

# LSynth – LDraw CAD Bendable Parts

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# History

- Syngress Publishing ([www.syngress.com](http://www.syngress.com)) wanted to publish LEGO building instruction books
- MLCad used to lay out designs
- LPub used to create publishable artwork
- Could not document designs with cables and hoses
- Necessity is the mother of invention

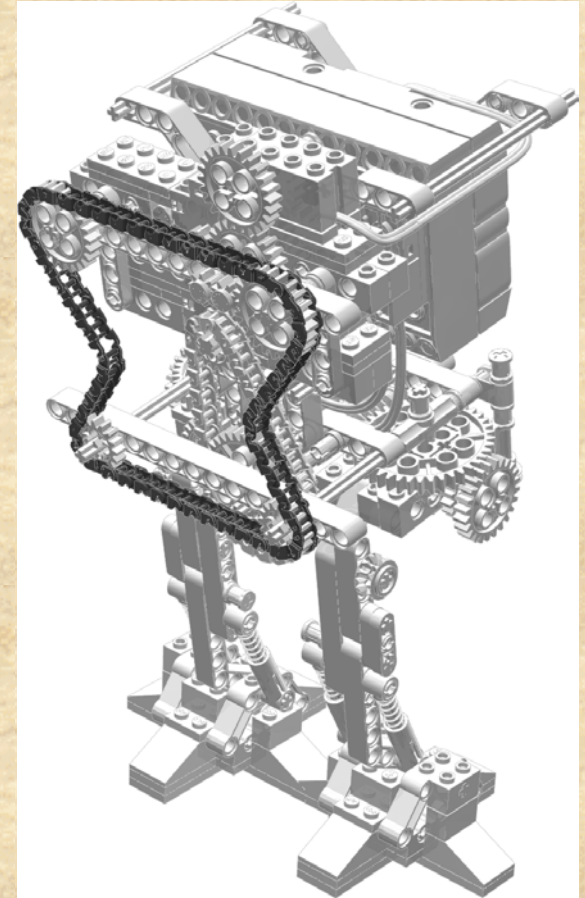
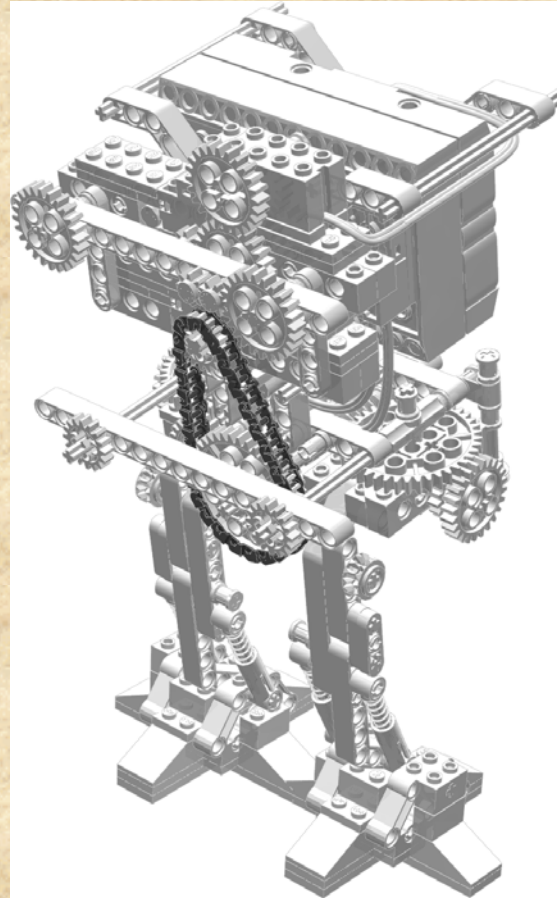
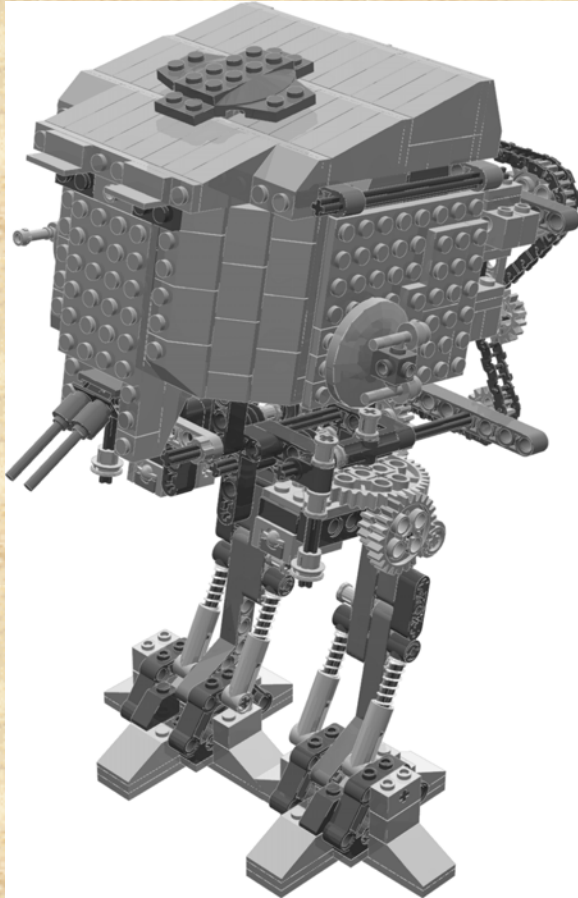
# LDraw Parts Family

- 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
  - Parts in Parts
- Fixed shaped parts

# Changing Shape

- Pneumatic pistons, switches, pumps, polarity switches
  - Represented by multiple LDraw parts
  - Managable in MLCad
- Chains
  - LDraw provides single chain link
  - Laborious to make entire chain flow around gears
- Hoses, pneumatic, Flex-System, electric cables, rubber bands, treads
  - Can use tens, hundreds or thousands of segment parts (unmanagable for humans)

# Example Chain



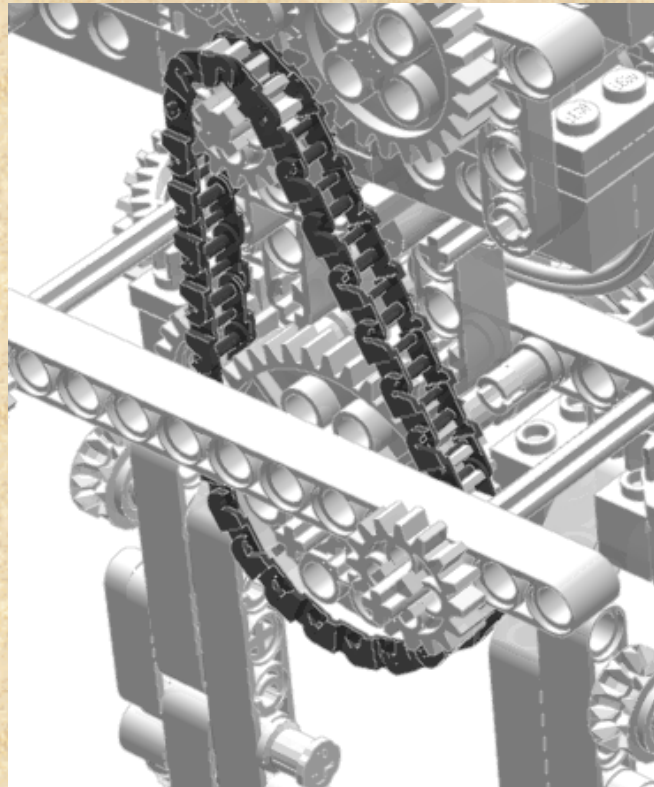
# Synthesizer

- Short Attention Span – boring to lay out each link
- Program to compute position of each chain link
- Describe chain specification in LDraw compatible format
- Program reads in LDraw file, creates new LDraw file with synthesized parts

