Hello and welcome to the exciting world of 3D Bioprinting!

We are excited to have you here. The technology you have in front of you has the potential of creating real, live human tissues and it is only your imagination that limits what you can do. This manual will serve as your guide for setting up your INKREDIBLE 3D Bioprinter, maintaining it, and also notifying you about safety precautions to ensure a long-lasting product lifetime. Make sure you read the entire manual before using the product for the first time. Let`s begin this exciting journey!
1. Safety information
Before you start using your INKREDIBLE 3D bioprinter, please take time to review the entire manual. Maloperation of the INKREDIBLE 3D bioprinter instrument can lead to severe and irreversible injuries if the safety instructions are not followed. Throughout the manual we will use the following two symbols to indicate if there is risk for equipment damage or personal injury:

⚠️ WARNING! This symbol will indicate if there is risk of personal injury.

⚠️ CAUTION! This symbol will indicate if there is risk of causing damage to your INKREDIBLE 3D Bioprinter or other equipment.

In addition to the manual, we are continuously uploading instruction videos on our YouTube-channel, CELLINK3D. To access it go to:

http://tiny.cc/rbz7xy

1.1 General safety information

In order to respond to the INKREDIBLE 3D Bioprinter and its relevant security requirements, the instrument has to be operated by trained personnel, who are aware of the risks and dangers that can be induced to themselves, as well as for the staff being in close proximity with the INKREDIBLE 3D Bioprinter. The staff being involved in the installation, or the maintenance of the system or a part of the system, has to be qualified through appropriate training. Use the instrument only for its intended purpose as described in the documentation. Do not modify the instrument, sub-components or accessories.

⚠️ WARNING! Never reach into the instrument until all components of the instrument have come to a complete stop. Moving parts can cause serious injuries.

⚠️ WARNING! The INKREDIBLE 3D Bioprinter is fitted with a 365nm (405nm optional) UV LED. Do not look directly at the light source. Always wear protective gear when operating the system, including UV protective goggles.

⚠️ WARNING! Before cleaning, inspecting, adjusting, repairing or disassembling the instrument or the dispensing units, stop the instrument, turn off the main switch and disconnect if from its electrical power source.

⚠️ WARNING! Improper mounted pressurized air spouts, liquid spouts or cartridges can be dangerous. Verify that all connections are properly connected and all components are specified for use with the intended pressure. Verify that the supplied air pressure does not exceed 400 kPa.
1.2 Protective equipment

WARNING! Always wear protective goggles and gloves while handling dangerous materials that can be absorbed by skin or which are toxic, strike-attractive, corrosive, causing allergies, carcinogenic, reproduction-endangering or mutagenic to humans.

WARNING! Always read the material safety data sheets, packing labels, manufacturer or dealer’s catalogue first and use adequate safety equipment.

1.3 Liquids and dispensing media

WARNING! Before starting to work with hazardous dispensing materials, the operator has to be informed about the characteristics of the material and its compatibility with the dispensing unit. The information can be found in the material safety data sheets, packaging labels, manufacturer or dealer catalogues. Always use adequate safety equipment.

1.4 Opening the product and service

WARNING! The INKREDIBLE 3D Bioprinter SHOULD NOT be taken apart. Doing so endangers both the users and the equipment! The INKREDIBLE 3D Bioprinter IS NOT user servicable! Opening of the instrument’s electrical panel will void the warranty.
2. Introduction to your INKREDIBLE 3D Bioprinter
The INKREDIBLE 3D bioprinter is a pneumatic-based extrusion bioprinter with dual printheads and UV LED curing system for bioprinting of complex human tissue models and organs for tissue engineering research. It is a cost-effective unit for innovators to enter the 3D bioprinting field and start bioprinting living tissues at ease. It can be used as a standalone unit thanks to its LCD controller or it can be monitored through a computer with the use of the accompanied software. Your three-dimensional CAD models are translated into coordinates and instructions for the INKREDIBLE to allow the bioprinter to move according to a defined path. The bioprinting process works through the extrusion of a bioink or hydrogel biomaterial combined with human cells in a bottom-up, layer-by-layer fashion until a 3D construct is built. Once the construct has been bioprinted, it is crosslinked using the UV LED curing system or ionic solutions, depending on your bioink’s crosslinking requirements.

