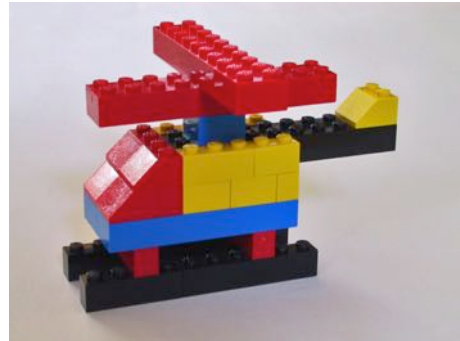


## Worksheet: From Helicopter Design to Mechanical Engineering

Who does not dream of flying? Before a complicated, expensive machine like a helicopter can be built, a lot of planning work is needed. Budgets have to be calculated, financing for a new development be raised! The idea for a new machine initially arises in ones head. To make the idea tangible and to develop the new product with others, the new maschine has to be put into sketches on paper and a model designed from simple components, such as playdough, lego, plastic or cardboard. Thereafter, ideally the three-dimensional model, as well as a coputer aided digital model, can be moved in space. That is exactly the goal of the following tasks.

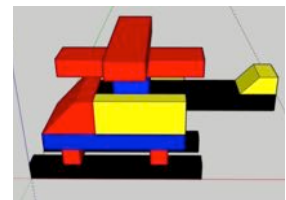
1. Build the helicopter model shown on the left with Lego blocks or using similar shapes from a different material such as paper, playdough, cookies or a sheet of cake.