# Chain Synthesis Example

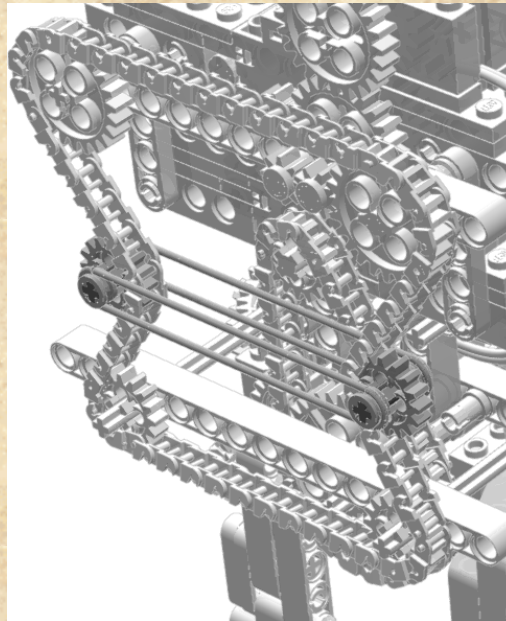
- Synthesis Specification

- 0 SYNTH BEGIN CHAIN 0
- 0 SYNTH HIDE
- 1 7 7 -402.228 6.319 1 0 0 0 0.984808 0.173648 0 -0.173648 0.984808 4019.DAT
- 1 7 -23.3 -283.878 -12.499 1 0 0 0 0.984808 0.173648 0 -0.173648 0.984808 3649.DAT
- 0 SYNTH END



# Advanced Chain Specification

- 0 SYNTH BEGIN CHAIN 0
- 0 SYNTH HIDE
- 1 4 98.1 -297.675 29.55 1 0 0 0 0.984808 0.173648 0 -0.173648 0.984808 4019.DAT
- 0 SYNTH OUTSIDE
- 1 4 92.1 -377.194 43.162 1 0 0 0 0.984808 0.173648 0 -0.173648 0.984808 4019.DAT
- 0 SYNTH INSIDE
- 1 4 107.7 -474.123 59.934 1 0 0 0 0.984808 0.173648 0 -0.173648 0.984808 3648.DAT
- 1 4 -92.1 -473.978 60.463 1 0 0 0 0.984808 0.173648 0 -0.173648 0.984808 3648.DAT
- 0 SYNTH OUTSIDE
- 1 4 -83 -376.782 43.588 1 0 0 0 0.984808 0.173648 0 -0.173648 0.984808 4019.DAT
- 0 SYNTH INSIDE
- 1 4 -83 -297.547 29.464 1 0 0 0 0.984808 0.173648 0 -0.173648 0.984808 4019.DAT
- 0 WRITE SYNTH END

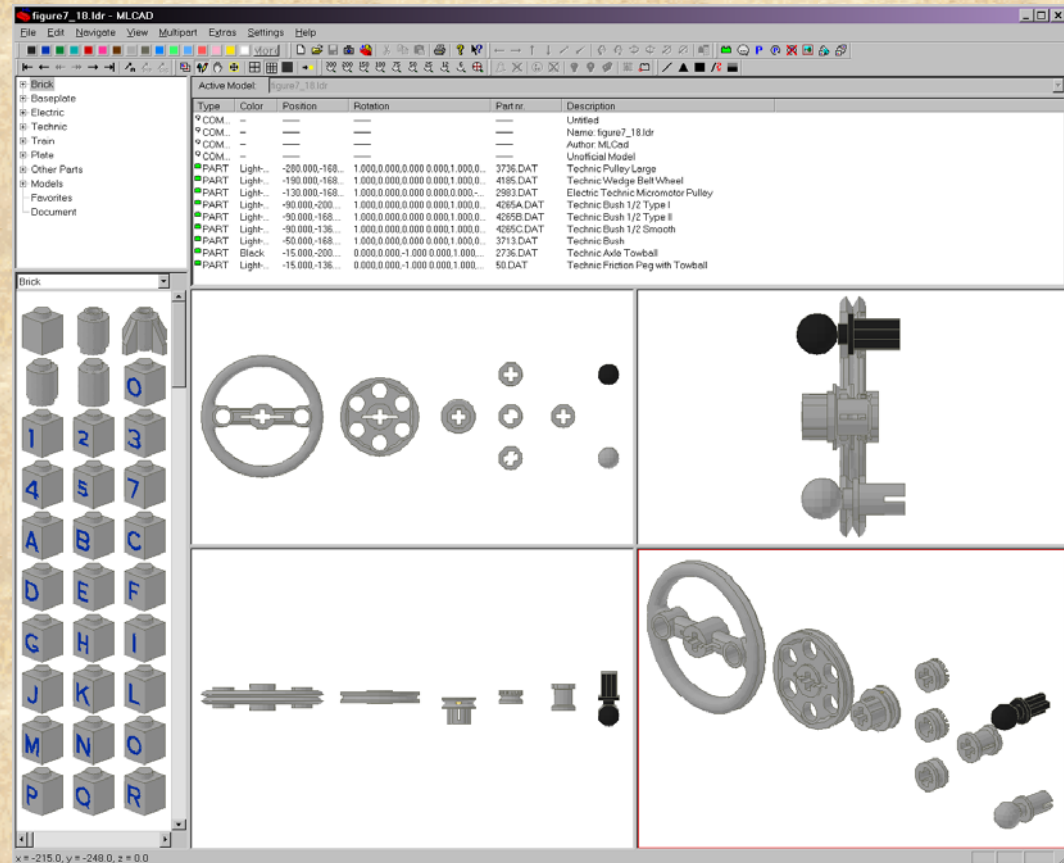


# All in One Synthesizer - LSynth

- Hose “types”
  - Ribbed hose
  - Flex System Hoses
  - Electric Cables
  - Pneumatic Hoses
  - Flexible Axles
  - Fiber Optic Cables
- Band “types”
  - Rubber Band
  - Rubber Tread
  - Plastic Tread
  - Chain
- Not done
  - Springs
  - Strings
  - Other?

# Rubber Bands

- Just belt synthesis
- Use Pulleys as constraints
- As many pulleys as you want
- Inside, Outside, Cross
- Limited to Planar synthesis for now



# Simple Band Example

The screenshot displays the MLCAD software interface for a file named 'figure7\_17\_s.Idr'. The interface includes a menu bar (File, Edit, Navigate, View, Multipart, Extras, Settings, Help), a toolbar with various modeling tools, and a left-hand 'Brick' palette containing a grid of 26 numbered and lettered bricks (1-26). The main workspace is divided into four viewports: top-left shows a top-down view of two pulleys connected by a red band; top-right shows a side view of the pulley and band; bottom-left shows a perspective view of the pulley and band; bottom-right shows a perspective view of the pulley and band from a different angle. A parts list table is visible in the upper right area of the workspace.

Type	Color	Position	Rotation	Part nr.	Description
COM...	-	-	-	-	Untitled
COM...	-	-	-	-	Name: figure7_17_s.Idr
COM...	-	-	-	-	Author: MLCad
COM...	-	-	-	-	Unofficial Model
COM...	-	-	-	-	SYNTH BEGIN RUBBER_BAND 4
PART	White	-110.000,-10...	1.000.0.000.0.000.0.000.0.000.0...	3736.DAT	Technic Pulley Large
PART	White	98.000,-10.00...	1.000.0.000.0.000.0.000.1.000.0...	3736.DAT	Technic Pulley Large
COM...	-	-	-	-	SYNTH SYNTHESIZED BEGIN
PART	Red	-110.000,34.0...	0.000.1.000.0.000.-1.000.0.000...	LS31.DAT	~Technic Flex-System Hose Segment
PART	Red	-109.500,34.0...	0.000.1.000.0.000.-1.000.0.000...	LS31.DAT	~Technic Flex-System Hose Segment

x = 20.0, y = -20.0, z = 0.0

# Crossing Band

figure\_19\_s.ldr - MLCAD

File Edit Navigate View Multipart Extras Settings Help

Active Model: figure\_19\_s.ldr

Type	Color	Position	Rotation	Part nr.	Description
COM...	---	---	---	---	Untitled
COM...	---	---	---	---	Name: figure_19_s.ldr
COM...	---	---	---	---	Author: MLCad
COM...	---	---	---	---	Unofficial Model
COM...	---	---	---	---	SYNTH BEGIN RUBBER_BAND 4
PART	White	-110.000,-10.000...	1.000.0.000.0.000.0.000.0.000.0.000.0.000.0.000...	3736.DAT	Technic Pulley Large
COM...	---	---	---	---	SYNTH CROSS
PART	White	98.000,-10.000...	1.000.0.000.0.000.0.000.0.000.0.000.0.000.0.000...	3736.DAT	Technic Pulley Large
COM...	---	---	---	---	SYNTH CROSS
COM...	---	---	---	---	SYNTH SYNTHESIZED BEGIN
PART	Red	-91.385,29.86...	-0.423,0.906,0.019-0.906,-0.423...	LS31.DAT	~Technic Flex-System Hose Segment
PART	Red	-90.930,29.65...	-0.423,0.906,0.019-0.906,-0.423...	LS31.DAT	~Technic Flex-System Hose Segment
PART	Red	-90.476,29.44...	-0.423,0.906,0.019-0.906,-0.423...	LS31.DAT	~Technic Flex-System Hose Segment
PART	Red	-90.022,29.23...	-0.423,0.906,0.019-0.906,-0.423...	LS31.DAT	~Technic Flex-System Hose Segment

