Hands-on Lab

CAD – Studio Basics

This lab reviews the installation of Bricklink's Stud.io (called Studio for the rest of this lab) Lego CAD package. Specifically, Studio is introduced to show how one creates Lego-based assemblies, and step-by-step build instructions.   This is important because such CAD packages enable one to document and archive one's mechatronic assemblies, towards goals of generating BOM (Bill of Materials).

Preliminary: Studio Package

There are several CAD packages to construct Lego-based assemblies. MLCAD is a popular one but in 2016 Bricklink released their own. This is important because Bricklink is the de facto standard repository for all things Lego; it features the 3500+ parts in the Lego inventory and connects buyers and sellers. Once one creates their Studio-based assembly, they can request sellers to bid and ship parts. Such sales enable a designer to assess market price for an assembly and hence evaluate financial impacts of part selection and design decisions

One downside is that Studio does not have an animate feature (yet). But for the purposes of documenting and archiving build instructions, Studio is more than suitable. This tutorial has been tested on Windows 7 machines. The Studio website claims the software will operate with Apple (OS X).

**Step 1:** Download and install Studio: https://studio.bricklink.com/v2/build/studio.page

Step 2: Launch Studio to see that it works

  A.   Select Tutorial (**Figure A**) from the opening screen (Lego-based snail assembly). This will introduce how to manipulate views (e.g. pan), orient, connect and color parts.
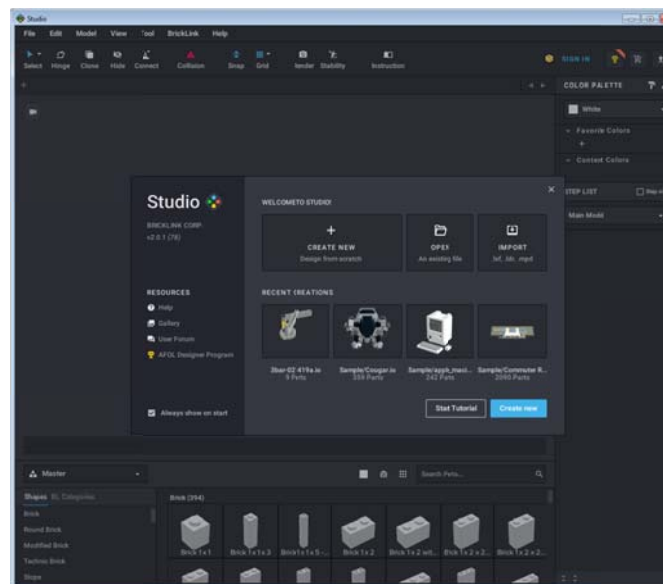
Figure A: Studio opening screen. Clicking "Tutorial" will introduce mouse movements to choose, orient, color, and connect parts
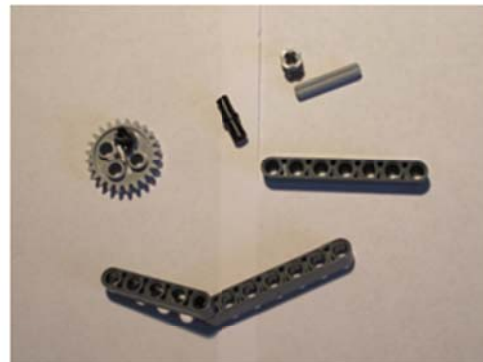
Concept 1 – helloStudio3Bar1_0: Create assembly and build instructions.
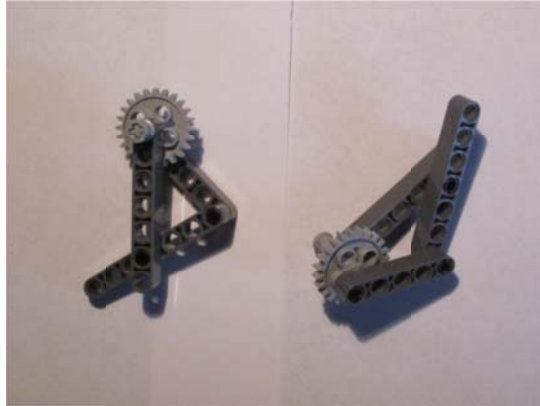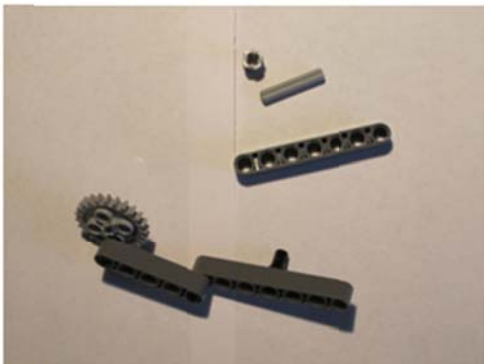

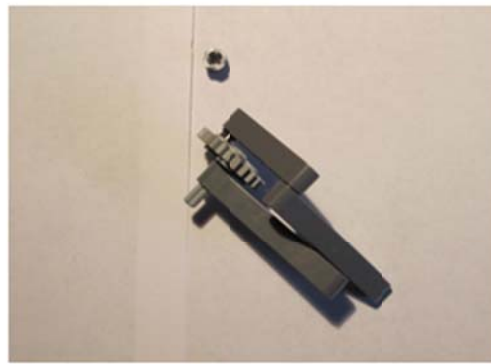3-bar crank to be documented in Studio

Step 1: Parts. NB: Contrast parts 4459 and 3673

Step 2: Pin the Gear. Join Beam 5 and Beam 7

Step 3: Pin Beam 7 and Gear to Beam 5

Step 4: Axle and bush the Gear. Join 2 Beam 7s.