2. Draw the helicopter (without Lego knobs) from the side, front and top, onto the checkered paper. A nub should correspond to a box. The skids or rotors are each already marked on the checkered paper.

**Tip:** Turn the helicopter so that you can see it exactly from the side (or from the front or from the top) and look with just one eye.

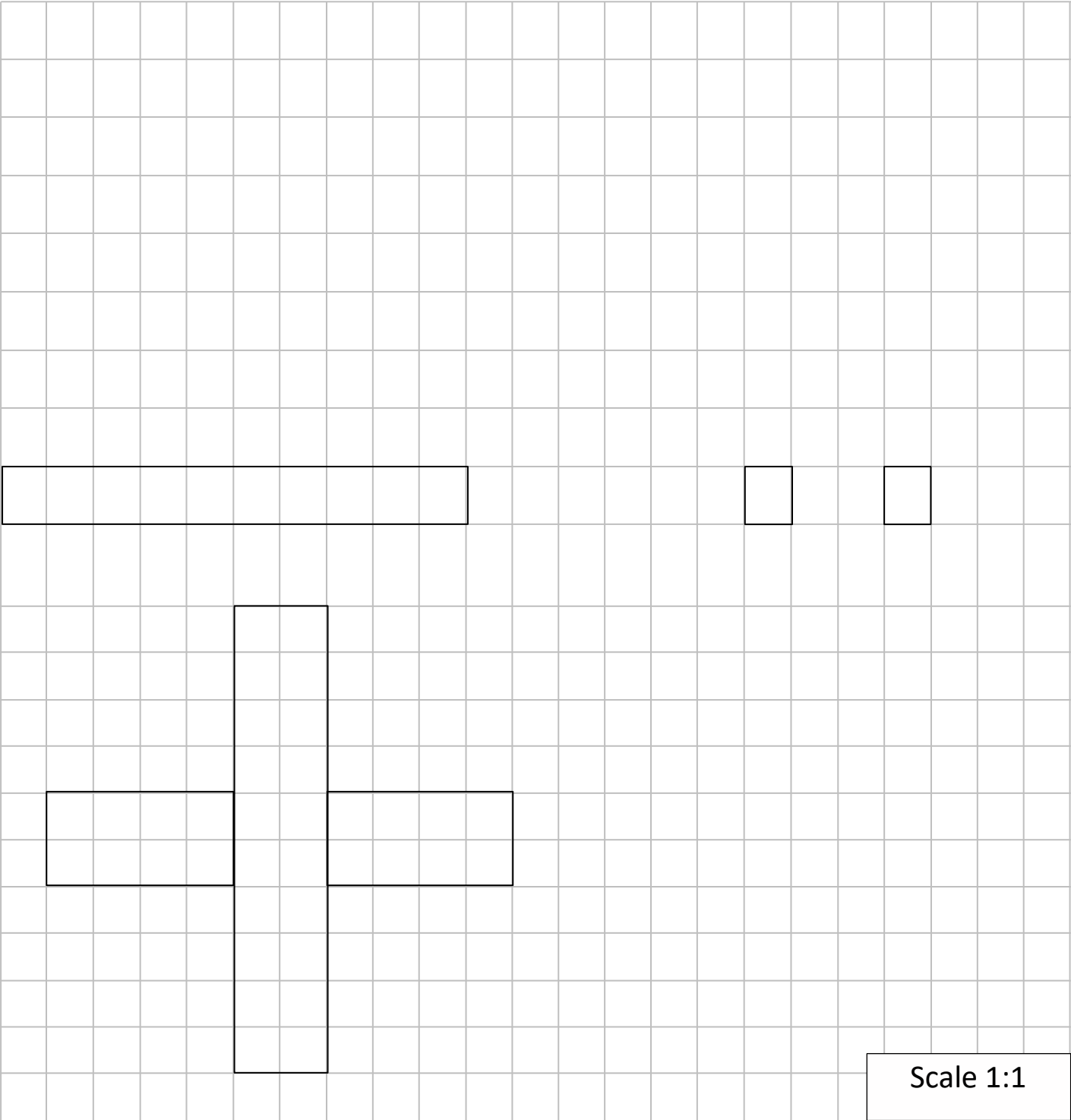
3. Get to know three-dimensional drawing using isometric paper starting on page 3 of the worksheet. die Draw the basic forms next to the pre-drawn forms for practice.
4. Now draw the helicopter onto the isometric paper on page 4. Check your drawing using the transparent solution foils. If you find the helicopter too difficult to draw, use the solution foils as a help or draw a house, a letter of the alphabet or a shape of your choice.
5. Create a three-dimensional model of the helicopter with the free program SketchUp, which can be accessed in the Internet browser by entering "app.sketchup.com". This requires registering with Trimble, providing an email address, and choosing a password, unless you already have a Google Account that you can use to log in as well.



