constructed, and that no other active entities appear in the driving scene other than the car being tested (that is, this is not a racing situation; just solo driving). We can then focus our efforts on making the driving environment especially compelling in its own right.

Burning Rubber
canyon test track layout



The story will require that the user configures the vehicles for three different driving conditions: a smooth fast highway, a winding dirt road, and off-road. This single environment will contain all three conditions as different routes to take around the environment. By default, the route to take will depend on where in the story progression the user is at the time. The user may also select a different route to take before he begins, just for fun. The track will display different markers and pointers, or put up gates, which will direct the user along the proper route. If the user has missed a gate on the prescribed route, the system will inform him of this upon completion.

At the start of a test drive, the program transitions from inside the base to outside at the start/finish line. The user will be granted 3 laps to try for a best lap time. After crossing the start/finish line the third time, the car will stop and the scene transitions back inside the base.

5.3. Knowledge base content

The knowledge base is the sum of all the information that is displayed on the KB9000. This includes information that causes or controls activities like building instructions or tests.

5.3.1. Tips & Tricks

A "Tip and Trick" is a construction method for a common design problem based on the geometrical system of LEGO Technic. The methods are kept at a simplified or abstract level, so that the kid can use them for constructing a model of his own design. The building instructions are closely linked to the Tips & Tricks section. The purpose of the Tips & Tricks section is to educate the kid to become a better LEGO builder. By understanding the rules and tricks of LEGO Technic they can improve their skills.

The categories of Tips and Tricks that Burning Rubber features are steering, gearing, framing, suspension, engine and differential. Three aspects of each example are featured:

structure/form:
At the most abstract, this is the LEGO Technic geometry that governs the construction in question. While some tip constructions are themselves structures and therefore do not need such explanation, the motion-based tips (comprised mostly of gears and axles) would benefit from having their accompanying structure/geometry shown as an overlay (therefore showing the tip as "buildable"). The "structure" option on a tips page, then, appears only for motion-based tips and turns on an overlay of the accompanying structure.

For those tips that are structural in nature, we will illustrate issues of form – the shapes and volumes that the construction accomplishes. Technic, by nature, is a "transparent" medium; unlike standard LEGO which builds walls and solids, Technic achieves form by constructing frames that imply solid volumes. The "form" button on a structural tip will illustrate the implied volumes and shapes of the construction.

principles
Every tip has an idea behind it. Technic embodies numerous physical principles, and these principles are expressed in the "language" of Technic elements. An overlay illustrates the same principles but in a more abstract and straightforward language, using basic symbolic notations of force, motion, direction, etc. Selecting the "principles" button will therefore overlay this abstract description of the idea, probably animated, on the actual Technic construction.

variations
A tip can vary within its "type" (e.g. using a 8 beam instead of a 6 beam) or within its "family" (e.g. different steering systems). These variations are apparent in other models in the kit, and the "variations" page will show these other examples. By clicking on a variation, it replaces the current tip and can be explored in the same way.

For more details on the content of the Tips & Tricks section see Appendix F.

5.3.2. Catalogue
The catalogue will present all of the currently available Technic models laid out in a grid. A collection of images or a movie and a description of the model is displayed for each box. The other LEGO boxes that include a CD-ROM will be presented with additional interactivity -- e.g. a QTVR of the finished model.

5.3.3. Story background
The kid can find out more about the characters, their vehicles and the world description in the story background. A personal record file provides detail on the story characters. A technical manual describes the vehicles and their specialties. In the world description, the child can gain information about the Technic civilization, the crime-fighting organization he is serving in, and about the bad guys' organization.

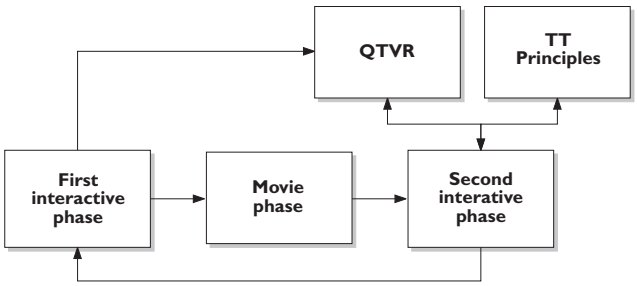
5.3.4. The Base
The Base section will provide the user with background information and details about the base and all its facilities. The functions of the construction area and the lab facility will be explained, using a plausible fiction to describe a "logically consistent" universe as the setting for the story, the activities and the models. For example, the kid can find out how the tests work (e.g. the physical explanation how a balance table can measure the center of gravity), or that it is the robot assistant who constructs the "virtual" model at the command of the building instructions. The base section also includes descriptions about the test tracks and their requirements.

5.3.5. Test & adjust reference
This section presents the physical principles involved in setting up the vehicles. Car weight, power output, wind resistance, etc. and their relationships are all explained. Reference is made to the functional connections between the car adjustments, test measurements and driving results. Descriptions of each adjustment's options with its pros and cons are also presented. This can be considered the "help pages" for the adjust/test challenge.

5.3.6. Building instructions

The building instructions are the initial reason for the CD-ROM. The electronic medium has many advantages over paper instructions, such as moving images (instead of stills) and interaction with the user.

The building instructions are divided into building steps similar to the ones in the traditional printed version. It is very important to choose the right level of complexity for each step because we neither want to bore or expect too much from the child. Each step is split into 3 phases: a first interactive phase, the movie phase and the second interactive phase.



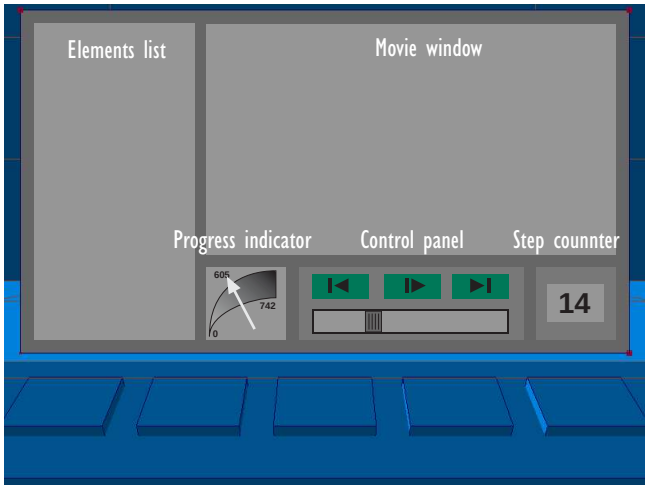
The three phases of the building instructions

In the first interactive phase, the child identifies the elements used in this step either through a display in which all necessary elements and their number are shown (element list) or through the movie itself in which all elements are displayed in their start positions (movie window). The element list is interactive i.e. whenever the user rolls over an element, it rotates. Seeing the element from different angles helps the user to find the plastic equivalent on his table. When he then clicks on it the element, all elements of this kind appear highlighted in the movie window. This function is available in the first and second interactive phase. Whenever the user rolls over an element in the movie window the equivalent element in the element list starts to spin.

In the second phase (movie phase) the child watches the elements fly together in the movie window. The child needs to understand the translations and rotations of the elements to be able to imitate them on the plastic model.

In the last phase (second interactive phase) the user can explore functional units (Tips & Tricks) of the model by moving the mouse over the movie window. Whenever the user rolls over a unit it is highlighted, and a click leads to the corresponding section of the Tips & Tricks.

At any time the user can take a look to the left (building area) and see the "virtual" model in exactly the same state of completion as in the building instructions (and hopefully as the plastic model). He can spin the model around to look at it from any angle in order to compare it with the plastic model.



Building instructions interface

Windows
Element list - displays all elements of the current building step
Movie window - shows the instructions

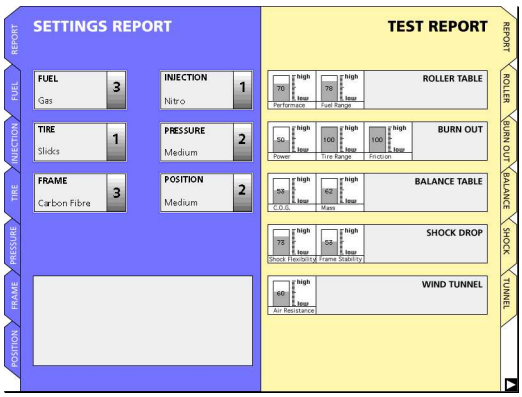
Controls
Play/Pause - starts and pauses the movie
Slider - access to every single picture of the movie
Next step - jump to the next building step
Previous step - jump to the last building step

Indicators
Step counter - displays the number of steps completed, and the number remaining
Progress counter - displays the progress counted in how many elements have been assembled (e.g. 456 of 610)

For more details on the building instructions see Appendix A.

5.3.7. Lab research

The lab section of the KB9000 presents a test and an adjust screen together to give the user an immediate result to his choices. The interface will be designed with high quality renderings and illustrations to improve intuitive understanding. The chosen options for each adjustment have direct influence on the measurements of the tests.



Adjust/Test interface

Adjustments
The user can use the KB9000 to make fictional adjustments on the fuel type, injection, tire type, frame material and frame position in order to improve the vehicles driving characteristics. These adjustments are mainly invisible because we want to build up the illusion that it is the child's own "plastic" model in the base. Essential changes like adding a spoiler on the virtual model would destroy this illusion because they are not possible with the elements in the box. The adjustments have a relevant connection to real car physics, and they provide enough variations to give the game an interesting level of complexity.

The adjust section is divided into a report page and six adjustment pages. The report summarizes the current settings for the adjustments. The default setting establishes an average car so that the user can drive immediately, but he won't be able to meet any stated goals. Whenever the user rolls over an adjustment option, a reference window pops up and illustrates the functional connection to the test measurements.

A click brings him to a more detailed adjustment page. There is one adjustment page for each of the mentioned adjustments in which the user can choose from three different options. Whenever he makes a change, a reminder pops up on each test button that that test need updating. Similar to the report page, a reference window appears on rollovers displaying information about the option.

At any time the user can click on the navigation bar on the left to jump directly to any other page.

Please see Appendix B for more detailed information.

Test
The user can run a series tests on the car to measure several aspects of the vehicle. These measurements vary directly according to the chosen option for each adjustment. The available tests are:

- a speed table, for measuring engine performance and fuel range
- a burn-out, for measuring power, tire range and friction
- a balance table, for measuring mass and center of gravity
- a shock-drop, for measuring frame stability and shock flexibility
- a wind tunnel, for measuring air resistance

The test section of the KB9000 is divided into a report and six test pages. Whenever the user has made an adjustment, a reminder appears on each test that needs an update. The report summarizes the current test results (measurements). Each test page includes test control buttons and detailed and graphical representations of test results. At any time the user can click on the navigation bar on the right to jump directly to any other page.

Please see Appendix B for more detailed information.

5.3.8. Drive

The user can drive on the test tracks at any time, even without making any adjustments or tests before – just as long as a model has been built. When the user selects the "drive" button on the console, the KB9000 presents to the user a choice between a speedway, a winding road and an off-road track, though the "default" track will always be the one relevant to the current mission. When the user "OK's" the selection, the driving begins.

When the user has completed three laps on the test track, the drive segment ends and he is brought back into the base. The KB9000 presents at that time a driving report of vehicle "telemetry" measurements from on the track. Measurements include top speed, fastest lap time, vehicle stress, and fuel consumption. The report will highlight which parts need improvement, giving the user some feedback for making the next series of adjustments.

5.3.9. Communications

One final function of the KB9000 screen is for telecommunications with the Hero character. The Hero will contact the user "from the field" and present the next mission brief. When the user feels the vehicle is ready for the next mission, he can contact the Hero via the KB9000.

The KB9000 also communicates to the user the Hero's progress – all action animations after the opening animation are presented on this screen, just as if the user were watching the events transpire on the local news.

5.4. The characters

Digital technology allows us to add this entirely new dimension to LEGO products. Characters add depth and life to a digital environment, and give the child "personalities" to deal with and laugh at. (Note: all names in this section are tentative, subject to revision)

5.4.1. Dan Thunder - the "hero"

Every good adventure or action story needs a central figure for good, a hero, to right the wrongs and to bring justice and order to the world. Usually, the child assumes the role of hero, for in most games the user is solely responsible for the game outcome. This CD is much more modest in its intentions, which was not to be a game in the first place.
Instead, the user is cast as the hero's team member, a valuable technician, who is solely responsible for seeing to it that the vehicles are in the best possible conditions to chase down the bad guys. The hero is then cast as "motivator," giving direction and meaning to the tasks in the base.

Dan Thunder is now free to become a sort of "anti-hero," a more unique character with flaws that will help to entertain and motivate the user in alternative ways. For example, Dan's enormous ego and super-serious attitude can make him appear as a buffoon at times (a "jab" at adults). His flaws can also be the cause of a "plot twist" near the end of the story that places the user in the role of "unsung hero."

5.4.2. J.O.E. (Joint Operations Environment) - the robotic assistant

Just as every such story needs a hero, many also benefit from having a mentor, a guide or coach to lend wisdom and offer advice. At the age of 9, however, a child starts to resist such "parental" help, so we've disguised the mentor in this product in the form of the base itself. Called the "Joint Operations Environment" or J.O.E. for short, the base appears to have intelligence and personality of its own and even perhaps vaguely anthropomorphic qualities (resembling human form) in some of its components.

J.O.E. does not look like or behave like a mentor. As a machine, its purpose is to serve the human. It prompts the user, constructs the vehicles (as the user constructs it at home), morphs for the tests, opens the door, even prepares coffee. Through its prompts, though, J.O.E. acts as a subtle coach, suggesting next moves and pointing out reference options in the KB9000.

Having a robot as a character allows some freedoms that an ordinary Technic character does not. For one, the amount of character animation is greatly reduced. Another reason is that any flaws in the "intelligence" of a machine character is much more easily forgiven than in a human character, so the A/I can be less than perfect and still be acceptable.

5.4.3. Pup - comic relief

To provide relief from the too-serious and too-technical aspects of working in the base, there is a small animal, a mascot. Pup is of indeterminate species, possibly a cross between a puppy and a lizard, to give it a unique "creepy/cute" appearance that would delight a 9 year old. It apparently has no other reason to exist in the base but to provide diversion and amusement. To further amaze, Pup has the extraordinary ability to enter the virtual world of the KB9000, a comment on the meta-virtual nature of the whole product.

Pup will appear between tasks and exhibit behaviors similar to other "virtual pets" that are currently on the market. It will require attention only between tasks – after building, after a test drive, etc., but will appear during a task engaged in some mischievous behavior, such as getting blown across the room during the wind-tunnel test.

But Pup has ulterior purposes as a help agent. If the user is exhibiting signs of getting stuck, usually indicated by a long pause, Pup comes on the scene and sits down on the appropriate choice (appropriate 80% of the time, wrong the rest). If Pup annoys the user, he can be sent to his bed for good.

5.4.4. bad guys

The bad guys appear only in the animated chase scenes. They have only a few moments for characterization, so they will be stereotypical gang guys – unshaven, maniacal, etc.

5.5. Story

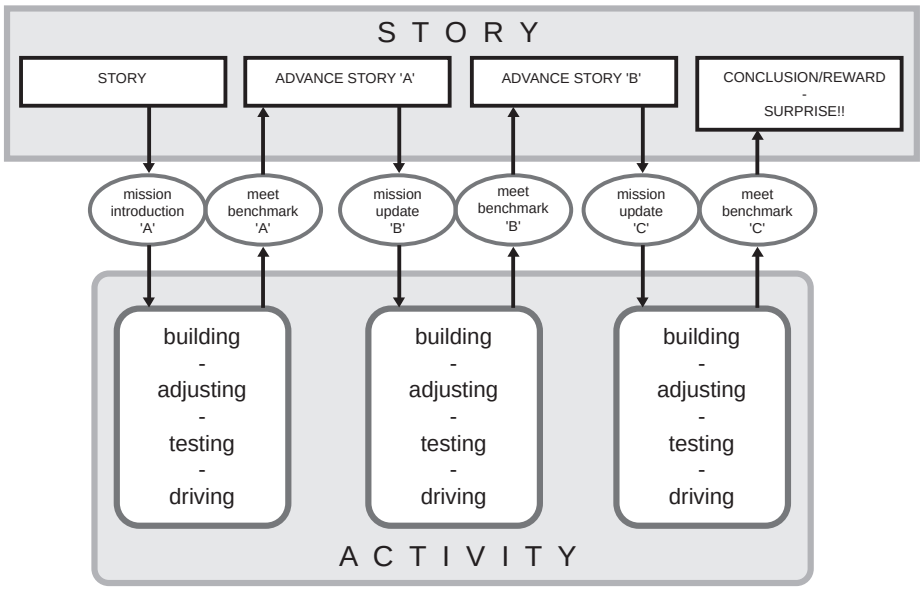
The story aspect of Burning Rubber is considered an important element to the product, but is not intended to be the "essence" of the product. It has been developed with a number of goals in mind, each intended to inspire the user and to relate in some way to LEGO values.

For more details on the content of the Story see Appendix C.

5.5.1. story structure

The story will be told through a series of pre-rendered animated scenes that combine into a linear narrative (For economic reasons, but also to heighten user curiosity, the details of the story are provided in the base computer's "fact file"). Such simplicity is necessary not only to save production costs, but also to keep the "gaming" influence to a minimum. The main point of this product is to provide fantasy activities to complement to building of the plastic models, and a true "computer game" would only detract from this purpose. The resulting story is intended only as support for these activities.
The story animations will show epic confrontations on the high desert, beyond the walls of the secret base, beyond the world of the user. The user will watch these scenes from the base computer display. Prior to and following these scenes, the user will engage with the characters in pre-animated form as they brief the user on his role and mission. These "mission updates" serve as transitional devices between the linear narrative and the non-linear base activities.

Burning Rubber
story progression



5.5.2. sets context and mood

The opening animation will set up a basic story premise: good vs. evil, and introduce some of the principal characters. The fast pace of the animation, the music and clever camera angles will create an exciting and cool mood. This animation will also feature the model designs, showing them in glorious action and stimulating the user's desire to possess them himself. The rugged ambiance of the high desert is also suggestive of danger and adventure.

5.5.3. increases exuberance

The opening animation and subsequent mission introduction are intended to leave the user feeling that he is a critical part of the story. The models, the base, and the activities available to the user will therefore have meaning and purpose: to catch the bad guys! The story will set up a conflict and leave the resolution of the conflict with the user. This will give the activities a sense of personal meaning.

To further foster the user's enthusiasm and interest, the story will unfold in surprising ways. The characters, somewhat predictable at the beginning, will reveal themselves to be a bit more complex than expected. The story resolution will present a twist of major significance, a twist foreshadowed by the characters' complexity. The goal is to keep the child curious, letting that curiosity grow, and providing an unexpected and satisfying resolution.

5.5.4. gives meaning to accomplishment and reward

The activities in the base are really quite simple. There is no built-in competition or score-keeping. It is intended to be a place of open-ended play and exploration; the user builds the vehicle of his fancy, tries different configurations and takes it for a test drive. Not all children respond well to this lack of structure, and so goals are introduced. The story provides meaning for these otherwise arbitrary goals.

To meet a goal is an achievement, and achievement deserves reward. Therefore, the story not only provides the motivation but also issues reward; the user gets to witness the surprise conclusion and is granted permission to forever play freely in the base. Forever, that is, until Version 2 comes out...

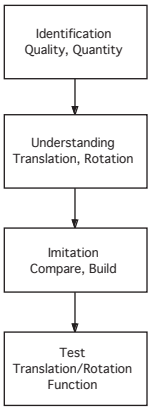
Appendencies

Collection of works produced during the concept developing process

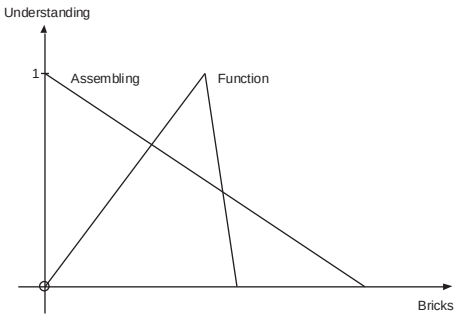
Appendix A: Building instructions research

Theory

The use of multimedia building instruction is split into four parts.



First the necessary elements of the step have to be identified according to kind and number. It's important to find the right amount of elements per step because not enough would bore and to many would expect too much from the child. The steps should be divided into their functional context as long as the function is not too complex or its conflicts with the necessary assembling order.
The following illustration explains the connection between the understanding of the assembling/function according to the number of elements per step.



The second part is the understanding of the building step. The child has to understand the translation and the rotation in the movie.

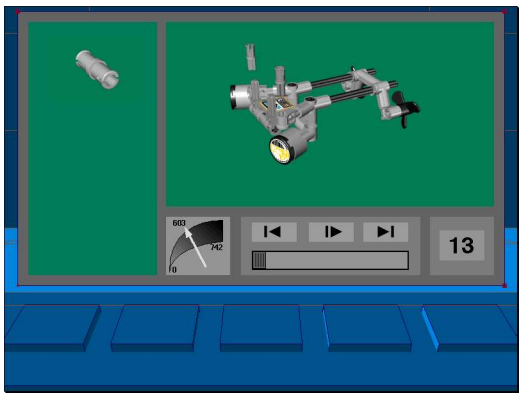
The next part is the imitation of the seen on the model. The child has to compare the movie with the model and assemble the elements in the right order.

The last part is controlling if the elements are in the right place and if the the function is working. The child can change from the virtual view to the virtual reality view with is better for comparing.