**Figure 1.1A:** Photo-based build instructions for a 3-bar crank

Figure 1.1A shows the Lego numbers associated with each part. Using them will often help one find the parts in Studio. Lego parts also have different names depending on vendors. For example in Step 2, Beam 5 denotes a beam with 5 holes. Studio doesn't call them "beams". Rather, they use "Liftarm".

https://www.bricklink.com/catalogTree.asp?itemType=P denotes over 80,000 Lego parts into several dozen categories. It's best to get used to the categories and use the graphics to find the part you're interested in. For example, the Beam 5 is found as follows: "**Technic, Liftarm**" and

one would scroll down to see the picture of the Beam 5, which called "**Technic, Liftarm Thick 1 x 5**" and is part **32316**.

Step 1: In Studio click `File – New` and then `File – Save As` with the filename **`helloStudio3Bar1_0.io`**. This will yield a new canvas.

Step 2: Referencing **Figure 1.1A**, type `32316` in the `Search Parts` field (see **Figure 1.2A left**). This will allow one to bring the Beam 5 part into the canvas (**Figure 1.2A right**).
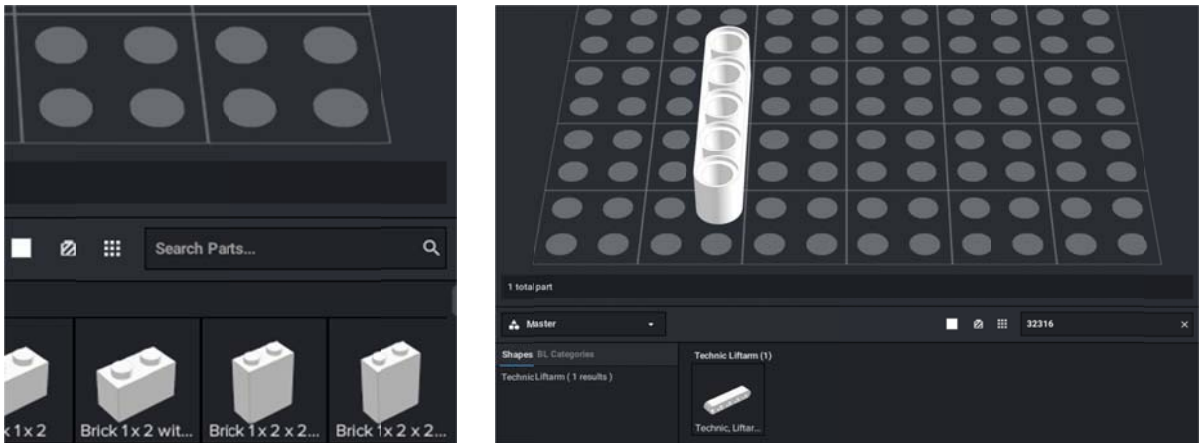
Figure 1.2A: Studio's lower right corner has a "`Search Parts`" field (left figure). If known, one can type in the Lego part number `32316`. The Beam 5 Lego part is the result of the search (right figure). One can then click and then drag the part into the canvas.

Step 3: Add color to the part

Select a Lego part in the canvas by clicking on it. The right-side of the Studio's canvas features a pull-down menu to select the part's color. Choose `Dark Bluish Gray` (**Figure 1.3**). Save your assembly (**helloStudio3Bar1_0.io).**
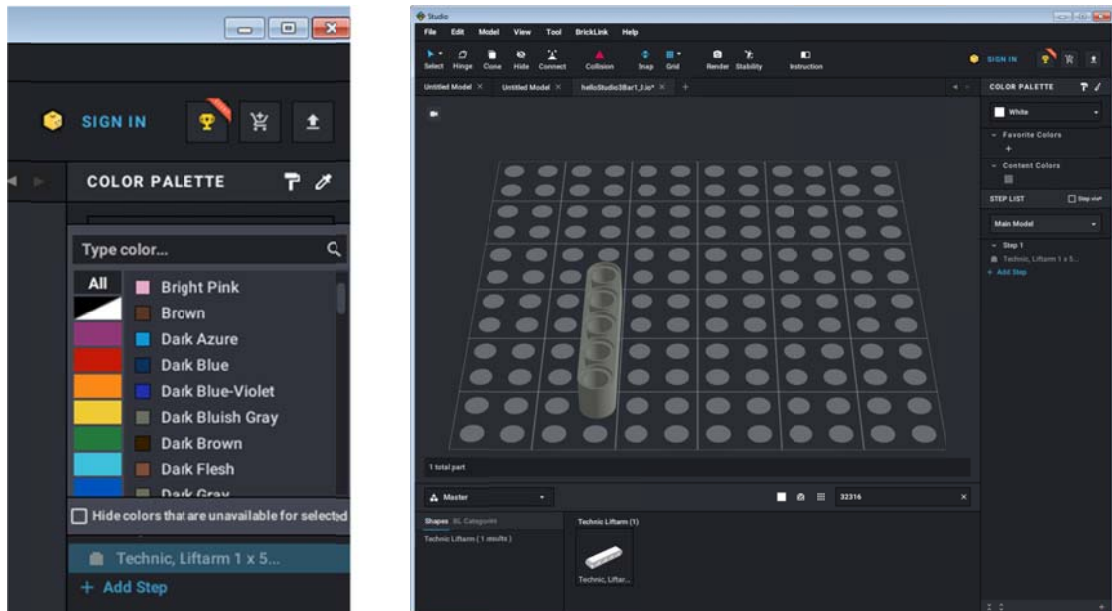
Figure 1.3: Clicking on a part, selects it. Using the pull-down menu (left) one can select and color the part (right)