6. Do you enjoy topics such as these? You can find more information on this subject in the explanation to this experiment "From Helicopter Design to Studying Mechanical Engineering at the TUHH". Information all about mechanical engineering studies at the Hamburg University of Technology (TUHH) can be found on the university's homepage: [www.tuhh.de](http://www.tuhh.de).

Sideview

Front view



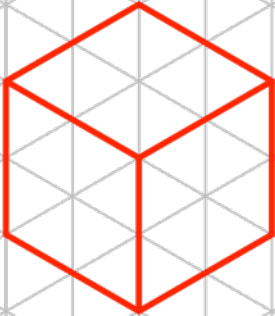
Scale 1:1

Top view


Draw these three basic shapes again next to the subscribed ones:

**Isometric paper for perspective drawing**

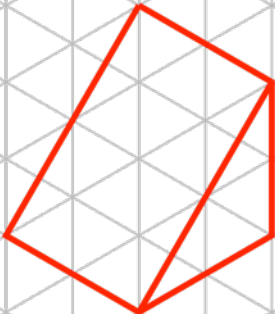
Cube



Cuboid



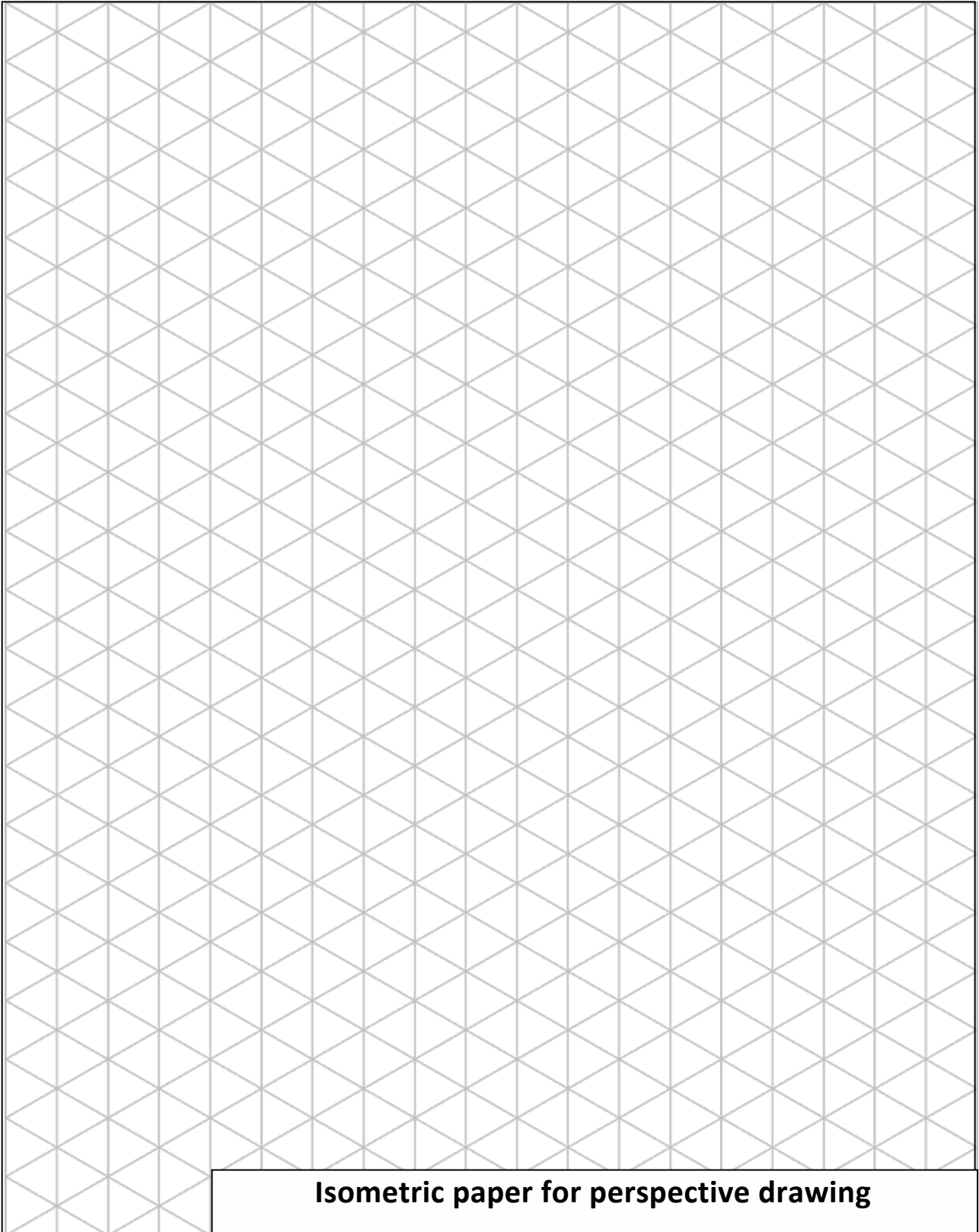
Triangular prism



The image shows a large sheet of isometric paper with a grid of small triangles. Three 3D shapes are drawn in red: a cube, a cuboid, and a triangular prism. Each shape is drawn using the isometric grid lines to create a perspective view. The cube is a simple cube, the cuboid is a rectangular prism, and the triangular prism is a triangular prism. Each drawing is accompanied by a label in a box above it.

Tip: For the triangular prism, first draw the lines that run along the guidelines.