Brick

x = 30.0, y = -28.0, z = 0.0

# Advanced Cross

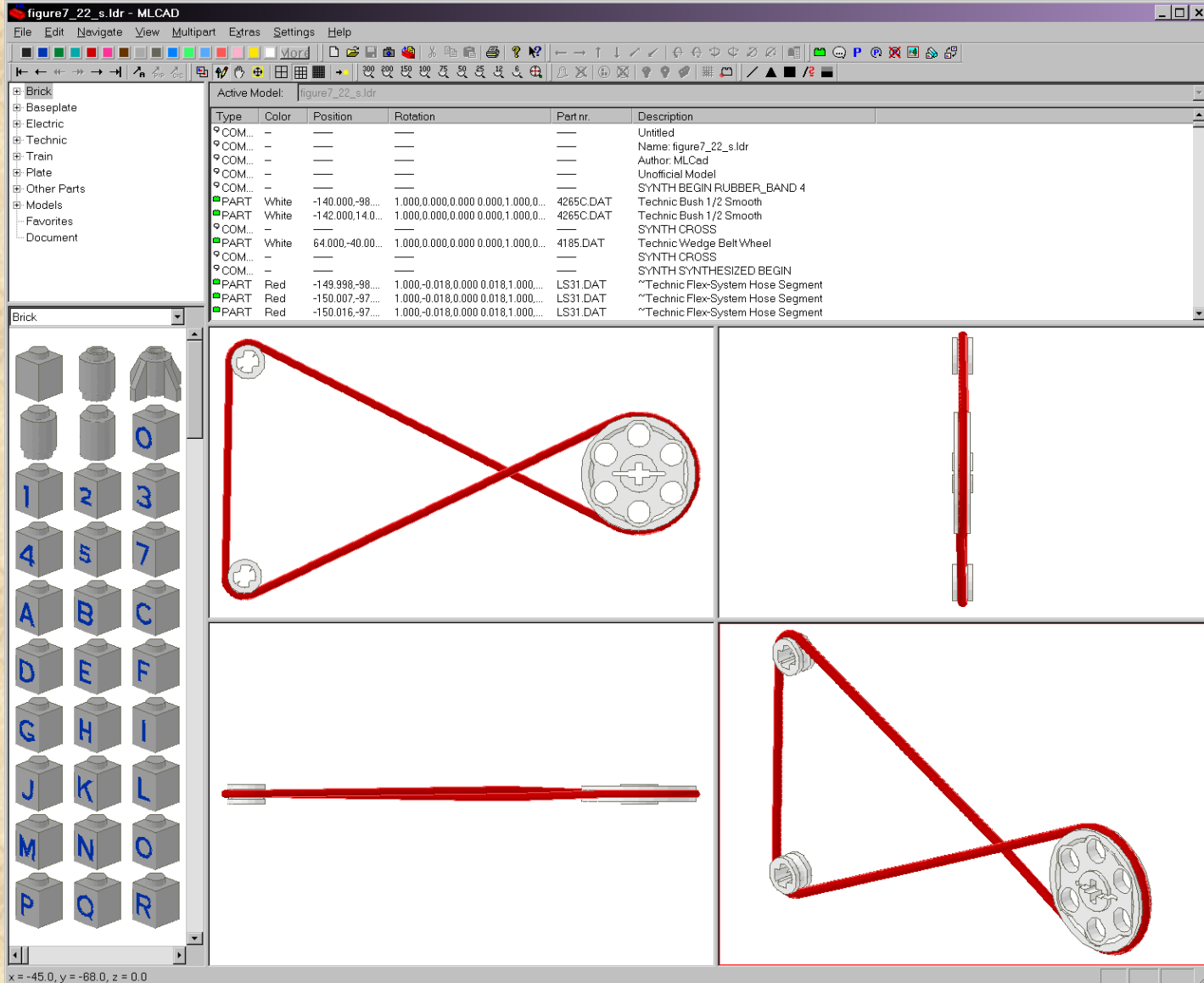
figure7\_22\_s.ldr - MLCAD

File Edit Navigate View Multipart Extras Settings Help

Brick Baseplate Electric Technic Train Plate Other Parts Models Favorites Document

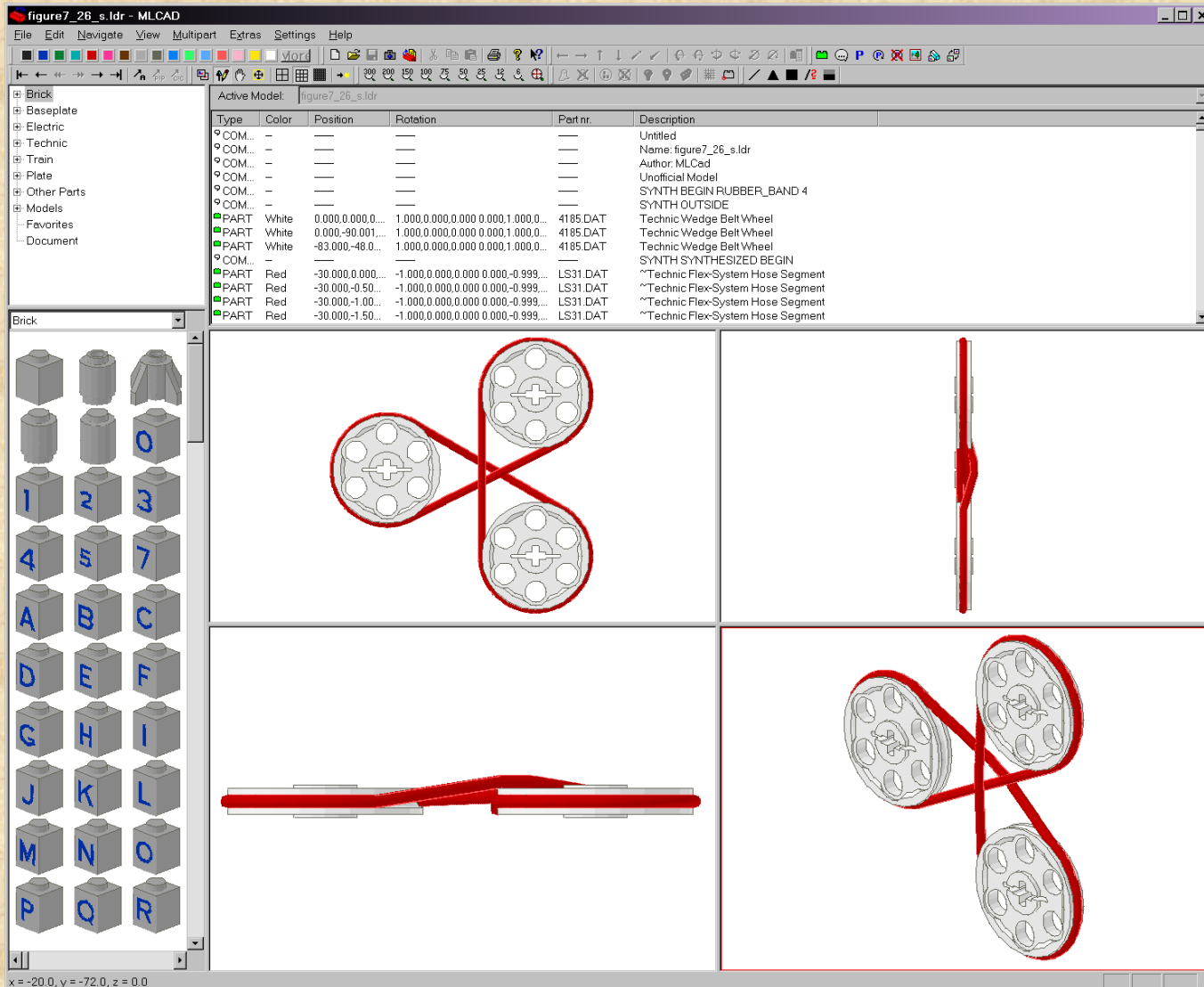
Type	Color	Position	Rotation	Part nr.	Description
COM...	---	---	---	---	Untitled
COM...	---	---	---	---	Name: figure7_22_s.ldr
COM...	---	---	---	---	Author: MLCad
COM...	---	---	---	---	Unofficial Model
COM...	---	---	---	---	SYNTH BEGIN RUBBER_BAND 4
PART	White	-140.000;-98...	1.000;0.000;0.000;0.000;1.000;0...	4265C.DAT	Technic Bush 1/2 Smooth
PART	White	-142.000;14.0...	1.000;0.000;0.000;0.000;1.000;0...	4265C.DAT	Technic Bush 1/2 Smooth
COM...	---	---	---	---	SYNTH CROSS
PART	White	64.000;-40.00...	1.000;0.000;0.000;0.000;1.000;0...	4185.DAT	Technic Wedge Belt Wheel
COM...	---	---	---	---	SYNTH CROSS
COM...	---	---	---	---	SYNTH SYNTHESIZED BEGIN
PART	Red	-149.998;-98...	1.000;-0.018;0.000;0.018;1.000...	LS31.DAT	~Technic Flex-System Hose Segment
PART	Red	-150.007;-97...	1.000;-0.018;0.000;0.018;1.000...	LS31.DAT	~Technic Flex-System Hose Segment
PART	Red	-150.016;-97...	1.000;-0.018;0.000;0.018;1.000...	LS31.DAT	~Technic Flex-System Hose Segment