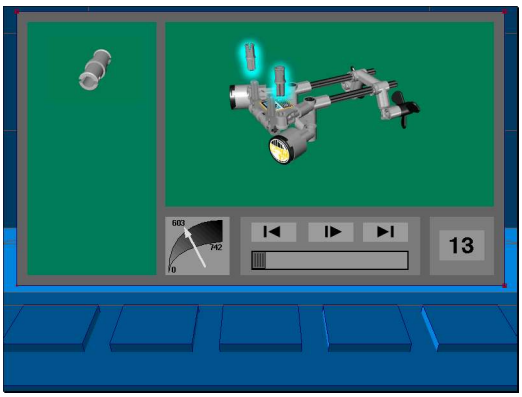
You can think of the virtual view as being a computer in a computer. The virtual reality view is the part of the CD ROM that tries to look like reality e.g. the base or the world.
The second part is the understanding of the building step. The child has to understand the translation and the rotation in the movie.
The next part is the imitation of the seen on the model. The child has to compare the movie with the model and assemble the elements in the right order.
The last part is controlling if the elements are in the right place and if the the function is working. The child can change from the virtual view to the virtual reality view with is better for comparing.
You can think of the virtual view as being a computer in a computer. The virtual reality view is the part of the CD ROM that tries to look like reality e.g. the base or the world.

Conversion into practise

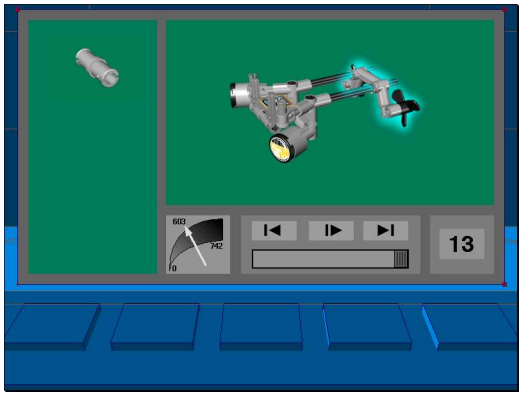
The child identifies the elements either through a display in which all necessary elements and their number are shown or through the movie itself in which all elements are displayed in their start positions (picture 1)3. The element window is interactive (picture 2) i.e. whenever the child rolls over an element with the mouse its start to rotate and when he klicks all the elements of this kind appear highlighted in the movie window. This function is available in the first and last picture of each movie. The same function in the other way round is only available in the first picture.
Whenever the child rolls over a functional unit of the car in the last picture of a movie it appears highlighted and a click leads to the according Tips&Tricks section (picture 3).
To check if all elements are in the right place the child can change into the VR Mode (picture 4) in which he can take a look an the model from all angles (QTVR) and



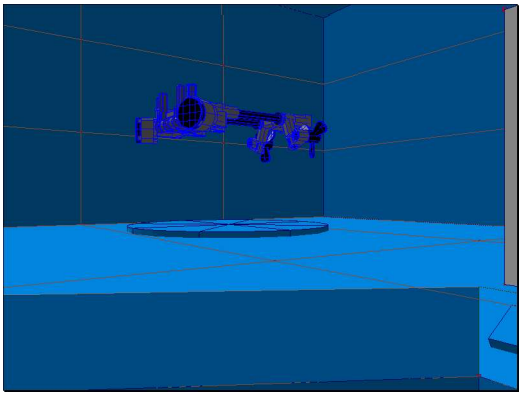
Picture 1



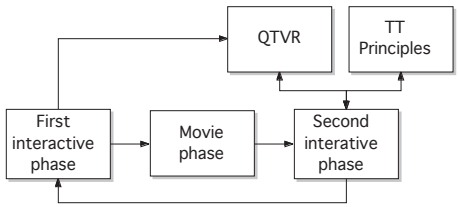
Picture 2



Picture 3


Picture 4

compare it with his plastic model. To go on with the building he has to go back to the virtual mode. A test instruction is given whenever a functional unit is completed.



Phases of building

Interface

There are two views in the Building instructions. The interactive first/last picture, the movies and the indicators are part of the virtual view whether the QTVR is part of the virtual reality. The change of view can be compared with a camera pan.

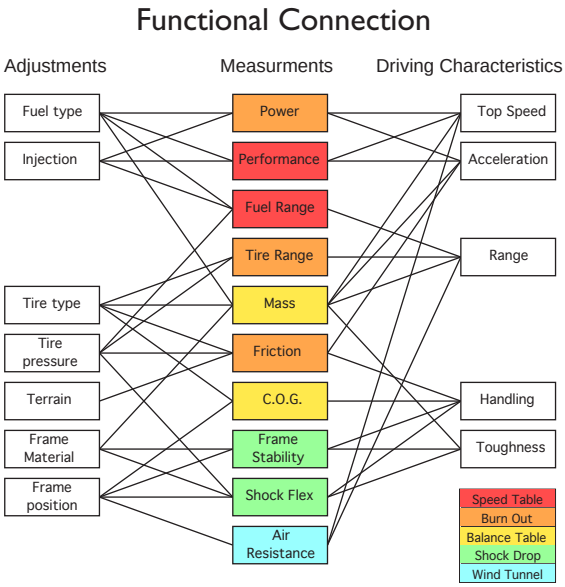
Our aim is to use as less buttons as possible.

Play/Pause - starts and pauses the movie
Slider - access to every single picture of the movie
Next step - jump to the next building step
Previous step - jump to the last building step
VR/V - change of view

Indicators
List of elements - displays all elements of the current building step
Step counter - displays the number done and still to do steps
Progress counter - displays the progress counted in how many elements have been assembled (e.g. 456 of 610)

Appendix B: test and adjust research

The test/adjust system is a small logical riddle. We are going to tell the kids the influence of the adjustments on the measurements and the dependence of the driving characteristics on the measurements. They have to put these two pieces of information into one system. Even so they might not understand the hole riddle they're still able to solve it by try & error.



Adjustments

The Adjustments have to be invisible because we don't want to change the model. They should provide enough variations to give the game an interesting level of complexity. Each Adjustment has 3 different options. Each options has different influences (see graph) on the measurements according to their value (see Table).
The Adjustments are:

Fuel type

Options: hydrogen, propanol, gas
Influence on: power, performance, fuel range, mass

Hydrogen has a light mass and it gives you a high performance, medium power but a small fuel range.
Propanol gives you high power and medium performance / fuel range / mass.
Gas gives you a long fuel range, but a heavy mass and small power / performance.

Injection

Options: nitro, NO2, none
Influence on: power, performance, fuel range

Nitro gives you a high performance, but only a low power and a small fuel range.
NO2 gives you high power, but only a low performance and s small fuel range.
No injections gives you a big fuel range but no extra power or performance.

Tire type

Options: slicks, intermediums, treads
Influence on: tire range, mass, friction, C.O.G

Slicks have a light mass, a long tire range and they give you a low COG. They have a good friction an asphalt, a medium friction on country lanes and a low friction on off road tracks.
Intermediums have a medium mass / tire range / COG. They have good friction on country lanes, medium friction on country lanes and off road tracks.
Treads have a high mass, a low tire range and a high COG. They have good friction on off road tracks medium friction on country lanes and low friction on asphalt.

Tire pressure

Options: high, medium, low
Influence on: fuel range, tire range, friction, shock flexibility

High tire pressure gives you a medium fuel range and a low tire range / shock flexibility. It gives you medium friction on asphalt and low friction on country lanes and off road tracks.
Medium tire pressure gives you a long fuel / tire range and a medium shock flexibility. It gives you good friction on asphalt and country lanes and medium friction on off road tracks.
Low tire pressure gives you a high shock flexibility, a medium tire range and a low fuel range. It gives you good friction on off road tracks, medium friction on country lanes and low friction on asphalt.

Frame material

Options: aluminium, titanium, carbon fibre
Influence on: mass, frame stability, shock flexibility

Aluminium has a small mass, medium frame stability and low shock flexibility.
Titanium has high frame stability, medium shock flexibility and a high mass.
Carbon Fibre has a high shock flexibility, a medium mass and low frame stability.

Frame position

Options: high, medium (only B-Model), low
Influence on: C.O.G. , frame stability, air resistance, shock flexibility

A high frame position gives you a high shock flexibility, but a high air resistance / COG and a low frame stability.
A medium frame position gives you medium shock flexibility / air resistance / COG / frame stability.
A low frame position gives you a high frame stability and a low air resistance / COG / shock flexibility.

(Terrain)

Options: asphalt, country lane, off road
Influence on: friction

To get a good friction on asphalt you need slicks with a medium tire pressure.
To get a good friction on a country lane you need intermediums with medium tire pressure.
To get a good friction on off road tracks you need treads with low tire pressure.

Measurements

The measurements are mathematical functions of the first grade. Their results are always between 1 and 100 and their dimension will not be displayed.

	Depends on	Inluence on	Range	Dimension
Power	fuel type, injection	top speed, acceleration	0-100	kw
Performance	fuel type, injection	top speed, acceleration	0-100	rpm
Fuel Range	fuel type, injection, tire pressure	range	0-100	l/100km
Tire Range	tire type, tire pressure	range	0-100	km
Mass	fuel type, tire type, frame material	top speed, acceleration, range, toughness	0-100	kg
Friction A	tire type, tire pressure, terrain	acceleration, handling	0-100	kg/sq mm
Friction CL	tire type, tire pressure, terrain	acceleration, handling	0-100	kg/sq mm
Friction OR	tire type, tire pressure, terrain	acceleration, handling	0-100	kg/sq mm
COG	tire type, frame position	handling	0-100	cm
Frame Stability	frame material, frame position	handling, toughness	0-100	degree of hardness
Air Resistance	frame position	top speed, range	0-100	cw=
Shock Flexibility	tire pressure, frame material, frame position	handling, toughness	0-100	N/sq mm

Tests

Speed table

Measurements: performance, fuel range

JOE pushes the lever forward. The same cylinder from the balance table pushes out of the floor at the rear of the car, sliding the slab forward. The vehicle is held in place by JOE. The cylinder comes to rest directly under the rear wheels. (5 seconds)
JOE starts the car and applies the accelerator. The rear wheels start spinning, spinning the cylinder with it. This spinning reaches a very high rate (after 3 to 8 seconds, depending on choice) and continues indefinitely.

Burn out

Measurements: power, tire range, friction

JOE puts the car in front of a sensor wall and the back wheels are put on a sensor plane. There are three different planes which simulate the three different track surfaces (asphalt, country lane and off road). The engine is run on full power and the sensors in the wall recognise the strength of the push. The sensors in the plane measure the push of the wheels in the driving direction. The tires burn out and the wear of is measured after the engine is switched off.

Balance table

Measurements: mass, centre of gravity

JOE pulls a lever. A slab rises out of the floor rises carrying the car. The slab is balanced upon a large cylinder, horizontal and crosswise to the car, and rises to a height of about 1 meter (4 seconds).
JOE forces the lever back and forth. The cylinder rolls forward and back very quickly, unbalancing the slab and car, and then quickly regaining balance (about 4 more seconds).

Shock drop

Measurements: frame stability, shock flexibility

JOE starts turning a crank. From above, drops a dangling claw or hook, which grabs the vehicle (at the center of gravity) and lifts it (JOE reverses crank direction). This activity is accompanied by an assortment of machine noises. The car rises out of site, and the noises continue for an unreasonable amount of time (about 10 seconds). JOE flips a switch with a click. The car falls with exaggerated force in a really satisfying whoosh/creak hybrid noise. (3 seconds) Immediately afterward, JOE drags a scan beam across the car, front to back. (7 seconds)

Wind tunnel

Measurements: air resistance

JOE pulls a rope. Large openings appear in the walls in the front of and behind the vehicle. A thin rod is held out horizontally in front of the forward opening.
JOE pulls the rope again. The sounds of huge fans starting. The rod starts to smoke at points, which drift into streams toward the car. The fans pick up speed, blowing out miscellaneous detris, and driving the smoke into cool bands across the car.0

Driving Characteristics

The driving characteristics are mathematical functions of the first grade. Their results are in relation to reality and their dimension will be displayed.

Top speed

Depends on: power, performance, mass, air resistance
To get a fast car you need high power / performance and low mass / air resistance.

Acceleration

Depends on: power, performance, mass, friction
To get a high acceleration you need high power / performance / friction and low air resistance.

Range

Depends on: fuel range, tire range, mass, air resistance
To run you car over a long distance you need a high fuel / tire range and low mass / air resistance.

Handling

Depends on: friction, cog, frame stability, shock flexibility
To get a good handling of your car you need high friction / frame stability and a low cog / air resistance.

Toughness

Depends on: mass, frame stability, shock flexibility
To get a tough car you need a high frame stability / shock flexibility and low mass.

	Depends on	Range	Dimension
Top Speed	Power, Performance, Mass, Air resistance	39 - 310.7	km/h
Acceleration A	Power, Performance, Mass, Friction	11.55 - 2.4	0-100 km in sec
Acceleration CL	Power, Performance, Mass, Friction	11.55 - 2.4	0-100 km in sec
Acceleration OR	Power, Performance, Mass, Friction	11.55 - 2.4	0-100 km in sec
Range	Fuel range, Tire range, Mass, Air resistance	79.4 - 332.4	km
Handling A	Friction, COG, Frame stability, Shock flexibility	0-100	degree of handling
Handling CL	Friction, COG, Frame stability, Shock flexibility	0-100	degree of handling
Handling OR	Friction, COG, Frame stability, Shock flexibility	0-100	degree of handling
Toughness	Mass, Frame stability, Shock flexibility	0-100	degree of toughness

The best settings for the driving characteristics are:

	fuel type	injection	tire type	tire pressure	frame material	frame position
Topspeed	Propanol	Nirto	Slicks	-	Aluminium	Low
Acceleration A	Hydrogen	Nitro	Slicks	Medium	Aluminium	-
Acceleration CL	Hydrogen	Nitro	Intermediums	Medium	Aluminium	-
Acceleration OR	Hydrogen	Nitro	Treads	Low	Aluminium	-
Range	Gas	None	Slicks	Medium	Aluminium	Low
Handling A	-	-	Slicks	Medium	Titanium	Low
Handling CL	-	-	Intermediums	Medium	Titanium	Low
Handling OR	-	-	Treads	Low	Titanium	Low
Toughness	Hydrogen	-	Slicks	Low	Carbon Vibre	High

Tracks

Speedway

You need a high top speed and medium acceleration / handling to make it in the required time.

Winding country lane

You will need a high acceleration / handling and medium toughness to finish this track in time.

Off road track

You will need a high degree of toughness / handling and medium acceleration to finish this track in time.

Apendix C: Story

Prologue

Planet TECHNIC - 532 y.o.b. (year of the brick)

Having found their niche in the planet's biosphere, the TECHNIC civilization is thriving. Spirit City gleams in fertile techronite canyons, powered by techronic crystals.

But not all is well. The ruthless Yugdab has developed a process that uses techronite to destabilize TECHNIC constructions! He has provided his rotten bandits - Krej, Peerc, and Elohssa - with some crazy, souped-up vehicles to steal from techronite mines, escaping across the vast desert surface of Planet TECHNIC to the secret hide-out. Yugdab plans to use the crystal in his evil plan to conquer Spirit City.

Enter Dan Thunder, popular, acclaimed, fighter of slime and defender of the TECHNIC Ideal. Dan is patrolling the desert in his hot car, tracking down Yugdab's gang.

Chapter 1

ignominious defeat

(animation)

LEGO Technic logo, sound of wind. Enter faint sound of engine whine, getting louder, until logo explodes as A-model breaks through. Camera view spins to see model racing off into distance on a very flat, dry desert plane. Energetic music starts.

Helicopter view following car, zooms down to driver, Dan Thunder.

Cockpit view of D.T.

Sound of beeping. D.T. looks at on-board display indicating bad guy straight ahead.

DT makes visual contact with C1 vehicle and begins pursuit over desert flats.

Brief chase scene - several quick and dynamic cut scenes.

Close-up: bad guy turns to look at DT and grins, then shifts his car into overdrive.

In a great burst of speed, the bad guys leaves DT in the dust.

Close-up of DT frowning.

On-board display beeps again indicating another bad guy at the next left turn.

DT turns left and makes visual contact with C2 vehicle, and begins pursuit along a winding path along a hill.

Brief chase scene - several quick and dynamic cut scenes.

Close-up of bad guy fiendishly laughing.

Rips through a series of hairpin turns, effectively losing DT.

Close-up of DT very upset.

On-board display beeps yet again indicating another bad guy somewhere off the road to the right.

DT turns and makes visual contact with C3 vehicle and begins pursuit, this time over very rough, hilly terrain.

Brief chase scene - several quick and dynamic cut scenes.

DT wrecks his vehicle into a trench.

DT gets out of his vehicle unhurt and throws a temper-tantrum. After a moment, he pulls out his micro-communicator. "Thunder to Base. Come in, Base."

Aerial view of the base and test track area, nestled in the bottom of a canyon. Slow zoom.

Cut to overhead interior of base, looking down to Technic guy asleep at console, with dormant JOE in foreground. Voice-over: "Come in, Base!"

mission introduction

Immediately following the opening animation, the user is first shown the base.

Interior view of base from above, through rafters. It is quiet and dim, and bright sunlight from small windows high up shines beams through airborne dust. Camera slowly lowers past a dormant J.O.E. and zooms to Technic guy sitting behind console with head down. Spidery arms of J.O.E. suddenly activate with a jerk and the faint sound of rapid pneumatics..

> *J.O.E. (softly, accent reminiscent of MacDiver): Alert. Incoming message. (pause, then again more loudly) Incoming message. Alert! (loudly) ALERT! Wake up...please!!*

Technic guy raises his head quickly and looks around. Cut to his point of view (from now on, the primary p.o.v. inside the base), looking to up at JOE, a 'bot suspended from the center of the base's superstructure.. When JOE addresses the user, the user faces forward and JOE's "body" moves forward - as on a rail - to occupy a greater part of the user's field of vision.

> *J.O.E. (gesturing with arms to the right, towards the KB9000 screen): It's Dan. He says it's urgent...*

User's p.o.v. pans down towards the KB9000 screen, with a large image of an angry Dan Thunder. Pup is sitting at the foot of the screen and is watching Dan, tail softly wagging.

DT: (sarcastically) Good morning, princess! What.... we're not giving you enough to do? Well, that's all gonna change.
It seems our old nemesis Yugdab and his gang have a new scam going. They've been stealing techronite supplies from the mines and stashing it somewhere... we think he's devised a way to use it to destabilize our vehicles. You should see the mess mine is in right now.
Anyway, if I know Yugdab, he's got a truly diabolical plan in mind. We need your help.

Dan's image gives way to rotating image of A-model. Pup stands up, still looking at screen.

DT: This is the car I've been using to track them down. It's a great car, but it has proven insufficient... We need you to give it a tune up, improve its performance.

The A-model image gives way to the C1-model. Pup gets up and walks off-screen, tail between legs.

DT: We've managed to intercept the plans for one of their new fleet. This design is extremely fast, but does not maneuver well. You need to get my car at least as fast as this one so that I can chase it down.

KB9000 image back to Dan

DT: Let me know when you've got something. This is DAN THUNDER, over and out...

Dan walks off-camera, leaving an image of the desert sky in the background.

J.O.E.: Dan? DAN? ... It seems he's forgotten to hang up again. Well, my friend, it seems we have some work to do. Here, have some tea. Did you sleep well?

Hi-tech teapot machine by front console dispenses a cup, with sugar. Pup stick nose up over console counter and sniffs at cup.

achieving benchmarks 1 and 2

To proceed to the next story animations, where Dan successfully captures the C1 and C2 models, the user must contact Dan to inform him the car is ready. As part of JOE's base introduction, he refers to the communications device as the means to contact Dan.

Since the user can call Dan at any time, Dan may judge whether or not the user has adjusted the car appropriately and, if not, may turn down the user's offer.

Scene: "Dan: not ready" [4 versions]

Dan's a busy, mildly stressed-out guy and doesn't like being bothered unnecessarily. When the communications screen opens on the KB9000 screen, the user has interrupted him at some important activity [playing a video game, reading the funny pages, napping, eating, picking his teeth, etc.]

> *DAN: Huh? Already? Let's see...[looks at nearby screen] Hey, this isn't going to be fast enough. I should know, I was out there. Keep at it. We can't afford to fail again! This is DAN THUNDER, over and out...*

Typically, Dan has forgotten to hang-up the phone, so we're left watching him as he resumes his task. Either the user shuts off the communicator by pressing the button (not likely) or JOE does so, muttering, returning the KB9000 screen to the most recent page.

Other versions:

> *[if summoned before or during building]*
> *DAN: Yeah? What are you bothering me for? Get busy! uh...This is DAN THUNDER, over and out...*

> *[after 2nd consecutive improvement] DAN: OK, let's take a look at what you've got... hmmm. You're getting close, but remember it's my neck on the line out there. Keep working on it - maybe JOE can help. This is DAN THUNDER, over and out...*

After the "Dan, not ready" scene, JOE offers his two-cents worth. The advice varies depending upon user's behavior to that point.

Scene: "JOE suggestion" [4 versions]

JOE shuts off the telecom and comes forward. The p.o.v. will pan up to him automatically.

> *J.O.E.: Excuse me, but we really must construct a vehicle, first. Don't you agree?*

or

> *J.O.E.: May I suggest making some modifications in the Lab? (I'd be happy to move the model there for you.)*

or

> *J.O.E.: Perhaps if you tried a different [frame material], you might get some faster results. The "Top Secret" file has some excellent data on vehicle performance issues. Try looking there.*

If the car has been adjusted appropriately, Dan accepts the user's offer.

Scene: "Dan: ready" (3 versions)

Once again, we've bothered Dan in a busy mood.

> *DAN: So, partner, you got something? Let's see.... hmmmm... impressive! I think this just might do the trick. I'll be right over to pick it up, stand by. This is DAN THUNDER, over and out!*

Again, Dan forgets to hang up. This time, he's walked out of the camera view and the user is looking at his messy living room, kitchen, etc. JOE will shut it off.

> *JOE: Tsk, tsk... He never logs out, does he? Hmmm...*

If the car has been adjusted properly, and the user does not call Dan, JOE will interject (when?) with a suggestion to call Dan.

Scene: "JOE: ready" (passive alternative)

After finishing a test drive and reviewing the results. If the user begins to do anything to change the car, in the "build" or "lab" areas, JOE will come forward and the p.o.v. will pan up to him automatically.