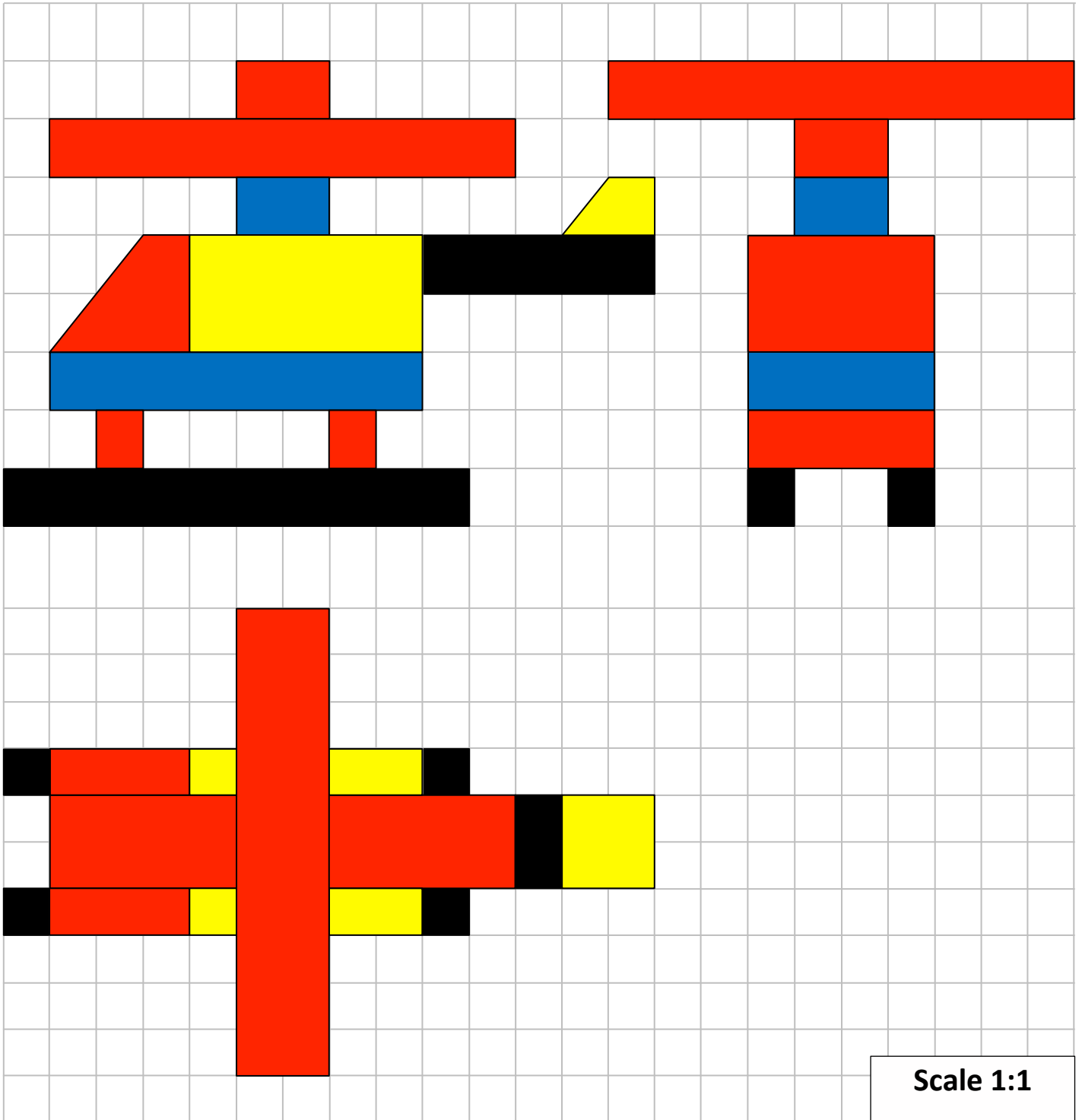
Draw the helicopter, a house or a figure of your choice on the isometric paper:



