

LPub – Building Instruction Publishing Tool

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History

- Syngress Publishing (www.syngress.com) wanted to publish LEGO building instruction books
- Had no tools to do the artwork
- Multiple authors doing artwork by hand – inconsistencies
- Necessity is the mother of invention

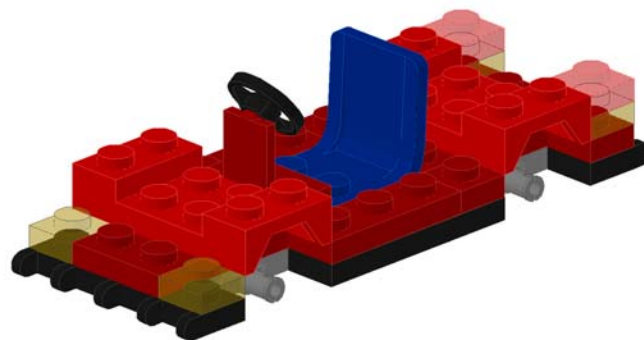
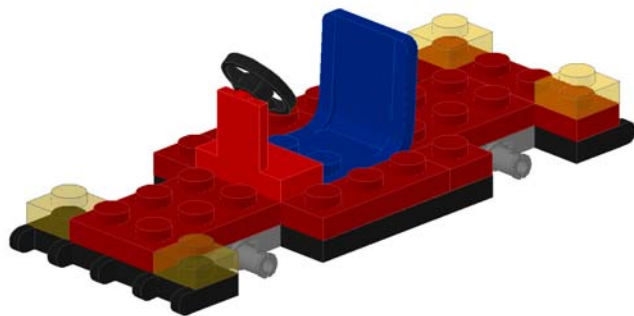
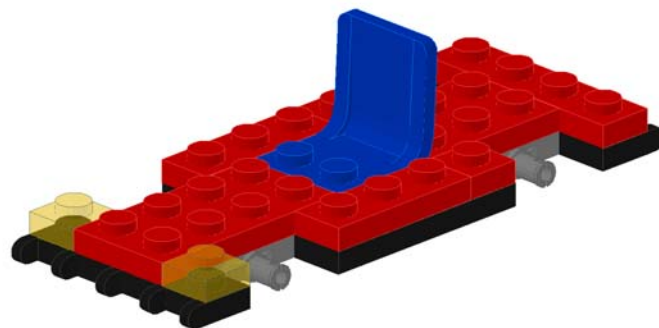
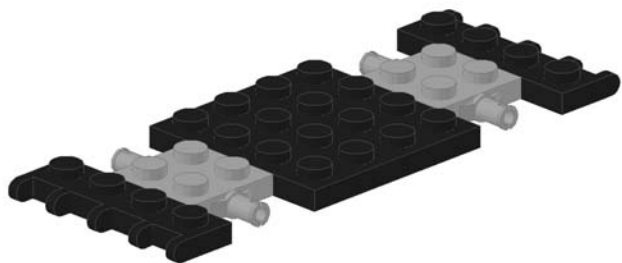
Building Instructions

- A sequence of images that shares how to build something out of a pile of bricks
- LDraw program, LDraw file format and the LDraw parts library was created by James Jessiman to be able to share building instruction electronically
 - Parts, lines, triangles, quads
 - STEP, CLEAR
 - Parts in Parts

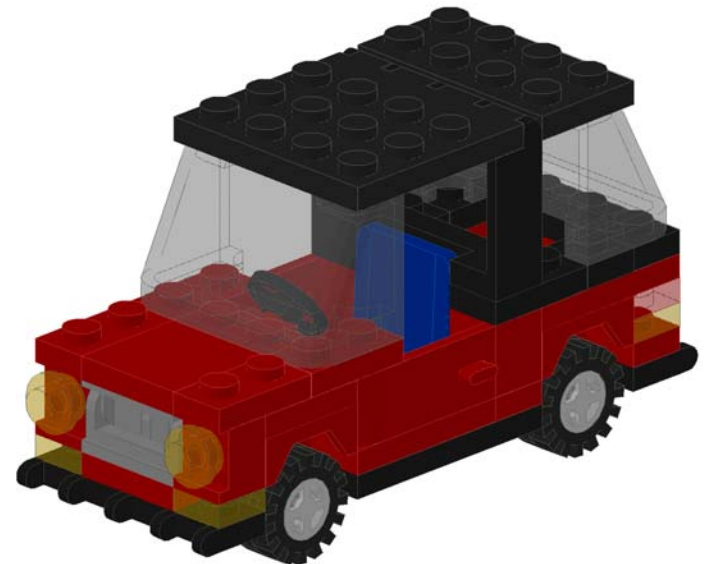
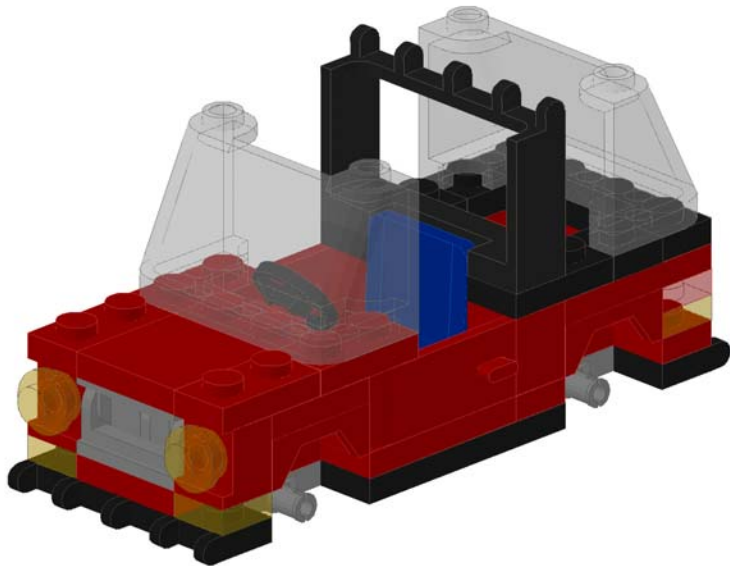
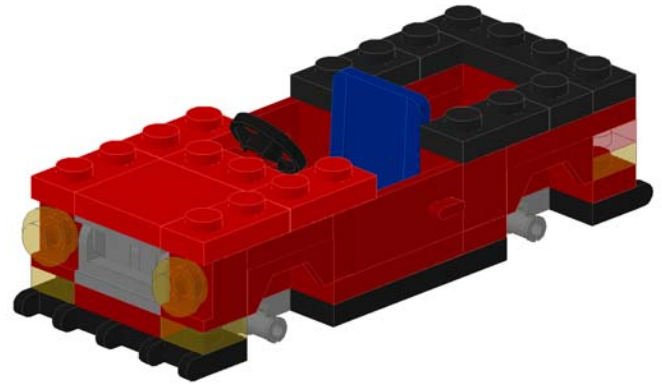
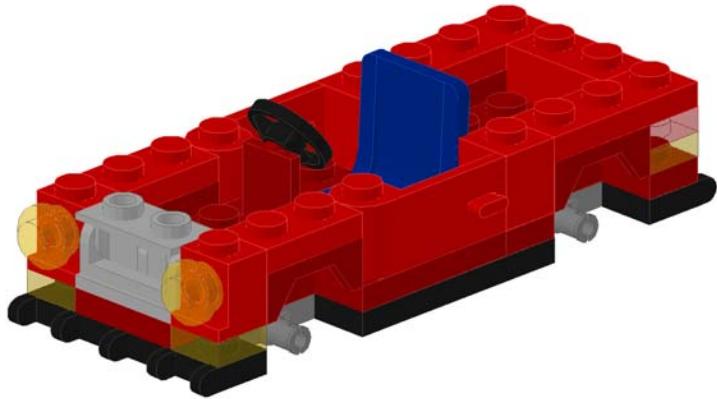
MLCad