Step 4: Alternative method to search for parts – Using words

Refer to **Figure 1.1A** and type `gear` in the `Search Parts` field. Scroll thru the parts inventory (**Figure 1.4 Top**) and hover over parts to find `3648: Technic Gear 24 Tooth (New Style with Single Axle Hole)`. Select it and put one on the canvas (**Figure 1.4 Bottom**). Color it `Dark Bluish Gray`. Save your assembly (**helloStudio3Bar1_0.io).**
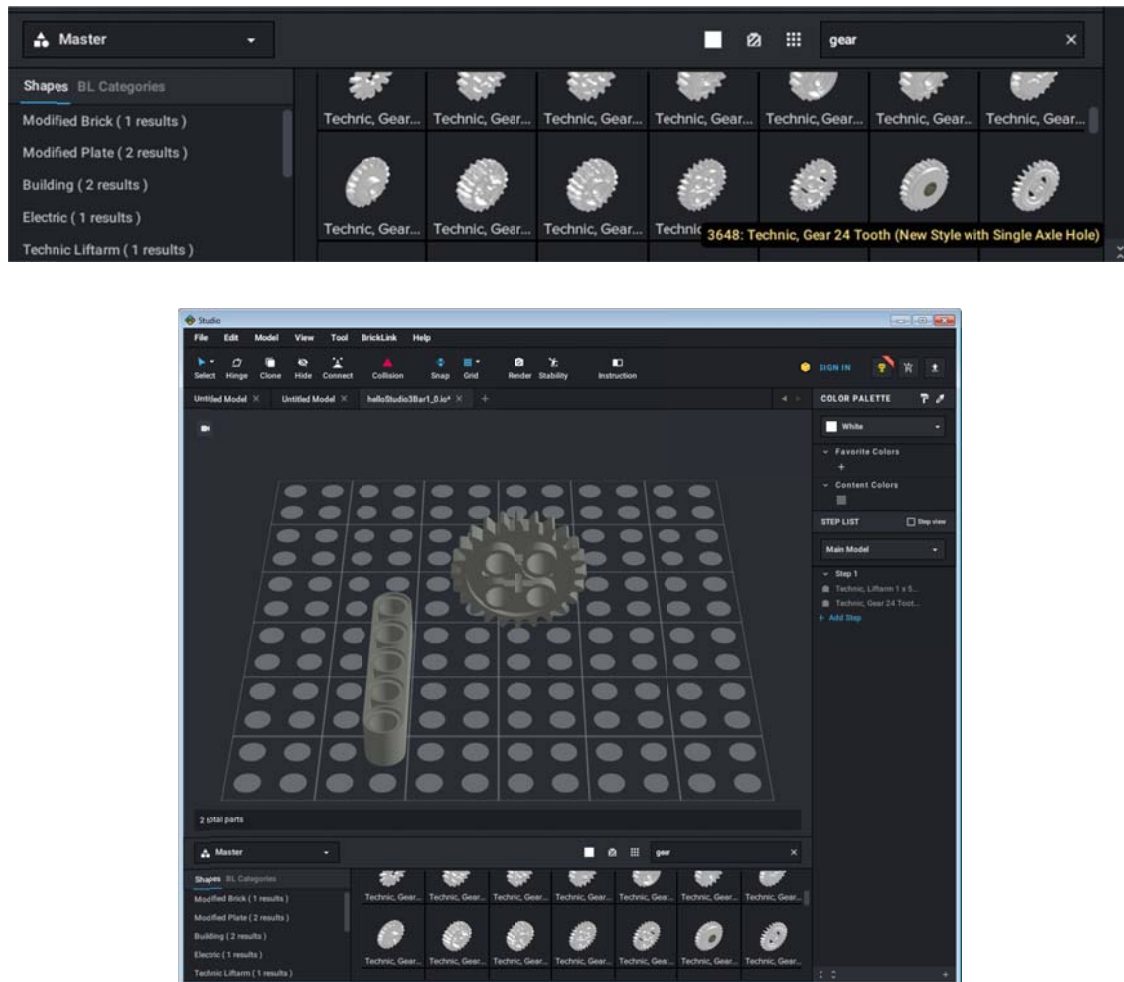

Figure 1.4: Typing "`gear`" in the `Search Parts` field brings an inventory of Lego gears (top). Select the Gear 24 part, bring it into the canvas and color it `Dark Bluish Gray`.

Step 5: Alternative method to search for parts – Browsing

Browsing Categories either by `Shapes` or `BL` (Bricklink) `Categories` can also help one find suitable parts. Referring to **Figure 1.1A**, one needs a Beam 7.

