3D Printing and Reprap

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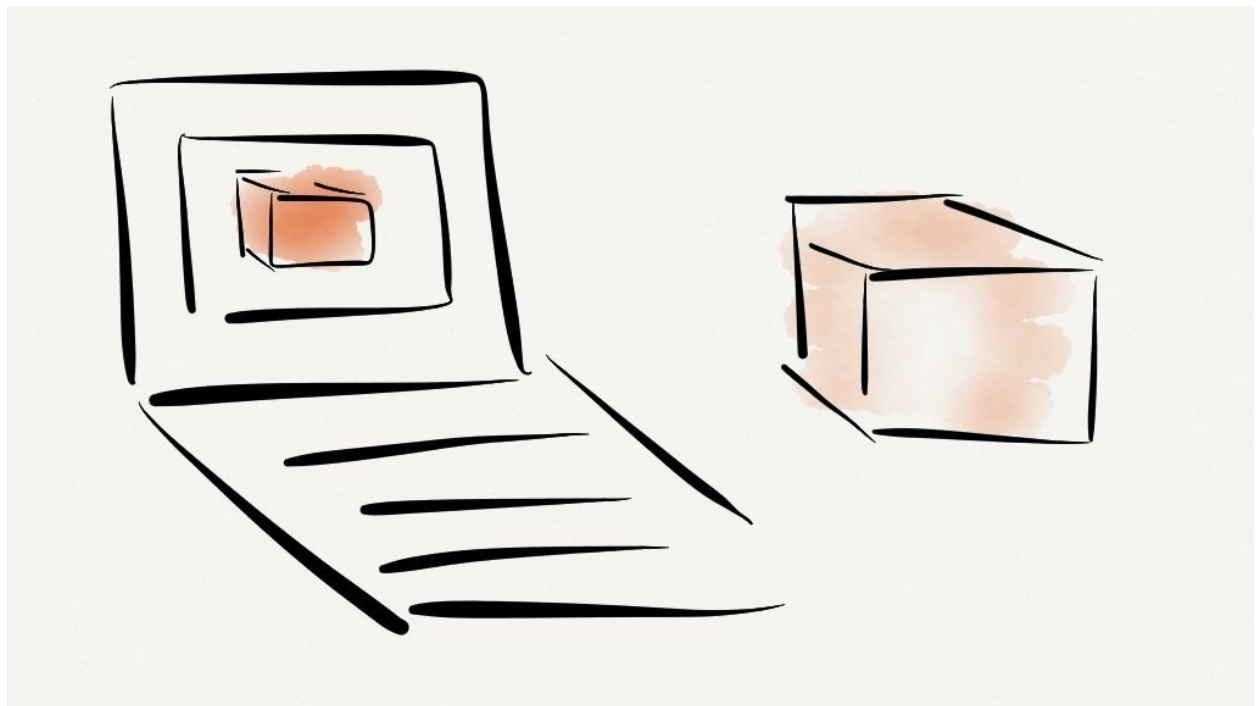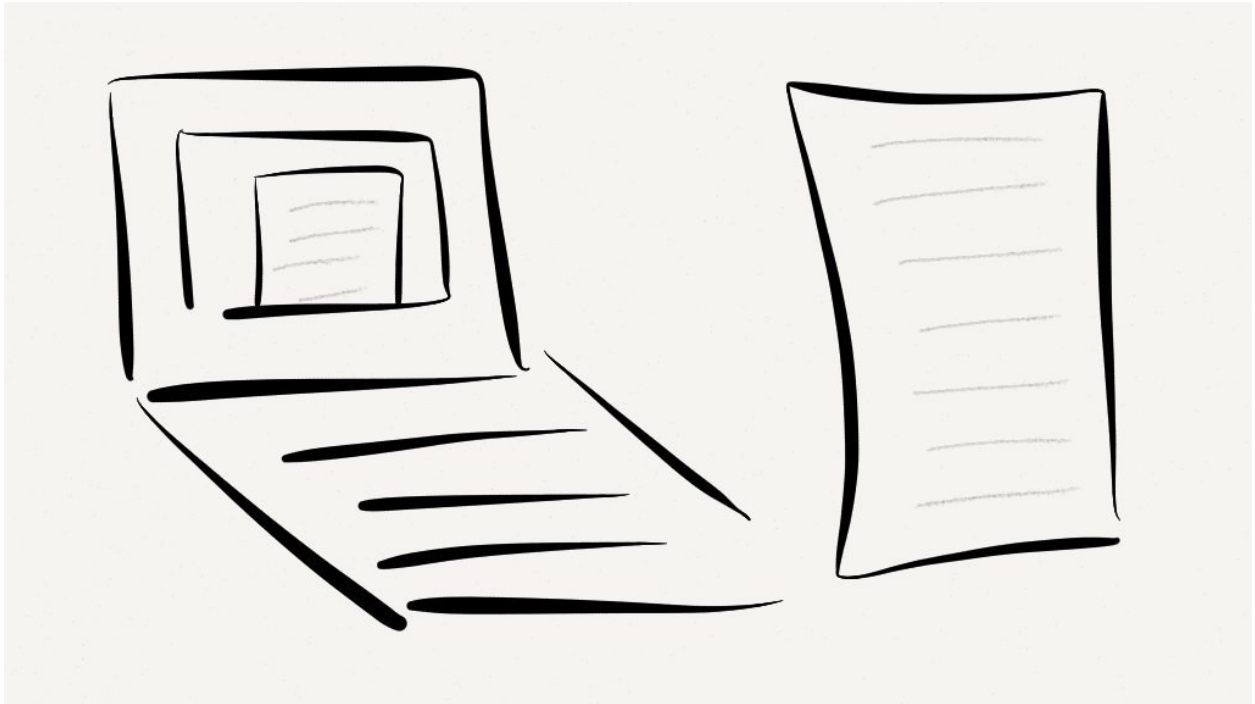# Chapter 1: Introduction