2.1 Specifications

2.1.1 Bioprinting

Bioprinting Technology: Pneumatic-based microextrusion system
Printheads: 2 pneumatic-based extrusion printheads.
1 UV LED curing system 365 nm (405 nm optional)
Build Volume: 130 x 80 x 50 mm. Printbed has Insets for P100 petri dish and multi-well plates
Positioning Precision: XY: 10 µm [0.0004 in]; Z: 2.5 µm [0.0001 in]
Layer Resolution: 100 µm [0.0039 in]
Hydrogel’s viscosity range: 0.001 to 250 Pa.S [1 to 250,000 cP]
Max. Operating Pressure: 700 kPa
Set Pressure Range: 5 to 400 kPa
Sensitivity: Within 0.2% F.S. (0.8 kPa)
Repeatability: Within ±1% F.S. (4 kPa)
Minimum Unit Setting: 1 kPa
Pressure Display Units: kPa, MPa, kgf/cm², bar, psi, inHg and mmHg
Printhead's Response Time: 5 ms or less (ON), 4 ms or less (OFF)
Nozzle Length: Auto-calibration, 6.35 mm [0.25 in] to 38.1 mm [1.5 in]
Nozzle Diameter: User dependent, 50 to 1540 µm
2.1.2 Software
Software Bundle: Slic3r, Repetier-Host, HeartWare
File Types: STL/OBJ/AMF
Supports: Windows (XP 32 bit/7+), Mac OS X (10.6 64 bit/10.7+) and Ubuntu Linux (12.04+)
Connectivity: USB, SD-card

2.1.3 Physical specifications
Frame: Chemically resistant, powder-coated high grade steel
D x W x H: 330 x 370 x 380 mm [19.1 x 16.5 x 14.7 in]
Shipping Box: 59 x 55 x 43 cm [23 x 21.5 x 17 in]
Shipping Weight: 20 kg [44.5 lbs]

2.1.4 Electrical
Power Supply Adapter:
  Input: 100-240VAC, 50/60Hz, 2.0A
  Output: 24VDC, 6.67A, 160W Max
Portable, Oil-free Air Compressor:
EU/UK/AU/CH: 230VAC, 50Hz
US/MEX/CA/JAP/Taiwan: 110VAC, 60Hz
INKREDIBLE 3D Bioprinter:
  Input: 24 VDC, 6 A

2.1.5 IP-classification
IP10

⚠️ CAUTION! If you want to use another air supply than the one provided by CELLINK, please contact us to avoid damage to your INKREDIBLE 3D Bioprinter.
3. Unpacking your INKREDIBLE 3D Bioprinter
When unpacking your INKREDIBLE 3D Bioprinter, be careful not to grab onto any movable parts or lose components. We recommend you grab it by the side window frames and pull it out from the box.

Once the INKREDIBLE 3D Bioprinter has been carefully taken out of the box, all protective films, zip ties and plastic parts preventing the axes to move during transportation can be removed. Once all protective materials have been removed, the INKREDIBLE can be placed at its intended place of operation (for example inside a biological hood or laboratory bench).

WARNING! Always be two people present when unpacking your INKREDIBLE 3D bioprinter to avoid personal injury.

CAUTION! The INKREDIBLE should never be placed on wet, damp, moist or humid surfaces.

CAUTION! Do not force or tear anything during the unpacking or setup process as this may irreversibly damage your INKREDIBLE 3D Bioprinter.
3.1 Contents of the box

[1x] INKREDIBLE 3D Bioprinter
[1x] User manual
[1x] Electrical supply box containing:
[1x] 24 V Power supply
[1x] Power cord
[1x] USB cable
[1x] Consumables box containing:
[2x] 3mL cartridge with CELLINK START
[4x] 3mL cartridge with piston and end caps
[2x] Blue conical nozzles (GA 22)
[2x] Red conical nozzles (GA 25)
[2x] White conical nozzles (GA 27)
[1x] Straight stainless steel nozzle (GA 22)
[1x] 24 well plate
[1x] Glass petri dish
[1x] UV-protective goggles
[1x] Tube with adapter to air compressor
[1x] Air supply box containing:

[1x] 150 W, 300 kPa portable, oil-free air compressor

[1x] STARTINK-kit containing:

[1x] Cell syringe
[1x] Prefilled syringe with 3 mL of CELLINK Bioink

[1x] Dispensing unit
[1x] Mixing unit
[1x] Filling cartridge
[2x] 5 ml of crosslinking solution
[1x] Material safety data sheet
[1x] Application note
4. Product map
[1] On/Off Button
[2a] Printhead 1 (Ph 1)
[2b] Printhead 2 (Ph 2)
[3] UV LED
[4] Printbed
[5a] Digital pressure monitor for printhead 1
[5b] Digital pressure monitor for printhead 2
[6] SD-card reader
[7a] Printbed adjustment butterfly screw
[7b] Printbed adjustment butterfly screw
[7c] Printbed adjustment butterfly screw
[8] Control knob
[9] Main LCD display
[10a] Cartridge air connector for printhead 1
[10b] Cartridge air connector for printhead 2
[11a] Pressure regulator for printhead 1
[11b] Pressure regulator for printhead 2
[12] Power input
[13] Pressure connector
[14] USB input
5. Operating your INKREDIBLE 3D Bioprinter
5.1 First time set up of your INKREDIBLE 3D bioprinter

The following steps should be followed the first time the INKREDIBLE 3D Bioprinter is used, as well as every time it is moved from one place of operation to another.