To illustrate browsing, click `BL Categories` and scroll down to `Technic` and click to reveal sub-folders (**Figure 1.5 Top**). Scroll and click `Technic, Liftarm` and then browse for the `32524: Technic, Liftarm 1 x 7 Thick`. Click and drag into the canvas. Color the Beam 7 Yellow (**Figure 1.5 Bottom**).
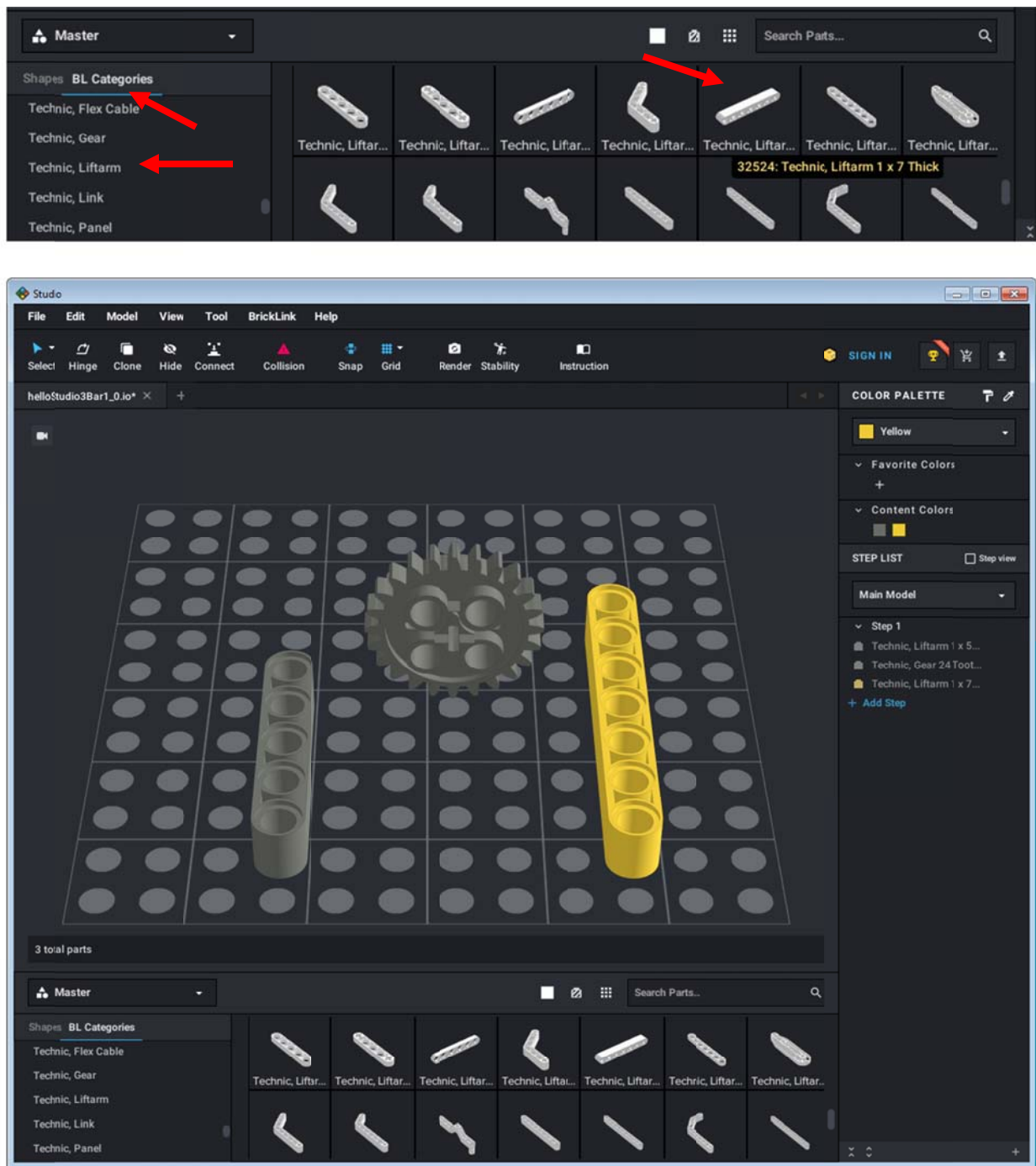
Figure 1.5 Searching for parts by images. Top: red arrows highlight key steps; one can browse parts by Shapes or BL Categories. Choosing the later, one can use Bricklink's part naming convention (which is universally used by Lego designers). Bottom: The Beam 7 parts was selected, brought into the canvas and colored yellow.

Step 6: Referring to **Figure 1.1A**, add 2 `friction pegs` to the canvas and color them `Black`. Next, connect parts so that it looks like **Figure 1.6**: one friction pin inserts into the `Gear 24`; one friction pin connects the `Beam 5` and `Beam 7`. Save your assembly (**helloStudio3Bar1_0.io).**
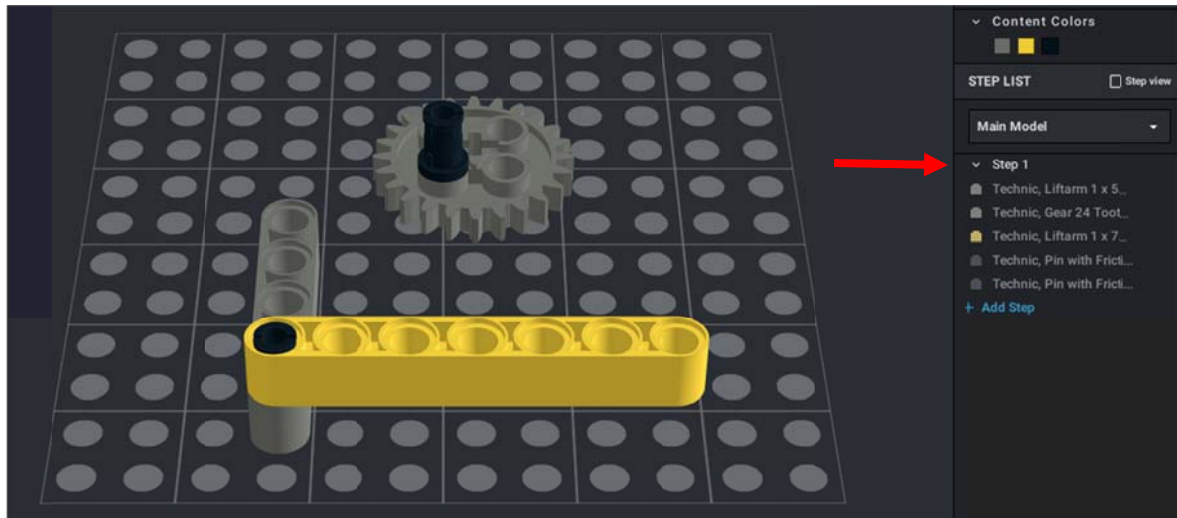
Figure 1.6: Refer to **Figure 1.1A top-right** photo to connect the parts are shown here. One also notices (red arrow), that the parts involved are grouped as `Step 1`.