Brick

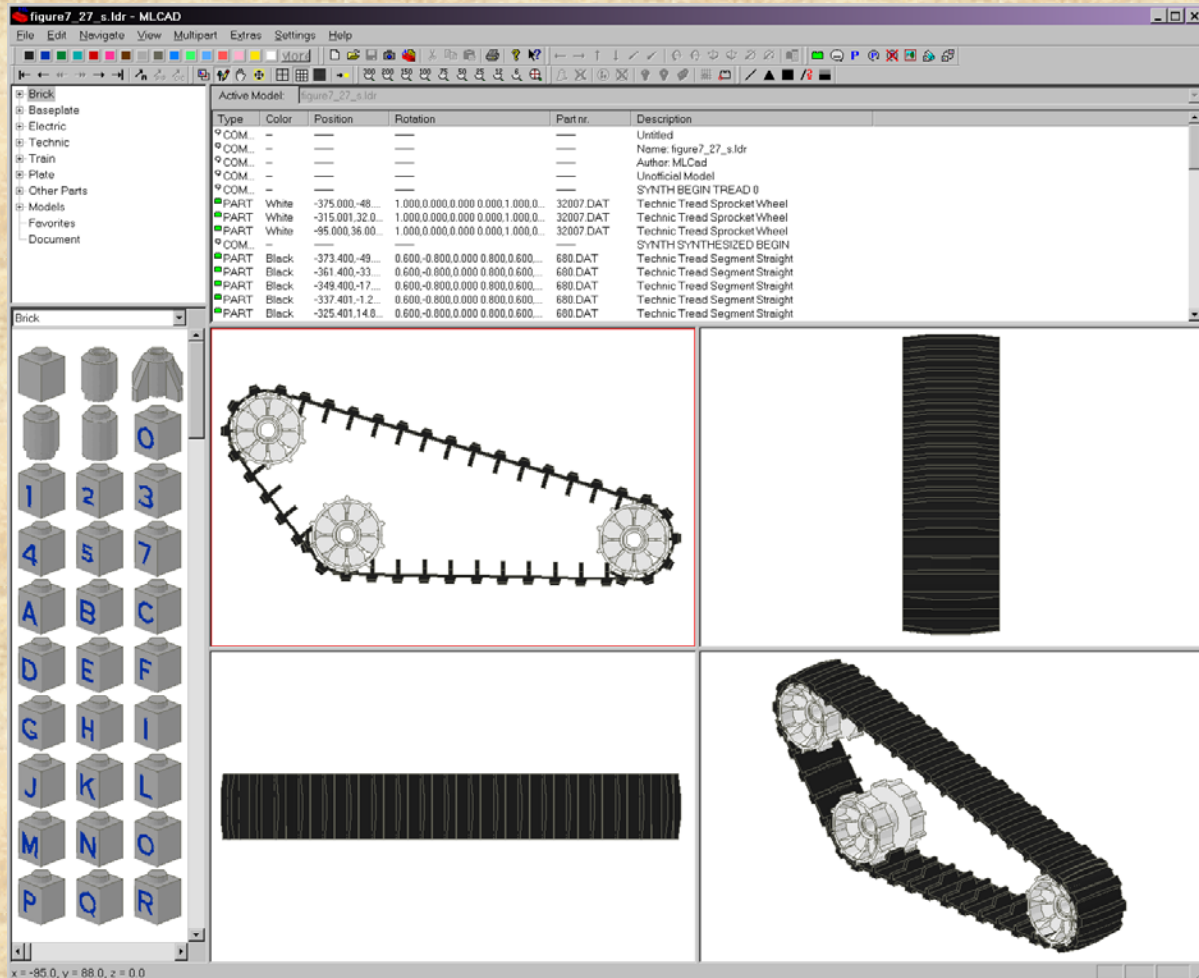


x = -45.0, y = -68.0, z = 0.0

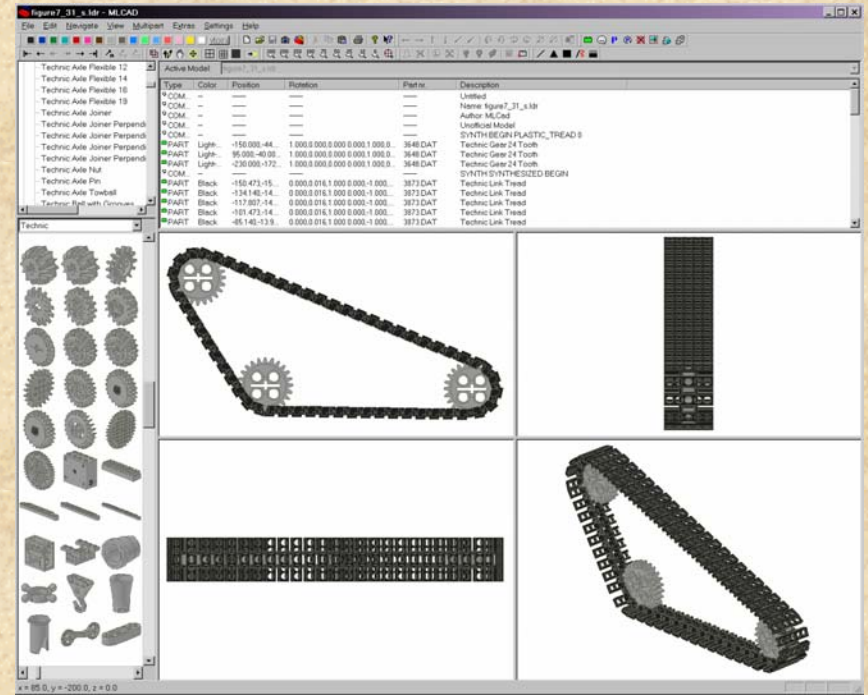
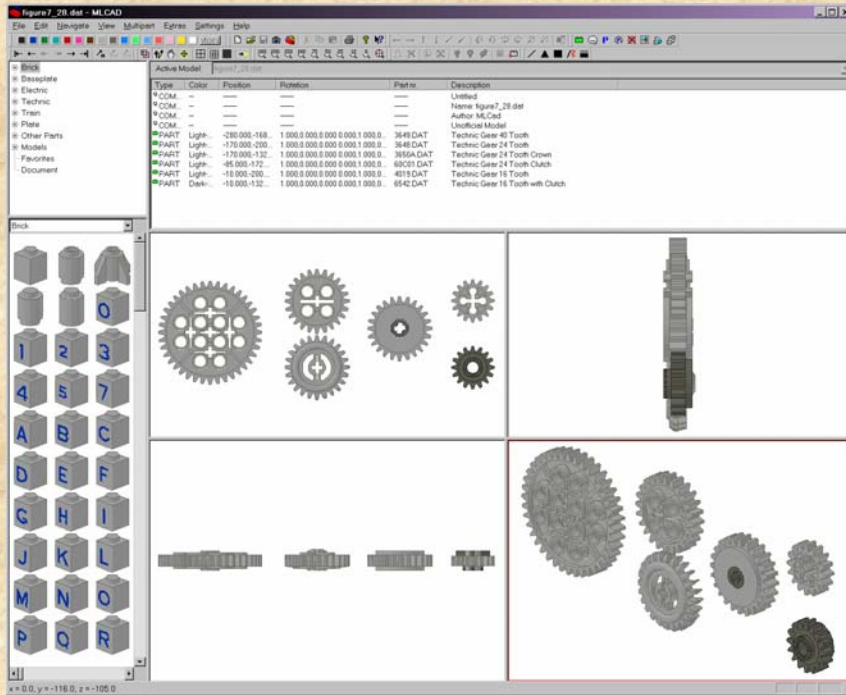
# Fun Rubber Band