- Windows based design entry tool
- Lets you build electronic representation of models using graphics user interface
- Combines LDraw support for building instructions with new features provided by MLCad
 - ROTATION STEP
 - BUFFER EXCHANGE
 - GHOST
- Written by Michael Lachman

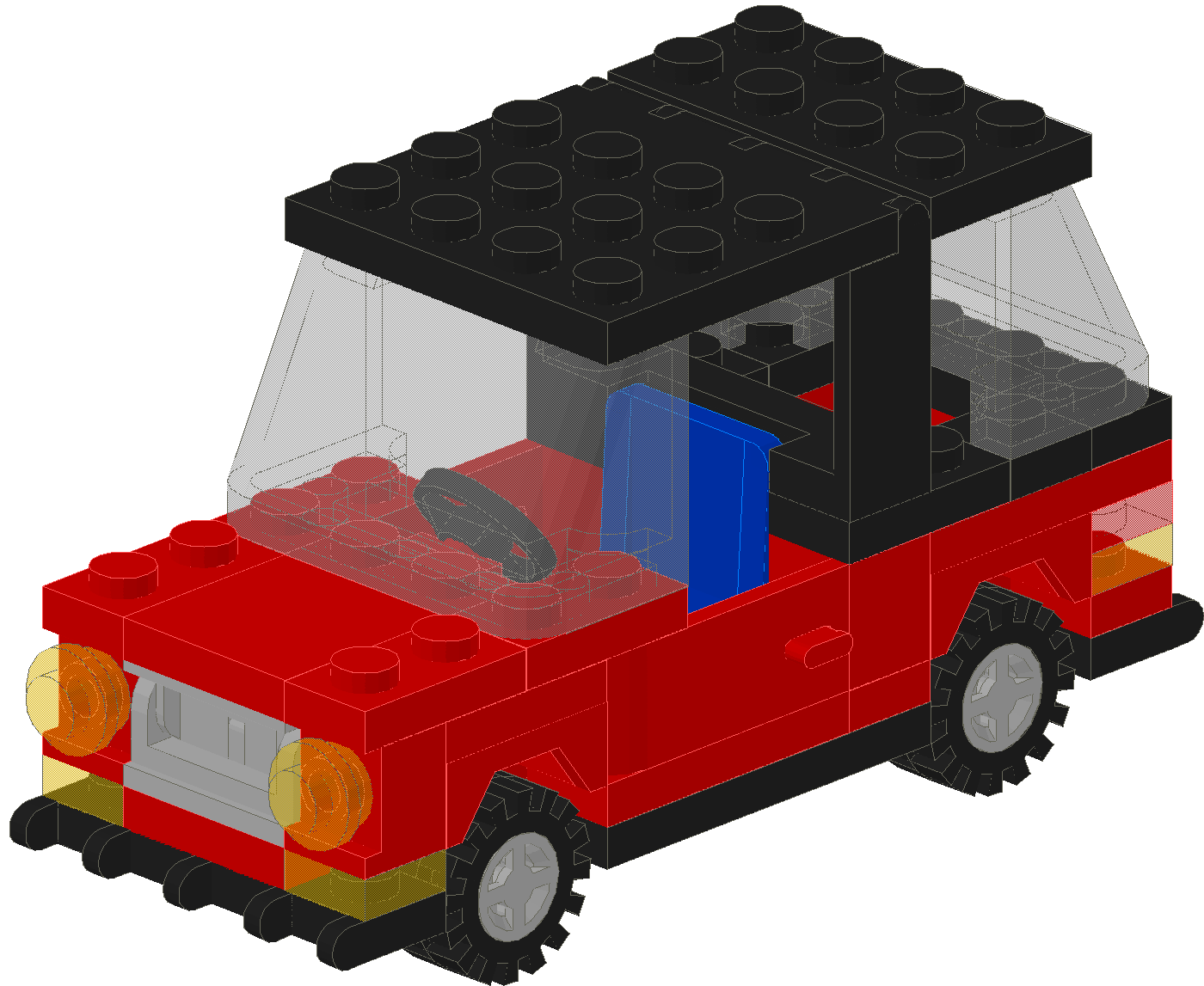
Car Steps 1-4



Car Steps 5-8



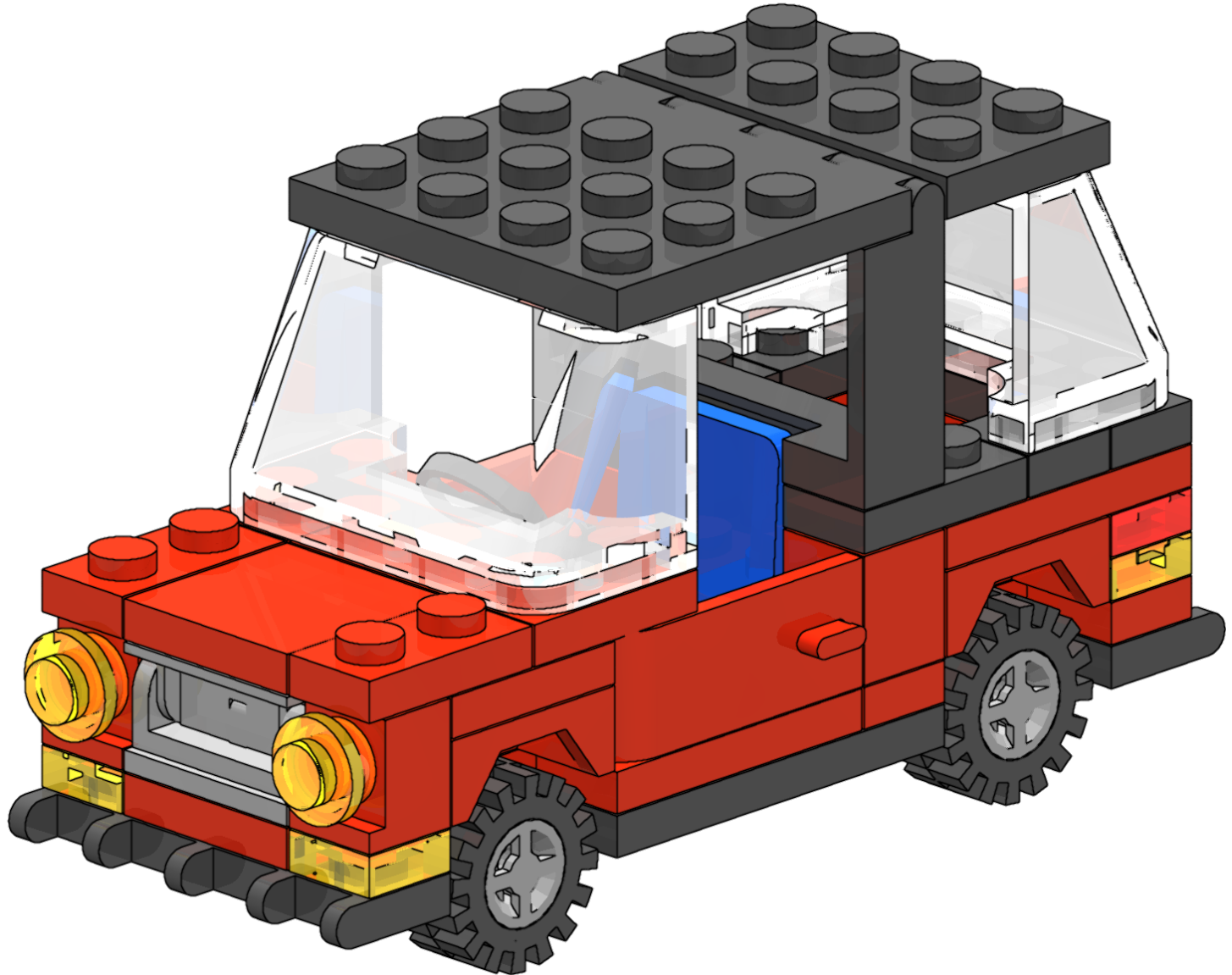
MLCad Render



POV-Ray Render



MegaPov Render



LPub

- Automate the process of producing book quality building instructions
- Combines the power of pre-existing tools
 - MLCad
 - L3P
 - POV-Ray
 - MegaPov

Manual POV-Ray Process

- Translate LDR to POV using L3P
 - Use Step Clock to provide LDraw STEPs
 - Manually modify POV file for
 - Orthographic Camera
 - MegaPov find edge facility
 - Light Setting
- Manually implement ROTATION STEP using modified LDRs
- Render Images using POV-Ray
- Repeat for sub-models
- Laborious for all but simplest building instructions

L Pub Automation

- Run L Pub
- Adjust Settings
 - MegaPov
 - Orthographic
 - Others
- Create Building Instructions
 - Processes all levels of sub-models
 - Applies settings to all sub models
 - Provides Capabilities not available through Step Clock
 - Totally automatic

LPub Process

- Create Step LDRs – one per STEP or ROTATION STEP
- Create POV files using step LDRs and L3P
- Post process POV file
- Render POV files
- Render Parts/Create Part List Images
- Create Bill of Materials Image
- Create web pages that tie it all together