5.1.1 Calibrating the Printbed
It is important to ensure that the printbed is completely leveled compared to the internal axes of your INKREDIBLE 3D Bioprinter.
1. Verify that the INKREDIBLE 3D Bioprinter is disconnected from both the power outlet, the compressor, and your computer.
2. Insert an empty cartridge with nozzle into printhead 1 [2a] and push that printhead manually to the bottom most position.
3. Move the printbed manually, so the tip of the nozzle touches the surface of the printbed right in front of the adjustment screw to the back left [7a].
4. Leaving the printbed where it is, move the printheads manually so that nozzle is right in front of the adjustment screw to the back right [7c]. Adjust the butterfly screw until the nozzle touches the surface of the printbed.
5. Again, leaving the printbed where it is, move the printhead so that the nozzle is right behind the front adjustment screw [7b]. Adjust the butterfly screw until the nozzle touches the printbed.

5.1.2 Supplying Power and Air
1. Plug the power cord into the back [11] of the INKREDIBLE 3D Bioprinter and then into the power outlet.
2. Connect the air tube (provided) to the air compressor and then to the back of the INKREDIBLE 3D bioprinter [12].
3. Turn on the air compressor and regulate the air pressure of the air compressor to 300 kPa, using the knob on the top of the unit.
5.2 Bioprinting with the INKREDIBLE 3D Bioprinter

The following steps should be followed every time you use your INKREDIBLE 3D Bioprinter:

5.2.1 Installing the Cartridges
1. Attach nozzles to your cartridges with CELLINK Start (or other bioink of your choosing).
2. Connect the pressure connectors for printheads [10a] and/or [10b] to the printheads [2a] and/or [2b] by twisting the cartridge connectors.
3. Insert the cartridges inside the printheads [2a] [2b].

CAUTION! Verify there are two power outlets running on different fuses available at the workspace, otherwise the air compressor might cause electromagnetic interference with the INKREDIBLE.

CAUTION! Press the cartridges down thoroughly prior to initiating the next sequence.

4. Next, the INKREDIBLE 3D Bioprinter needs to be homed and calibrated.

5.2.2 Homing the Bioprinter:
1. Start by turning the INKREDIBLE on with the power button [1].
2. Use the following sequence to home the INKREDIBLE 3D Bioprinter:
3. Remove all objects from the printbed [4] (such as well plates, petri dishes etc.)
4. Lower the printbed [4] manually by simply pushing down at the back of the printbed.
5. Press the control knob [8] once to enter the menu.
6. Turn the control knob [8] to select “Prepare Bioprint” and press to enter.
7. Turn control knob [8] to “Home Axes” and press it to select. The INKREDIBLE 3D bioprinter will now home all axes. The nozzle of printhead 1 should be in the middle of the printbed once the sequence is completed.

WARNING! Never reach into the instrument while it is moving. Wait until all parts have come to a complete stop before reaching into the instrument.

5.2.3 Calibrating the Z axis:
1. Next, the Z Axis needs to be adjusted and calibrated to bioprint in a petri dish. Use the following sequence to do this:
2. Place a petri dish onto the printbed [4].
3. Press the control knob [8] once to enter the “Menu”.

straight out from the side of the INKREDIBLE 3D bioprinter.
4. Turn the control knob [8] to select “Prepare Bioprint” and press the control knob [8] to enter.
5. Turn the control knob [8] to select “Move Z” and press the control knob to enter. You have now entered Manual Z Calibration Mode. On the display you should see: Z:+040.0 (position of Z axis: 40 mm).
6. Turn the control knob [8] until the nozzle of printhead 1 is right above the petri dish. A space of about 0.1 mm should be visible between the printbed and the tip of the nozzle. You can use a piece of paper to slide between the nozzle and the petri dish to measure the distance. The paper should slide freely without too much friction.
7. Once the correct distance has been selected, Press the control knob [8] once to exit the Manual Calibration Z mode.
8. Select “Calibrate Z” using the control knob, press the control knob to confirm.

5.2.4 Setting the pressure:
Finally the printing pressure needs to be adjusted to ensure a good flow. To do this, use the following sequence:
1. Unlock the pressure regulators [11a] and [11b] by pulling the knobs straight out from the side of the INKREDIBLE 3D bioprinter.
2. Turn down the pressure in both printheads to 0 by turning the pressure regulators [11a] and [11b] counter clockwise until they reach a complete stop. The digital pressure monitors, [5a] and [5b], should now display 0 kPA (If not, see “8.2.10 Pressure monitor not displaying correct pressure”).
3. Turn on the compressor.
4. Turn the control knob [8] to select “Prepare Bioprint” and press to enter.
5. Turn the control knob [8] to select “Turn ON PH1”. Printhead 1 [2a] is now turned on.

CAUTION! When the pressure and the printhead are turned on the printhead will immediately start dispensing printing material. Be sure to collect the spare material in a separate container (for example a spare petri dish or lid) to avoid it from interfering with the bioprint.

