Before You Begin

This tutorial will cover only the basic strategy of LASER!, what the various game pieces do, and how they can be used. It does not attempt to teach the actual operation of the LASER! game window. Since you are required to actually run a series of tutorial puzzles on LASER! during this tutorial, you should be familiar with the Basic Operation section in the Manual before beginning.

Starting The Tutorial

The LASER! part of this tutorial consists of a series of very simple puzzles and their solutions. Each will highlight what one part does. Parts which have multiple uses may contain more than one tutorial demo.

Click on the Puzzle Group icon ( ) on LASER! and open the group "TUTORIAL". This text will follow the tutorial puzzles sequentially. I'll tell you when you should advance to the next puzzle of the group with the right arrow button (

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Tutorial 1: The Basic Concept

The basic idea behind LASER! is to direct light from one or more light sources ( )

to one or more light targets (

) located somewhere on the "work bench." Each light source will produce one color light. Each target will expect to receive a particular color light. Any other color will not activate it. All targets must receive the required color light for a puzzle to be "solved."
There are seven colors of light available:

<div align="center">

RED **BLUE** **GREEN**
CYAN **YELLOW** **VIOLET**
WHITE

</div>

Red, blue, and green are *primary colors* -- they are pure colors.   Cyan, yellow, and violet are *secondary colors* -- they are composed of two primary colors added together.   White consists of all three primaries added together.   The following chart will illustrate this:

	RED	GREEN	BLUE
Red	X		
Green		X	
Blue			X
Cyan		X	X
Violet	X		X
Yellow	X	X	
White	X	X	X

The first tutorial puzzle consists of simply a source and target, both properly aligned. You don't have to do anything to make it "work."   To try it, press the RUN button on the icon bar .   Then advance to the next puzzle with the right arrow button

Tutorial 2:   Filter Demo

Note that in this tutorial, the light source is violet but the target wants red light shining on it.   If you press the RUN button, you'll see that the device never stops since the target isn't hit.   You can turn the device off by pressing the RUN button again.

A red filter will fix this problem.   Advance to the next tutorial screen to see the solution.   Try pressing the RUN button now...   You'll notice that the device operates properly.

What does a filter do?   Why did the filter fix the device?   Good questions -- here are the answers.

A FILTER will pass only the light components of its color.   The red filter, for instance, will only pass red light because red is a primary color.   A yellow filter will pass both the red and green components of light, since red and green produce yellow.   The color chart from the first tutorial puzzle can be used here as well to predict what colors will pass through a filter.

Where did the red light come from in this experiment?   In the above table (it's used a lot!!), note that violet -- which is coming out of our source -- consists of red and blue.   The red filter will only pass the red component of the violet light -- and block the blue.   The red is exactly what we need for the target, so the device works properly.

The following table will illustrate exactly what results from various light and filter combinations:

LIGHT \ FLTR	RED	GREEN	BLUE	CYAN	VIOLET	YELLOW
RED	Red	-NONE-	-NONE-	-NONE-	Red	Red
GREEN	-NONE-	Green	-NONE	Green	-NONE-	Green
BLUE	-NONE-	-NONE-	Blue	Blue	Blue	-NONE
CYAN	-NONE-	Green	Blue	Cyan	Blue	Green
VIOLET	Red	-NONE-	Blue	Blue	Violet	Red
YELLOW	Red	Green	Green	Green	Red	Yellow
WHITE	Red	Green	Blue	Cyan	Violet	Yellow

Note that the filter has an entrance/exit from only the left or right.   The filter will work in either direction -- but will only work for horizontal light.   If a light beam strikes this filter from the top or bottom, the beam will be absorbed.   There are other filters which will work only with vertical light beams.

Tutorial 3:   Phosphor Demo

Advance to this tutorial puzzle with the right-arrow button.   Hmmm..   We need white light, but have a blue light source.   White contains red green, and blue, though.   How can we get and combine all three colors when we only have a light source for one of them???   Advance to the solution to find out!

The Phosphor will generate output light of its designed color regardless of what color light is put into the input.   In our case, we get white light from the white phosphor by putting our blue light into it.