# Rubber Tread



# Chains and Plastic Treads



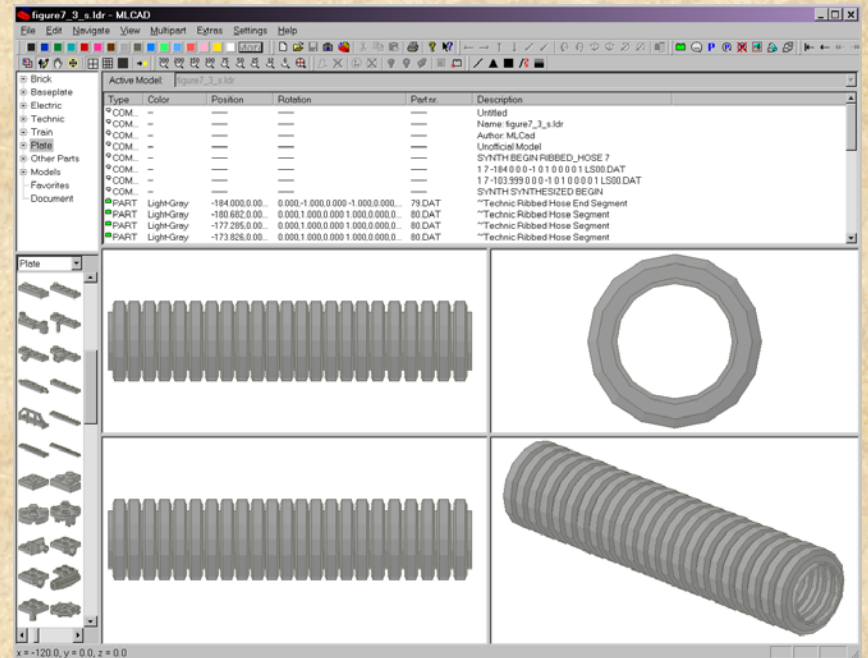
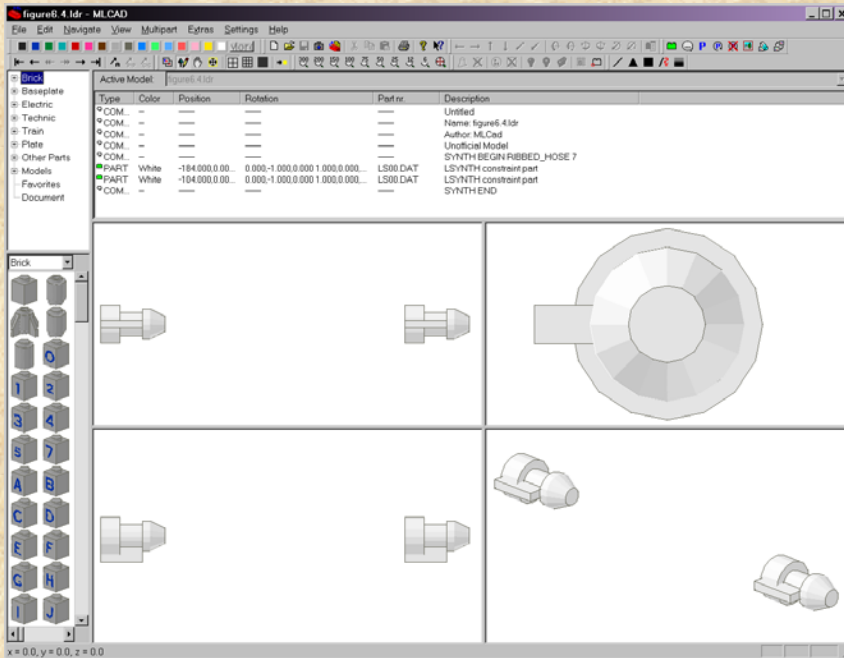
# Future Enhancements

- Non-planar bands
  - Parallel planes
  - Intersecting planes
- Non-belt bands
  - Beams, liftarms, bricks as constraints
- Quality Control
- Part Count Reduction

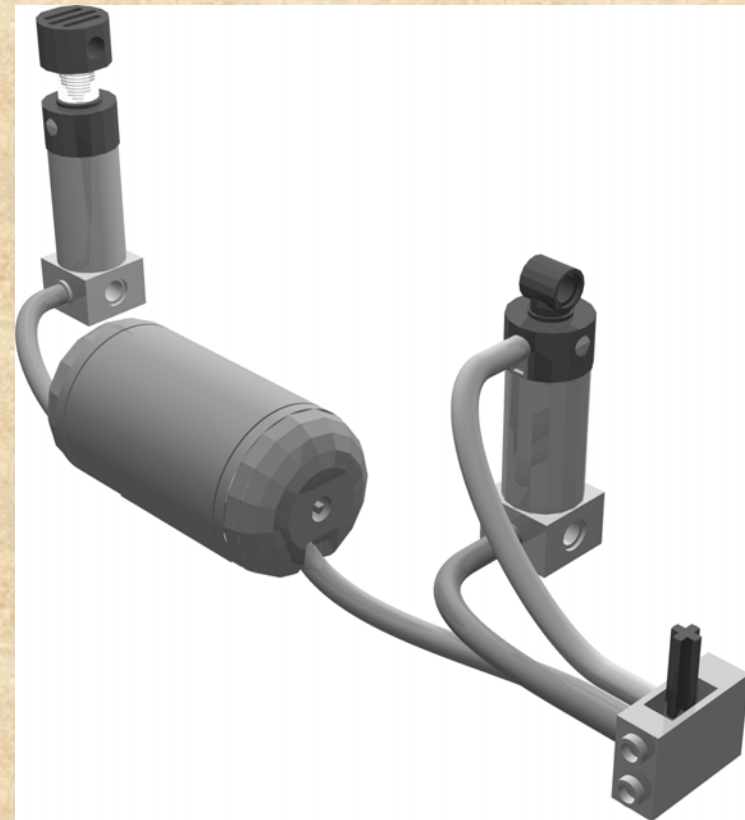
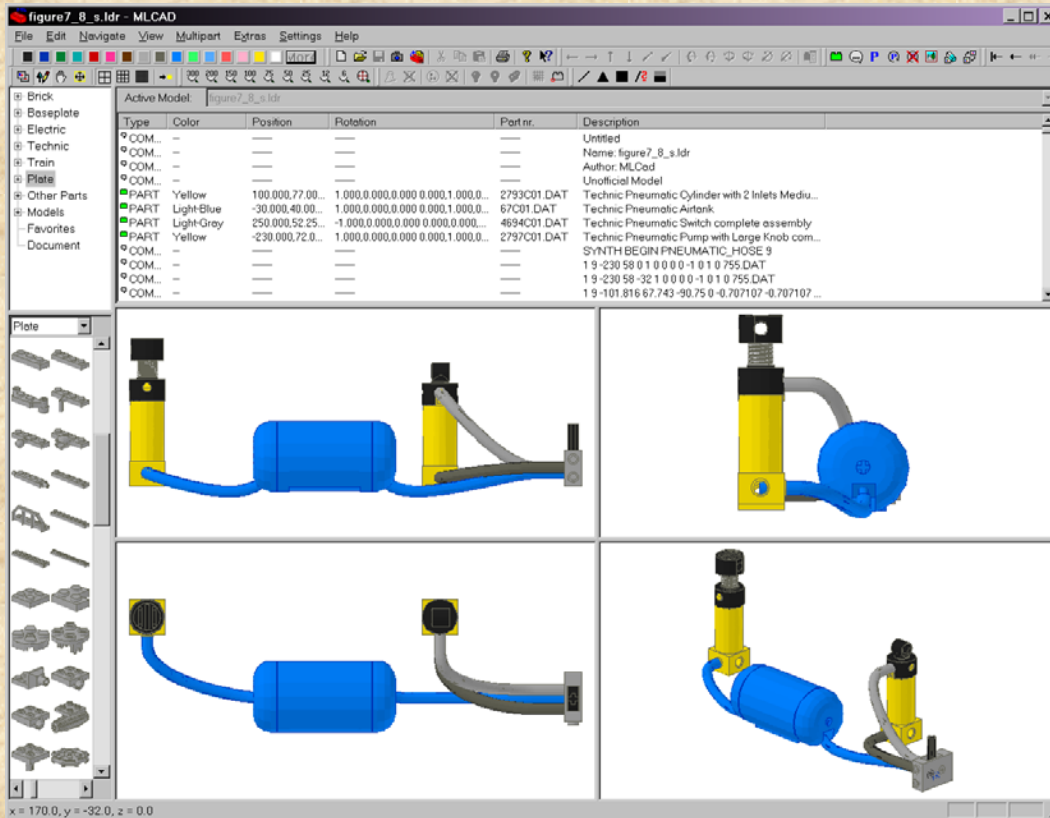
# Hose Types