> *J.O.E.: I must say, I think this set-up looks rather good! I'm sure that Dan will be pleased. Wouldn't you like to call him now? Just press on the button below the microphone, here [gesture].*

Scene: "JOE: ready" (pro-active alternative)

After finishing a test drive in record time, the user is returned to the base interior p.o.v. As the doors shut and the room glare subsides, the KB9000 flashes "Record Time" above the drive report. JOE comes forward:

> *J.O.E.: Excellent! Truly excellent. I think Dan will be quite happy with your results.*

Immediately after Dan accepts the set-up, JOE moves the vehicle to the "drive" position. After a moment, Dan enters the base. This is the first time the user has seen him in person, the other times in the animation and on the telecommunicator.

Scene: "Dan takes off" (3 versions)

With a small boom, a door opens on the opposite end of the room, shining bright light and causing the rest of the room to dim in contrast. Dan's shadow fills the doorway, and after some footsteps, the door slams shut. The user's eyes readjust for a moment and we see Dan inspecting the vehicle.

> *DAN: Yes.....yes.... Uh-huh! Well, this looks promising, for sure. Alright, it's time to do some justice!!*

Dan leaps into the car, and starts it up. JOE begins opening the doors, again to high contrast, and Dan peels out just as light floods the user's vision. The next animation then starts.

Chapter 2

bouncing back - capturing C1

(animation)

Cue exciting music

Fade in from bright screen, helicopter view of A model on desert flats. Camera pans to show it chasing C1 model.

Bad guy grins and hits overdrive. Pulls away.

Dan hits injection.

Dan gains on bad guy.

Dan pulls up alongside bad guy.

Bad guy tries bumping and evading Dan, unsuccessfully.

Dan reaches down below his seat and pulls out a techronite grenade.

Dan lobs the grenade at the bad guy – grenade lands and attaches to stud on bad guy's vehicle.

Bad guy's vehicle starts to wobble. After a few moments it breaks apart.

Bad guy skids on his butt to a stop.

Dan pulls up alongside, hops out and cuffs bad guy.

Fade to white.

mission update 1

When the progress animation concludes with Dan capturing a bad guy, the user is presented immediately with a new challenge.

Fade in from bright screen, as doors to base start to close. The vehicle is back in the base, in the "drive" area. Dan hops out, glances at the user and gives a quick thumbs-up sign, and exits the base. Pup follows at his heels, but is shut out at the exit door – he sits down by the door. JOE begins cleaning the vehicle down with high-pressure air hoses. Meanwhile, he turns towards the user and the KB9000 screen rises up, displaying a still-shot from the moment of capture.

> *JOE: Did you see that? Marvelous! Those techronite grenades sure come in handy. And what's more, we've captured plans for another of their clever vehicles.*

screen displays C2 vehicle

JOE: My analysis and Dan's accounts show this vehicle to be highly maneuverable. Dan will need you to adjust our vehicle some more, sacrificing speed for handling. You may consider using the B model for this one. It's up to you.

Chapter 3

gaining momentum - capturing C2

(animation)

[2 versions, one with A model, one with B model]

Cue exciting music

Fade in from white, aerial view of A {or B) model on winding road on edge of cliff.

Ground level view of quiet bend in road. C2 model suddenly comes dashing around the corner, soon followed by A (or B) model.

View of bad guy repeatedly looking over shoulder, a worried look on his face.

View of Dan, smiling confidently.

Cockpit view from bad guy, passing sign indicating especially treacherous curves ahead.

View of bad guy, with a look of determination.

Close aerial view of C2 and A (or B) models. C2 makes it through first two bends, but wipes out on the third. A (or B) model slows down as approaches.

Bad guy sitting on ground next to wrecked vehicle, dazed. A (or B) model pulls up in foreground. Dan's feet walk up to bad guy. Bad guy is lifted up and cuffed. Dan smiles and laughs.

Fade to white.

mission update 2

When the next progress animation concludes with Dan capturing another bad guy, the user is again presented immediately with a new challenge.

Fade in from bright screen, as doors to base start to close. The vehicle is back in the base, in the "drive" area. Dan hops out and exits the base without acknowledging the user. JOE begins cleaning the vehicle down with high-pressure air hoses, causing pup to scamper quickly out of the way. JOE turns towards the user and the KB9000 screen rises up, displaying a new still-shot from the moment of capture.

JOE: Another job well done! We've got them on the run now, I'm sure of it. And look...

screen displays C3 vehicle

JOE: We've captured plans for yet another of their new vehicles. This one is really tough – it can handle some really grueling terrain. You may recall that Dan was chasing this one before when he cracked up the car. We'll need you to do what you can to make our vehicle up to this challenge. Good luck!

achieving benchmark 3

This is the final benchmark to achieve, and therefore is the prelude to the climax of the story. Several things happen to surprise the user's expectations.

Either on his own, or prompted by JOE (see "JOE: ready"), the user initiates a call to Dan.

Scene: "Dan: whiner" [2 versions]

For several seconds after making the call, several "rings" of the phone, Dan appears on the screen in bed almost completely under the covers.

DAN: [weakly] uhhhnnnn.....what... Oh, yeah. Yugdab.... uhhhhnnnn.... I've gotta heeeaaadache.... Call me back tomorrow. This is D-D-D-Dan Thunder.....over.....

JOE reaches over and hangs up.

JOE: Can you believe that guy? I told him to go easy on the ice cream! What shall we do? We have no time to waste! Latest intelligence tells us that Yugdab will begin the final phase of his diabolical plan any moment now.

Pup jumps up on the console and gets into the user's face. Pup turns around to face JOE and starts jumping and "barking."

JOE: Oh my, little one, what a brilliant idea! Yes, indeed. You! You've shown great skill out on the test track. Pup and I agree that it's up to you to hunt Yugdab down. You're our only hope. Got get them!

The camera pulls back to behind the user's traditional point of view to show the back of the Technic figure that sits at the console. The figure vaults over the console (much as he does whenever a test drive begins), pup hops into passenger seat, the doors open, and the vehicle drives out while the screen fades to white.

Begin final animation.

Chapter 4

the final assault - [your name] capturing C3 and the hideout

(animation)

cue exciting music

Driver's point of view of B model approaching rugged terrain. Technic figure is driving, with pup in the passenger seat. On the first hill, pup gets airborne, but manages to land back in his seat.

Close-up on Technic figure's face – very intense expression.

On board display beeps.

POV: C3 model crosses directly in front of B model!

Close aerial view, B model turns sharply and begins pursuit.

Extended chase scene. Lots of high-speed jumps and thunderous landings. Pup just barely hangs on.

Shot of narrow canyon, very, very deep. Pan up to approaching vehicles.

Bad guy, knowing what's ahead, starts cackling.

Close-up of pup, worried expression.

Bad guy soars over chasm. View from below.

B model approaches chasm, music builds. B model launches into the air.

Slow-motion sequence of model, Technic guy, pup, model in air, bad guy looking back surprised.

B model lands safely and continues chase.

Bad guy is really mad.

POV: Yugdab hideout comes into view. An elaborate non-Technic construction (more like Connext?).

B model drives up to hideout. Technic figure starts throwing techronite grenades, continues driving, evading other grenades.

Pup graps a grenade in his mouth and jumps out of vehicle.

Technic figure in B model continues throwing grenades and evading.

Pup jumps into a small opening.

Yugdab is at his console, directing the counter assault.

Pup sneaks up and drops the grenade onto the back of Yugdab's throne. Run's out.

B model begins to fall apart and technic figure begins retreat. Pup runs along and jumps on board.

Wide shot of hideout. It starts to shake and wobble. Parts start flying into the air, and in a few moments it all collapses in a great rush.

Yugdab is caught in the rubble, cursing in his own strange language.

Pup runs up to Yugdab and sits on his head.

Technic figure joins them, and cuffs Yugdab.

Fade to white.

reward scene

After the last animation, where the user's character and pup capture Yugdab's hideout, the user returns to the base where JOE and Dan react to this success.

Scene: "congratulations" (2 versions)

Fade in from white, as base doors close. Point-of-view from cockpit of vehicle, parked in "drive" area. Pup hops out of the car and scampers ecstatically back and forth, up on the console, back to the floor, etc. POV looks up at JOE.

JOE: [waving "arms" about excitedly] My goodness! That was fabulous! You really came through – I knew you would! Heartiest congratulations!

POV gets out of car as pup jumps up and down on the "hood" of the vehicle. Dan is sitting behind the console, feet propped up, head back with a washcloth on his forehead.

Dan: [weakly, with an unenthusiastic thumbs-up] Yeah. Way to go partner.

Dan gets up and walks slowly out of the base. POV goes around behind console. KB9000 screen pops up. Pup sits on console in front of it.

JOE: I have an important incoming message for you. [whispered] High Command...

An older-appearing Technic figure appears on-screen, looking very solemn. An aid appears at his side and whispers something to him. He nods, and addresses the user.

HC: My child, you have done a great deed today, a deed that will go down in the legends of Planet TECHNIC. Through your skillful work at the base and your brave resourcefulness in the searing desert, you have brought down our civilization's greatest nemesis. We will be forever in your debt.
As a small token of our gratitude, I grant you full ownership of the base and all it's models [holds up paper deed]. We trust you will put this great resource to purposes of good and preserving the Technic Ideal.

On screen, another pup-like creature, but a different color, sticks it's nose right into the camera, out of focus. In the base, pup stands up on his hind legs. On screen, the HC takes his pup into his arms.

HC: And for your little friend there, my eternal thanks. Bye, bye.

The screen goes blank, then presents an image of the deed to the base. Pup sits back down and turns to look at user.

JOE: My, oh, my! What an honor! Well, "master," I'll tidy up around here a bit. Of course, now you're free to do whatever you please – it's your place, now. If you'd like a printout of you deed, then just click on it.
Maybe you'd like to get a better look at Yugdab's vehicles. He's evil, but he sure is clever. As always, I'm here to serve you....

Appendix D: The Tutorials

Base tutorial

J.O.E.: What shall we do first? How about an introduction to the base?

As JOE speaks, the KB9000 flashes an example graphic relevant to what he's talking about. These graphics go by quickly, and are intended to arouse curiousity, not necessarily to inform.

J.O.E.: To begin with, my name is JOE, short for Justice Operations Environment. I'll be your assistant here in the lab. And this is pup [gestures to pup] um well, moving on:.

KB9000 screen pops up, flashing random "screen shots" about 1 or 2 per second

J.O.E.: This screen here is the KB9000 display, where all the information you need will be shown.
OK. To look to the left, move your mouse cursor to this side of the screen. [gesture to left edge]

wait for user to move cursor to left – repeat after 10 seconds if necessary

J.O.E.: This is the building area, where I will assemble the vehicles in the base, following your instructions.

view moves back to KB9000, showing an example of building instructions

J.O.E.: Anytime you'd like to build a model, press this button [gesture to BUILD] for the instructions.
Now, to look to the lab on your right, move the cursor to this side of the screen, or press this button. [gesture to LAB]

wait for user to move cursor to right

J.O.E.: This is the lab, where you can adjust the vehicle's properties to make it run better. The lab also is built for a variety of helpful tests [gesture to test buttons].

view moves back to KB9000

J.O.E.: But to really be sure of the vehicle's performance, you'll need to test drive it on one of 3 special track circuits [gesture to DRIVE]. This button here will get you started there.

And, let's see oh, yes. If you're feeling especially curious, you've been granted access privileges to the "Top Secret" file [gesture] on the KB9000. There you will find all sorts of useful information about Technic, vehicle performance issues, this lab, our mission, and so on.

If you want to contact Dan to tell him the vehicle is ready, press the intercom here [gesture].
If you have any questions, click on me here [gesture] and I'll try to help out.
OK, then? Let's get started. Would you like to build something? [gesture to BUILD]
Maybe you'd like to get a little background information. [gesture to TOP SECRET]

Building tutorial

The first time BUILD is selected a tutorial is offered.

J.O.E.: This is the building instruction screen.

The KB9000 screen shows an example step from Rubber Duck. Pup jumps up on the console and crawls into the screen. J.O.E. gently pushes him to the side and continues.

J.O.E.: The elements you need for each step are shown here [pointing at element window]. Where the parts go is shown here. [pointing at animation window] At the beginning of each step, you can see which are which by moving your cursor over each window. [example]

You can play the step by pressing here, or using the jog slider here. When you're ready for the next step, press here; or to go back, press here. If you have any questions, just point at me. Got it? Let's get building!

When the instructions reach a step where a tip-link becomes available, JOE interjects:

JOE: You're doing a great job! Here's something new: at the end of each step, the model in this window [gesture] has links to tips and tricks. Try it! You can always return to the instructions where you left off.

If the user has ventured into tips and tricks, the first two times JOE will tell how to get back:

JOE: Remember, if you want to return to building, just click on this button here. [gesture]

If - after having built one model, adjusted, tested, driven, and even advanced the story – the user chooses the BUILD button, JOE reminds the user that in order to construct again, one must first deconstruct.

The user presses BUILD, and JOE moves the car to the build area.

JOE: If you are wanting to build another model, I'm afraid we're running short of elements. You'll have to take apart the current model in order to build a new one. If you'd like me to explode this model, press this button here [gesture]

Pup, if in view, dives for cover.

Lab tutorial

If the user has not constructed anything, yet chooses LAB:

Pup walks into the middle of the empty lab and sits down, bewildered.

JOE: We won't very well be able to adjust and test a vehicle if we have not yet built one.

This first time the user chooses LAB (with a model built):

JOE moves the vehicle to the Lab area, dropping it in place.

JOE: OK, then. This is where we can make adjustments to the vehicle and run some diagnostic tests on it.
You can run tests at any time by choosing one of these buttons here [gesture]. The test results will appear automatically on the KB9000 screen to your left. [camera pans to screen, showing an example test-results screen] To get more information about these results and what they mean, use your mouse cursor to explore the screen.
If you select the ADJUST button [gesture], you'll see you have a selection of frame materials, fuel types, tire types, and so on, which you can choose from to improve the vehicle's performance. Keep in mind that each choice has some benefits as well as drawbacks – you can find out more about these by doing a little exploration. I suggest you frequently test your adjustments in the lab to see how you are doing.
Remember, Dan needs this car to be especially fast. Let's see what we can do, shall we?

Drive tutorial

If the user selects drive and no model is constructed:

The KB9000 screen drops, the doors open, and pup walks out to middle and sits down to clean himself.

JOE: Excuse me? Shouldn't we construct a vehicle to drive first?

Doors shut, and KB9000 comes back up at same point left off.

For the first time user picks drive after building a model.

JOE picks up the vehicle from the building area or the lab and drops it in the middle of the base, behind the KB9000 screen. The screen shows the track selection menu.

JOE: Now, since this is your first time on the test track, I felt you might need an introduction. The base features 3 test tracks: a speedway, a winding crooked course, and an off road course. Before you begin driving, you need to pick one of them from this menu [gestures]. Once you've picked a course, you're ready to take off.

A standard test is three laps around the course of your choice. I'll be keeping track of your lap times and your top speeds.

The vehicle controls are very easy. Use the arrow keys on your keyboard – the up arrow accelerates, the down arrow brakes, and the left and right arrow. well, you can figure that out.
So, if you're ready to go, pick a course and get ready to roll!

After completing a three laps, and the user is back in the base, for the first time:

Having commented on the driver's performance (see "Missions"), the KB9000 shows the drive report.

[to be determined]

user time-out

In the event the user does not respond within 90 seconds, pup jumps onto the console and sits on the KB9000 button. After another minute, he walks around behind the screen and appears in 2D on the KB9000 screen, becoming "virtual-pup." Every minute or two he walks across the screen and makes a selection at random, advancing through the knowledge base as a sort of "screen-saver" for the user.

Appendix E: Use of QTVR object movies

The possibility to change the perspective to any angle in a QTVR object movie helps to compare the VR model with the plastic model on the table. The intuitive usability is ideal for children. The only problem is the file size of the movies.

The compression doesn't work on QTVR as good as on QT because keyframe compression is not possible
A complete QTVR movie with a smooth and free ability to move is frame intensive.

If we are forced for productional reasons to decrease the file size of the QTVR movies then we have the following possibilities:

- Use QTVR movies only after milestones
- Decrease the smoothness of the movie through using less frames per turn
- Limit the free moving to fixed angles
- Limit the moving to one or two axes

The following tables show the file size and compression of three test movies. The visual quality of the movies is not considered:

Movie A

Degree	Pan	Tilt	Total	Size	Type	Color	Quality	Playability	Filezise k	Compression
10	36	18	648	240 x 240	Animation	32	100	308.0	8100	93,10%
10	36	18	648	240 x 240	Animation	32	75	175.0	4600	52,87%
10	36	18	648	240 x 240	Animation	32	50	131.8	3400	39,08%
10	36	18	648	240 x 240	Animation	32	25	124.4	3200	36,78%
10	36	18	648	240 x 240	Animation	16	100	108.4	2800	32,18%
10	36	18	648	240 x 240	Animation	16	75	95.8	2500	28,74%
10	36	18	648	240 x 240	Animation	16	50	93.5	2400	27,59%
10	36	18	648	240 x 240	Animation	16	25	90.9	2300	26,44%
10	36	18	648	240 x 240	Animation	8	100	353.9	9300	106,90%
10	36	18	648	240 x 240	Cinepak	32	100	389.2	10200	117,24%
10	36	18	648	240 x 240	Cinepak	32	75	363.9	9500	109,20%
10	36	18	648	240 x 240	Cinepak	32	50	363.9	9500	109,20%
10	36	18	648	240 x 240	Cinepak	32	25	143.1	3700	42,53%
10	36	18	648	240 x 240	Cinepak	8	100	382.4	10000	114,94%
10	36	18	648	240 x 240	Cinepak	8	75	359.3	9400	108,05%
10	36	18	648	240 x 240	Cinepak	8	50	359.3	9400	108,05%
10	36	18	648	240 x 240	Cinepak	8	25	247.3	6500	74,71%
10	36	18	648	240 x 240	Raw	32	100	333.4	8700	100,00%

Movie B

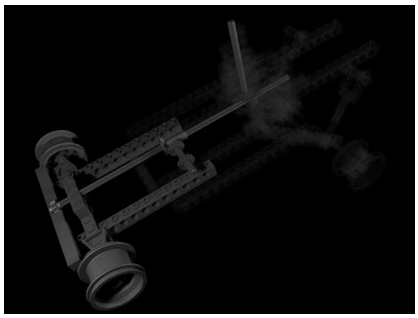
Degree	Pan	Tilt	Total	Size	Type	Color	Quality	Playability	Filezise	Compression
20	18	9	162	240 x 240	Animation	32	100	339.5	1900	90,48%
20	18	9	162	240 x 240	Animation	32	75	194.2	1100	52,38%
20	18	9	162	240 x 240	Animation	32	50	147.1	882,7	42,03%
20	18	9	162	240 x 240	Animation	32	25	138.3	830,3	39,54%
20	18	9	162	240 x 240	Animation	16	100	120.1	721	34,33%
20	18	9	162	240 x 240	Animation	16	75	106.5	639,2	30,44%
20	18	9	162	240 x 240	Animation	16	50	104.1	624,6	29,74%
20	18	9	162	240 x 240	Animation	16	25	101.2	607,4	28,92%
20	18	9	162	240 x 240	Animation	8	100	395.5	2300	109,52%
20	18	9	162	240 x 240	Cinepak	32	100	438.0	2500	119,05%
20	18	9	162	240 x 240	Cinepak	32	75	409.4	2300	109,52%
20	18	9	162	240 x 240	Cinepak	32	50	409.4	2300	109,52%
20	18	9	162	240 x 240	Cinepak	32	25	162.1	973,1	46,34%
20	18	9	162	240 x 240	Cinepak	8	100	429.6	2500	119,05%
20	18	9	162	240 x 240	Cinepak	8	75	404.3	2300	109,52%
20	18	9	162	240 x 240	Cinepak	8	50	404.3	2300	109,52%
20	18	9	162	240 x 240	Cinepak	8	25	283.8	1600	76,19%
20	18	9	162	240 x 240	Raw	32	100	367.6	2100	100,00%

Movie C

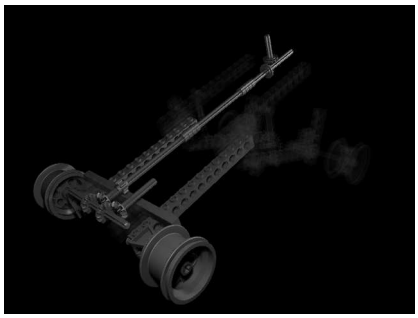
Degree	Pan	Tilt	Total	Size	Type	Color	Quality	Playability	Filezise	Compression
30	12	6	72	240 x 240	Animation	32	100	276.2	828,6	91,65%
30	12	6	72	240 x 240	Animation	32	75	149.8	449,4	49,71%
30	12	6	72	240 x 240	Animation	32	50	109.7	329,3	36,42%
30	12	6	72	240 x 240	Animation	32	25	101.3	304	33,62%
30	12	6	72	240 x 240	Animation	16	100	90.2	270,6	29,93%
30	12	6	72	240 x 240	Animation	16	75	79.1	237,4	26,26%
30	12	6	72	240 x 240	Animation	16	50	78.1	234,5	25,94%
30	12	6	72	240 x 240	Animation	16	25	78.0	234	25,88%
30	12	6	72	240 x 240	Animation		100	345.9	1000	110,61%
30	12	6	72	240 x 240	Cinepak	8	100	383.7	1100	121,67%
30	12	6	72	240 x 240	Cinepak	32	75	363.8	1000	110,61%
30	12	6	72	240 x 240	Cinepak	32	50	363.8	1000	110,61%
30	12	6	72	240 x 240	Cinepak	32	25	145.2	435,8	48,20%
30	12	6	72	240 x 240	Cinepak	8	100	376.3	1100	121,67%
30	12	6	72	240 x 240	Cinepak	8	75	359.3	1000	110,61%
30	12	6	72	240 x 240	Cinepak	8	50	359.3	1000	110,61%
30	12	6	72	240 x 240	Cinepak	8	25	266.6	799,8	88,46%
30	12	6	72	240 x 240	Raw	32	100	301.3	904,1	100,00%