The phosphor has only one input and one output.   Light must strike it on the input side. Light beams which hit any other side will be absorbed.

The phosphor device is available in a wide variety of colors and directions.

Press the right arrow button to advance to the next tutorial puzzle.

Tutorial 4: Mirror

Advance to the next tutorial puzzle.   In this one, note that the light must enter the target from a different direction than the light source produces.   How do we re-direct the light? With a mirror, of course!

The Mirror will reflect any light hitting it in exactly the direction that you'd expect.   All mirrors are two-sided.   Any light hitting it will be reflected off at the appropriate 90-degree angle.   Advance to the solution of this tutorial puzzle to see the

mirror in action.

There are two mirrors available -- one is angled from upper left to lower right.   The other is angled from upper right to lower left.   Advance to the next tutorial to see a different kind of mirror.

Tutorial 5:   Half-Mirror

Hmmm... One light source...   Two targets!   Somehow, we've got to split that one beam into two.   The half-mirror will do this job.   Advance to the solution to see it in action.

The Half Mirror is a mirror whose reflective coating is so thin that only half the light is reflected by it.   The other half passes right through.   This results in two beams -- one as if the mirror was a full mirror and another as if the mirror wasn't even there!   Like the standard mirror, there are two different half-mirrors available.   One is angled from the upper left to the lower right.   The other is angled from the upper right to the lower left.

In this puzzle, the half mirror was used as a beam splitter.   It can also at times be used as a combiner.   Advance to the next tutorial puzzle to see that type of arrangement.

Tutorial 5B: Half Mirror as a Beam Combiner

We previously saw the Half Mirror used to split a beam into two targets.   This time, we have two sources.   However, the targets require the sum of the sources (RED + BLUE = VIOLET).   The Half Mirror can solve this one, too!   Advance to the solution screen to see how.

The color passing through the mirror is combining with the mirror being reflected from its other side.   The colors are then adding and producing the resultant color.

Advance to the next tutorial puzzle to see a really good use for the mirror's reflective property.

Tutorial 6: The Wall

The Wall isn't a helpful component (usually).   Its primary use is so the puzzle designer can make life harder for you.   Or for you, as a puzzle designer, to make life harder for someone else!

The wall is a blocker.   All light beams hitting the wall are absorbed.

In this tutorial, we use mirrors to bounce the light around the wall and into the target on the other side.   Advance to the answer section to see how this is done.

While the wall is primarily meant as a blocker used by the puzzle designer, it can (and will) also be used as a part that's needed in a solution.   There can be times (as you'll see later) when colors are added together to produce the wrong color for a target.   In these cases, the wall may be needed to block one or more components of the light.   Advance to the next tutorial puzzle to see an example of this.

Tutorial 6B: The Wall as a Blocker

The red and blue seem to be adding together in the half-mirror, producing purple. Unfortunately, the target wants pure blue.   We've got to somehow turn off the red light source.   Advance to the solution to see how a Wall component can do this.

Tutorial 7:   Combiner

Earlier, we saw how to use a Half Mirror as a combiner.   While it does get the job done, it's not really the method of choice (unless you're trying to confuse the puzzle solver!!).

There's a real component to do just that .   Advance to the next tutorial puzzle to see a situation which could use a combiner.

You'll notice that this situation could in fact work with a half-mirror just as well as a combiner -- but we've got a combiner on the shelf and not a half-mirror.   Watch out for places in puzzles where more than one part can solve a problem.   You may not know which to use until you know what else is needed to fix another problem.

Advance to the solution for this puzzle to see the combiner in action.   Note that the combiner has three inputs (the white and gray sides) and one output (the colorful side).   The light hitting all inputs will be combined into the output.   You can in fact use the combiner to produce white light from separate red, green, and blue sources.   There are four different combiners available -- one for each output direction.   Any light which hits the output side will be absorbed.   The combiner is a one-way device.   However, advance to the next puzzle to see something exactly opposite   from the combiner.