- Repeat for any sub-models

LPub Step Processing

- Read in LDR or DAT file
 - Perform Step Process for any sub-models
 - Create step LDR file for each STEP or ROTATION STEP in LDR
 - Rotate all parts if needed
 - Automatically center model
 - Buffer Exchanges
 - Ghosted parts

L3Pub POV Processing

- Run L3P on each step DAT to create step POV
 - User provided options: camera, lights, background, quality
- Post process POV file
 - Orthographic camera
 - Graying of parts from previous steps
 - Possibly convert to black and white
 - Shadow-less lights
 - Ambient, Diffuse, Reflection overrides
 - Common camera distance for all steps
 - MegaPov settings added
- Render images using POV-Ray

LPub Part Images

- Count part types and number used in each step
- Render each part if needed
- Gather part images together for each step
 - Sort by image size for decent packing
- Save part list image for step

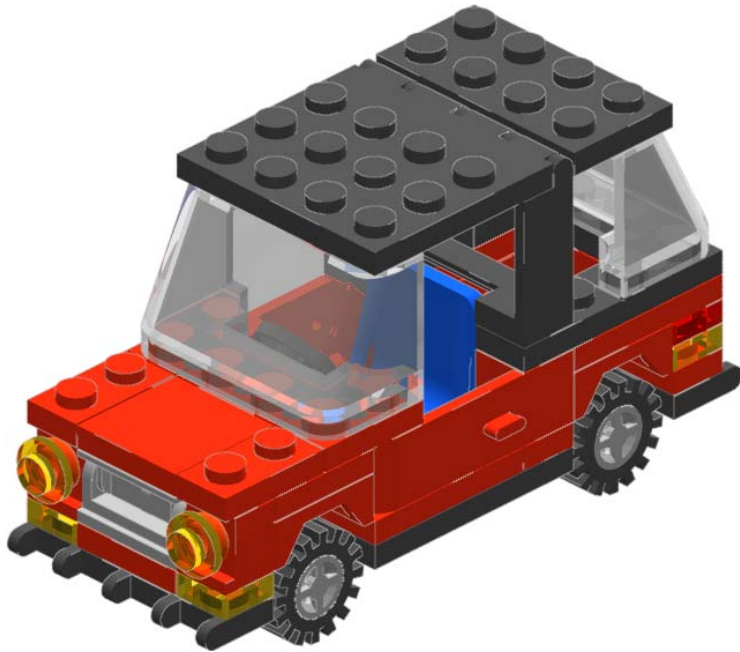
LPub Bill of Materials Image

- Count types and number of parts used in entire model
- Sort images by
 - Part description
 - Image size of part
- Produce image of all parts used

LPub Web Pages

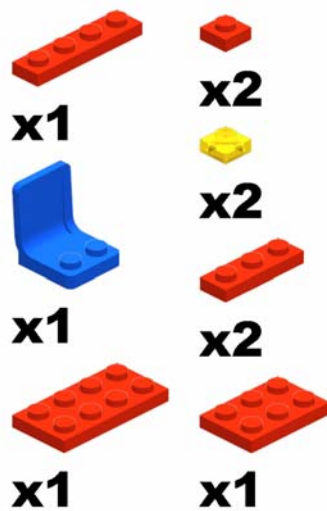
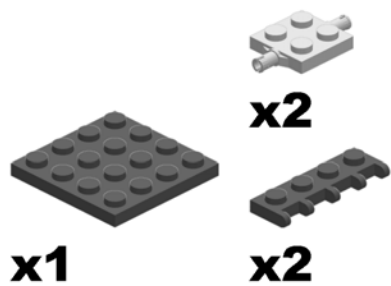
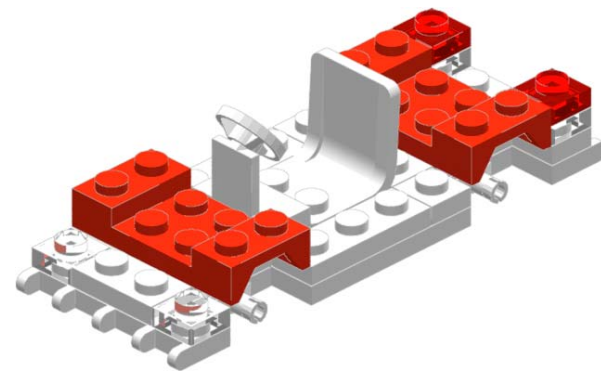
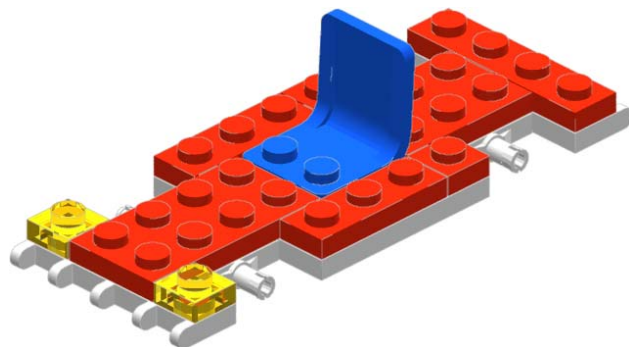
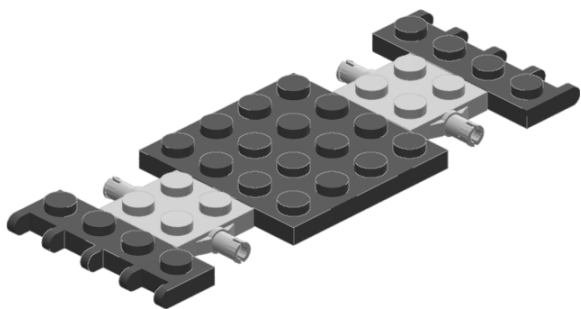
- Create web page for each step in each LDR file
 - Link to next step and previous step
- Display web page using browser