Step 7: Creating Steps

Before proceeding save your assembly. Next, the red arrow in **Figure 1.6** shows the parts needed to complete a step. Steps are used to eventually complete a build plan. To illustrate this, in the top ribbon bar, click `Instruction` and `OK to Proceed` (**Figure 1.7A left**) and will reveal the Step Editor (**Figure 1.7A right**). One can orient views (pan, zoom, orient) of the current assembly; this will be the view used in the build plan.
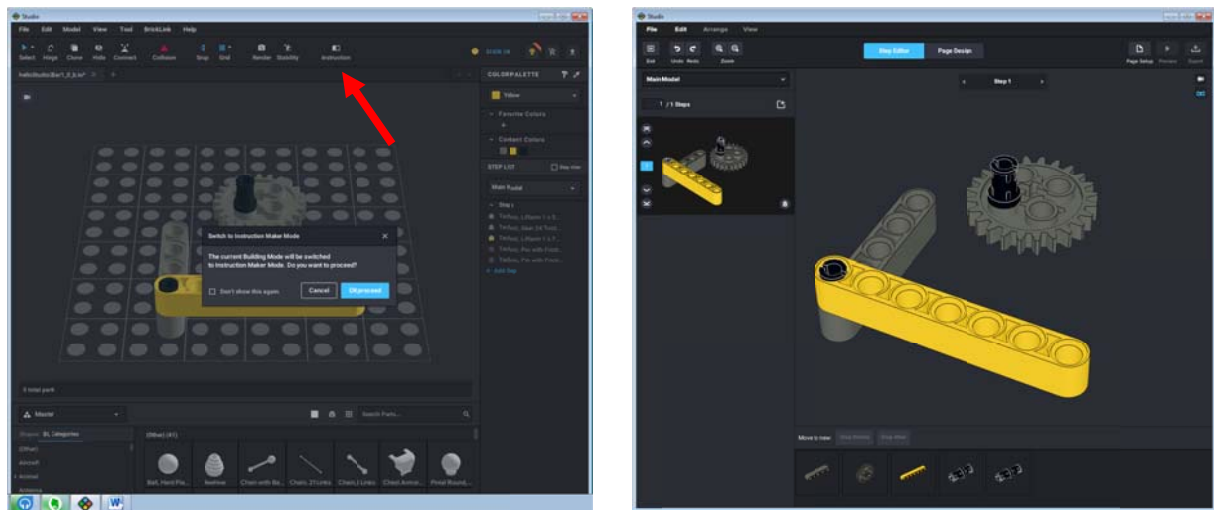
**Figure 1.7A:** Clicking Instruction (left) and OK to Proceed will result in the Step Editor (right).

Clicking `Page Design` will show what Step 1 of the Build Plan will eventually look like (see **Figure 1.7B left**). Clicking on Page Setup will allow one to set the page size to `Letter` (**Figure 1.7B right**).
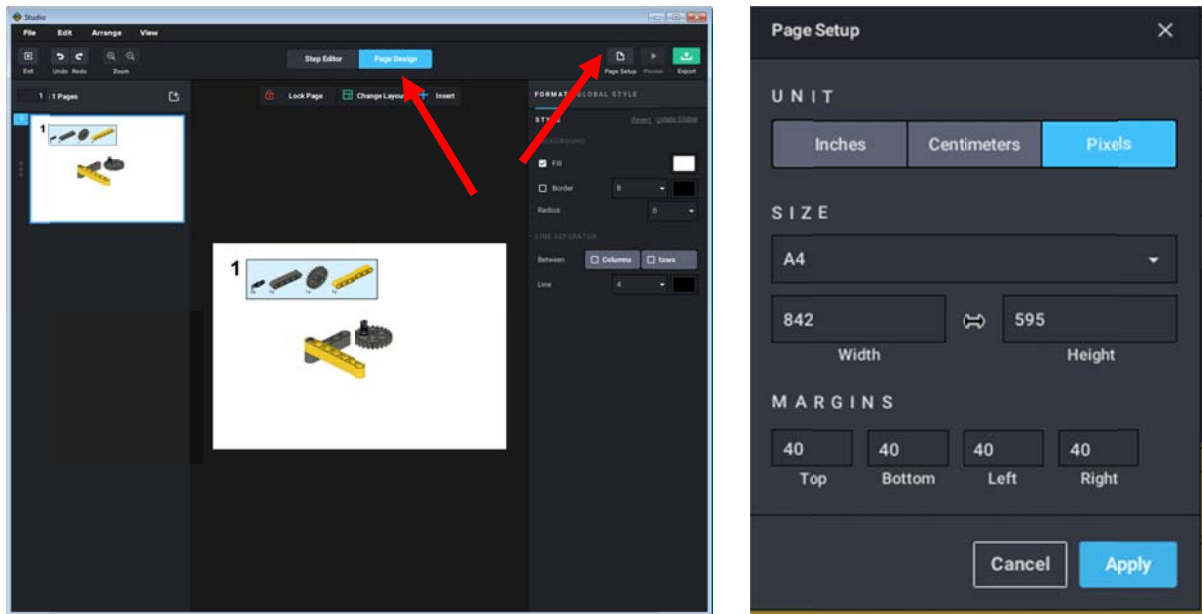
Figure 1.7B: Left: Step 1 of the draft Build Plan. One sees the result of clicking `Page Design` (red arrow); the parts that are involved in the step, as well as their connections. Clicking `Page Setup` (red arrow) results in a pop up box (right). Change the size to `Letter`.

**Step 8:** Add a new step

From **Figure 1.7B**, one can click `File – Exit Instruction Maker` to return to the Studio canvas. Referring to **Figure 1.1A** (lower left), the photo reveals the next step. In Studio, clicking `Add Step` (**Figure 1.8A left**) will result in Step 2 **No bricks in step** (**Figure 1.8A right**). One can now add new parts. Save your assembly (**helloStudio3Bar1_0.io).**
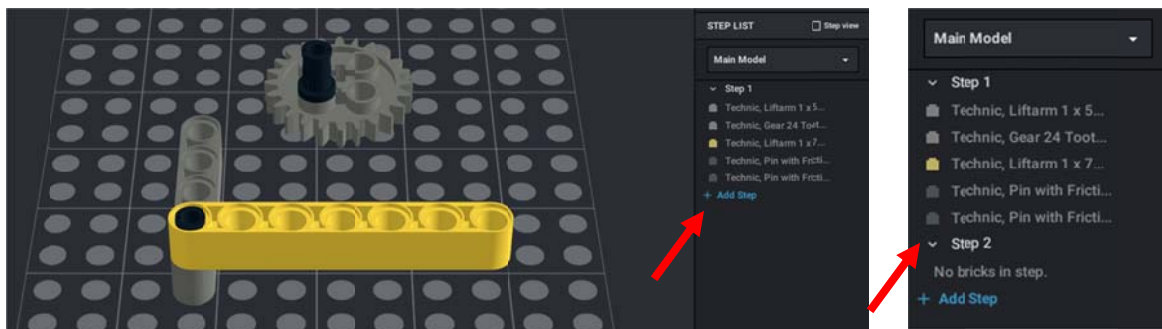
Figure 1.8A: The red arrow shows that steps can be added (left). Clicking `Add Step` results in Step 2 (right)