- Wanted to be able to route hoses and cables in complex designs
- Created special part for hose constraint
- Modified some LDraw parts to for better look
- No facility for true hose length

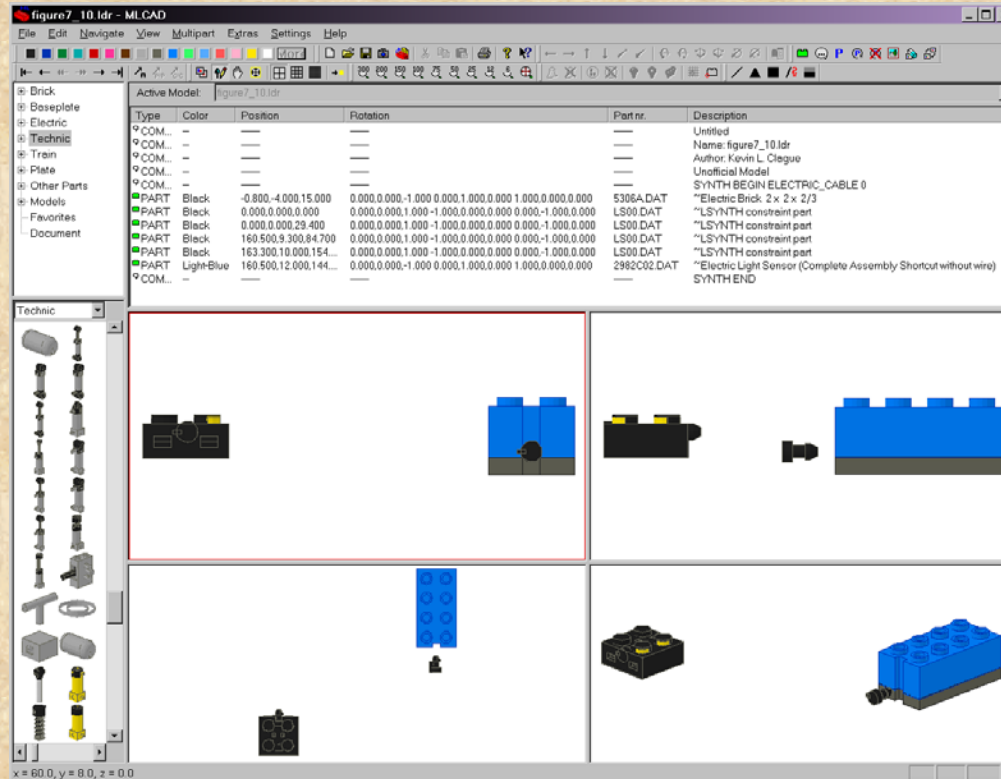
# Hose Example



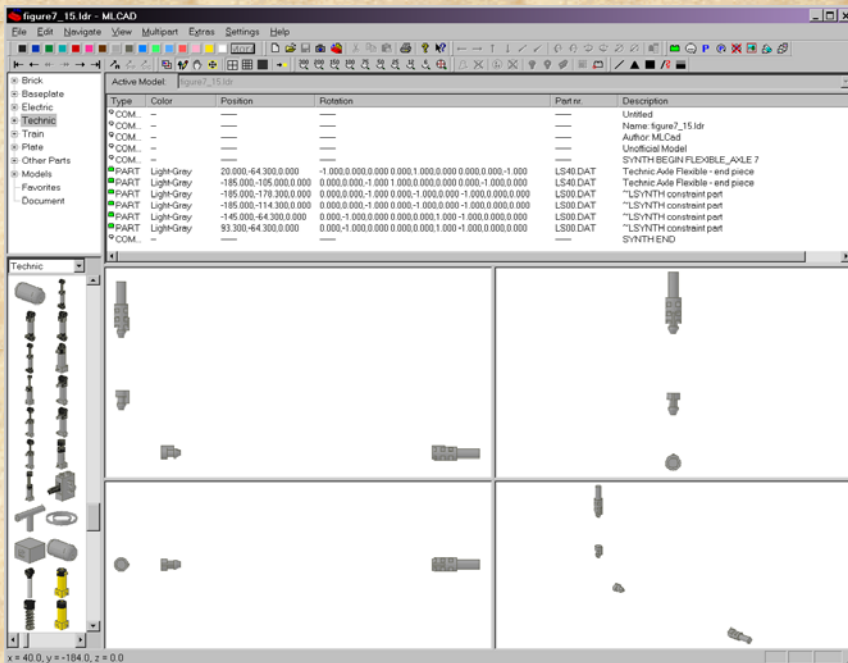
# Pneumatics



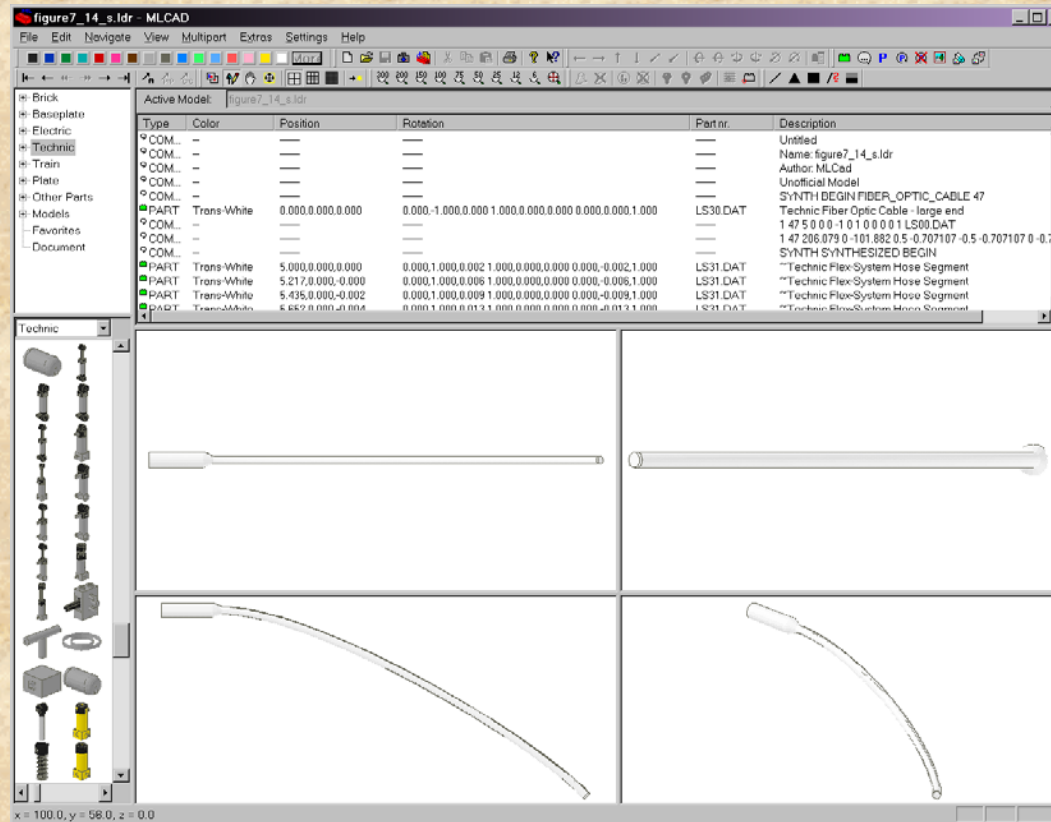