Car Revisited

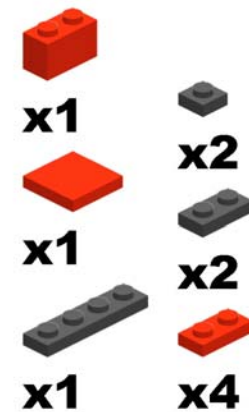
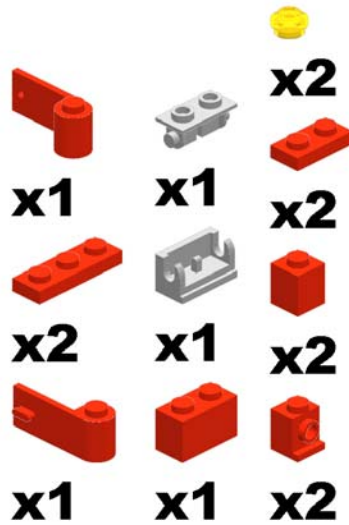
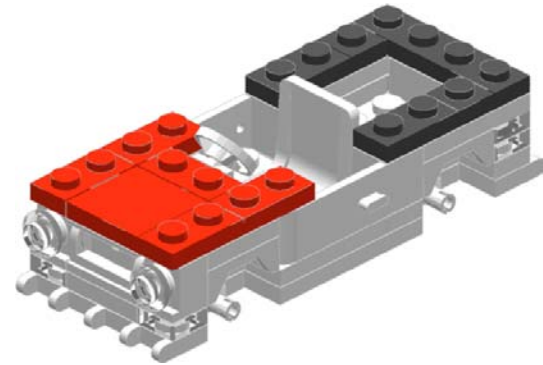
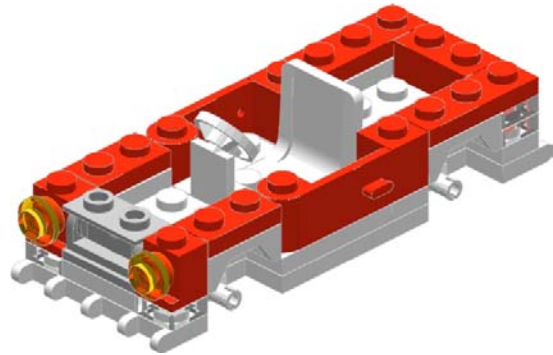


	x1	x2	x2	
x1	x1	x1	x2	
x1	x2	x1	x4	
x2	x1	x1	x2	x2
x2	x1	x1	x6	x4
x2	x1	x1	x4	x4
x2	x1	x1	x1	x1
	x1		x1	x2
				x2

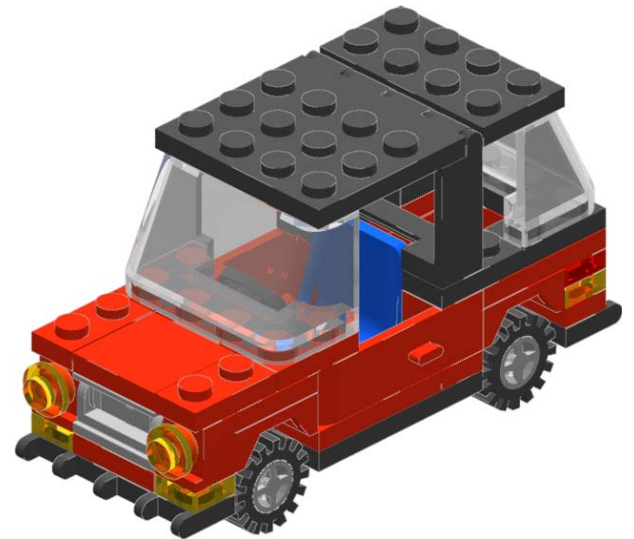
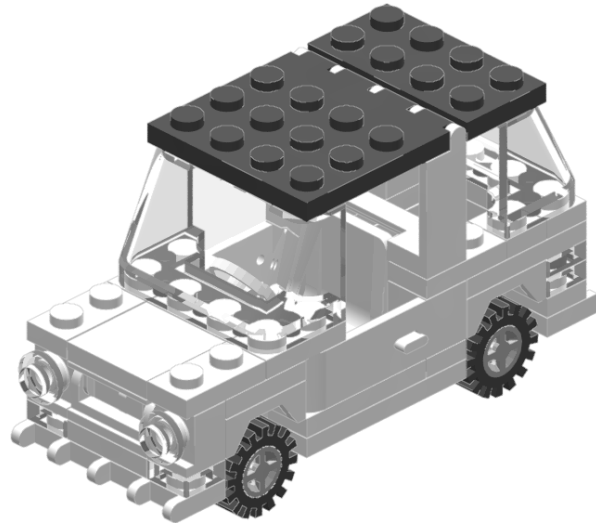
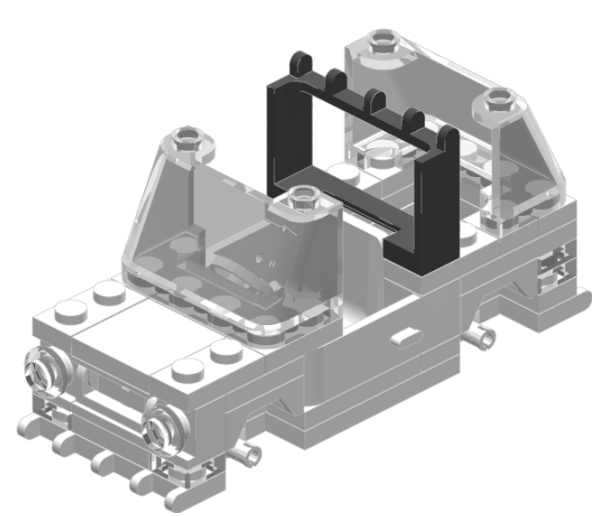
Car Steps 1-3