Add and insert a friction pin to the yellow Beam 7 and connect the Gear 24 to the Beam 5. Add Axle 3 such that the canvas looks like **Figure 1.8B**.
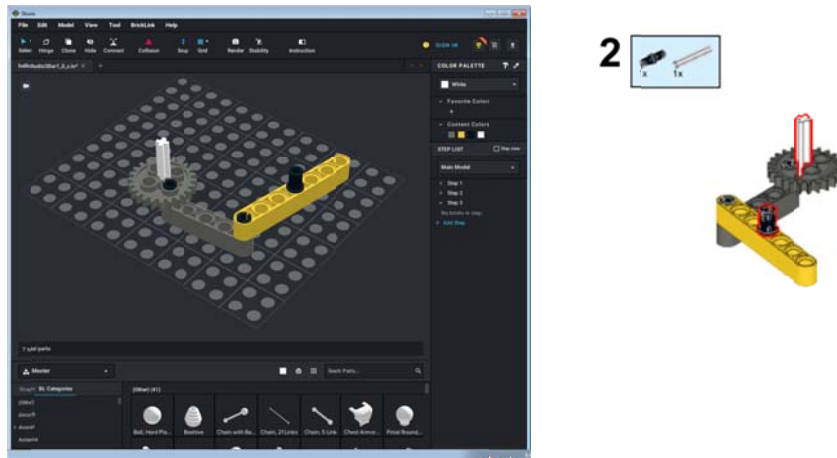
Figure 1.8B: Referring to Figure 1.1A photo, parts were added and connected (left) for Step 2. Clicking on `Instruction` results in the build plan (right).

Step 9: Complete last step

Again, referring to **Figure 1.1A** (bottom right), add a `Beam 7` (colored `Red`) and `bushing` (colored `Light Gray`) to resemble **Figure 1.9**. Save your assembly **(helloStudio3Bar1_0.io).**
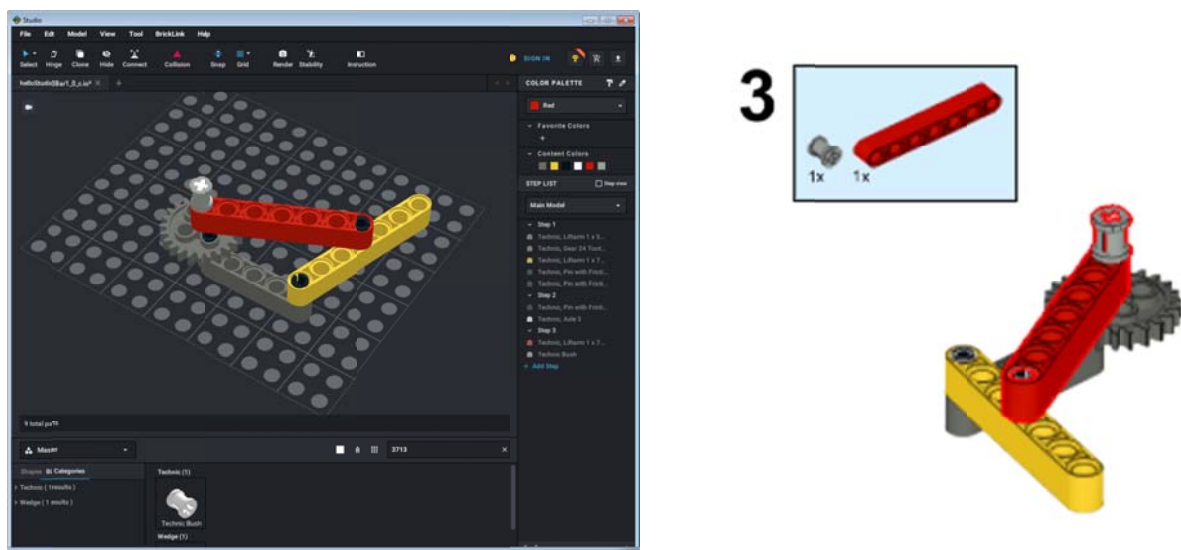
Figure 1.9: `Beam 7` and `bushing` colored `Red` and `Light Gray` respectively, were added under Step 3 and connected (left). This resulted in the build plan Step 3 (right).

## Congratulations on completing your first Studio Assembly and Build Plan

Concept 2: Creating the BOM and Publishing the Build Plan

Bricklink's Studio allows one to also create a Bill of Materials (BOM). Akin the **Figure 1.1A's Top Left** photo, the reader can identify the Lego parts needed to put together the assembly. Moreover, Studio can use this BOM to identify suppliers so one can order the parts.