Appendix F: Tips & Tricks

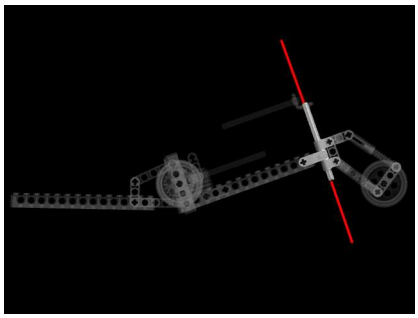
Steering



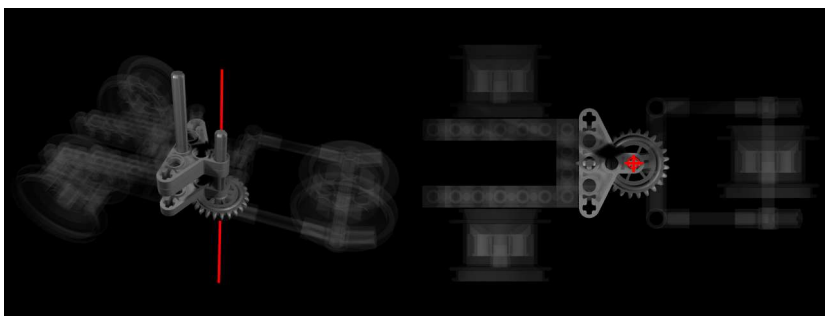
A Model



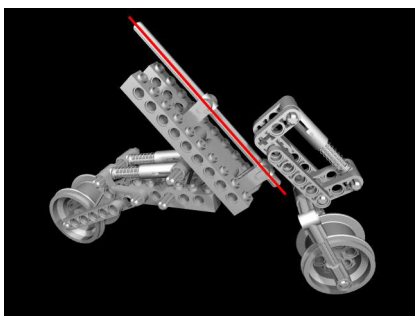
B Model



C1 Model



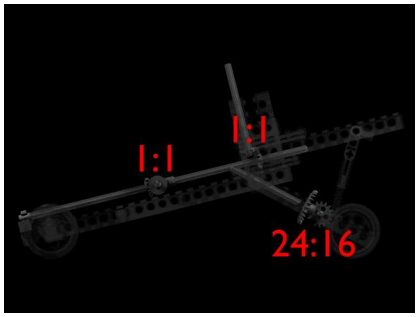
C2 Model



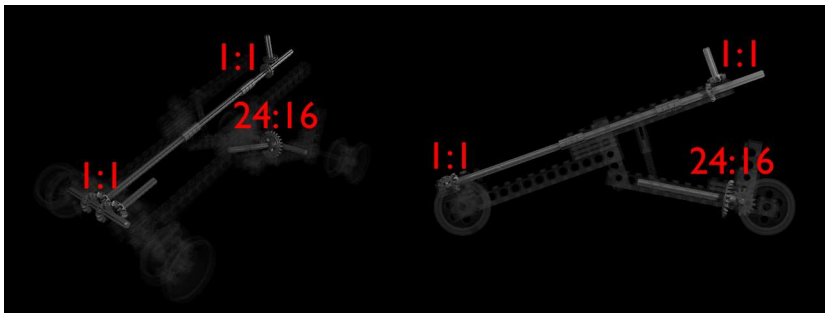
C3 Model

Gearing

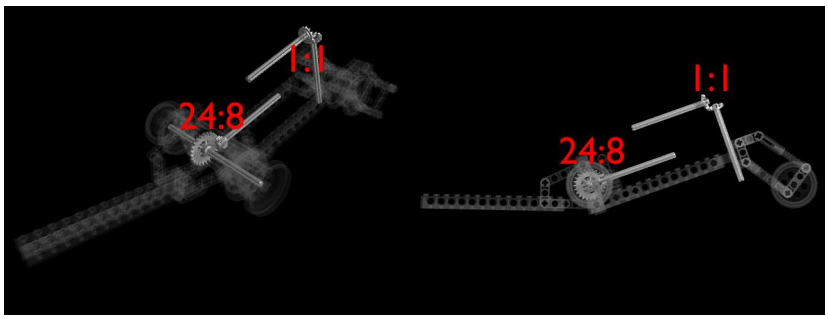
A Model



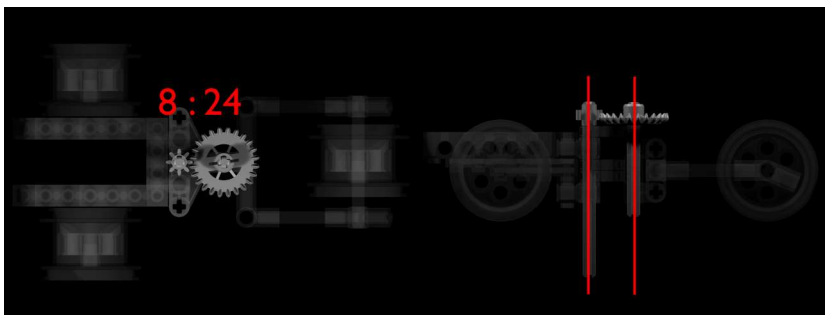
B Model



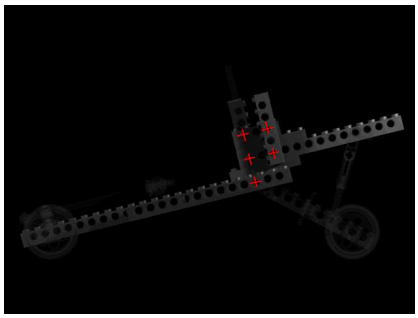
C1 Model



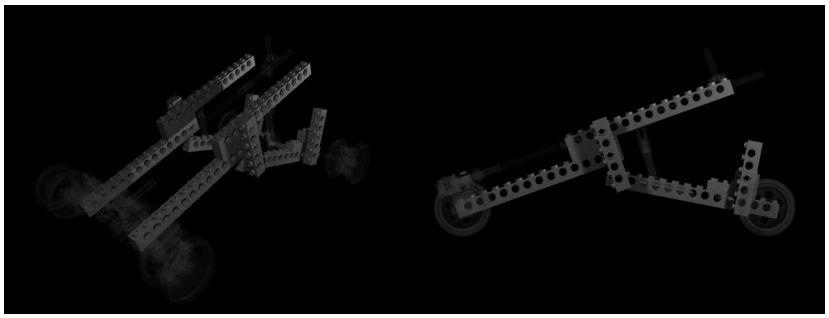
C2 Model



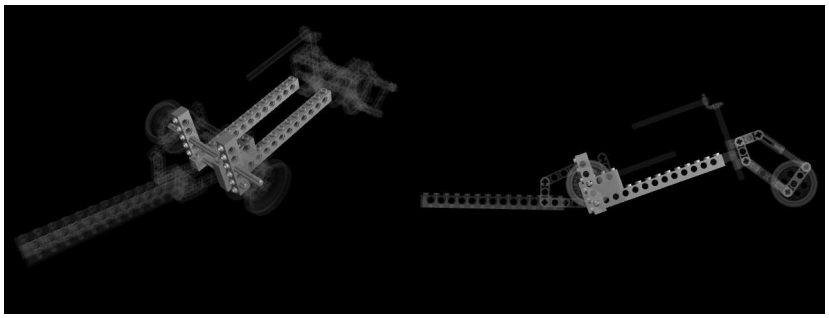
Lock



A Model

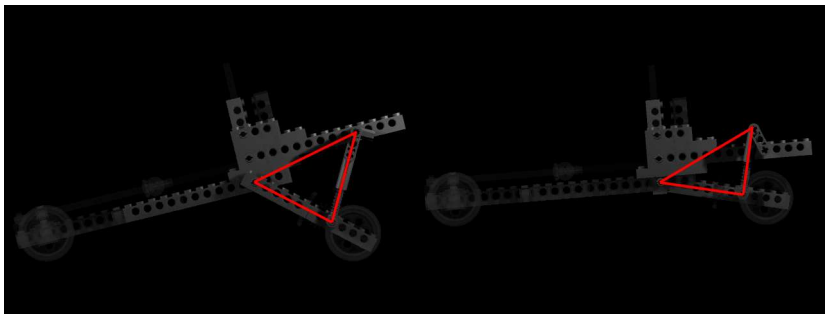


B Model

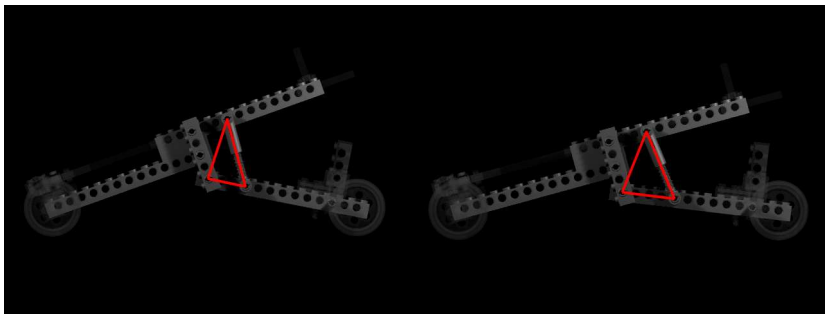


C1 Model

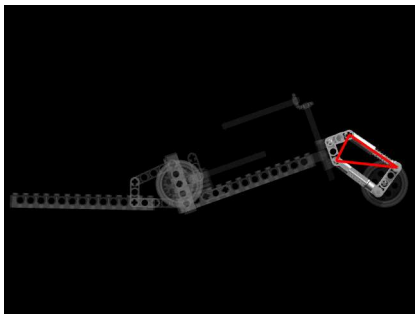
Suspension



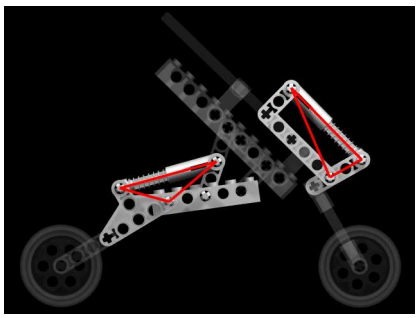
A Model



B Model

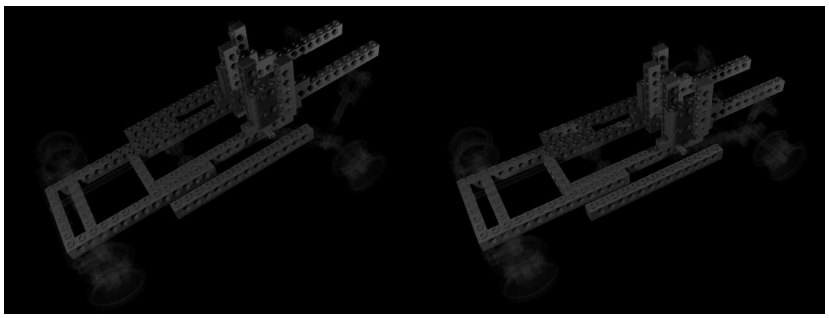


C1 Model

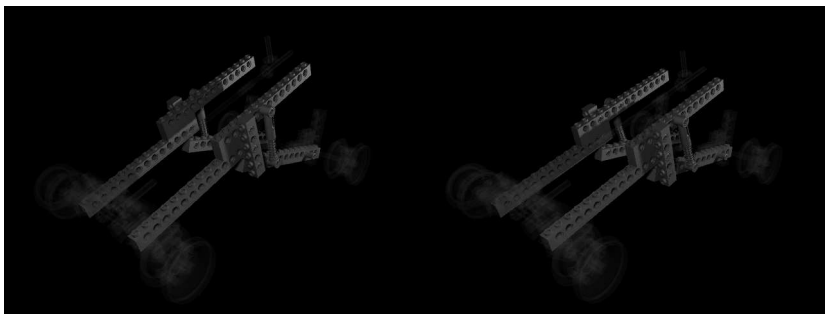


C3 Model

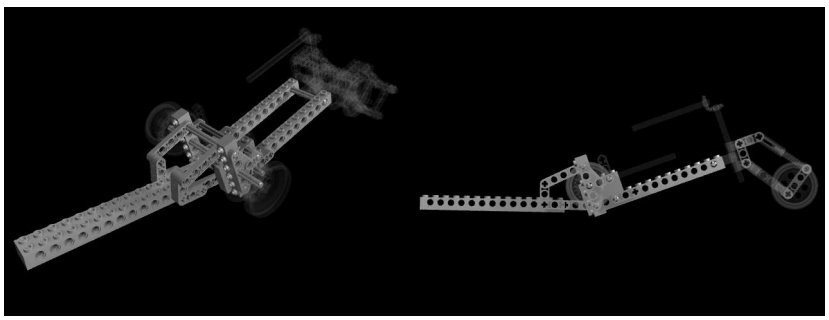
Chassis



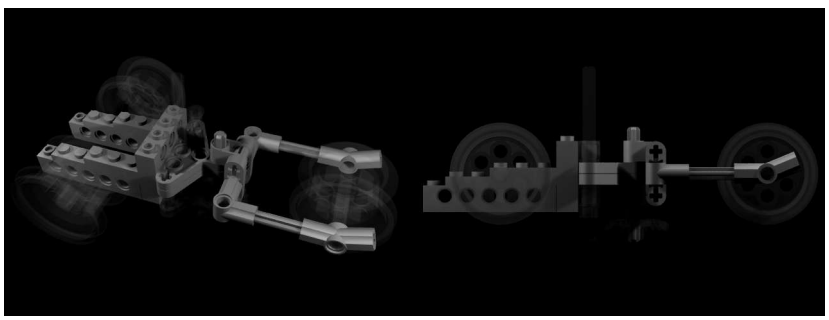