Car Steps 4-5



Car Steps 6-7



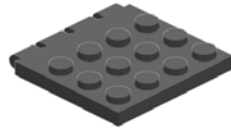
x1



x2



x1



x1



x4



x4

Rotation Step

Pneumadddict.mpd - MLCAD

File Edit Navigate View Multipart Extras Settings Help

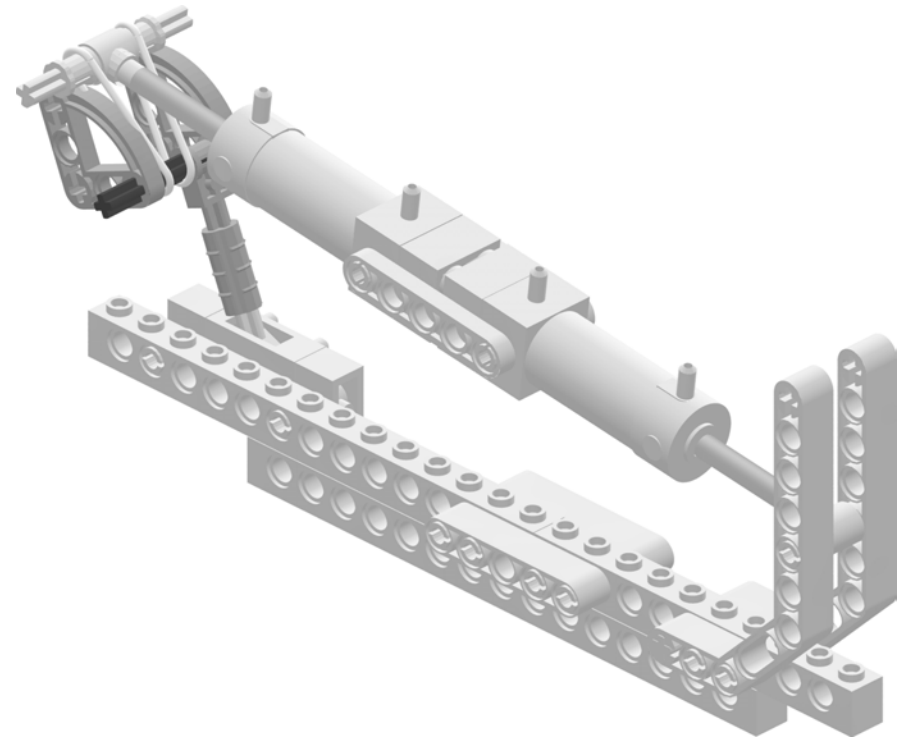
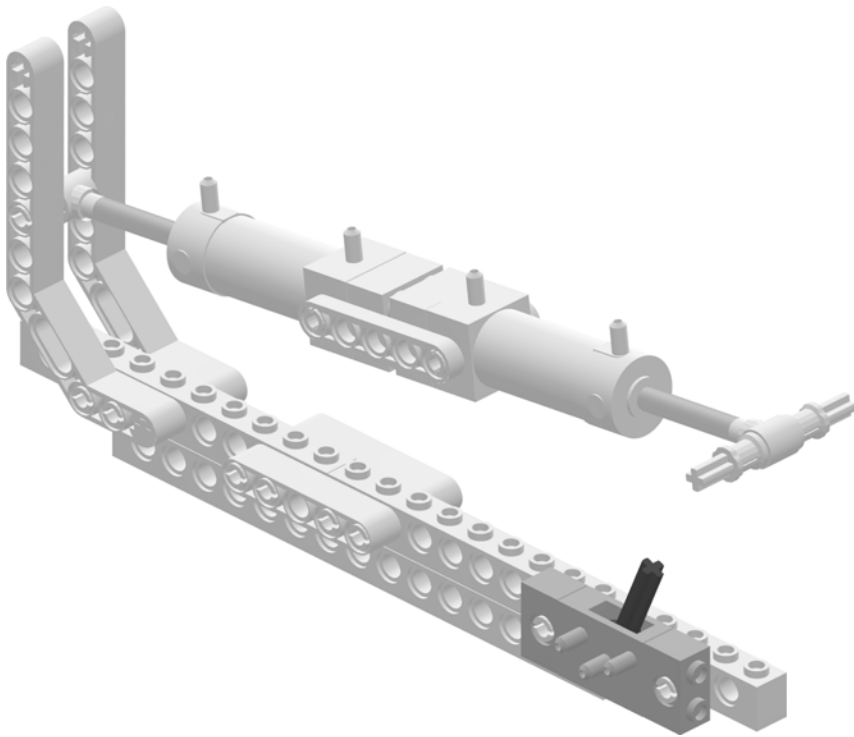
Active Model: or-gate.ldr

Type	Color	Position	Rotation	Part nr	Description
F STEP	---	---	---	---	---
PART	Light...	-324.695;-0.100;-20.000	1.000;0.000;0.000 0.000;0.000;1.000 0.000;-1.000;0.000	32009 DAT	Technic Liftarm 1 x 11.5 Double Bent
PART	Black	95.306;-0.098;-10.000	0.000;0.000;1.000 0.000;1.000;0.000 -1.000;0.000;0.000	4459 DAT	Technic Pin with Friction
PART	Black	15.305;-0.101;-10.000	0.000;0.000;1.000 0.000;1.000;0.000 -1.000;0.000;0.000	4459 DAT	Technic Pin with Friction
F STEP	---	---	---	---	---
PART	Light...	25.306;-0.099;-20.000	0.000;-1.000;0.000 1.000;0.000;0.000 0.000;0.000;1.000	3700 DAT	Technic Brick 1 x 2 with Hole
COMMENT	---	---	---	---	PLUST BEGIN SUB switch.ldr
PART	Light...	57.305;-0.098;-20.000	1.000;0.000;0.000 0.000;1.000;0.000 0.000;0.000;1.000	p_switch.dat	Technic pneumatic switch
PART	Light...	54.688;-0.587;-20.000	0.921;-0.391;0.000 0.391;0.921;0.000 0.000;0.000;1.000	p_switch.dat	Technic pneumatic switch lever
COMMENT	---	---	---	---	PLUST END
PART	Light...	105.307;-0.100;-20.000	0.000;-1.000;0.000 1.000;0.000;0.000 0.000;0.000;1.000	3700 DAT	Technic Brick 1 x 2 with Hole
F STEP	---	---	---	---	---
PART	Light...	105.569;-92.000;-20.000	0.921;-0.391;0.000 0.391;0.921;0.000 0.000;0.000;1.000	or-handle.ldr	Pneumatic OR gate handle
COMMENT	---	---	---	---	PLUST BEGIN
COMMENT	---	---	---	---	SYNTH BEGIN RUBBER_BAND 15
COMMENT	---	---	---	---	SYNTH HIDE
PART	Light...	134.552;-137.906;-15.000	0.919;-0.386;0.000 0.382;0.915;-0.092 -0.038;0.116;0.993	4265C DAT	Technic Bush 1/2 Smooth
PART	Light...	95.330;-93.157;-7.696	0.919;-0.386;0.000 0.382;0.915;-0.092 -0.038;0.116;0.993	4265C DAT	Technic Bush 1/2 Smooth
COMMENT	---	---	---	---	SYNTH END
COMMENT	---	---	---	---	SYNTH BEGIN RUBBER_BAND 15
COMMENT	---	---	---	---	SYNTH HIDE
PART	Light...	134.552;-137.906;12.000	0.919;-0.385;-0.091 0.393;0.914;0.105 0.043;-0.132;0.990	4265C DAT	Technic Bush 1/2 Smooth
PART	Light...	95.420;-93.261;3.657	0.919;-0.385;-0.091 0.393;0.914;0.105 0.043;-0.132;0.990	4265C DAT	Technic Bush 1/2 Smooth
COMMENT	---	---	---	---	SYNTH END
COMMENT	---	---	---	---	PLUST END
COMMENT	---	---	---	---	START REL
ROT-STEP	---	---	0.000;180.000;0.000	---	---
PART	Light...	93.197;-24.472;25.000	0.921;-0.391;0.000 0.391;0.921;0.000 0.000;0.000;1.000	handle-strap...	Pneumatic Gate Strap
F STEP	---	---	---	---	---
PART	Light...	94.692;-92.152;35.000	0.921;-0.391;0.000 0.391;0.921;0.000 0.000;0.000;1.000	4265C DAT	Technic Bush 1/2 Smooth
F STEP	---	---	---	---	---