## SOLUTION TRANSPARENCY

Sideview

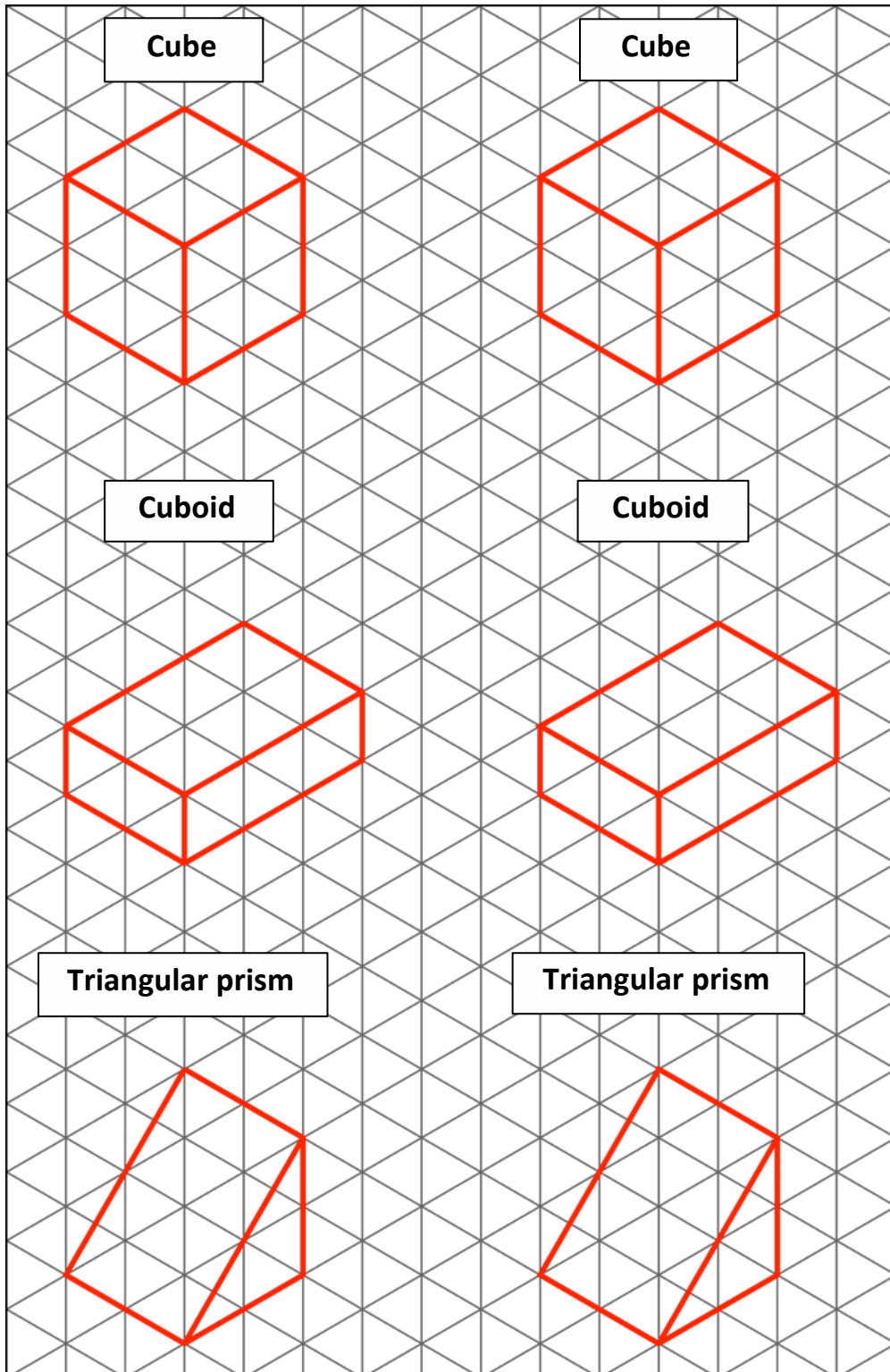
Front view



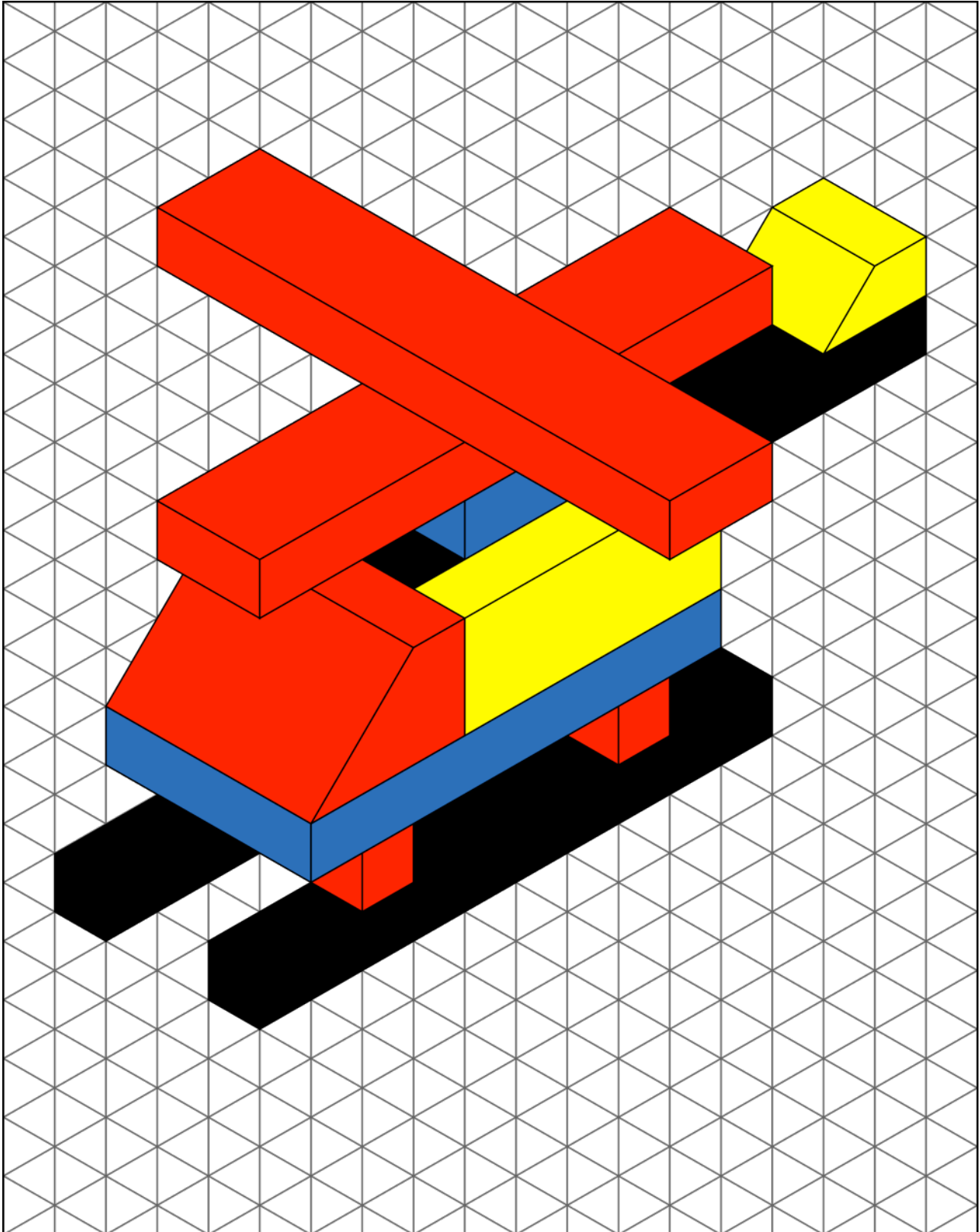
Scale 1:1

Top view

## SOLUTION TRANSPARENCY



**SOLUTION TRANSPARENCY**



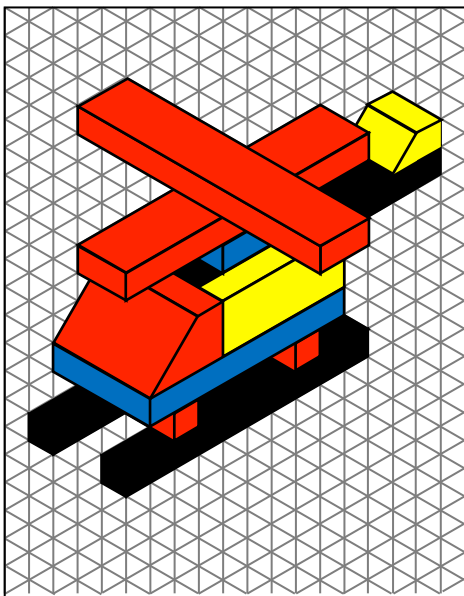
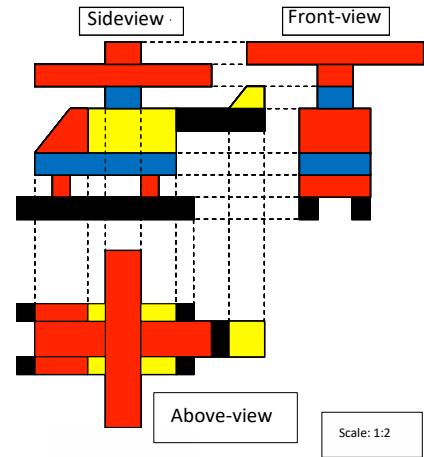
Nachwuchs  
campus



## From Helicopter Design to Studying Mechanical Engineering at the TUHH

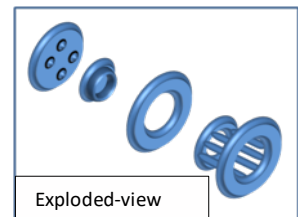
When a new product, such as a helicopter, is designed, technical drawings are created that show the individual parts and how they are assembled. Everything must be precisely drawn and described so that it fits together afterwards.