Tutorial 8:   Splitter

In this puzzle, we've got a white source, but need red, green, and blue beams for the targets.   Remember that white consists of all three of those colors.   If only we could dis-assemble the white beam...

The splitter will do exactly that!   Advance to the solution to see it in operation! Note that it has only one input and three colored outputs.   The ouput arrows indicate the color from the output port.   There are four splitters available -- one with an input in each of the four directions.

The splitter will not produce light.   A color component must be at the input port to come from its output port.   White produces output of all three colors.   Yellow, however, would produce only red and green beams.   That table mentioned long ago for tutorial one is useful yet again to determine what output beams will be produced by different color input beams.

Tutorial 9: Multi-Color Target

Now we'll start to get complicated!   Advance to the next puzzle and let the fun begin!

Everything looks like parts you've seen before, right?   Take a closer look at that target. Note that it has three bands of color -- first red, then yellow, and finally white.   What does that mean?   It means the target wants to be hit by those exact colors *in that exact sequence!* How in the world can we possibly get a beam of light to change colors???   Advance to the solution to find out!

We start with white light and break it into its three components with a splitter.   Then we use mirrors to give each component a different path length to travel.   Since each beam of light travels at the same speed, a beam with a longer distance to travel will arrive later at a given point than a beam with a shorter distance.

Since we want the red to hit the target first, we give it the shortest path length.   At the end of its run, it goes into a combiner input.   Since nothing else is going in, red comes out of the combiner and hits the target -- which then turns into a yellow-white combination target.   One step completed!

To get yellow, we've got to combine the red with green.   So, that's the next one into the combiner.   When the green light hits an input, the output turns yellow -- which hits the now yellow-white target and turns it into a pure white target.   Step two completed!

Finally, route the blue through the longest path for the longest delay and dump it into the combiner's third input.   All three colors will combine into white and complete the last phase of the three-color target.   Puzzle solved!

For another way to get the same effect (and to see a brand new component), advance to the next puzzle.

Tutorial 10: Delay Line

In this puzzle, we've got to produce a red-violet-white sequence of light.   However, there

are no mirrors to provide different lengths.   Instead there are delay line components.   Advance to the solution to see them in operation.

The red goes directly into the combiner and onto the target.   We then need to add blue to

create violet.   A short delay in the blue beam will work.   Finally, we've got to add the green.   This requires a slightly longer delay.   Note the small number in the center of the delay line components.   It indicates how many "time pulses" the output will be delayed for.   With the four-count delay line in the blue beam and the eight-count delay line in the green beam, everything works perfectly.

Any side of the delay line can be an input.   The opposite side will be the output.   The beam will be output in the exact same direction with the exact same color -- only it will be delayed.   There are two-, four-, six-, and eight-pulse delay lines available.

We've only got one more component to go.   It must be something from outer space -- I've never seen anything quite like it here on earth!   Advance to the next puzzle to check it out!

Tutorial 11:   VariFilter

The part that looks like a multi-colored mist ([image]) is a *VariFilter*.   The VariFilter is an interesting device.   It changes to a filter to match the color and direction of the first beam of light to hit it.   For instance, if it's hit by red light from the top, it'll turn into a red vertical filter.   There's one unusual twist to this change.   If the VariFilter is first hit by white light from any direction, it'll turn into a blocker.   Once the VariFilter changes to another device, the new device is stable and will not change again.

Note in the sample puzzle that the red is getting to the VariFilter before the blue, and therefore changing the filter to red.   We've got to stop or delay the red beam to solve this problem.   Advance to the solution to see how its done.

The spare VariFilter is put in line with both the red and extra white source.   Because the white's closer, the VariFilter is turned into a blocker to stop the red.   Without the red beam, the other VariFilter turns blue and the blue passes through to the target.

That's the end of the tutorial.   You've seen every component available in LASER!   You should now be able to explore the art of solving and creating puzzles.   Before you begin to solve puzzles, I'd recommend that you go into Puzzle Create mode and just "play around" with the pieces for a time to be sure you know what each does and to discover any limitations or hidden uses that may be there.