Step 1: Open Instructions

Open **helloStudio3Bar1_0.io** and click on `Instruction`. In the left pane, hover over Step 1 and `Right-Click - New Page` (Figure 2-1 left). This will then insert a new page before Step 1 (Figure 2-1 right).
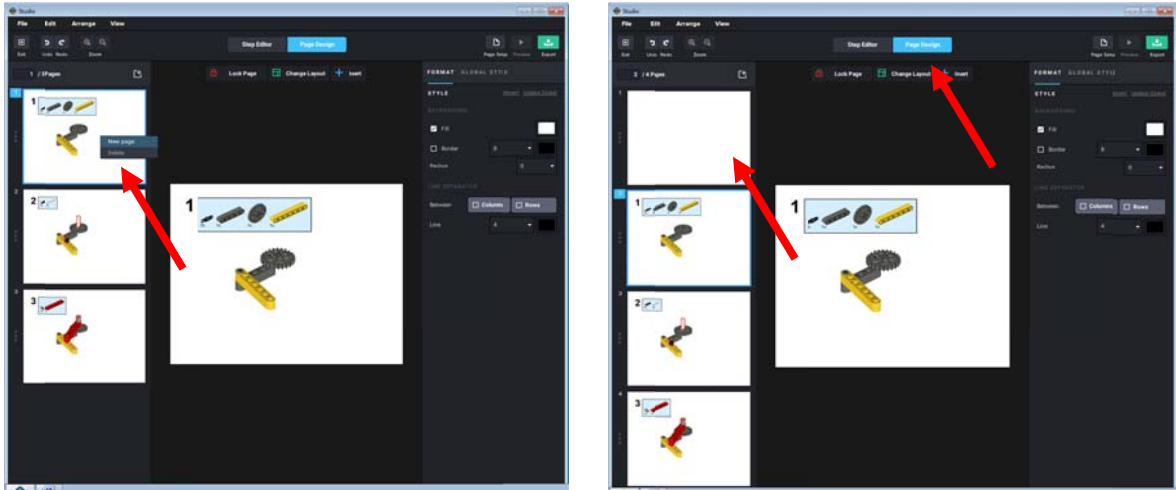
Figure 2-1: Left: Hover the mouse over a page (red arrow) and right-click. This results in adding a new page (right).

Step 2: Add the BOM

Click `Insert Page` (see **Figure 2-1 right red arrow**) and select `Bill of Materials` (**Figure 2-2 left**). This will then result in the BOM (**Figure 2-2 right**).
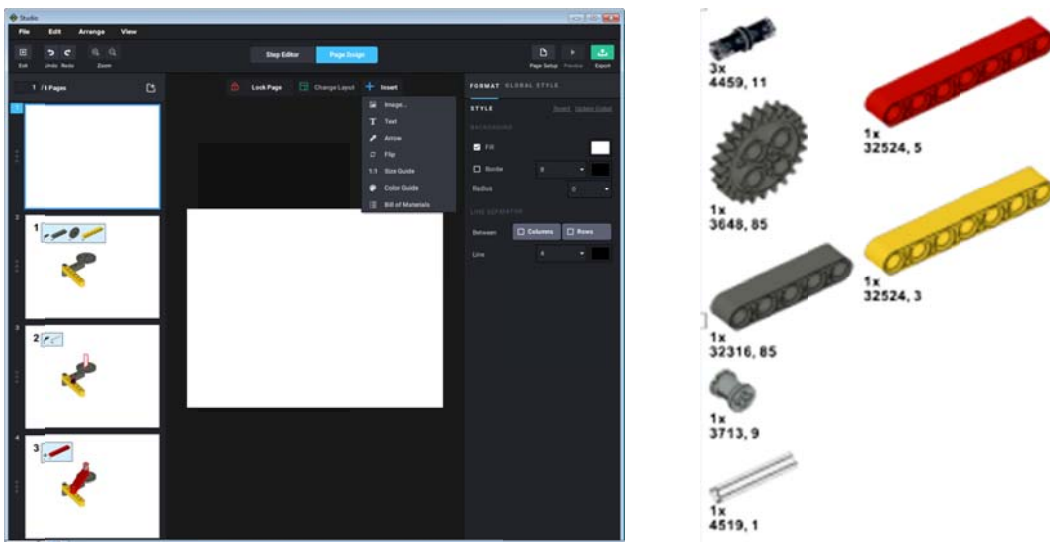
Figure 2-2: Clicking Insert Page allows one to select Bill of Materials (left). This results in Page 1 being filled with the necessary Lego Parts for the assembly, including the part number and its color code.

Clicking "`Change Layout`" allows one to create a more concise build plan. For example, **Figure 2-3** fits the 3 steps into a single slide.
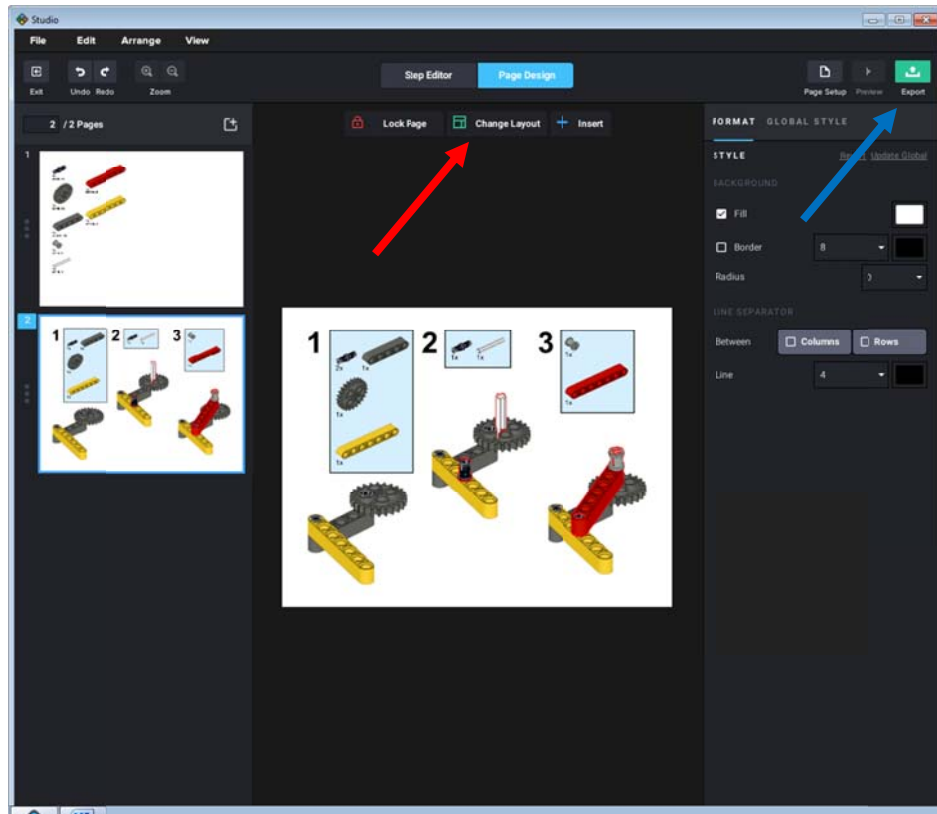

Figure 2-2: Clicking "Change Layout" (red arrow) allows one to choose different page layouts. This enables to move and resize images to create more concise and page-efficient build plans.