Brick

For Help, press F1

Rotation Step



Buffer Exchange/PLIST Ignore

6923_robot.lbr - MLCAD

File Edit Navigate View Multipart Extras Settings Help

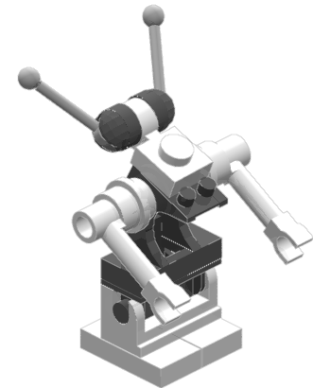
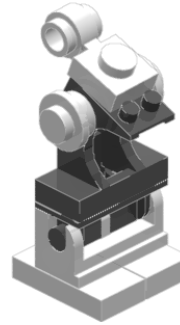
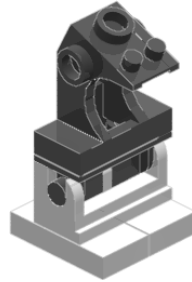
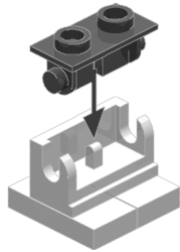
Active Model: 6923_robot.lbr

Type	Color	Position	Rotation	Part nr.	Description
COMMENT	---	---	---	---	6923 Robot
COMMENT	---	---	---	---	Name: 6923_robot.lbr
COMMENT	---	---	---	---	Author: Willy Tschager
COMMENT	---	---	---	---	Official Model
PART	White	0.000,0.000,10.000	1.000,0.000,0.000,0.000,1.000,0.000,0.000,0.000,1.000	3794.DAT	Plate 1 x 2 with 1 Stud
PART	White	0.000,0.000,-10.000	1.000,0.000,0.000,0.000,1.000,0.000,0.000,0.000,1.000	3794.DAT	Plate 1 x 2 with 1 Stud
BUFEXCHG	---	---	---	---	STORE A
STEP	---	---	---	---	---
PART	White	0.000,-24.000,0.000	0.000,0.000,-1.000,0.000,1.000,0.000,1.000,0.000,0.000	3937.DAT	Hinge 1 x 2 Base
PART	Black	0.000,-57.000,0.000	0.000,0.000,-1.000,0.000,1.000,0.000,1.000,0.000,0.000	3938.DAT	Hinge 1 x 2 Top
Quadrilateral	Black	(0,-44,-1) (0,-44,1) (0,-24,1) (0,-24,-1)	---	---	Quadrilateral
Triangle	Black	(0,-28,5) (0,-28,-5) (0,-18,0)	---	---	Triangle
STEP	---	---	---	---	---
BUFEXCHG	---	---	---	---	RETRIEVE A
COMMENT	---	---	---	---	PLIST BEGIN IGN
PART	Black	0.000,24.000,0.000	0.000,0.000,-1.000,0.000,1.000,0.000,1.000,0.000,0.000	3938.DAT	Hinge 1 x 2 Top
PART	White	0.000,24.000,0.000	0.000,0.000,-1.000,0.000,1.000,0.000,1.000,0.000,0.000	3937.DAT	Hinge 1 x 2 Base
PART	Black	0.000,-32.000,0.000	0.000,0.000,-1.000,0.000,1.000,0.000,1.000,0.000,0.000	2342.DAT	Space Control Panel (needs work)
COMMENT	---	---	---	---	PLIST END
STEP	---	---	---	---	---
PART	White	0.000,-56.000,-18.000	0.000,0.000,-1.000,-1.000,0.000,0.000,0.000,1.000,0.000	4073.DAT	Plate 1 x 1 Round
PART	White	0.000,-56.000,18.000	0.000,0.000,-1.000,1.000,0.000,0.000,0.000,-1.000,0.000	4073.DAT	Plate 1 x 1 Round
PART	White	6.710,-72.271,0.013	0.030,-0.343,0.939,0.005,0.939,0.343,-1.000,-0.005,0.030	4081B.DAT	Plate 1 x 1 with Clip Light - Type 2
STEP	---	---	---	---	---
PART	White	0.000,-56.000,-34.000	-0.500,0.000,-0.866,0.866,0.000,-0.500,0.000,-1.000,0.000	4735.DAT	Space Robot Arm
PART	White	0.000,-56.000,-34.000	0.500,0.000,-0.866,-0.866,0.000,-0.500,0.000,1.000,0.000	4735.DAT	Space Robot Arm
PART	Black	-13.000,-78.000,12.000	0.707,0.000,-0.707,-0.707,0.000,-0.707,0.000,1.000,0.000	298.DAT	Lever Small Base
PART	Black	-13.000,-78.000,11.000	0.707,0.000,0.707,-0.707,0.000,0.707,0.000,-1.000,0.000	298.DAT	Lever Small Base
PART	Light...	-13.000,-78.000,13.000	0.707,0.612,0.354,-0.707,0.612,0.354,0.000,-0.500,0.866	4593.DAT	Lever Small
PART	Light...	-13.000,-78.000,-14.000	0.707,0.612,-0.354,-0.707,0.612,-0.354,0.000,0.500,0.866	4593.DAT	Lever Small