# Electric Cables



# Flexible Axles



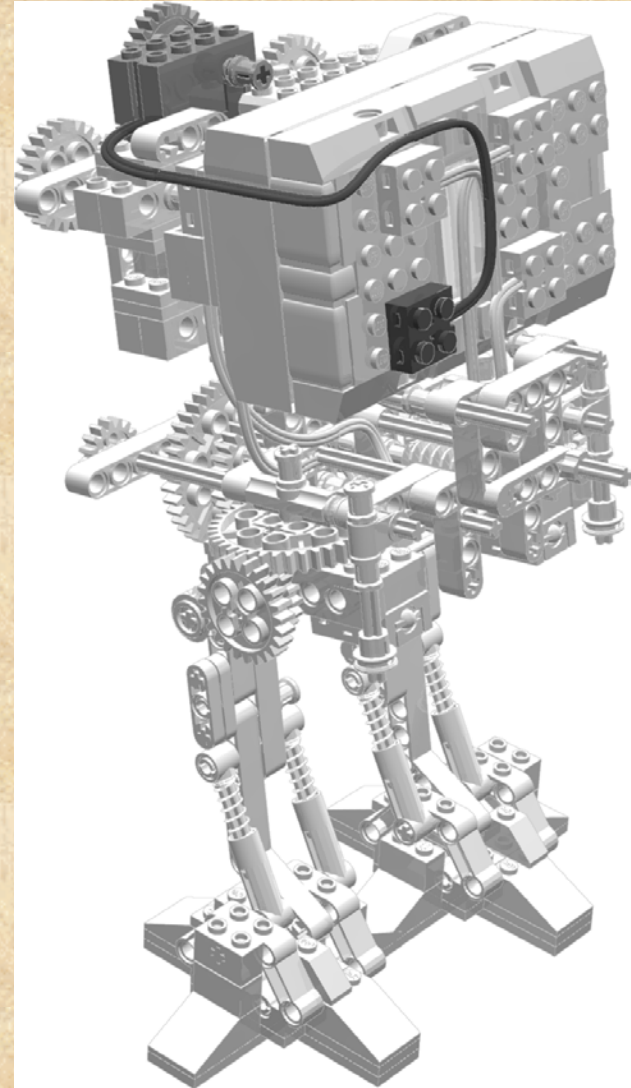
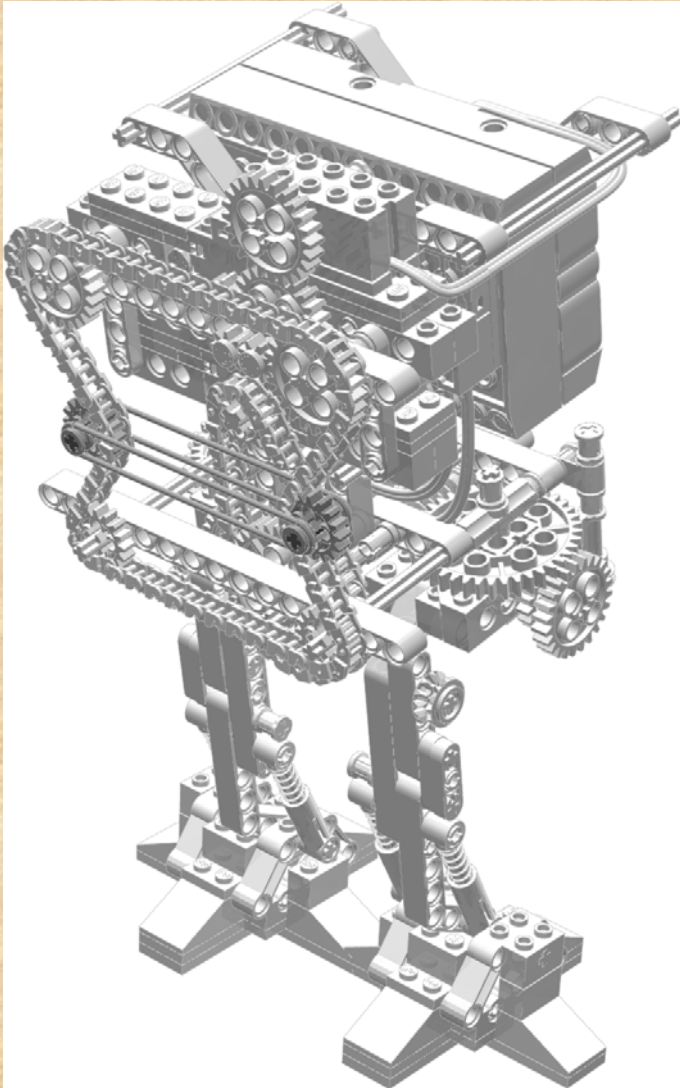
# Fiber Optic Cables



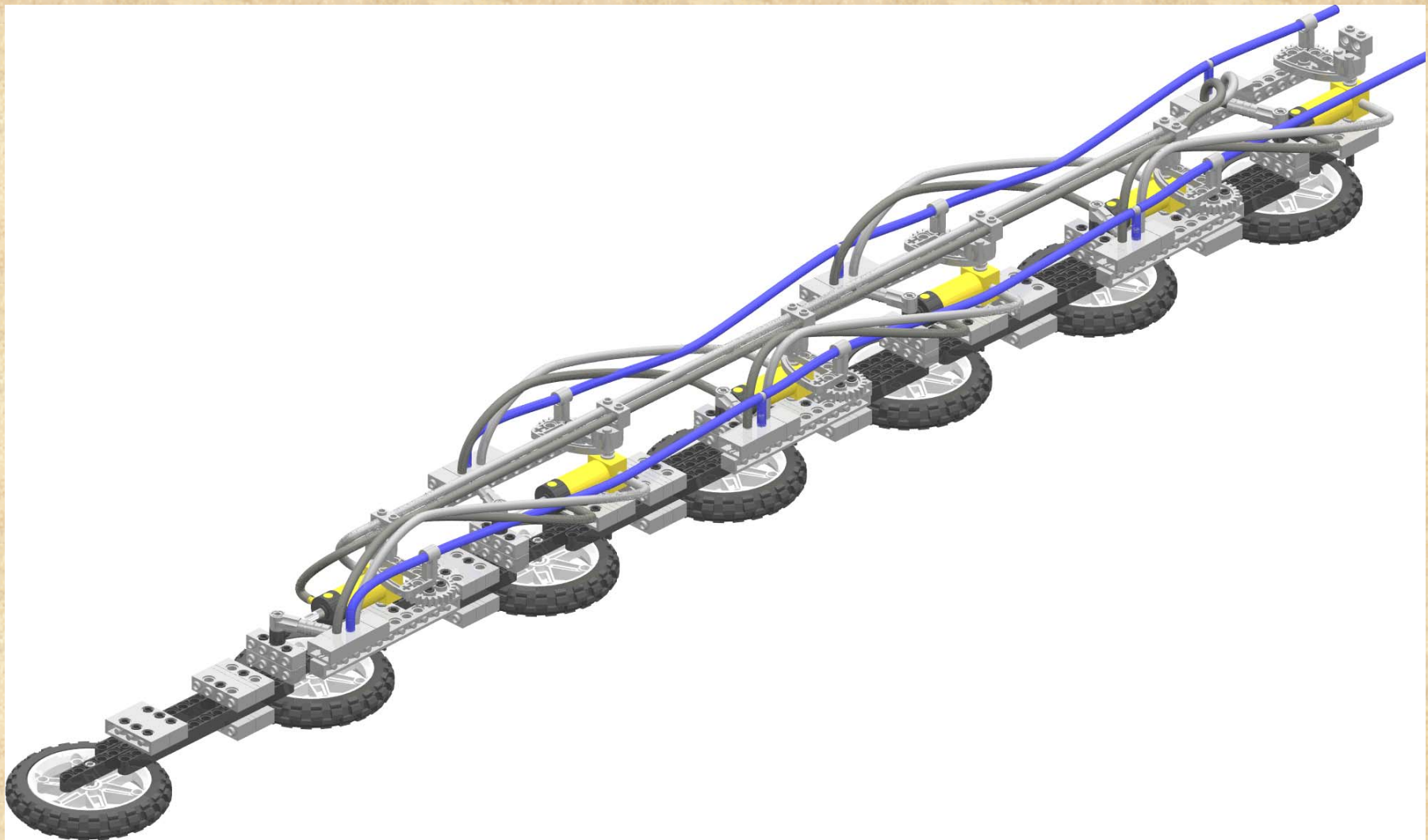
# Future Enhancements

- True Length
- Electric Cable Twist
- Bend ability of hose types
  - Pneumatic vs. rigid
- Quality Controls
- Part Count Optimizations