A Model



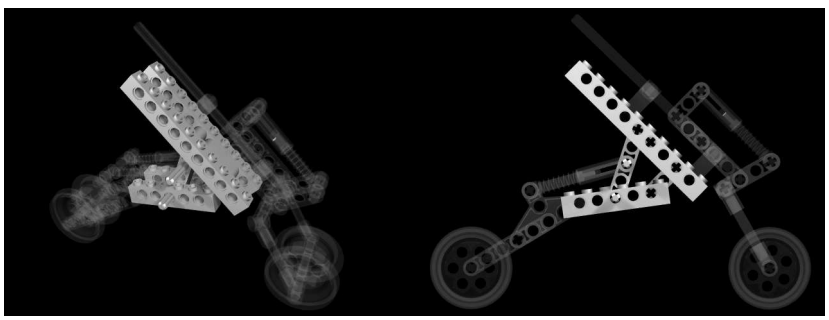
B Model



C1 Model



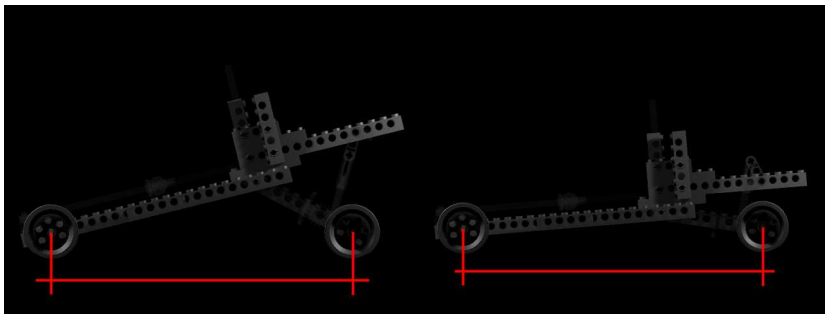
C2 Model



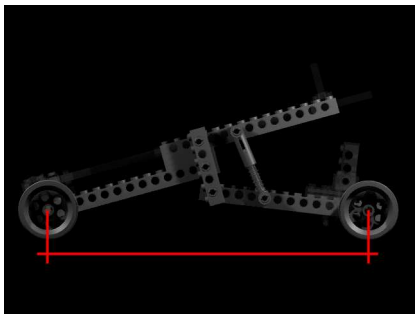
C3 Model

Turnradius

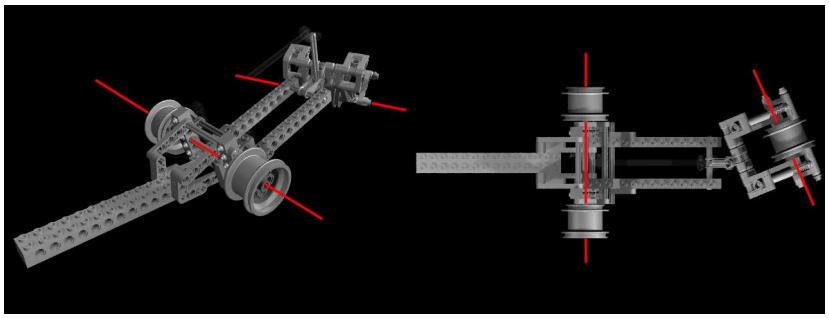
A Model



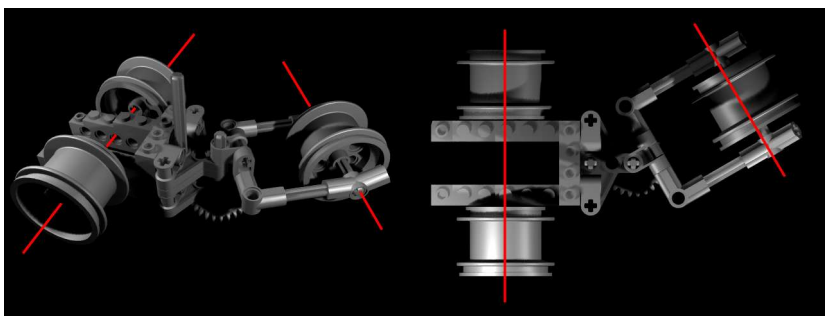
B Model



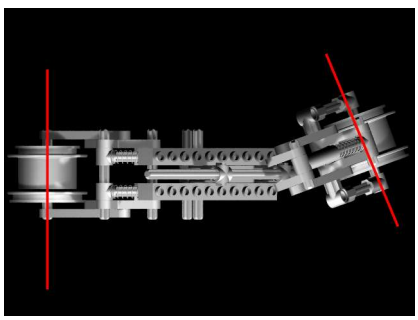
C1 Model



C2 Model

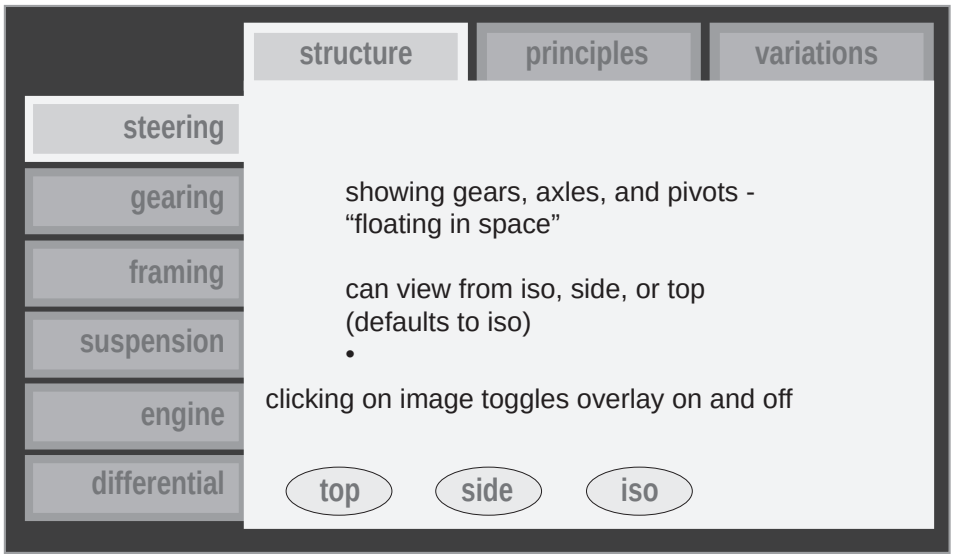


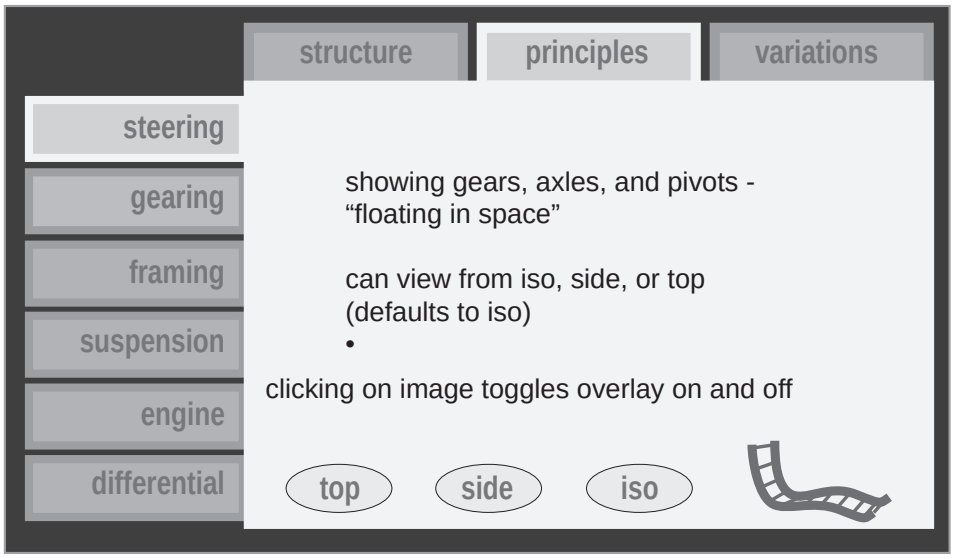
C3 Model

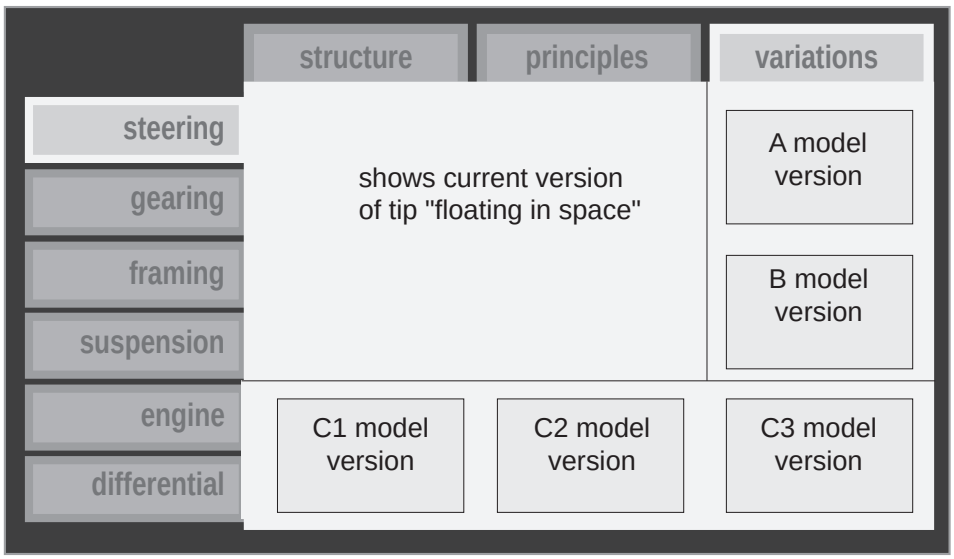


Structure

toggle layer off

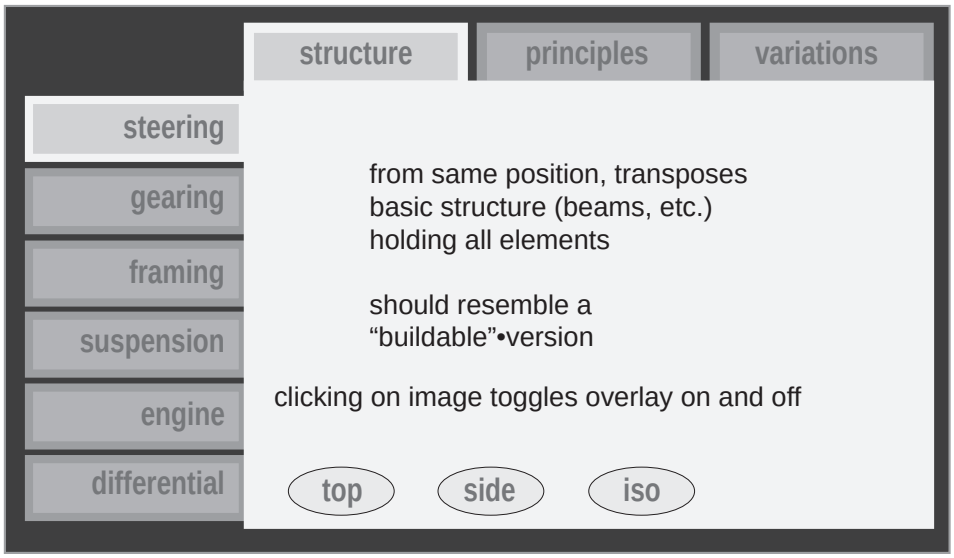


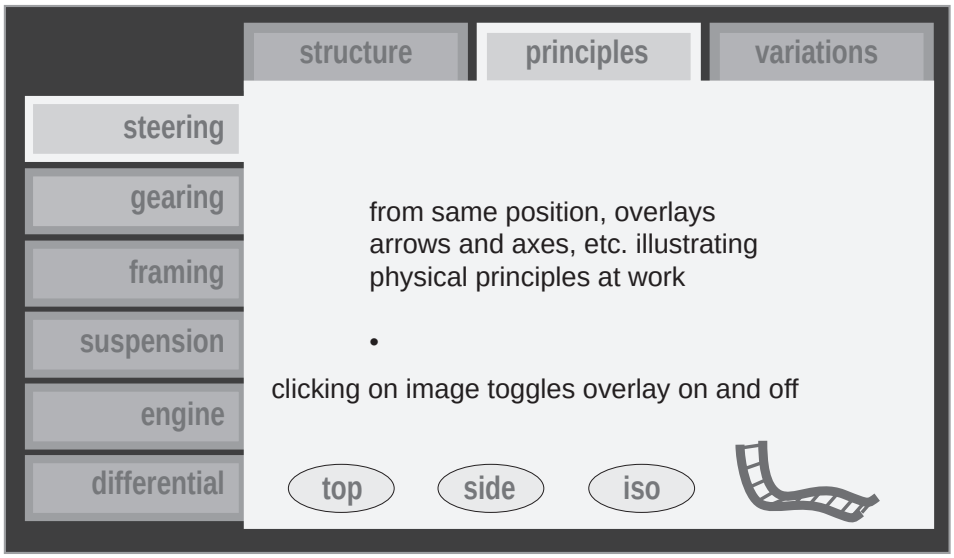


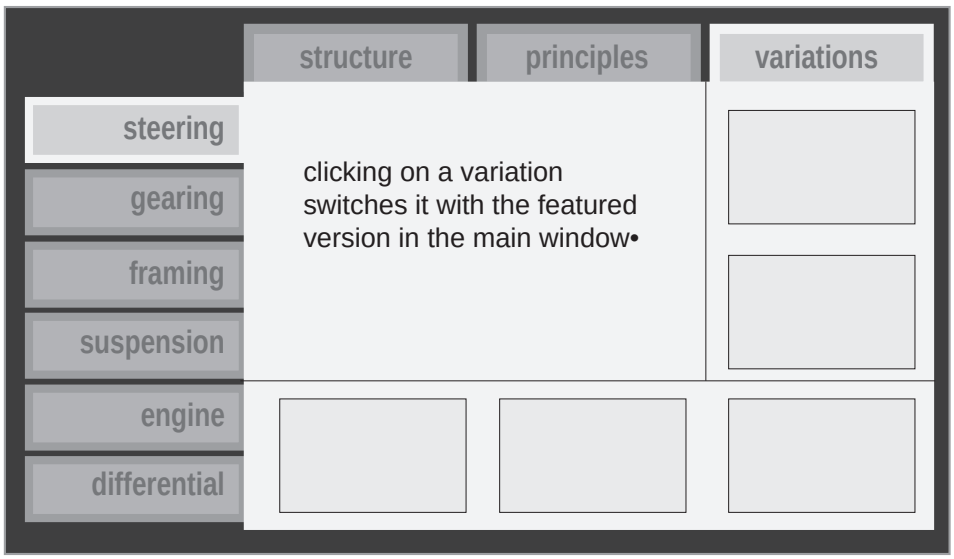


Structure

toggle layer on

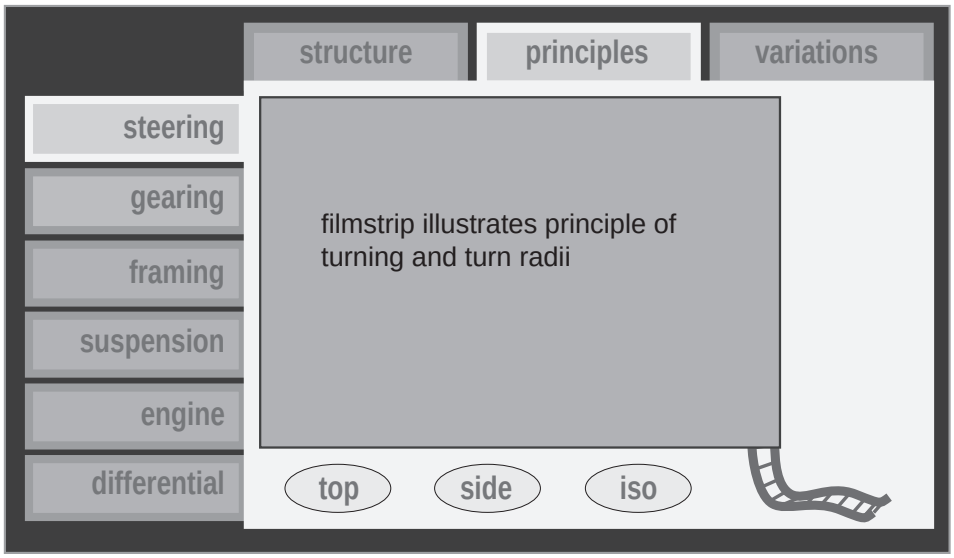






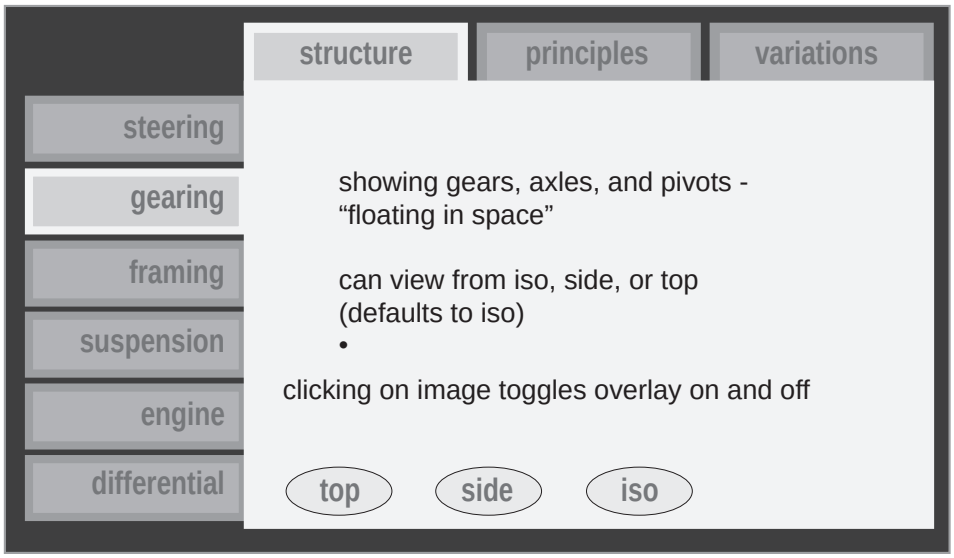
Structure

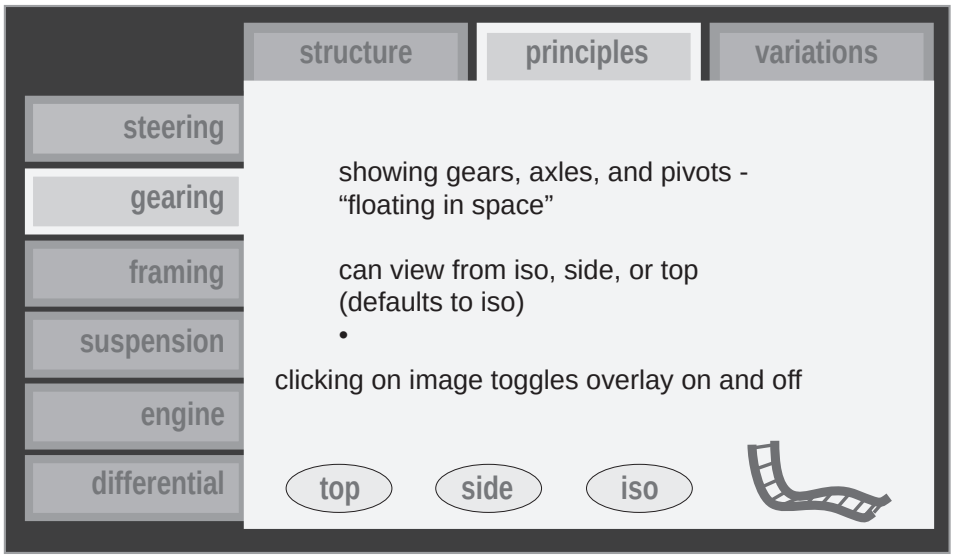
filmstrip window

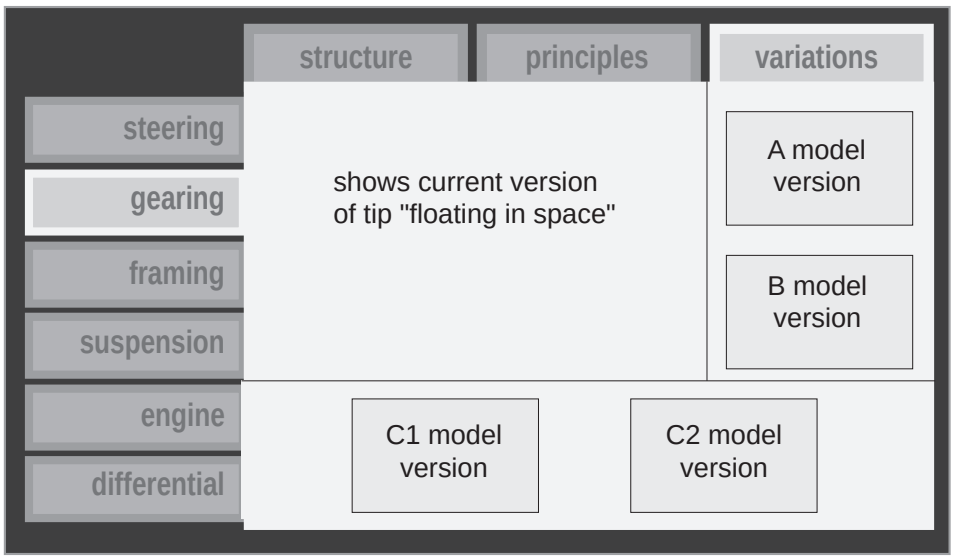


Gearing

toggle layer off

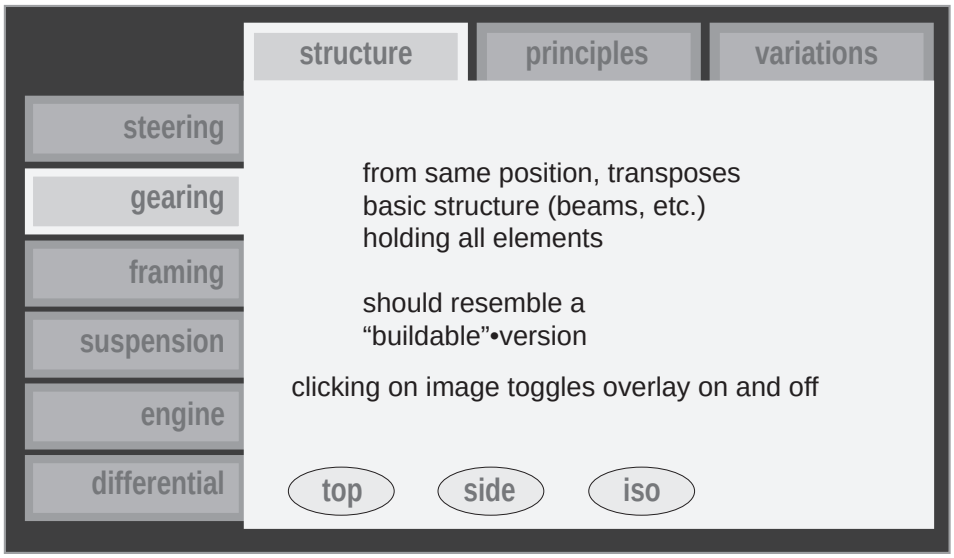


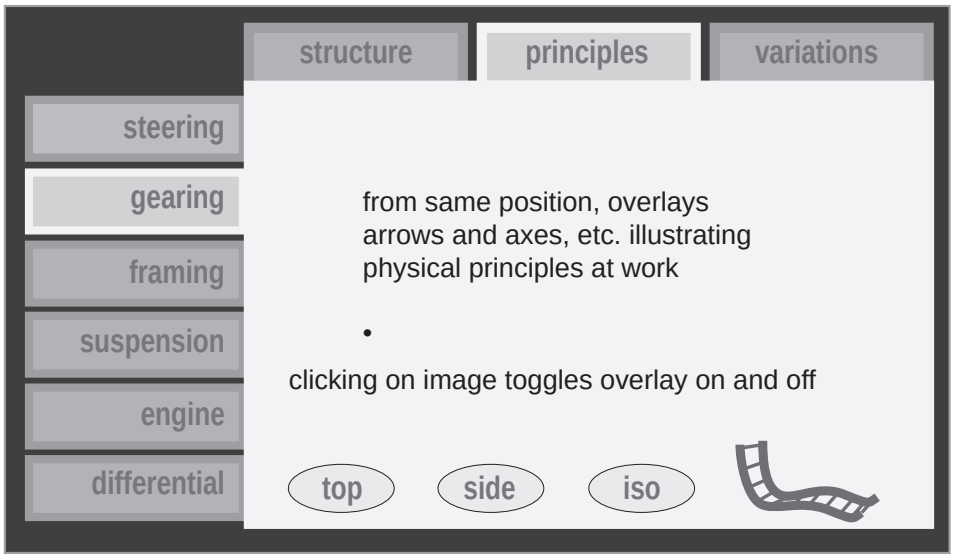