Once happy with the build plan, clicking `Export` (**Figure 2-2 blue arrow**) will allow one to select options like pages, file format (e.g. PDF or PNG), and folder/filename. Select `PDF` and save. Open the PDF to ensure the resulting file matches your build plan.

Exercises

1. From Studio, render your 3-bar linkage assembly as a high resolution POV-Ray 8-bit PNG image file. This creates a photo-realistic image (see Figure A-1 left).

2. Display information and costs for the assembly (see Figure A-1 right)

3. Create an "Add to Want List" (Figure A-2 left). This will require one to create a free Bricklink user account. Clicking "Buy All" will allow one to preview stores. Create Figure A-2 right, which is a sample store's pricing.
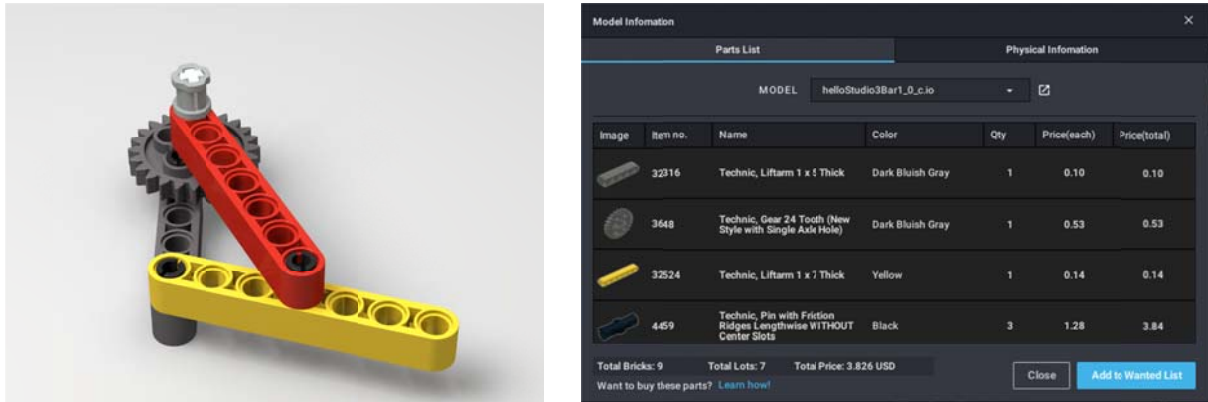
Figure A-1: Studio can create photo-realistic images (left) as well as the information on cost estimates (right).
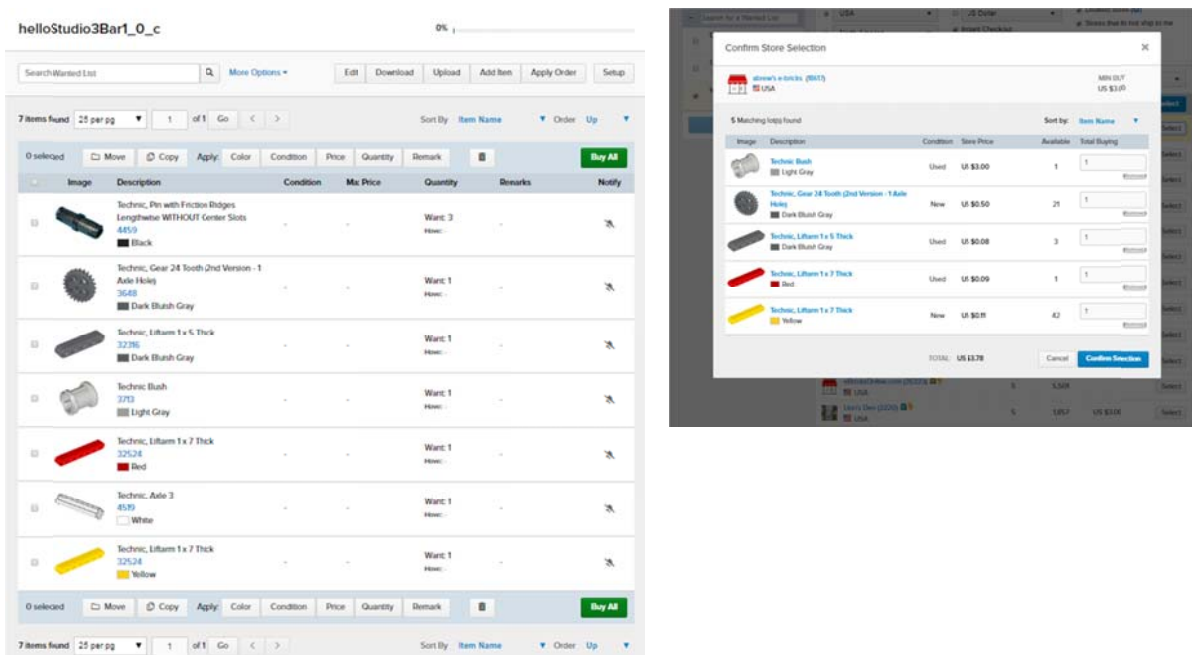
Figure A-2: Thru Studio, one can log into Bricklink to create a Parts Wanted List (left). Buying the parts list will have Bricklink search thru its vendor database to identify single-source stores. One example (right) shows one store's pricing.