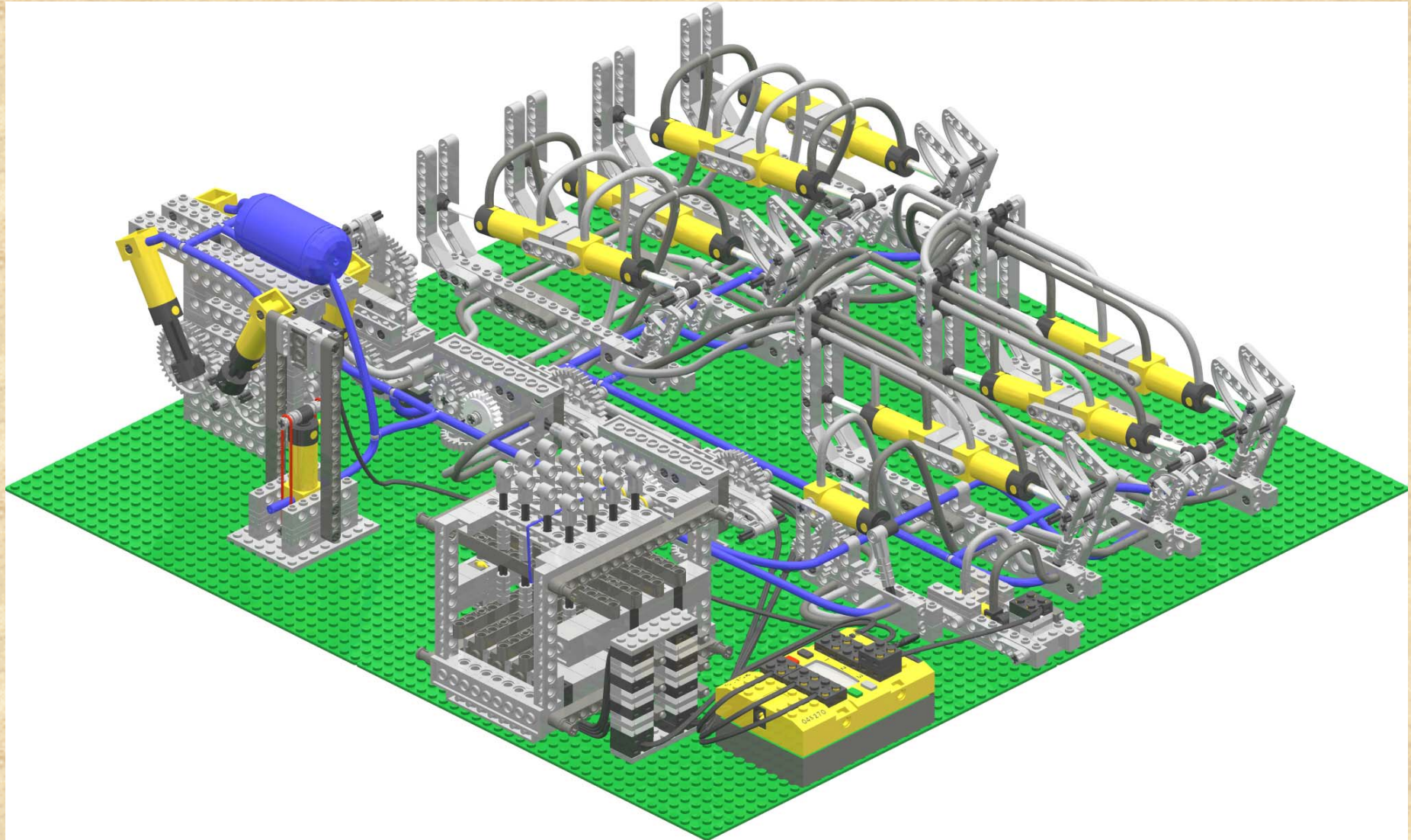
# Example



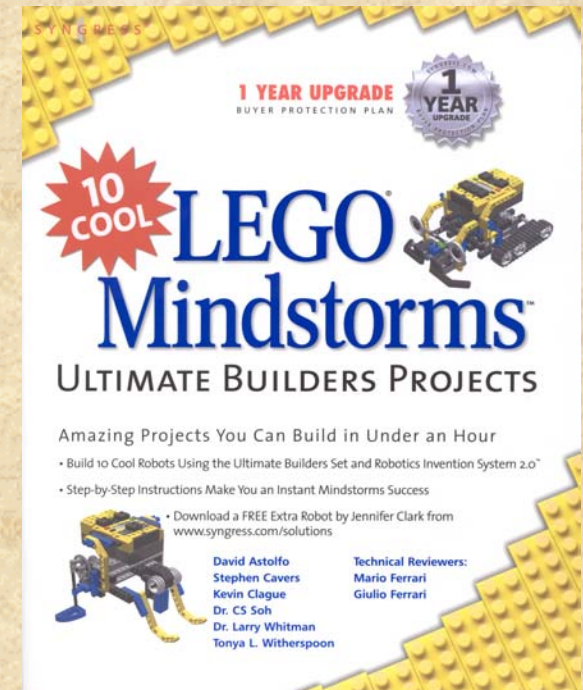
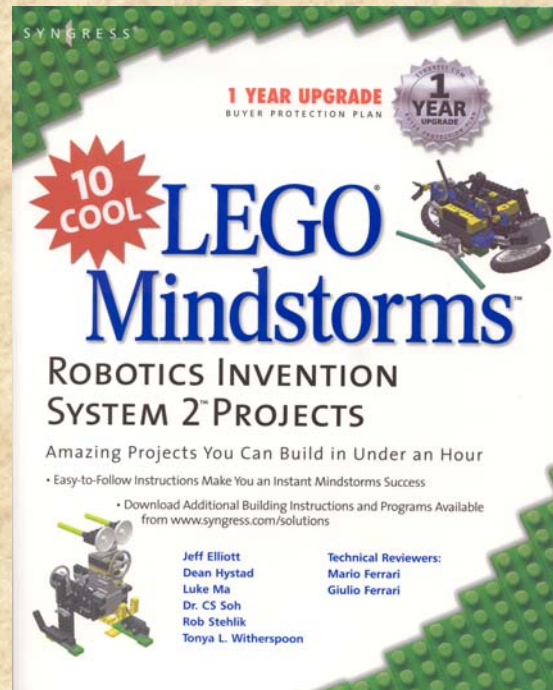
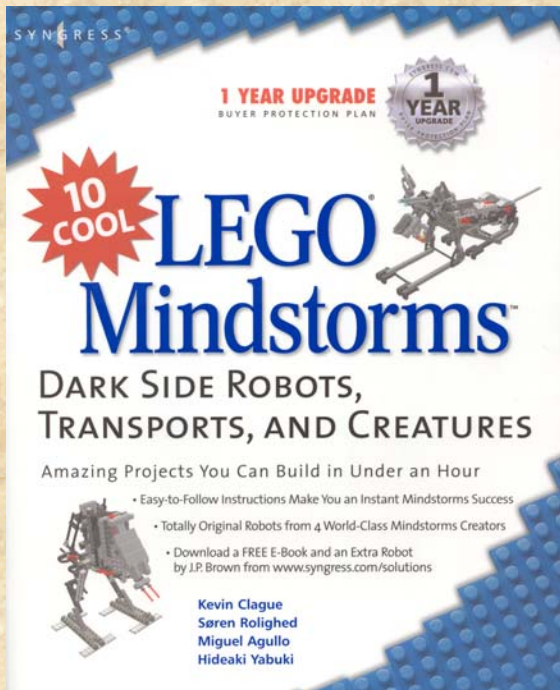
# Example



# Example



# Published Works



# Published Works



# Summary

- LSynth extends the abilities of LDraw CAD family
- Brings documentation to a new level
- Easy to use, familiar, fits well into LDraw CAD family
- Just scratched the surface
- Hope it gets integrated into MLCad
- Open Sourced on sourceforge