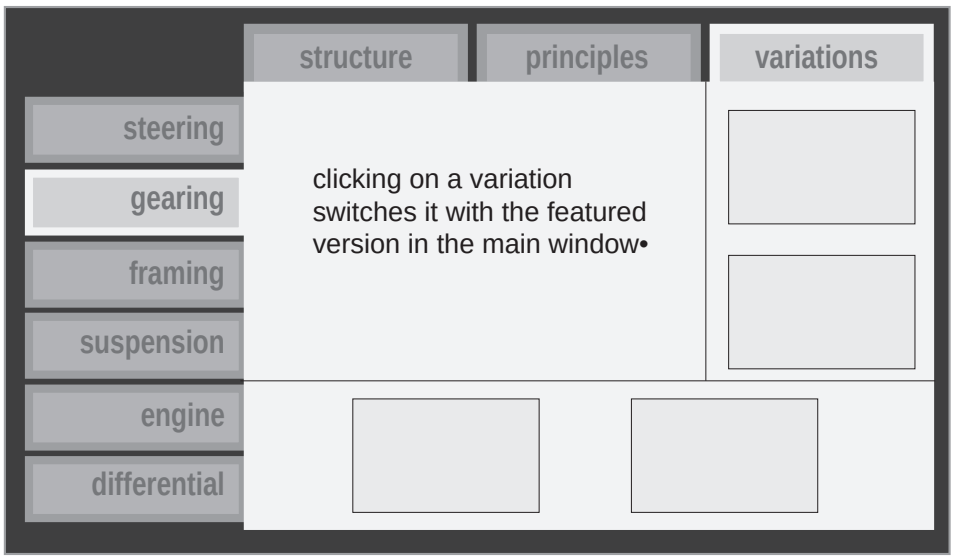


Gearing

toggle layer on

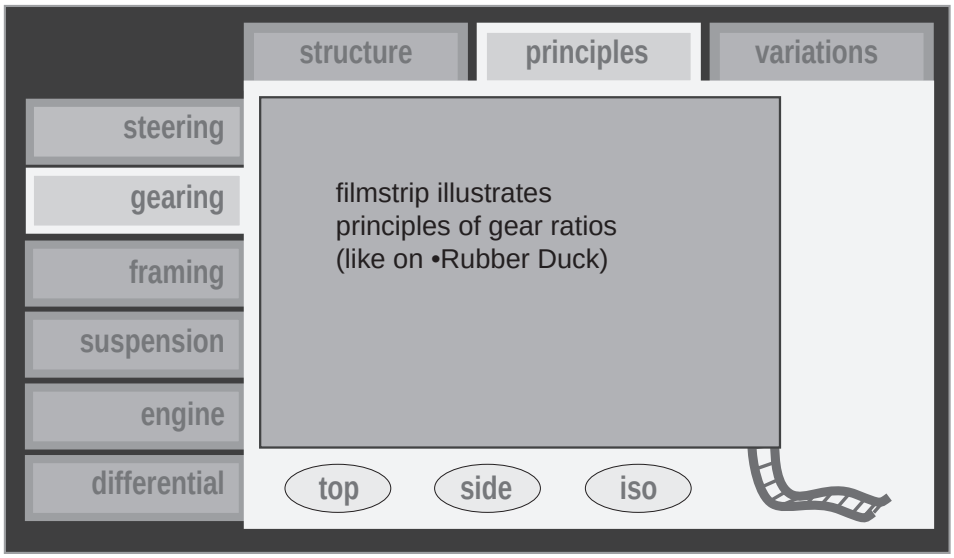






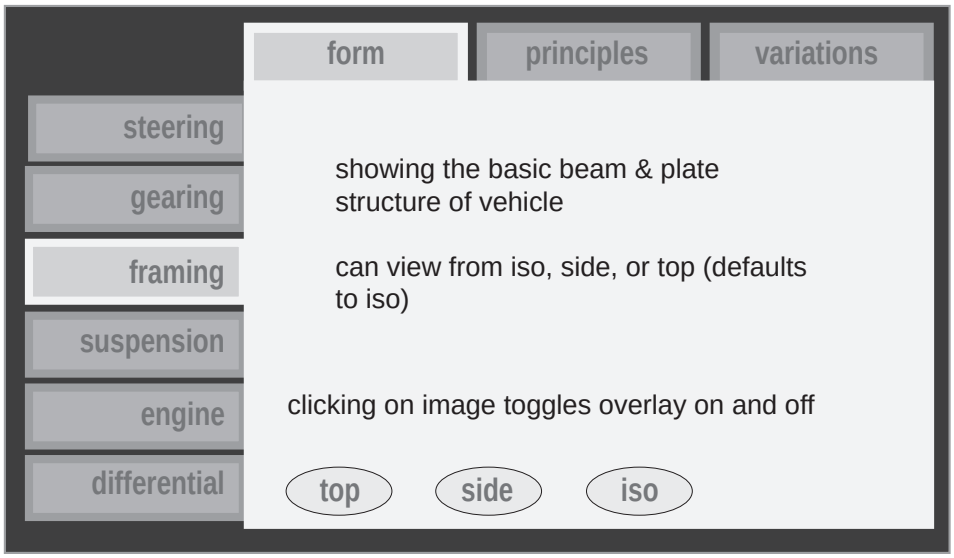
Gearing

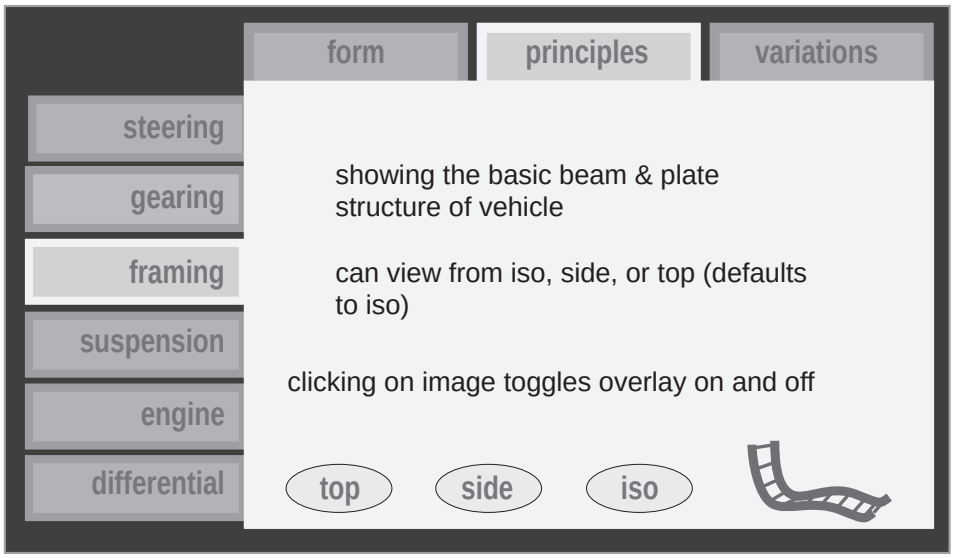
filmstrip window

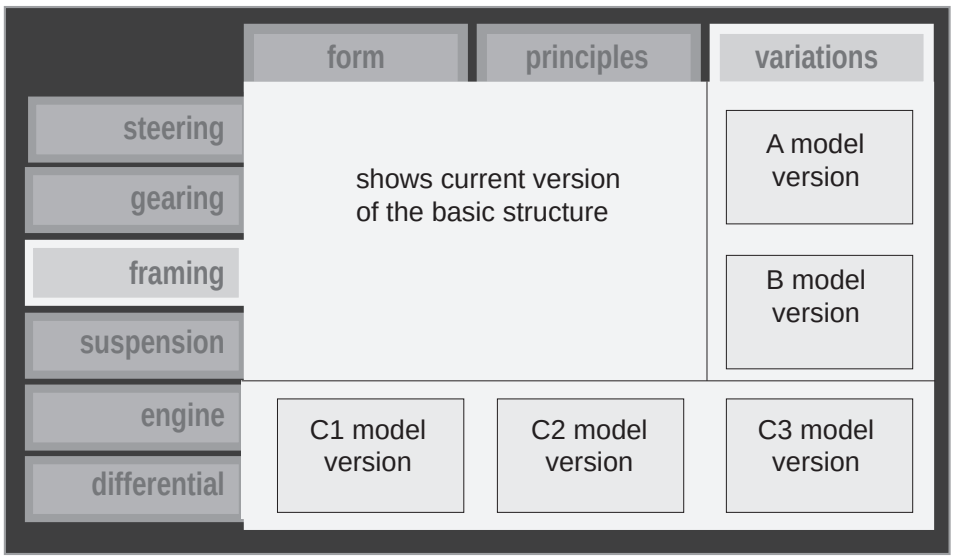


Framing

toggle layer off

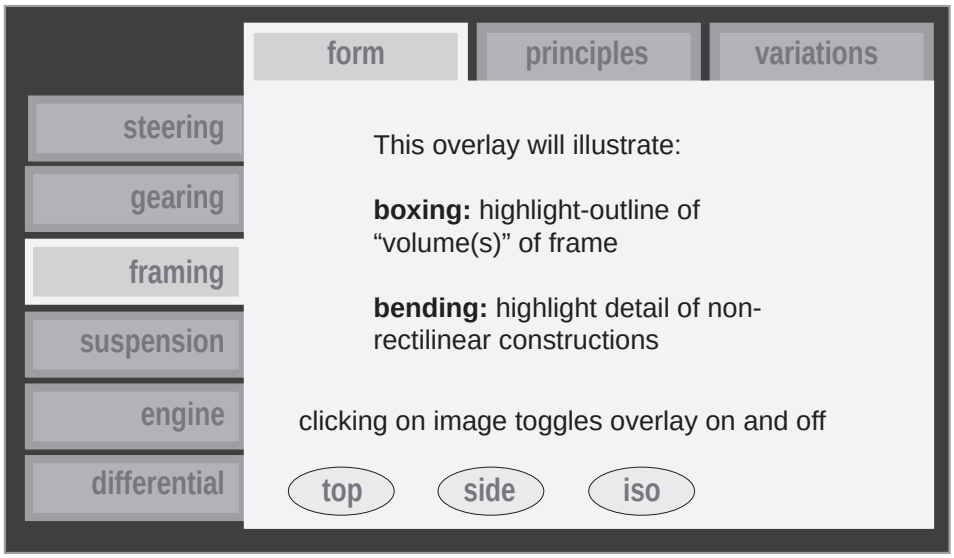


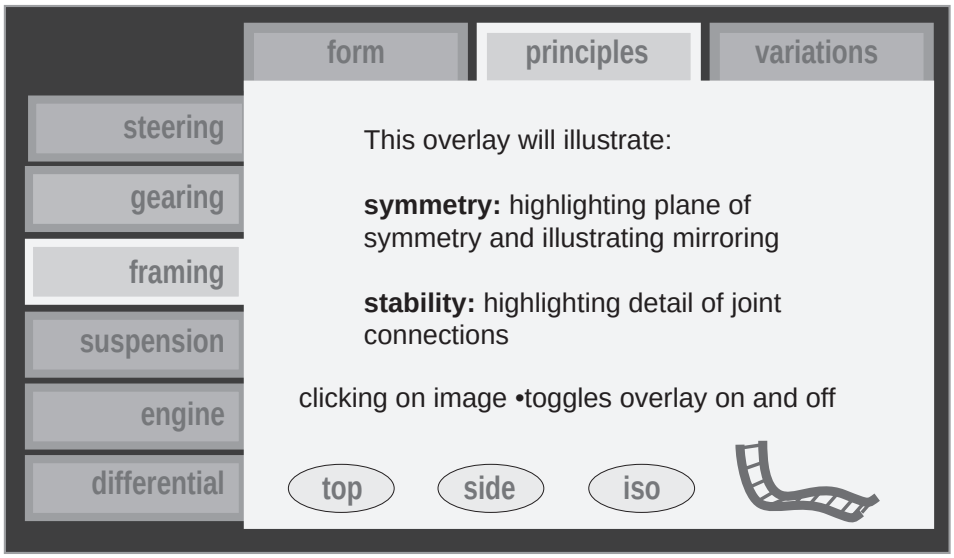


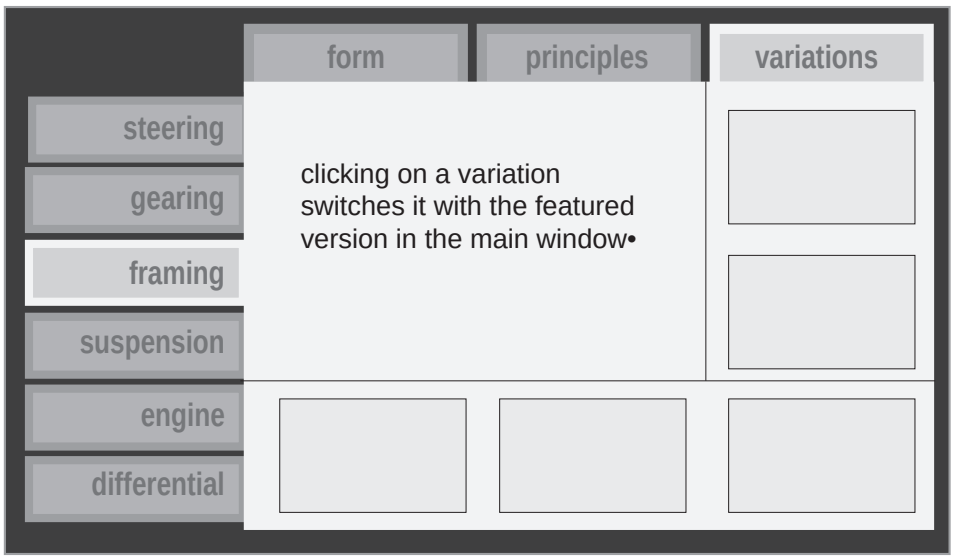


Framing

toggle layer on

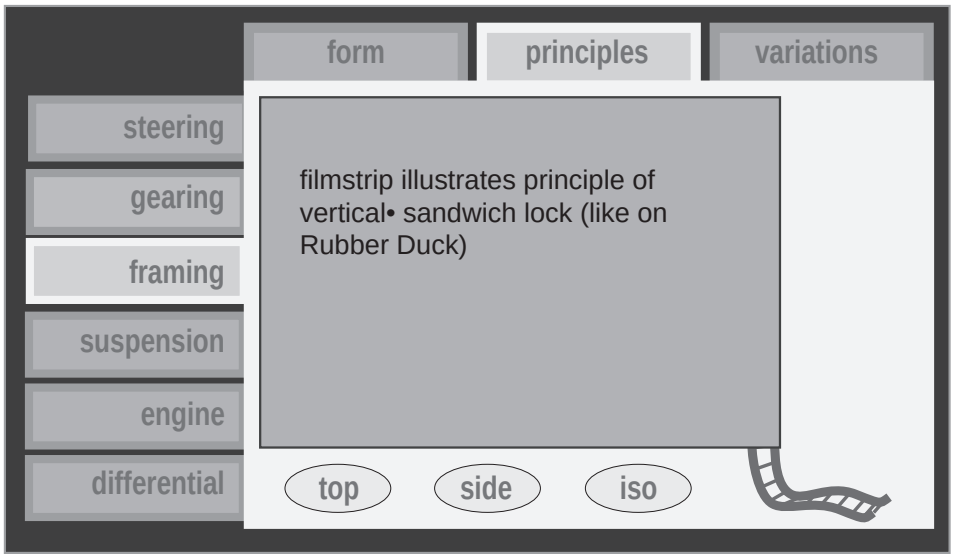






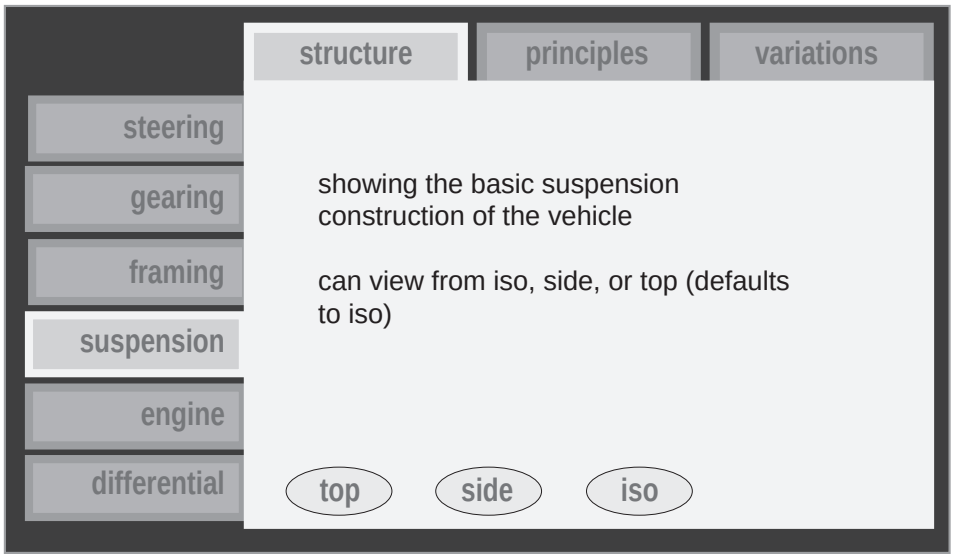
Framing

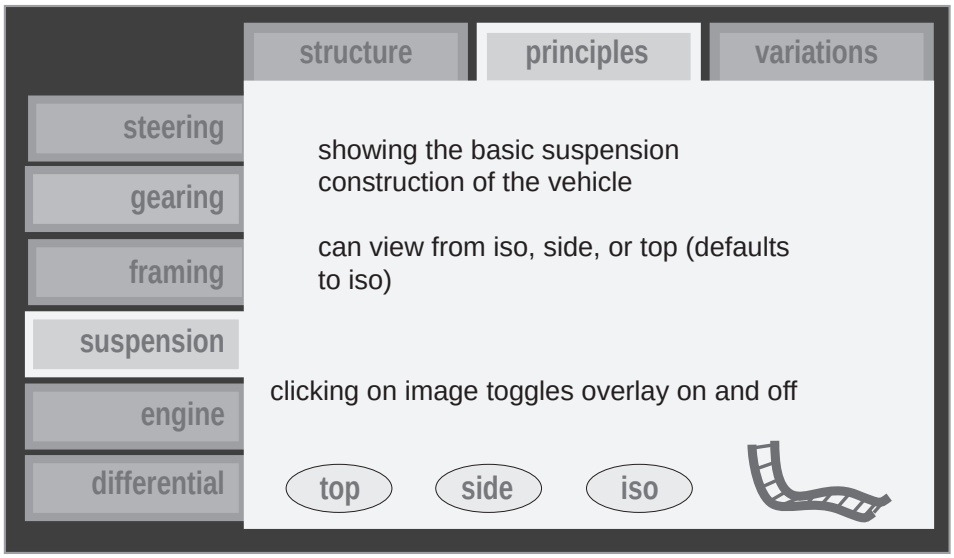
filmstrip window

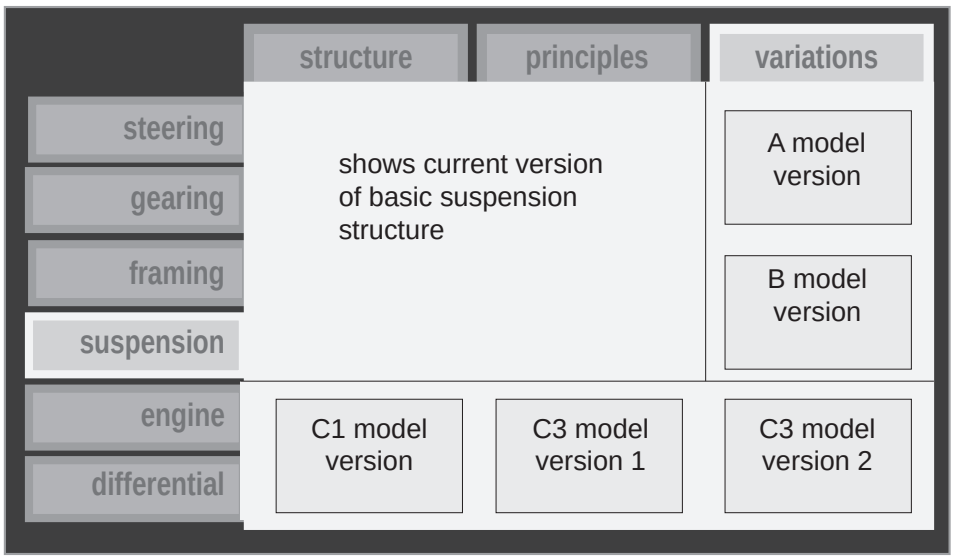


Suspension

toggle layer off

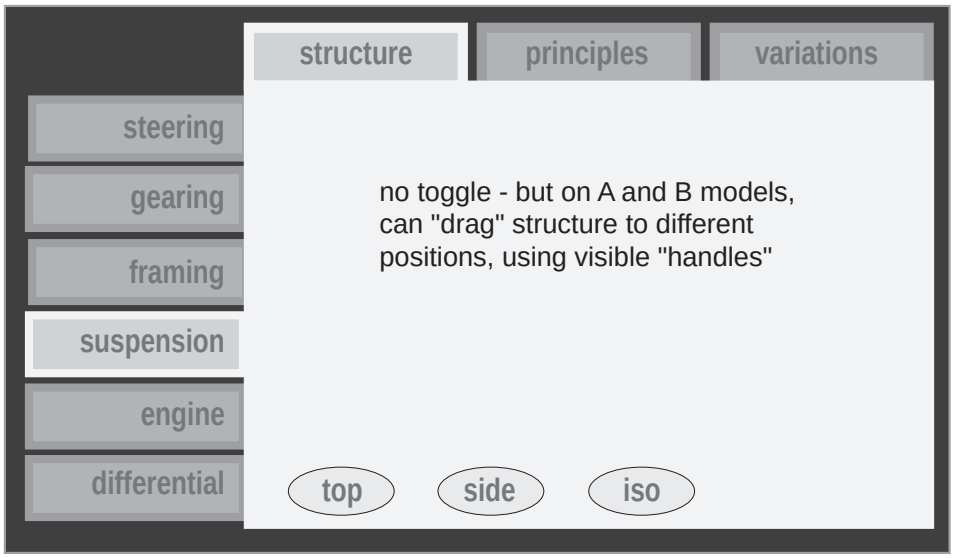


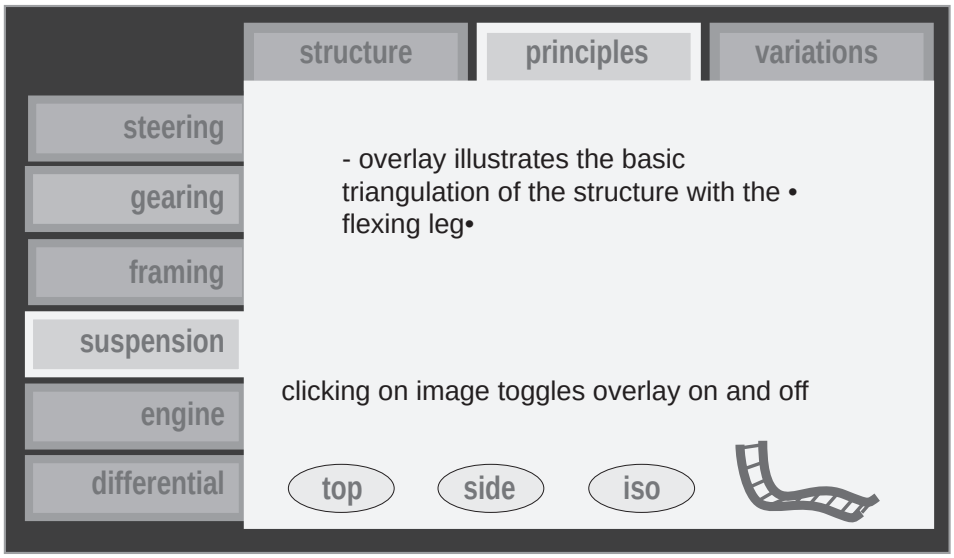


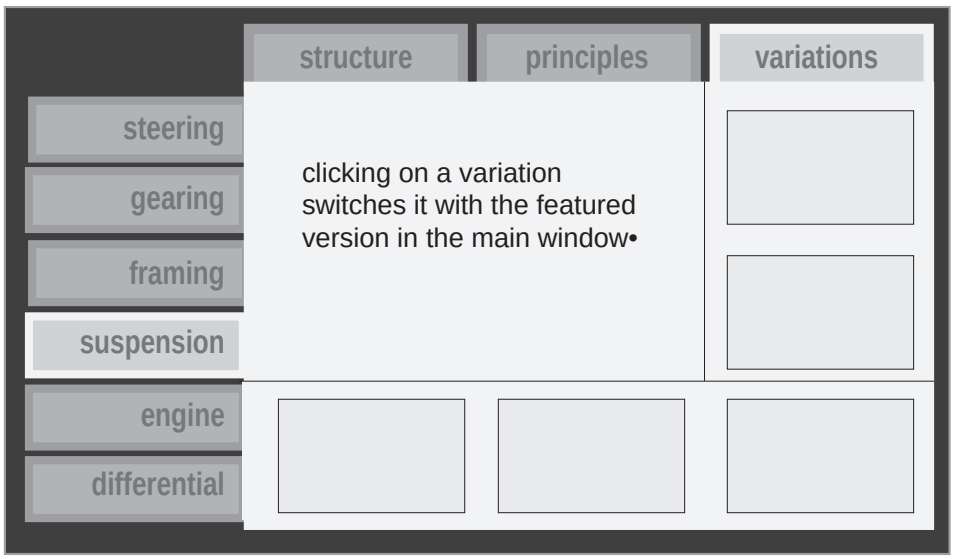


Suspension

toggle layer on

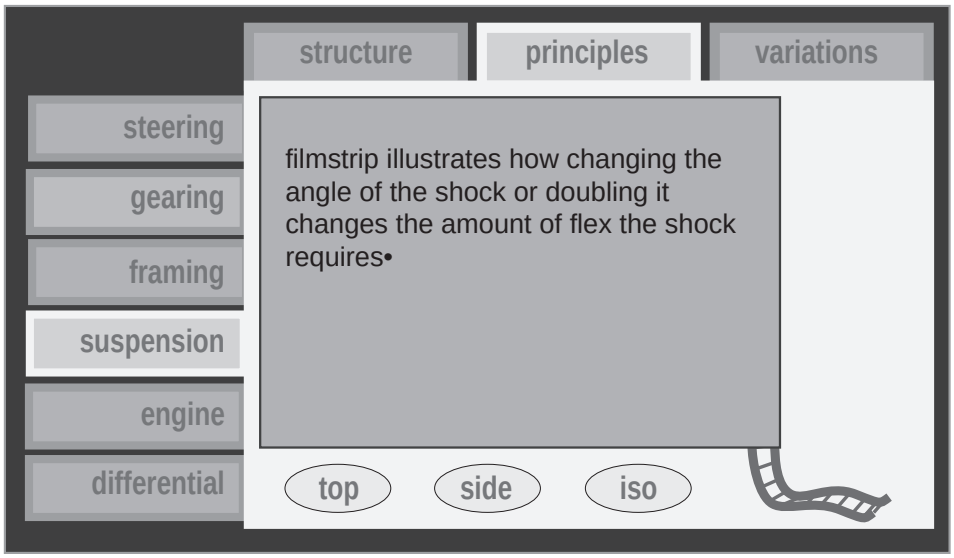






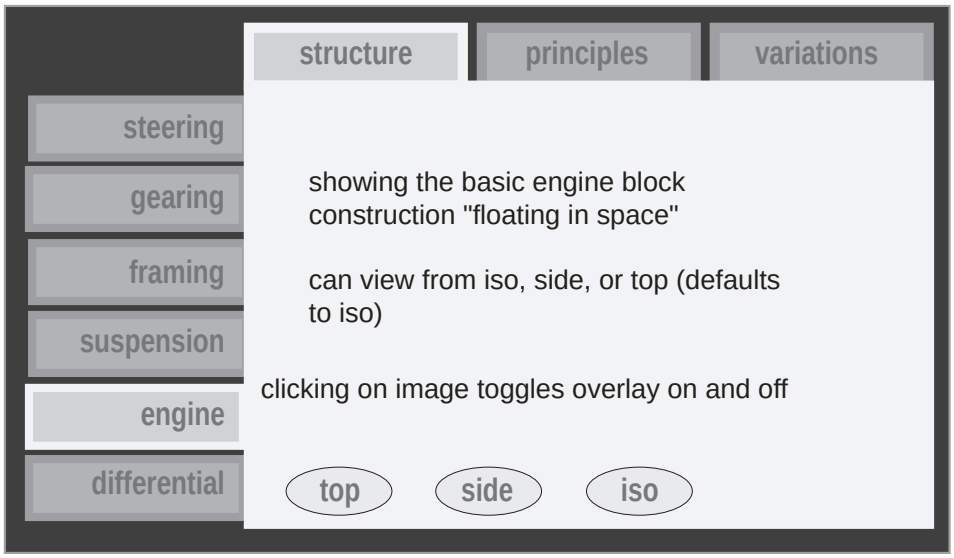
Suspension

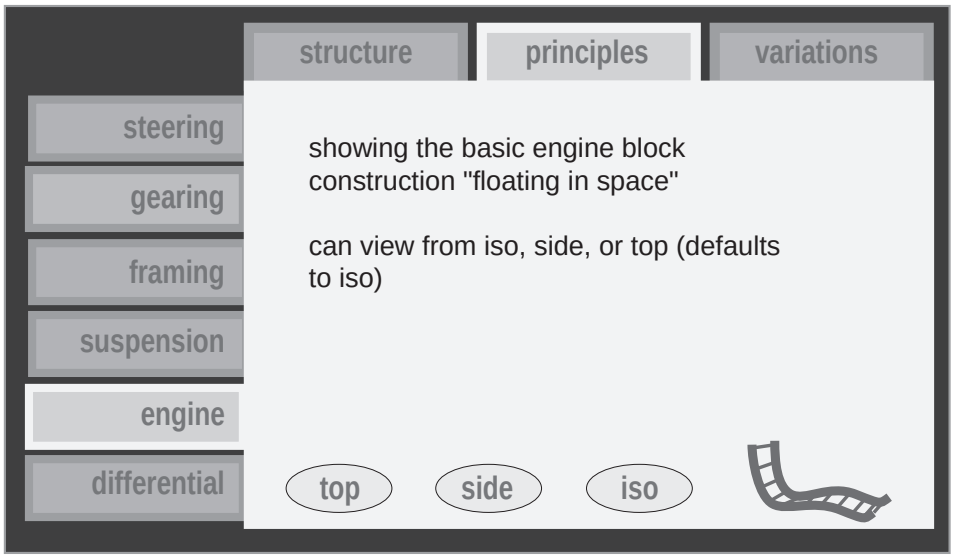
filmstrip window