6. Adjust the air pressure to your desired flow by turning the pressure regulator for printhead 1 [11a] (for CELLINK Start and a red nozzle, 28 kPa gives a good flow of printmass).
7. When you have acquired your desired flow, press the control knob to turn off the printhead (the printhead will turn on automatically when a bioprint is initiated).
8. Repeat this process for printhead 2 if you wish to print with dual print heads.
5.2.5 Starting the print:
1. The INKREDIBLE 3D Bioprinter is now ready to bioprint! Start by inserting your SD-card, containing the 3D model you want to print, into the SD-card reader [6].
2. In the menu, turn the control knob [8] to “Bioprint” and press to enter. If the “Bioprint” option does not show up in the menu, control that your SD-card is properly inserted and use the control knob [8] to select “Reload SD-card”. This should make the “Bioprint” option available in the menu.
3. Use the control knob [8] to select the model you wish to print and push to start the bioprinting process.

The bioprinting process is now running! The pressure can be adjusted during bioprinting process in order to have continuous flow, simply turn the pressure regulators [11a] and [11b]. Once the bioprinting process is completed the printbed will lower.

WARNING! The INKREDIBLE 3D Bioprinter includes moving parts that can cause injury. Never reach inside the INKREDIBLE while it is in operation. Always allow the INKREDIBLE 3D Bioprinter to come to a complete stop prior to reaching inside.

CAUTION! Never leave the INKREDIBLE 3D Bioprinter unattended during operation!

You can try bioprinting any of your bioinks or hydrogels. Simply, load it in the cartridges and configure your bioprinting parameters (printing pressure and printing speed). Configurations, pressure adjustments, and any development of printable biomaterial is your responsibility. CELLINK is not responsible for any clogging or damages caused by any user-dependent biomaterial bioprinted with your INKREDIBLE 3D Bioprinter.
5.3 Advanced features

5.3.1 Crosslinking using the UV LED
If you wish you can crosslink bioprints using the built-in UV LED crosslinking system of the INKREDIBLE 3D Bioprinter. To do so follow these steps:
1. Manually place the UV LED [3] as close as possible to the top of the bioprinted construct.
2. Select the “Utilities Menu” and press the control knob to enter [8].
3. Select “Turn ON LED” and press the control knob to turn on the UV LED. To turn off the UV LED curing, simply select “Turn OFF LED” and press the control knob [8].

The crosslinking time will vary depending on the bioink used and the thickness of layers/construct.

WARNING! Always wear UV protective goggles and gloves, and secure the environment of the instrument to other personnel while operating the INKREDIBLE. All safety equipment, including UV protective safety goggles, must be used with the UV curing system.

5.3.2 Bioprinting using dual printheads
To bioprint using dual printheads, first control the following:
1. When converting your 3D model to G-code, verify that you are using a profile that supports using dual printerheads.
2. Verify that both cartridges have the same length nozzle attached.

CAUTION! The INKREDIBLE 3D Bioprinter CAN NOT bioprint using nozzles with different lengths! Doing this can damage your INKREDIBLE 3D Bioprinter!

3. Verify that printhead 1 and printhead 2 are completely level with each other:
   - Select the “Utilities Menu” in the menu and enter by pressing the control knob [8].
   - Select “Home printheads” by pressing the control knob [8].
   - Select “Raise printheads” by pressing the control knob [8].
   - If the printheads are not completely leveled, follow the instructions in chapter 8.2.7 “Dual head bioprinting: Printhead 1 and printhead 2 are not leveled with each other after the “Raise printheads” option has been selected”.

CELLINK®
6. How to install and setup HeartWare
6.1 Installing HeartWare (PC)

NOTE: This section describes the install process for Windows PC software only. Skip to “6.2 Installing Repetier-Host (Mac)” if you own a Mac!

NOTE: If you have a previous version of HeartWare installed on your PC, perform the steps found in “6.1.1 Uninstalling HeartWare” before attempting to reinstall or update HeartWare. Failure to do so may cause slicing issues.

1. There are three ways of finding the HeartWare install file:
   • Insert the SD card that came with your machine and copy the file “setupHeartWare_2_4_1.zip” to your PC.
   • Refer to the electronic version of this manual, click the following link, navigate to “CELLINK HeartWare for PC” and download “setupHeartWare_2_4_1.zip.
   • Go to the CELLINK Support page at https://cellink.com/support/, click “Downloads” and select “Download” next to HeartWare.

2. Open the ZIP archive and run “setupHeartWare_2_4_1.exe”.

3. Select your desired language.

4. If prompted to setup the Python Runtime Environment, select “Yes”.

![Select Setup Language](image)

![Setup](image)
5. Click “Next” after the next three prompts unless you need to customize:
• The users for which Python is installed
• The path in which Python is installed
• The components of the Python package you want installed
However, leaving the default options is strongly recommended.

6. Click “Finish” to continue the installation of HeartWare.

7. You may select “Next” past the next several prompts unless you need to customize:
• The path for HeartWare
• The components of HeartWare
• The title of the Start Menu folder
• The option to create a shortcut upon installation
8. Click "Finish" to complete the installation.

6.1.1 Uninstalling HeartWare
Sometimes, issues with the functionality of HeartWare can be resolved by completely
uninstalling and reinstalling HeartWare. In addition, to update HeartWare, the old version,
must be completely uninstalled.
1. Click the “Start” icon on the bottom left corner of your desktop.
2. Click the “Settings” icon on the left side of the Start Menu.
3. Select “Apps”.