What is 3D printing?

Simply put, 3D printing is the process of turning an electronic three-dimensional model and turning into a real, physical, tangible object.

This might sound complicated, but it's only slightly more complex than printing two-dimensional objects (like this page) which you're probably already familiar with.
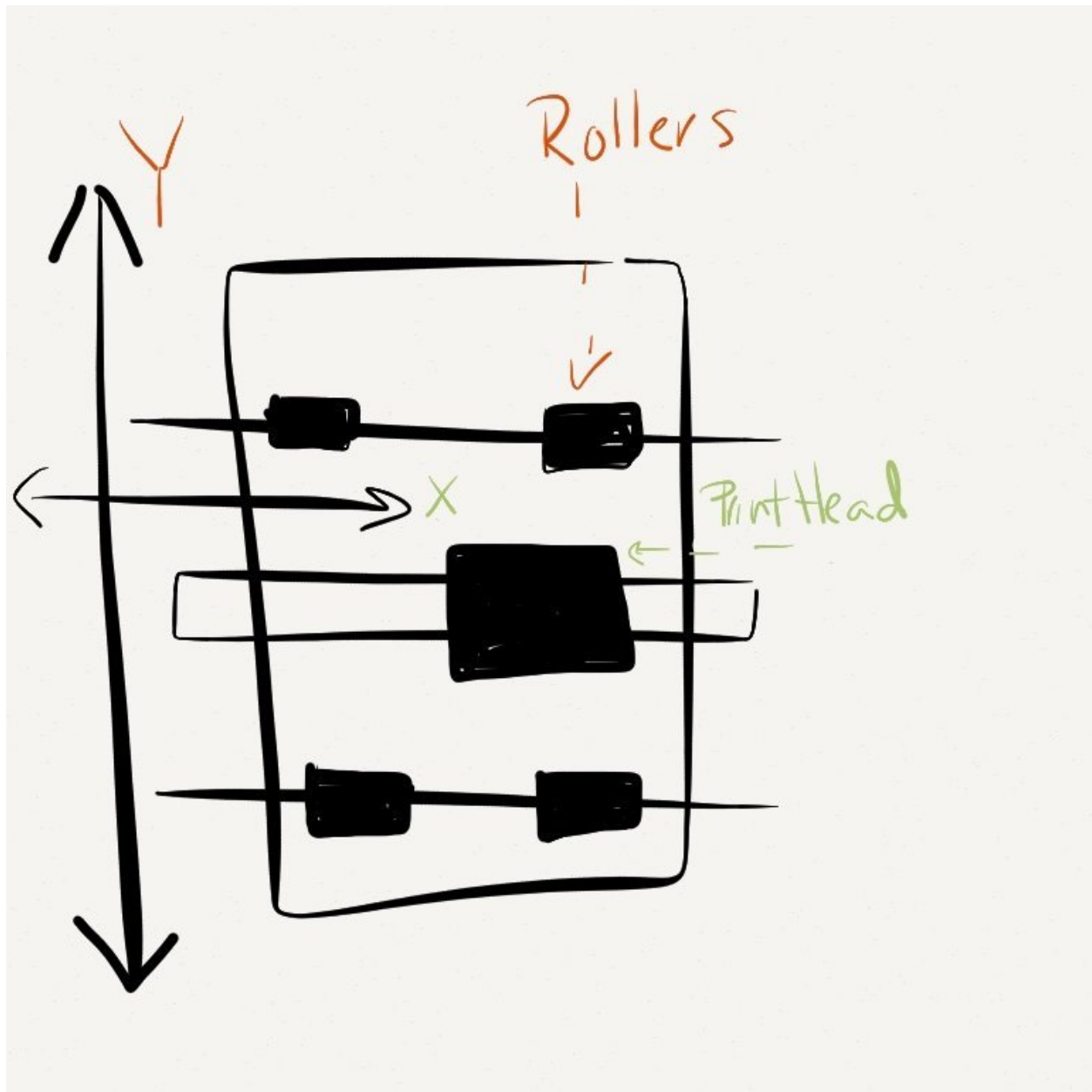
For example, if you start writing an email you're creating an electronic model of a two-dimensional object. If you were to print this email using your printer, the result would be a physical, tangible object built from the 2d model you created.