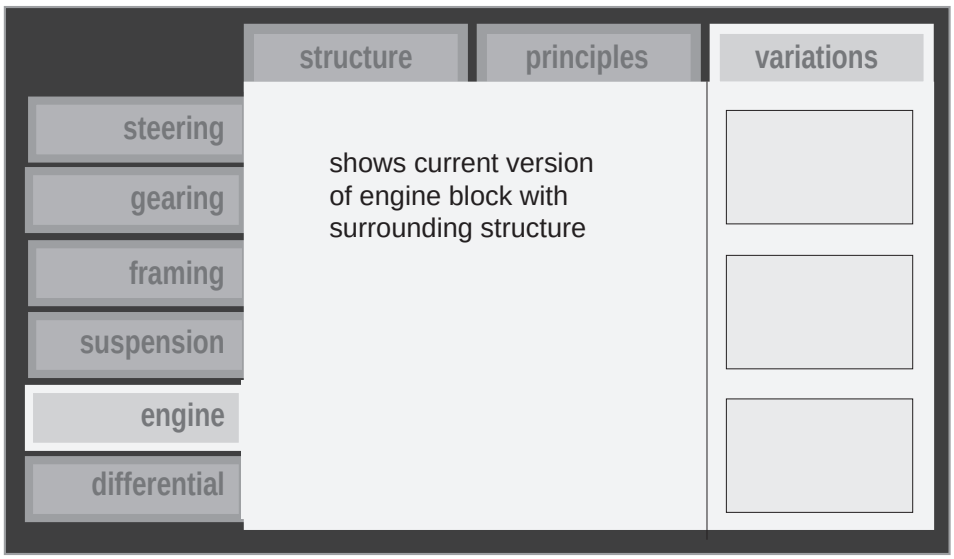


Engine

toggle layer off

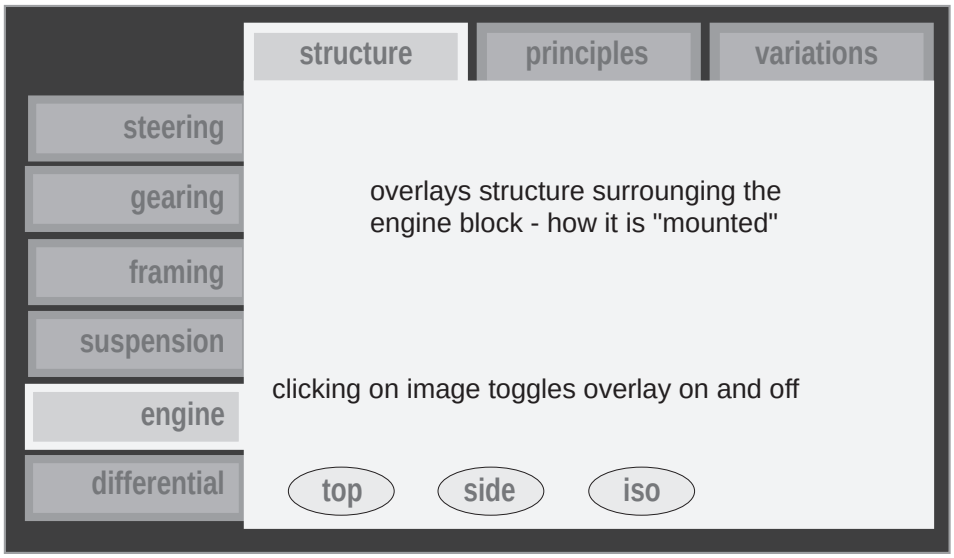


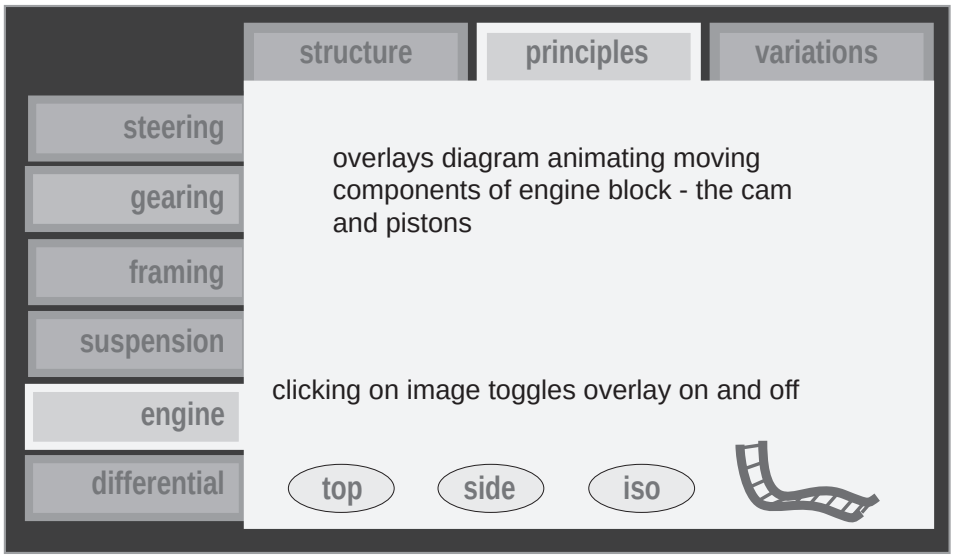


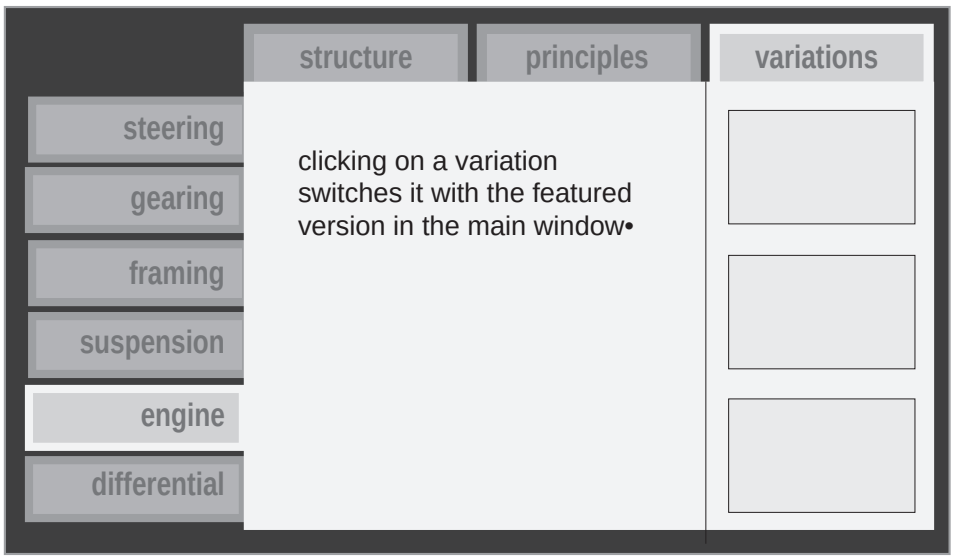


Engine

toggle layer on

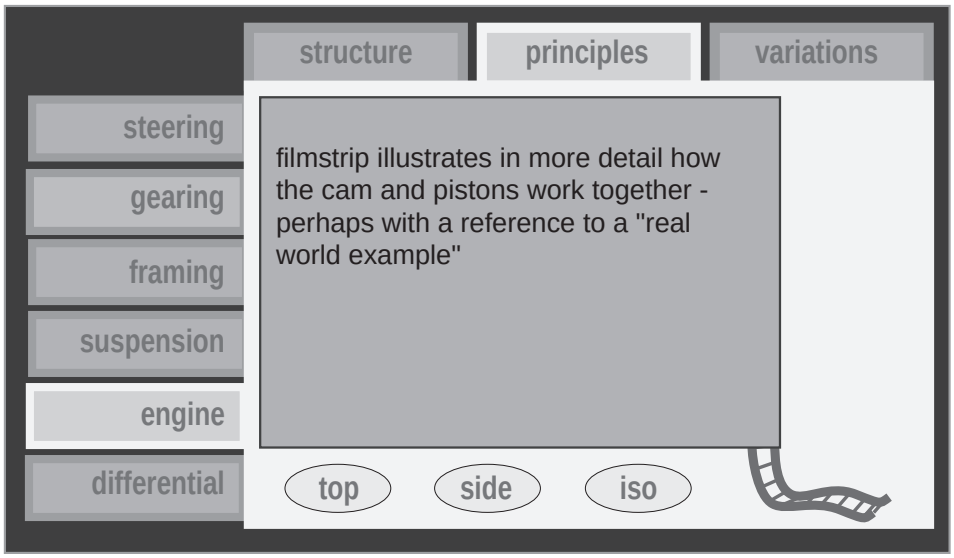






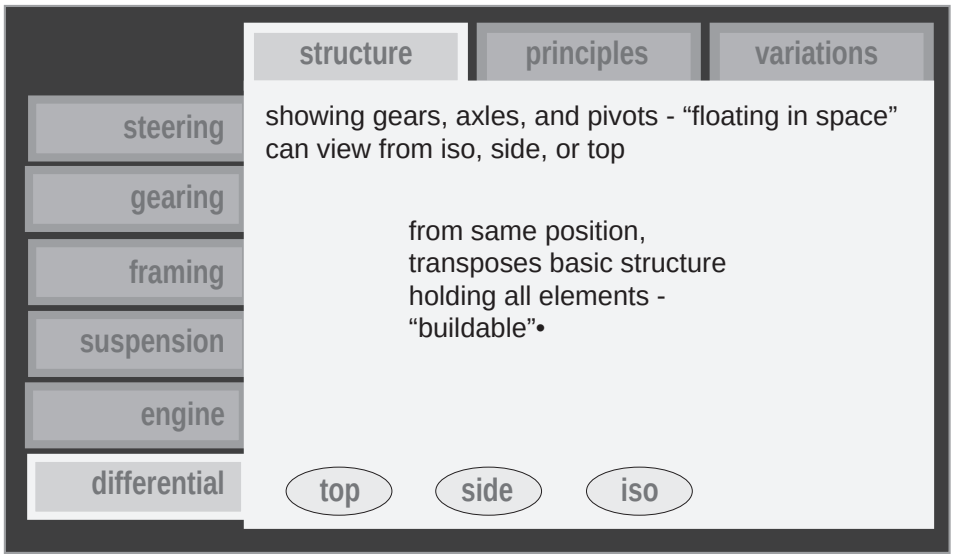
Engine

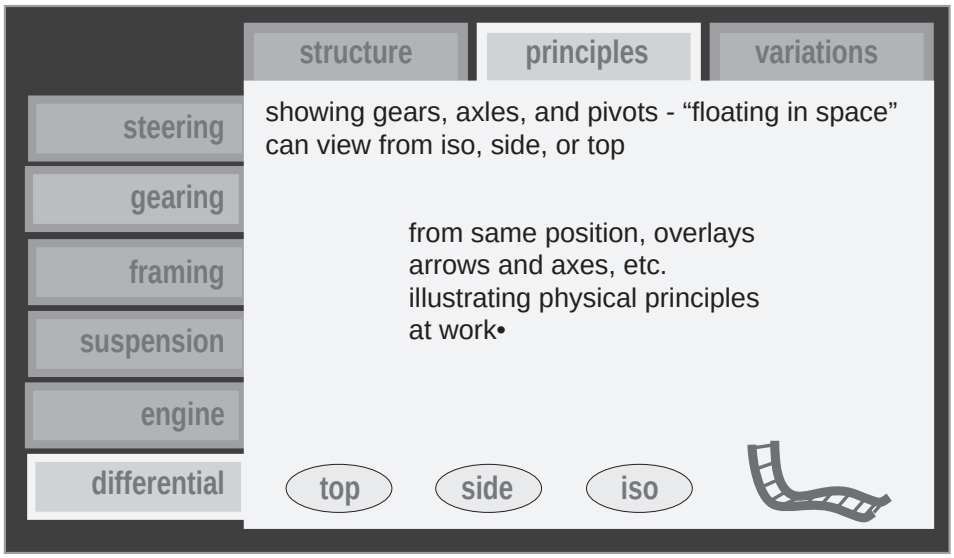
filmstrip window

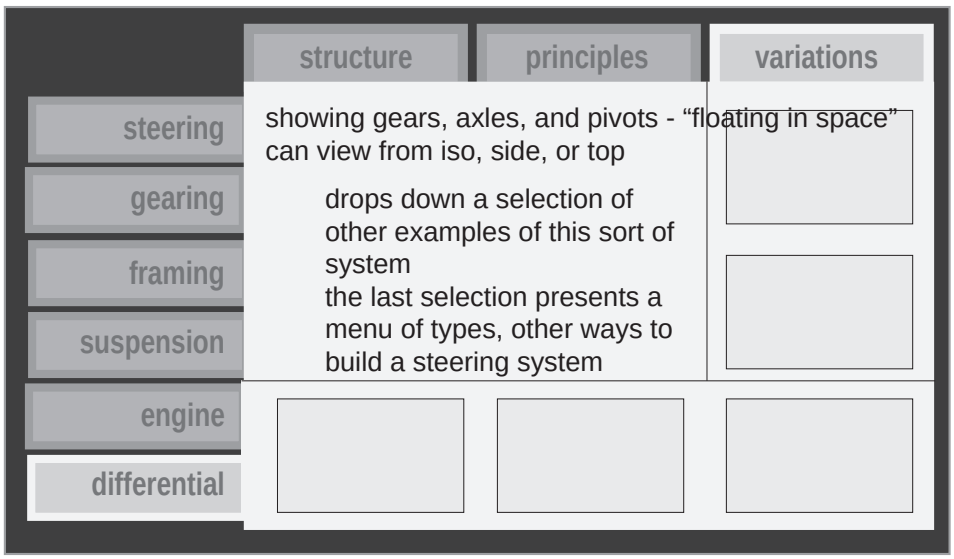


Differential

toggle layer off

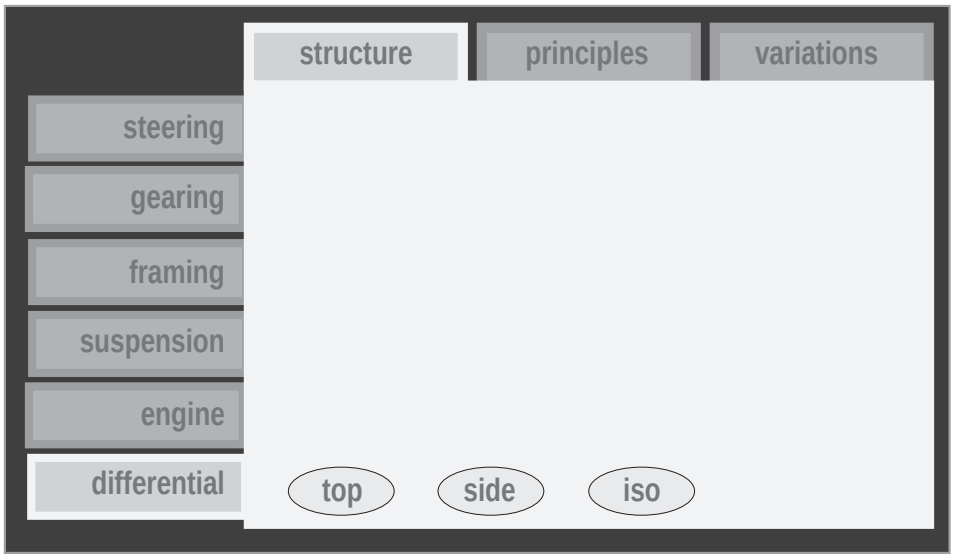


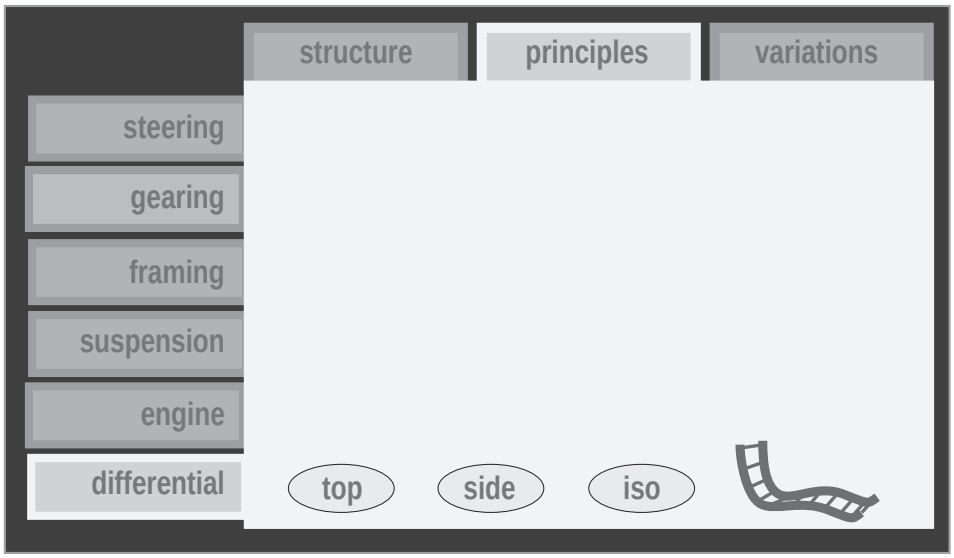


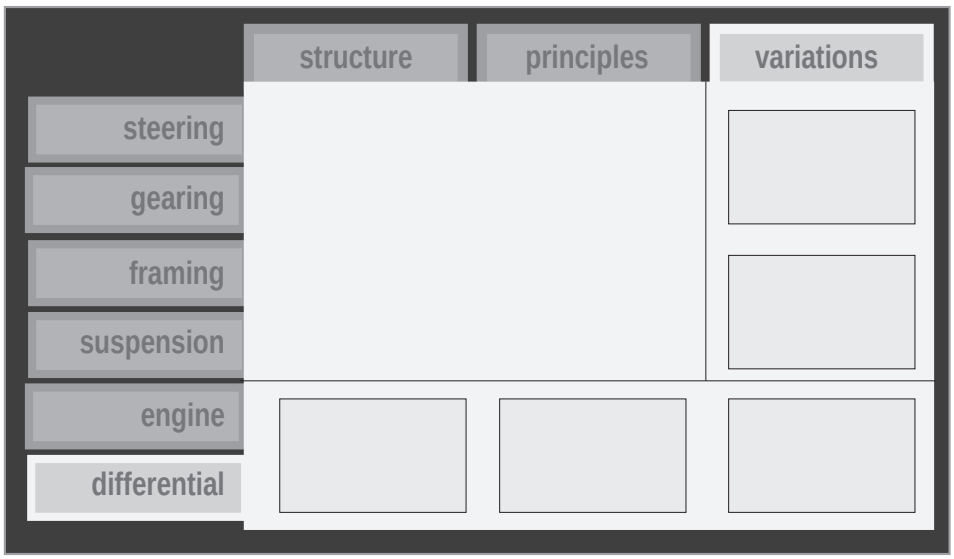


Differential

toggle layer on

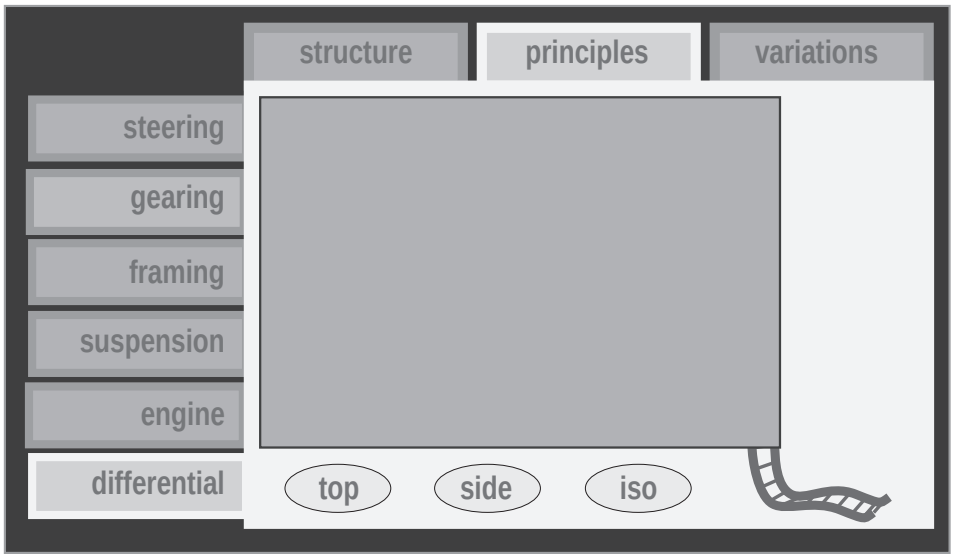




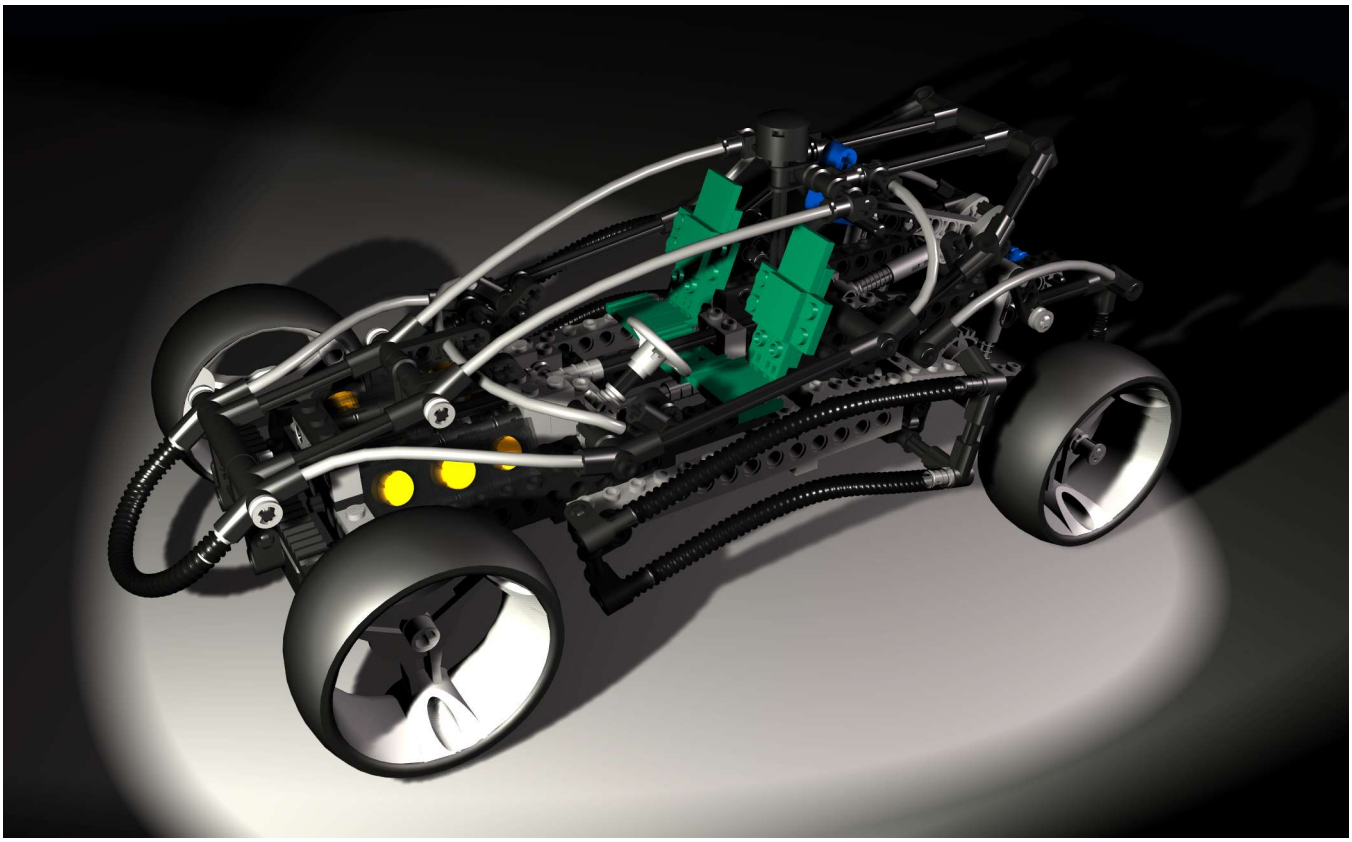


Differential

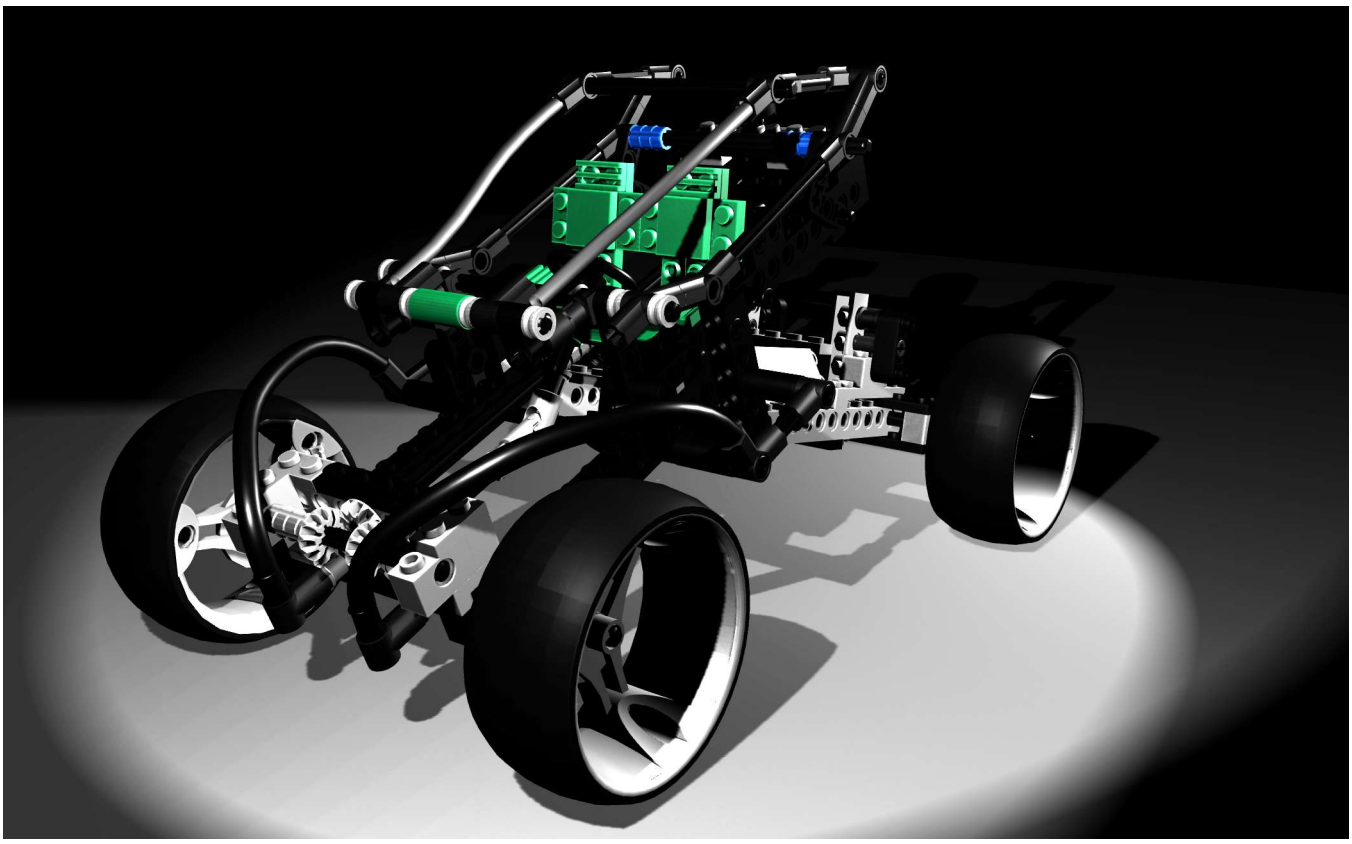
filmstrip window



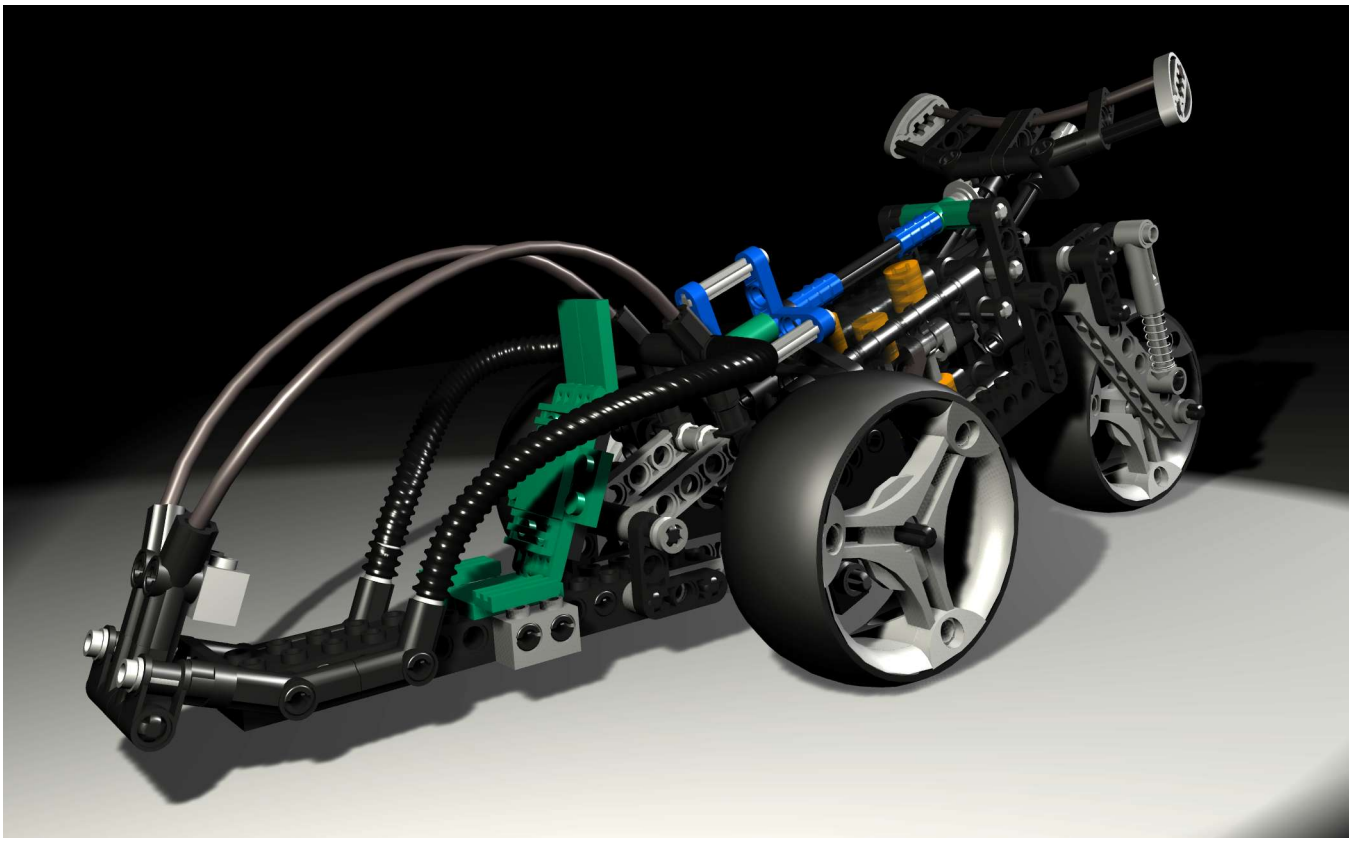
Appendix G: The Models



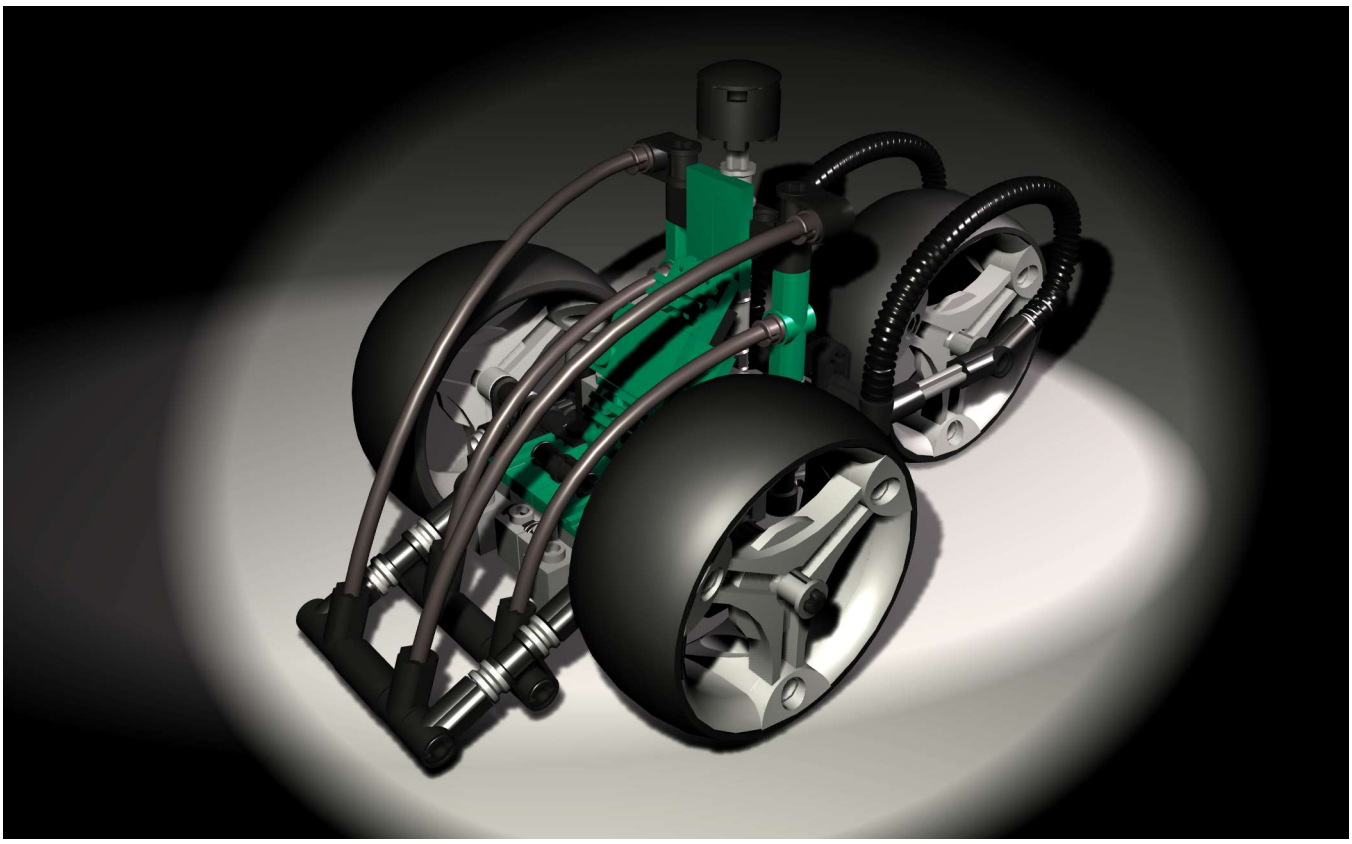
A Model



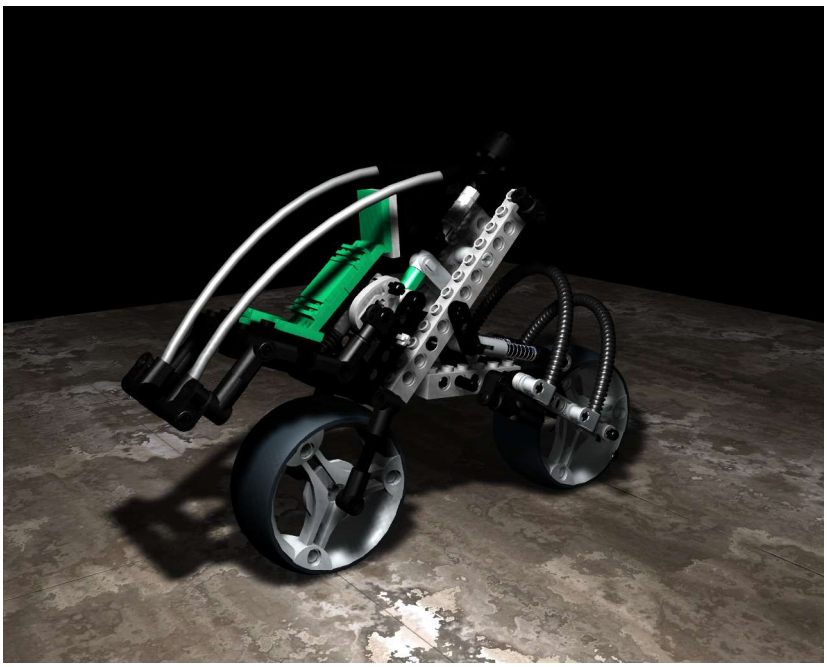
B Model



C1 Model

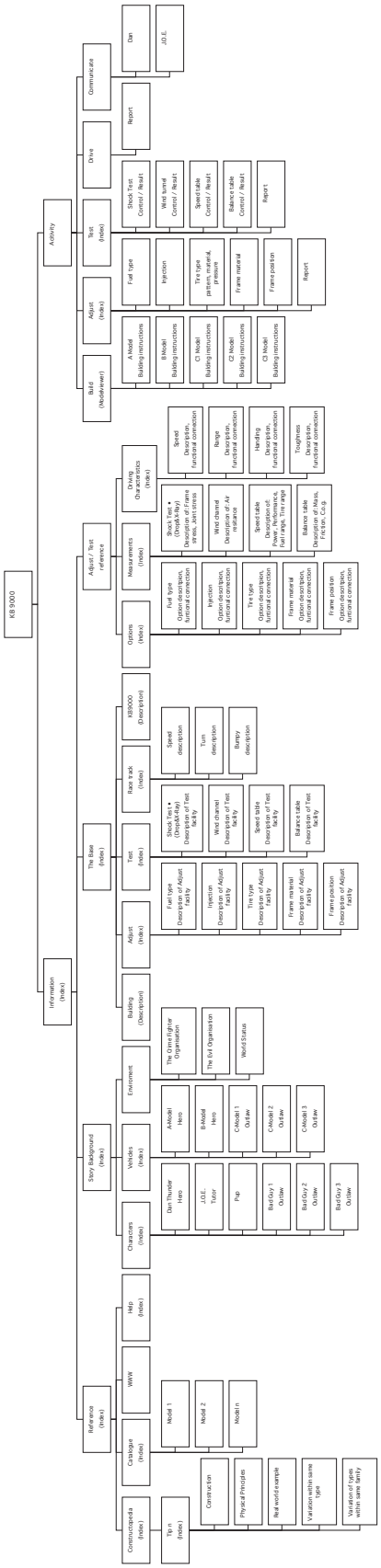


C2 Model



C3 Model

Appendix H: Knowledge base content



Knowledge base content

Acknowledgements

Imprint

Billund, the 05.09.97
Executive Producer - Michael Cech-Lucas
Producer - Dan Spikol, Adriana Eyzaguirre
Concept Development - Joseph Knight, Christoph Bartneck
Concept Consultants - Bjarne Tveskov, Michael Thomsen, George Schmidt
Liason at Futura - Lars Joe Hyldig
Examining board - Prof. Dr. Ing. Falk Hoehn, Prof. Dr. Dr. Thomas Jaspersen

Legal terms

Credits

mange tak til aksel og jeppe. many thanks to kris, jason, david and nigel. vielen dank an jesper, simon, alex und martin. tack så mycket till mattias, martin och frida.

a special thank to j.o.e.s.e.p.h. who was a great help for me and to my parents who supported me in many ways.

use the brick, luke!

Addresses

LEGO A/S
SPU Darwin
Klovermarken 120
7190 Billund
Danmark

FH Design & Medien Hannover
Faculity Industrial-Design-Informatik
Herrenhäuser Str. 8
30419 Hannover
Germany

Christoph Bartneck
Winterbergstr. 8
32602 Vlotho
Germany