![Windows Settings](image)
4. Scroll through the list till you find “Cellink HeartWare version 2.4.1”.

5. Press “Yes” on the following three prompts, and HeartWare will be uninstalled. This will not uninstall Python 2.6 or remove your Slic3r settings.
6.2 Installing Repetier-Host (Mac)

Repetier-Host allows Mac users to slice their models and control their machines; however, the functionality is not quite identical to HeartWare. Perform the Homing and Calibrating of the Z-Axis, which can be found in sections 5.2.2 and 5.2.3, before initiating the print from the Repetier-Host for Mac software.

1. Navigate to the Repetier-Host page by either:
   - Go to the CELLINK Support page at https://cellink.com/support/, click “Downloads” and select “Download” next to Repetier-Host.
   - Go to the Repetier-Host site “https://repetier.com/download-now/” and select “Repetier-Host Mac 1.10”.

2. Open the downloaded DMG file, and you will see the window below:

Secondary click “Repetier-Host Mac” and copy it.
3. Paste it into the “Applications” folder in Finder.

4. Open the “Repetier-Host Mac” file to start the install process.

A security message may appear because the Repetier-Host Application is from an “unrecognized developer”.

"Repetier-Host Mac" can’t be opened because it is from an unidentified developer.

Your security preferences allow installation of only apps from the App Store and identified developers.

"Repetier-Host Mac" is on the disk image "Repetier-Host-Mac_1.1.0.dmg". Google Chrome downloaded this disk image today at 12:54 PM from download.repetier.com.
5. Open the “System Preferences”.

6. Go to “Security & Privacy”.
7. Click “Open Anyway”.

8. Click “Open”
9. Open Repetier and read through the “First Steps” to familiarize yourself with the app. Then, follow the setup instructions in “6.3 Setting up HeartWare/Repetier Host to configure your software to your INKREDIBLE.
6.3 Setting up HeartWare/Repetier Host

1. When HeartWare starts for the first time, select “Skip this Version”
2. Start by clicking on “Printer Settings”
3. Copy the settings in the images below for any INKREDIBLE series bioprinter
4. Once you are done, press “Apply,” then click “OK.”
7. Slicing with HeartWare
To bioprint anything, computer-based models need to be converted into a series of instructions that the bioprinter can follow to make an object. The definitions below are meant to explain why slicing is a necessary process and why models cannot be directly transferred to the INKREDIBLE for printing.

7.1.1 Models
3D computer models represent objects or geometric volumes. These models can be generated from image stacks like CT scans and MRIs or from design software on a computer (CAD). Numerous file 3D model file types exist for use with different kinds of CAD software, each differing by the mathematical expressions used to store them on the computer. For 3D printing, the file most commonly used is a Stereolithography or STL file. An STL, in general, is a list of Cartesian coordinates grouped in threes to represent triangles. Edge-to-edge contact of these triangles forms a mesh that defines the exterior of an object.

7.1.2 Slices
The INKREDIBLE is a pneumatically driven bioprinter that extrudes material in thin strands. To build a model, the INKREDIBLE must extrude a series of strands in distinct paths such that the printed material looks like the model desired. An STL file does not have the information needed for the INKREDIBLE printhead to follow these distinct paths. In addition, as a hollow mesh, the STL lacks the inner structure information needed to prevent the top of the print from collapsing on itself. Slicing software breaks an STL into a vertical stack of paths that the INKREDIBLE can follow to both produce the exterior of an object and the inner structure to support it. Each path is broken into a list Cartesian points for the INKREDIBLE to follow called G-codes. The full list of INKREDIBLE movements and actions is called a G-Code file.
7.2 HeartWare Interface

The HeartWare interface can be divided into 5 sections:
1. Top Tool Bar
2. Left Tool Bar
3. View Window
4. Log
5. Right Control Window

7.2.1 Top Tool Bar
The Top Tool Bar contains buttons for loading models and G-code, connecting your machine, HeartWare preferences, and toggling the appearance of visualizations in the View Window. Below, you will find the capabilities of these buttons:

- **File** – Load models, take screenshots of the view window, show the directory where G-codes are generated, load recent models, and exit HeartWare.
- **View** – Snap camera to specific orientations with respect to the print area and toggle appearance of visualizations within the View Window [3].
- **Config** – Language, printer, and HeartWare settings and preferences
- **Tools** – Not relevant for CELLINK bioprinters.
- **Help** – Check HeartWare version. The rest of the functions are not relevant to CELLINK bioprinters.
- **Connect** – Connect your INKREDIBLE to your machine to control movements or run prints. Note: Your INKREDIBLE must be connected securely via the provided USB cable for this to work, and “SD Print” should be disabled from the “Utilities” menu on the INKREDIBLE.
- **Load** – Load G-Code and model files. Click the arrow to the right to view and load recent files.