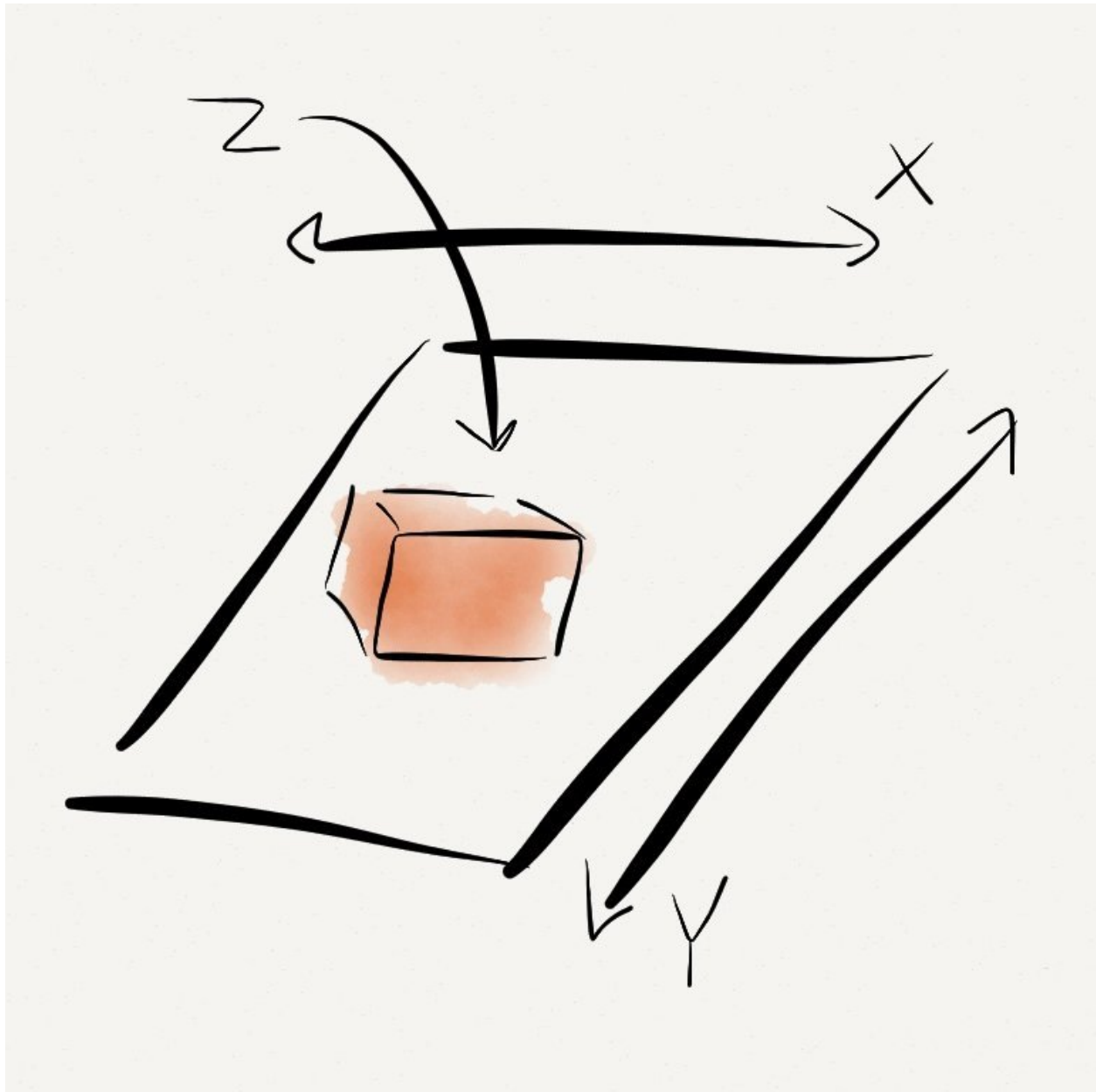**An email is a digital model of a old-fashioned letter**