Since each component has a spatial depth, but a sheet of paper is only flat, it is not easy to represent the object so that it can be properly imagined. Mostly it is shown in three views: from the front, from the side and from above. If you draw the side view next to the front view and the top view under the front view, you can take the dimensions from one view to the other, as the dashed lines in the figure show.

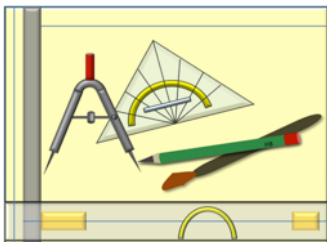


With simpler objects, one can already get a good spatial impression of the object from a view, the isometric view. You can get it by turning the object a bit and tilting it so that you see three sides at once. If the lines are only perpendicular and horizontal to the side and to the back, as in the case of a cube or cuboid, they run along the lines of isometry, which are already drawn as guides on isometric paper.

Because an assembled product may have its parts hidden by others, you can also make sectional drawings to see inside, or exploded views that show the individual parts at a distance.



In addition to the illustration of the object, a technical drawing also includes the dimensioning, so that you can see how long and wide a component should be at a glance. The scale of the drawing is given on the same page.

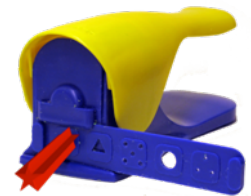


In former times, technical drawings on large drawing boards were drawn by hand with a pen, ruler and compass. Today, designers sit at computers and make drawings using CAD programs. CAD is an abbreviation that stands for Computer Aided Design and means computer aided design.

**Computer Aided Design (CAD):** Constructing on the computer has many advantages. Basic shapes such as rectangles and circles, but also entire components are already predefined and can be inserted into the drawing. There they can easily be enlarged, changed, moved or deleted. If you draw an item and need it again on an assembly drawing, you can copy it with a command and don't have to draw it again. To insert components or individual lines in the right place, there are functions that, for example, find the center of a circle or draw lines exactly at right angles to other lines. Since the screens in CAD are not as big as the drawing boards used previously, you can zoom in on parts of the drawing ("zoom in") and then look at the entire drawing again. The dimension can automatically be created by the program itself. Another advantage is shown when a new model is developed after a few years. Then you can change the old drawings and do not have to redraw everything. But, the possibilities of CAD go much further. Although the screen is only flat as a sheet of paper, you can create a three-dimensional model (3D model) of the component on the computer.

## How is a three-dimensional model created on the computer?


First, a two-dimensional view is drawn. This can then be extruded. This is like a kneading press, where you can squeeze the dough through various templates, for example, to obtain a star-shaped strand. Our helicopter would then look like the picture, that is, it would have the same thickness everywhere. With so-called "tools" you can then edit this model on the computer as a craftsman his workpiece. For example, there are tools for punching, drilling and rounding off.




With finished 3D models, not only the drawing work is done. Computer-controlled turning and milling machines can automatically produce the workpieces according to these plans (of course only components, not complete helicopters).

## Do you want to use a 3D drawing program at home?

There are several free programs that you can use for this. For all programs there are tutorials and help, so that you can teach yourself to use them.

 Suitable programs that are downloaded to your own computer are for example FreeCAD and OpenSCAD. Like most programs, FreeCAD is graphically oriented, which means that there are different drawing tools and basic forms from which the objects are built. In OpenSCAD, however, the objects are written in a programming language and the result is output as a drawing on the screen (example: "Cube (30; 30; 30)" draws a cube of edge length 30). Both programs can be found for downloading in the internet.

 There are also good programs that run on the web interface. The following programs are not only suitable for drawing, but also provide a good introduction to the Makerscene direction 3D printing and are available for free in student versions. The following list is sorted in ascending order of complexity. For beginners TinkerCAD has a simple interface, but there is a lot behind it. 3D projects can be designed and then printed with your own 3D printer. To draw the helicopter, e.g. Sketchup and onshape are good for beginners. Fusion360 is more complex, but also offers more options. Partly because of this, it is often used in companies and research institutions.