**Show Filament** – Hide and unhide the appearance of printed material in generated G-Code within the View Window [3].

**Show Travel** – Hide and unhide the appearance of printer movement with no extrusion (non-print moves) in generated G-Code within the View Window [3].

### 7.2.2 Left Tool Bar

The Left Tool Bar contains many of the same functions available within the View button of the Top Tool Bar [1], in addition to other buttons. Below, you will find the capabilities of these buttons:

- **Rotate** – Sets the left click + drag behavior of the mouse to move the camera around the print area.

- **Move Object** – Sets the left click + drag behavior of the mouse to move selected models across the printable area in the XY plane only.

- **Zoom** – Sets the left click + drag behavior of the mouse to move the camera closer and further from the print volume.

- **Zoom Objects to Fit** – Sets the camera distance from models such that the objects fill the dimensions of the View Window.

- **Isometric View** – Aligns the camera with the top-front-left corner of the print volume.

- **Front View** – Aligns the camera orthogonally to the front of the print volume.

- **Top View** – Aligns the camera orthogonally to the top of the print volume.

- **Use Parallel Projection** – Alters the perspective of the camera such that models closer to the camera do not appear larger than objects further away. Useful for qualitatively examining the relative size of objects.
7.2.3 View Window

The View Window allows you to perform several functions:
- Examine the size and position of models, relative to the print volume.
- Examine the results of transformations performed within HeartWare.
- Preview G-Code, as interpreted by HeartWare, for quick verification of accurate printer commands.
- View the progress of the print to compare the fidelity of the physical print to the commands listed in G-Code.

Interaction in this window is predominantly performed by holding down the left, right, or middle mouse buttons (MB), which can change functions with the use of buttons on the Left Tool Bar or the “Ctrl”, “Alt”, and “Shift” keys. Many of the same functions can be performed with different key combinations.

When “Rotate” from the Left Tool Bar is active:
- **Left MB** – Rotate the camera around the print area, using the center point of the current view as the axis of rotation.

When “Move Object” from the Left Tool Bar is active:
- **Left MB** – Drag a selected object in the XY-plane. You cannot select objects by clicking the “Left MB”.
- **Right MB** – Click a model to select it, then drag to move the object in the XY-plane.
- **Middle MB** – Pan the camera left, right, up, and down, using the current view as the plane of movement.

Holding “Ctrl” and:
- **Left MB, Right MB, or Middle MB** – Rotate the camera around the print area, using the center point of the current view as the axis of rotation.

Holding “Shift” and:
- **Left MB, Right MB, or Middle MB** – Pan the camera left, right, up, and down, using the current view as the plane of movement.
- **Clicking the Right MB** – Select multiple models in the print volume. Click a model again to deselect it.

Holding “Alt” and:
- **Left MB** – Drag a selected object in the XY-plane. You cannot select objects by holding “Alt” and clicking the “Left MB”.
- **Right MB** – No function.
- **Middle MB** – Pan the camera left, right, up, and down, using the current view as the plane of movement.
7.2.4 Log
The Log window provides feedback from both the slicer and a connected printer to confirm thorough slicing, display any errors, and record information from the printer such as temperature, action confirmation, and calibration coordinates. Through toggling of the radio buttons at the top of the Log, you can display and hide these different kinds of information.

7.2.5 Right Control Window
The Right Control Window contains all the tools need to progress through the workflow of slicing models. Through carrying out steps from the left tab to the right tab, models can be placed, scaled, designated print parameters, and sliced. This section will briefly cover the functions of each tab; however, details will be covered through the explanation of the workflow in section 7.2 Basic Slicing Workflow.

Object Placement – Add, translate, rotate, scale, and designate printheads for models.

Slicer – Select print, printer, and material settings, then slice models. You can find a shortcut to the Slic3r settings configuration here as well.

Print Preview – When selected, the visualization in the View Window will change to the most recently generated or loaded G-Code for the current HeartWare session. Save or run loaded G-Code, and view estimated print statistics regarding print time, layers, and lines of code. The visualization tool can provide a layer-by-layer preview of what the INKREDIBLE will print.

G-Code Editor – Displays the full set of G-code instructions, which can be edited and saved. By placing the cursor at a line in the code, a section of the visualization in the View Window will be highlighted yellow, indicating the effect of that line. The same visualization tools in the Print Preview are also available here.

Manual Control – If an INKREDIBLE is connected via a USB cable and the Printer Settings are correctly configured, many actions can be performed from this window such as movement, needle calibration, and temperature control (the LCD menu must be used to assign a temperature first).

SD Card – An SD card can be inserted into a computer and then the print carried out through a USB connection; however, running prints directly off the SD card inserted into the machine or from the local storage of the PC are more direct and reliable ways of printing.
7.3 Basic Slicing Workflow

7.3.1 Staging Your Models

Before you can create code, you must place models, in the form of .STL or .OBJ files, within the print volume, then scale and spatially arrange them to suit your application.

1. To add files you may:
   - In the Top Tool Bar, go to “File” > “Load”.
   - In the Top Tool Bar, click on the “Load” icon.
   - In the Right Control Window, click “Add Object”.