Brick

x = 140.0, y = 8.0, z = 0.0

Robot



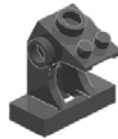
x2



x1



x1



x1



x2



x1



x2



x2



x2

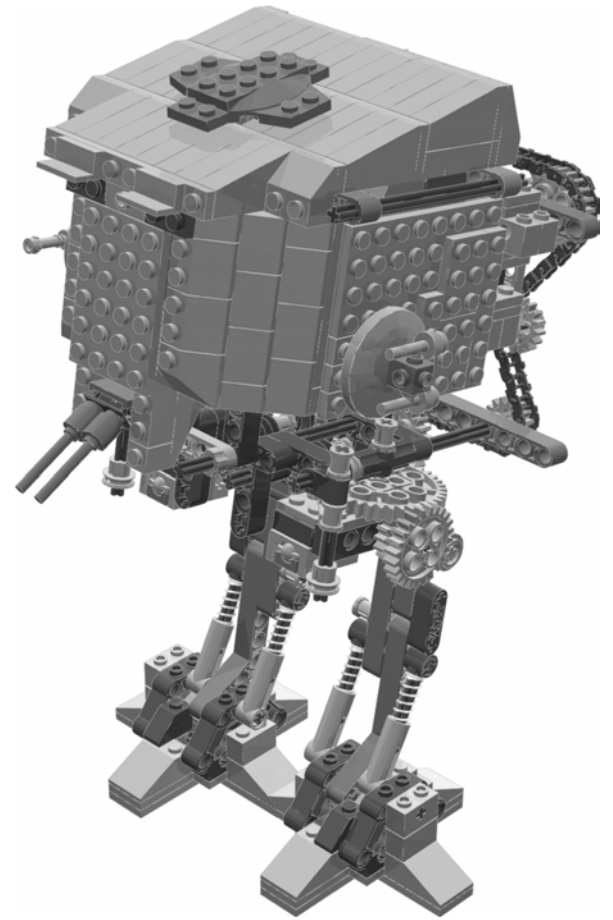
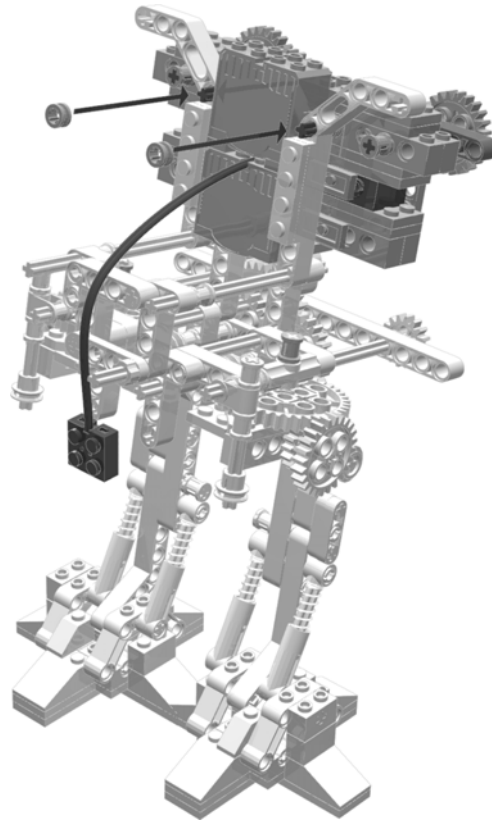
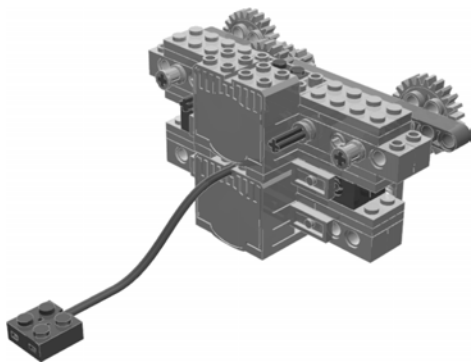
Ghost/PLIST Ignore

The screenshot displays the MLCAD software interface for a LEGO Technic assembly. The main window is titled "drive.dat - MLCAD" and features a menu bar (File, Edit, Navigate, View, Multipart, Extras, Settings, Help) and a toolbar with various modeling tools. On the left, a "Brick" palette shows a grid of different brick types, including standard bricks, plates, and connectors. The central area is dominated by a table listing the assembly's components.

Type	Color	Position	Rotation	Part nr.	Description
PART	Black	71.000,-31.000,30.000	-1.000,0.000,0.000,0.000,1.000,0.000,0.000,0.000,-1.000	3701.DAT	Technic Brick 1 x 4 with Holes
PART	Black	-49.000,-31.000,30.000	-1.000,0.000,0.000,0.000,1.000,0.000,0.000,0.000,-1.000	3701.DAT	Technic Brick 1 x 4 with Holes
PART	Light	-69.000,-7.000,20.000	-1.000,0.000,0.000,0.000,1.000,0.000,0.000,0.000,-1.000	3020.DAT	Plate 2 x 4
PART	Light	91.000,-7.000,20.000	-1.000,0.000,0.000,0.000,1.000,0.000,0.000,0.000,-1.000	3020.DAT	Plate 2 x 4
PART	Light	-79.000,1.000,20.000	-1.000,0.000,0.000,0.000,1.000,0.000,0.000,0.000,-1.000	3021.DAT	Plate 2 x 3
PART	Light	101.000,1.000,20.000	-1.000,0.000,0.000,0.000,1.000,0.000,0.000,0.000,-1.000	3021.DAT	Plate 2 x 3
STEP					
PART	Light	11.000,-23.000,0.000	-1.000,0.000,0.000,0.000,1.000,0.000,0.000,0.000,-1.000	71427C01.D.	Electric Technic Mini-Motor 9v
PART	Light	-39.000,1.000,20.000	0.000,0.000,-1.000,0.000,1.000,0.000,1.000,0.000,0.000	32028.DAT	Plate 1 x 2 with Door Rail
PART	Light	61.000,1.000,20.000	0.000,0.000,1.000,0.000,1.000,0.000,-1.000,0.000,0.000	32028.DAT	Plate 1 x 2 with Door Rail
PART	Light	41.000,-31.000,-20.000	0.000,0.000,-1.000,0.000,1.000,0.000,1.000,0.000,0.000	3023.DAT	Plate 1 x 2
PART	Light	-19.000,-31.000,-20.000	0.000,0.000,-1.000,0.000,1.000,0.000,1.000,0.000,0.000	3023.DAT	Plate 1 x 2
COMMENT					
	Black	11.000,-23.000,20.000	0.000,0.000,1.000,0.000,1.000,0.000,-1.000,0.000,0.000	5306a.DAT	SYNTH BEGIN ELECTRIC_CABLE 0
	Black	11.000,-19.000,20.000	0.000,0.000,1.000,0.000,0.000,0.000,0.000,1.000,0.000	LS00.dat	Ghost
	Black	11.000,-19.000,-50.000	0.000,0.000,1.000,0.000,0.000,0.000,0.000,1.000,0.000	LS00.dat	Ghost
	Black	11.000,37.000,-165.000	0.000,0.000,1.000,0.000,0.000,0.000,0.000,1.000,0.000	LS00.dat	Ghost
	Black	11.000,37.000,-235.100	0.000,0.000,1.000,0.000,0.000,0.000,0.000,1.000,0.000	LS00.dat	Ghost
	Black	11.000,33.000,-230.100	0.000,0.000,-1.000,0.000,1.000,0.000,1.000,0.000,0.000	5306a.DAT	Ghost
COMMENT					
					SYNTH END
STEP					
PART	Black	11.000,-31.000,20.000	-1.000,0.000,0.000,0.000,1.000,0.000,0.000,0.000,-1.000	3022.DAT	Plate 2 x 2
PART	Light	11.000,-103.000,0.000	-1.000,0.000,0.000,0.000,1.000,0.000,0.000,0.000,-1.000	71427C01.D.	Electric Technic Mini-Motor 9v
PART	Light	-69.000,-39.000,20.000	-1.000,0.000,0.000,0.000,1.000,0.000,0.000,0.000,-1.000	3020.DAT	Plate 2 x 4
PART	Light	91.000,-39.000,20.000	-1.000,0.000,0.000,0.000,1.000,0.000,0.000,0.000,-1.000	3020.DAT	Plate 2 x 4
PART	Light	-39.000,-47.000,20.000	0.000,0.000,-1.000,0.000,1.000,0.000,1.000,0.000,0.000	32028.DAT	Plate 1 x 2 with Door Rail
PART	Light	-79.000,-47.000,20.000	-1.000,0.000,0.000,0.000,1.000,0.000,0.000,0.000,-1.000	3021.DAT	Plate 2 x 3
PART	Light	61.000,-47.000,20.000	0.000,0.000,1.000,0.000,1.000,0.000,-1.000,0.000,0.000	32028.DAT	Plate 1 x 2 with Door Rail
PART	Light	101.000,-47.000,20.000	-1.000,0.000,0.000,0.000,1.000,0.000,0.000,0.000,-1.000	3021.DAT	Plate 2 x 3
STEP					
PART	Light	61.000,-71.000,10.000	-1.000,0.000,0.000,0.000,1.000,0.000,0.000,0.000,-1.000	6541.DAT	Technic Brick 1 x 1 with Hole