- **TinkerCAD** ([www.tinkercad.com](http://www.tinkercad.com))
- **Sketchup** ([www.sketchup.com](http://www.sketchup.com))
- **Onshape** ([www.onshape.com](http://www.onshape.com))
- **Fusion360** ([www.autodesk.de/products/fusion-360](http://www.autodesk.de/products/fusion-360))

**What else can you do with drawn 3D models?** If you are interested in Virtual Reality, you can view objects with VR glasses. These do not have to be expensive models. Cardboard holders, in which one can just insert a smartphone are good enough.

In order to be able to view a SketchUp 3D model with VR glasses, in addition to SketchUp you need the Kubity program, which must be installed at the beginning. On the website [www.kubity.com](http://www.kubity.com) there are corresponding versions for Windows and Mac operating systems. To get the 20-minute free preview of your own 3D models, after opening Kubity, press "I'll redeem a card later".

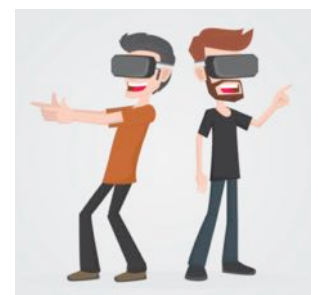
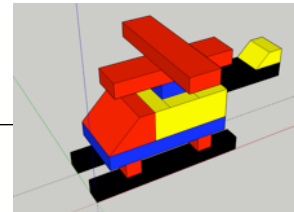


Bild Freepik.com

Then drag and drop the SketchUp model with the skp file format onto the window of the installed desktop application Kubity. After a short wait, the 3D model can then be viewed in the desktop application Kubity. To

display on the smartphone, you also need the smartphone app Kubity, which can be downloaded for free via the Google Play Store for Android or the Apple App Store. (Source: Wissensfabrik [www.wissensfabrik.de](http://www.wissensfabrik.de))

**Do topics like these interest you?** Studying mechanical engineering at the Technical University of Hamburg (TUHH) could be interesting for you! For more information, check the universities homepage [www.tuhh.de](http://www.tuhh.de). The homepage language can be changed to English.



## Drawing a helicopter with sketchup (App.sketchup.com)

### 1. Making basic settings:

- First click on the globe at the bottom of the screen and select your language. Then click on the question mark and select "Start Introductory Tour".
- Click on the menu icon in the upper left (). Click on "New model" and select mm as the unit.

### 2. Drawing the helicopter

- First, drive the eraser tool over the man to erase it.
- To get a full-scale image of the helicopter, look at the box drawings of the helicopter and assume that each box is 10mm wide and high. The basic dimensions of the helicopter are then 100 mm x 10 mm and 10 mm in height.
- To draw, select the Rectangle tool from the toolbar on the left. Draw a rectangle that starts at the origin (1st click) and spans towards the red and green axes (just drag without clicking). Then tap the exact measurements "100.10" and hit the Enter key. Zoom into the rectangle by first clicking on the Rotate tool at the bottom of the toolbar. From the tools that are now displayed, select the magnifying glass and use it to draw a box that includes the rectangle.
- Now select the push-pull tool and click on the rectangle to make it a three-dimensional shape. Type in as height 10.
- Now the 2nd skid must be drawn at a certain distance. To choose the correct starting point, select the tape measure from the toolbar. Click on the red axis and pull the measuring tape towards the green axis, stop at 30 mm. Now draw a rectangle of the size starting from the intersection of the green axis with the auxiliary line
- 100 mm x 10 mm to the rear and pull it up to a height of 10 mm with the "push / pull" tool.
- Next, draw the two Lego bricks lying across it. For this you can enter the distance with the aid of the tape measure and draw in the appropriate rectangle, which is then pulled up to 10 mm.
- It can happen that the new squares are automatically combined with the existing Lego bricks. A possible solution for this is to make a three-dimensional body from the resulting surfaces (planes) and then to separate the resulting body into the individual stones by adding or removing lines. For the triangle you can use the drawing tool.
- In the Materials menu on the right side you will find colors.