Your View Window will look like the image below, with the cylinder replaced with the model of your choice:

2. Now, you can perform transformations on your objects. Below is a description of information and buttons available in this tab:

The highlighted box corresponds to each model you load: the name of which is written below “Object Group 1”. You can change the visibility with the icon, view detailed model information with the icon, and delete the model with the icon.
**Export** – Once one or models have been positioned in a desired arrangement, they can be saved for later use. This can be useful if the same arrangement will be sliced at different thickness, run with different infill, or built with different materials.

**Add Object** – Load a model.

**Copy Object(s)** – Create additional copies of one or more models. These can be created in the same exact coordinates relative to the original or automatically spaced apart.

**Autoposition** – Automatically arrange multiple models 6mm apart from one another in the XY plane.

**Center Object** – Drop a single model in the center of the print area, leveled to a height of Z = 0mm

**Scale** – Resize models using scale factors. These factors can be applied to one or all axes simultaneously. In addition, the model can be scaled to fill the entire print volume (ratios will be preserved). Click “Reset” to return the model to its original size.

**Rotate Object** – Rotate an object around the X, Y, or Z axes using degrees. This can also be used to level the object with respect to what HeartWare determines is the closest flat surface.

**View Cross-Section** – Use a cutting plane to hide a portion of the model. The “Position”, “Inclination”, and “Azimuth” sliders control the amount and angle of the portion of the model that is hidden and shown.

**Things to consider when placing your models:**

- If printing multiple parts, leave a few mm of room between each part to ensure they don’t collide during the print.
- All materials need time to solidify when being printed. While this is happening, if there is nothing below to support the material it can sag, affecting not only that layer, but all the layers above it. This type of geometry is called an overhang. Try to orient parts or support them to minimize the presence of overhangs.
- Flat surfaces are the most stable, so you should try to use those as the base of the print, along the print bed.
7.3.2 Slicing Your Models

Once your models have been arranged, they can be sliced. There are a myriad number of settings you can control to dramatically change the properties of printed models from print to print.

1. Navigate to the “Slicer” tab in the Right Control Window and you should see the following:

**Slicer** – Method by which models are converted into discrete layers for printing. CELLINK bioprinters only use Slic3r.

**Print Setting** - Defines numerous parameters that affect the geometry of the printed object. This includes: the number of perimeters, the infill, and the speed of the printhead among others. See the Slic3r Guide for an in-depth explanation of these parameters. Correctly set up HeartWare software will include several presets based on applications you might be trying to accomplish such as printing scaffolds, blood vessels, tubules, or skin patches. These provide a basis from which settings can be fine-tuned to better suit the materials, mechanical-properties, porosity, or other characteristics you may need. “Organ Simple” is a great setting to use when initially becoming acquainted with various INKREDIBLE printing procedures.

**Printer Setting** – Provides the Slic3r with information as to the diameter of nozzles used and desired custom movement behavior to use before, during, and after the printing process. The default, “INKREDIBLE” will work for most materials.

**Filament Setting** – With respect to the INKREDIBLE, this solely provides temperature information to the Slic3r for materials that require different temperatures for printing or when printing with cells. The default “Untitled” will not set any temperature on the heads at all.

**Override Slic3r Settings** – Checking this box will enable the options below for applying a custom layer height or infill to a print without saving these settings permanently in a “Printer Setting” preset.
2. When you have selected the settings that align with your needs, click “Slice with Slic3r”. The software will automatically switch to the “Print Preview” tab and the View window will look like the image below.

The blue lines depict the path that the printhead will follow to extrude print your part. You can use the sliders under “Visualization” in order to examine the path of each or a set of layers.
3. The model sliced, and the G-Code generated, now you can decide how the file gets printed:

**Print** – If an INKREDIBLE is connected to the PC, you can run the print directly with this button. See 5.2.5 "Starting the Print" for how to print directly from a PC.

**Edit G-Code** – Clicking this will create a new "G-Code Editor" tab, which will become the active tab. Use the “GCode Guide” for assistance navigating this section.

**Save to File** – This function store will store the G-Code file in a local directory on the PC. This is useful for reusing the G-Code or modifying it using an external software suite.

**Save for SD Print** – Like “Save to File”, it is designed for reuse of the G-Code file; however, for space-saving reasons, comments within the code are completely removed. In addition, it performs modifications to the code that are not necessary for the INKREDIBLE. Using this function is not recommended.

Congratulations, you have sliced an object for use with your INKREDIBLE bioprinter!
8. Maintenance and troubleshooting
8.1 Maintaining your INKREDIBLE 3D Bioprinter

8.1.1 Cleaning your INKREDIBLE 3D Bioprinter
The INKREDIBLE 3D Bioprinter is coated with a chemical resistant coating. It can be cleaned with chlorine or ethanol in order to sterilize the surface.

8.1.2 Cleaning out moisture from the air compressor
About once a month collected moisture needs to be cleaned out of the air compressor. To do so simply press the valve on the bottom of the condensation collection cap.