This "model" (the email message) contains enough information to know what space on the sheet of paper need to be filled in with ink (black) and what space can be left blank (white). A more complicated model might include information about multiple colors as well, and depending on the capabilities of the printer, the paper that comes out might have colored letters (if it is a color printer) or black-and-white only, if that's all the printer can do.

Inside your printer, the model (email) is read line-by-line and a printhead in the printer squirts ink on the paper one line at a time. As each letter is printed, the head moves (this is the "X" axis) and prints the next letter. When the end of a line is reached, the paper is moved ("Y" axis) and the head prints the next line. When the end of the model file (email) is reached, the printer moves the paper in the Y axis to eject it.

A typical computer printer moves the paper along the Y axis while the ink cartridge moves in the X

3D printing is strikingly similar, but for and addition of a third axis, the "Z" axis. A model is constructed using an editor (editors are discussed in detail in Chapter 3), which is then sent to the printer. The model is then read line-by-line, moving the printhead along the X and Y axis just like the 2d printer, but squirting plastic instead of ink onto the print surface until the entire layer is complete.

The 3D printer adds a third axis (Z) to add depth

The key difference is that instead of ejecting the print surface (as the paper was ejected in the 2d printing example), the print head then moves upward (Z axis) and prints another layer on top of the first. This repeats until the end of the model file is reached and the completed object is then "ejected" from the printer.

There are many different types of 3d printer (just as there are 2d printers) but most current designs share this same process of building a model layer-by-layer. This technique is referred to as "additive manufacturing" (AM) to differentiate it from methods that create objects by removing material from a larger piece (such as milling, laser cutting, etc.).

This book will focus on these AM-type machines, which have been around for decades but had been available only to large corporations and educational facilities until the Reprap project made it possible for individuals to have access to these machines.

What is Reprap?

A RepRap is a type of 3d printer defined by one characteristic: it is designed to be capable of producing copies of itself. To you this might sound fantastic (or obvious), but to varying degrees all RepRap printers are able to produce some percentage of the parts necessary to produce replicas of themselves. More information on the benefits and history of RepRap printers and the RepRap project can be found in Chapter 2.

Anatomy of a 3D printer

Thanks to the open nature of the Reprap project, 3D printers are evolving rapidly and by the time you read this there will undoubtedly be types of printers available that didn't exist when this book went to press. However there are a number of components that most 3D printers share, either literally or at least conceptually.

Printhead

Printhead is a generic term that you don't see used too often in conversation about 3D printing because often more printer-specific terms are used, but the principle of a printhead exists in all current 3D printer designs. The heads job is to deposit material in a precise fashion in the location determined by the axis. In filament-based printers, the head consists of several sub-components that work together to prepare and deliver plastic precisely to the model. These components are commonly organized into two groups referring to their operating temperature; the **hot-end** and the **cold-end**.

When filament is fed into the printer it first passes through the cold-end components. The first component is the extruder drive. The extruder drives job is to pull filament from the spool and push it through the rest of the print head. A common form of extruder drive consists of a gear and a wheel where the filament is pinched between the two, and a motor attached to the gear turns it, driving the filament through at a precise rate.