The bottom half of the window contains four viewports showing different perspectives of the assembly: a top-down view, a side view, a bottom-up view, and an isometric view. The assembly consists of a central motor and various plates and connectors. The status bar at the bottom left shows coordinates: "x = 0.0, y = -82.0, z = -250.0".

Ghost



Advanced Features

- Consistent Scale
 - Examine POVs
 - L3P perfect framing
 - Maximum Camera distance
 - Good across steps in LDR
 - Minimum Camera Distance
 - Option to keep scale constant across sub-models

Advanced Features

- Surface/lighting model control
 - Ambient override – light from all directions
 - Diffuse override – light from specific direction
 - Reflection override – light that bounces off surface back to our eyes
- Shadow-less lights
- Orthographic – no perspective

Advanced Features

- Print vs. Screen resolution
 - Default image sizes larger for print
 - Font sizes larger for print
 - Default format is bitmap for print (loss-less), JPEG (lossy, but compact) for screen
- Black and White
 - Convert all colors to grayscale
 - Annotate colors in part lists

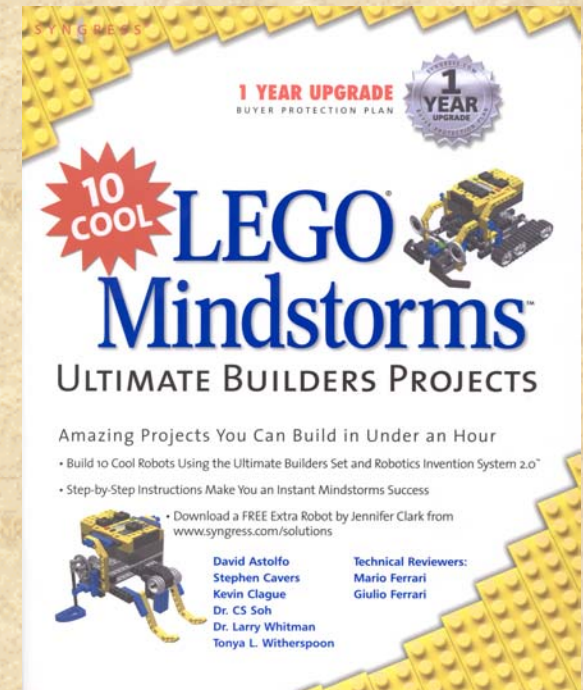
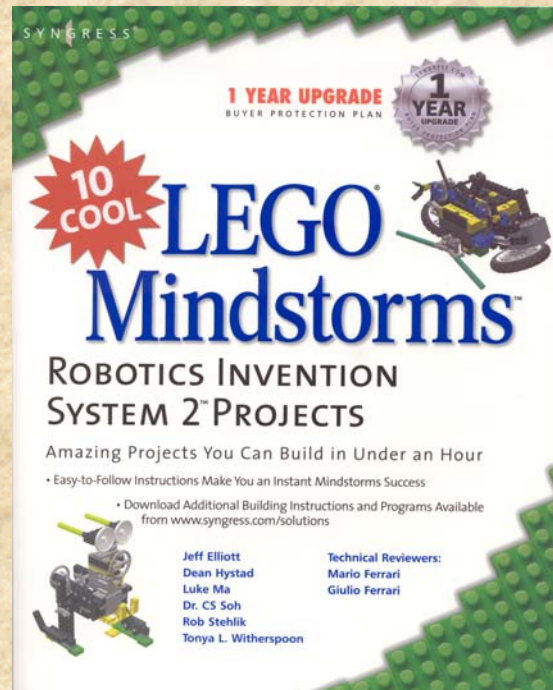
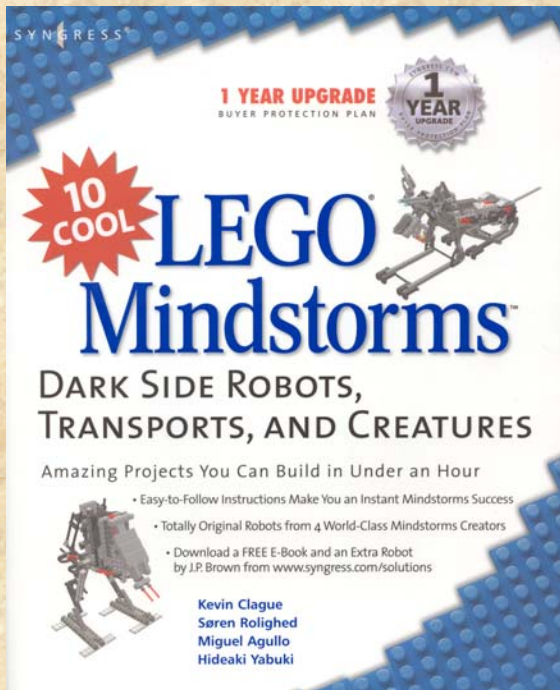
Advanced Features

- Previous Step Color Scaling
 - Highlight parts new to a step, by drawing old parts in different color
 - Mix part color with color scaling color to get new color
 - Proportional mix
 - Disable by using 100% part color, 0% scaling color

Part Caches

- POV Rendering is slow
- Save port/color images once they are rendered
- Tremendous speed up of part list images
- Caches for screen resolution+MegaPov,
Print resolution+MegaPov+Black/White
- Erase Part Image Cache

Published Works



Published Works



Summary

- LDraw/MLCad paradigm for building instructions very powerful, yet easy to master
- LPub is a logical extension of the paradigm into the world of photo-realistic rendering using L3P and POV-Ray
- LPub takes the drudgery out of creating building instruction images, and lets you focus on building instruction as a form of communication