8.1.3 Lubricating the lead screw and the carriage rods
After approximately 50 hours of build time, you should lubricate the lead screw and the carriage rods. PTFE-based grease should be used to lubricate the lead screw and liquid IP-lubrication should be used to lubricate the carriage rods. To lubricate the INKREDIBLE 3D bioprinter, follow these steps:

1. Turn off the printer and disconnect it from the power outlet.
2. Grasp both sides of the back of the printbed and push it gently to the bottom of the INKREDIBLE 3D Bioprinter.
3. Use a clean, lint-free rag or your finger to spread the grease onto the top section of the lead screw. Verify you get the grease inside of the threads themselves.
4. Grasp both sides of the printbed and move it to the top of the INKREDIBLE (be careful not to get any grease on the printbed).
5. Use a clean, lint-free rag or your finger to spread the grease onto the bottom section of the lead screw. Verify you get the grease inside of the threads themselves.
6. Gently push the X-carriage to the back of the printer.
7. Gently push the printhead carriage all the way to the left.
8. Lubricate the exposed segments of the carriage rods. Be careful not to spill any lubricant onto the baseplate of the printer.
9. Gently pull the X-carriage all the way to the front.
10. Gently push the printhead carriage all the way to the right.
11. Lubricate the exposed segments of the carriage rods.
12. Gently pull the printhead carriage from side to side a few times to spread the lubricant.
13. Gently pull the X-carriage forwards and backwards a few times to spread the lubricant.
8.2 Support for your INKREDIBLE 3D Bioprinter

Please visit CELLINK’s Support Portal for updated information on your INKREDIBLE 3D bioprinter.
www.cellink.freshdesk.com/
www.cellink.freshdesk.com/support/solutions/35000068779

8.2.1 One or both of the printheads are not dispensing ink or not dispensing ink in a continuous flow

The issue is most likely that the nozzle(s) are clogged. To fix this, do the following:
1. Press the control knob and select “Pause bioprint”
2. In the “Utilities Menu”, turn off the printhead(s).
3. Remove the cartridge(s) from the printhead(s) causing the problems WITHOUT removing the air pressure hose.
4. Remove the nozzle of the cartridge(s) and replace it with a new one of the same type.
5. Carefully place the cartridge(s) back into the printhead(s).
6. Press the control knob and select “Resume bioprint”.

8.2.2 The “Bioprint” option is not showing up in the menu

The issue is most likely that the SD-card was or is not properly inserted. To fix this, do the following:
1. Verify that the SD-card is properly inserted in the SD-card reader.
2. Select the “Reload SD-card” option from the main menu.

8.2.3 Selecting a file in “Bioprint” does not start the bioprinting process

The issue is most likely that the temperature was not set to 0 when preparing the print file in the Slic3r software. To fix this, do the following:
1. Open up the STL-file in the Slic3r software.
2. Under the “Filament Settings” tab, check that:
   - The extrusion temperature is set to 0 for both first layer and other layers.
   - The bed temperature is set to 0 for both first layer and other layers.

8.2.4 The layers of the bioprint are not evenly thick

The issue is most likely that the printbed is not completely leveled. To fix this, follow the sequence described in point 1 of chapter 5.1.
8.2.5 Printhead 1 is not turning off during non-printing movements
The issue is most likely that the postprocessor is not adding the proper content to the G-code file. To fix this, do the following:
1. Open up your G-code file in Notepad or a similar program.
2. Check if the line: "Post processed by INKREDIBLE post processor " is written at the top of the document.
3. If not, uninstall Python and reinstall it following the instructions in point 1 and 2 of chapter 6.1 “Setting up the Software”.
4. Open the Slic3r software.
5. Under “Print Settings”, go to “Output options” and check that the filepath to the postprocessor is correct (follow the instructions in point 7 and 8 of chapter 6.1 “Setting up the software”.
6. Resume the bioprinting process.

8.2.6 Dual head bioprinting: Printer is moving but not activating both printheads
The issue is most likely that the postprocessor is not adding the proper content to the G-code file. To fix this, follow the instructions in chapter 7.2.5 “Printhead 1 not turning of during non-printing movements” above.

8.2.7 Dual head bioprinting: Printhead 1 and printhead 2 are not level after the “Raise printheads” option has been selected
The issue is most likely that the printheads have gone out of alignment. To fix this, do the following:
1. In the “Utilities Menu”, select “Release steppers”.
2a. If printhead 1 is to far up, use the following sequence:
   - Push printhead 2 down until it releases from the carriage.
   - Carefully push printhead 1 down a little bit.
   - Carefully push printhead 2 back into place.
   - In the “Utilities menu”, select “Home printheads”.
   - In the “Utilities menu”, select “Raise printheads”.
   - Control if the difference between the printheads is less than 2 mm.
   If it is not, return to 2a or 2b, if it is, proceed to step 3.
2b. If printhead 1 is to far down, use the following sequence:
   - Push printhead 2 down until it releases from the carriage.
   - Carefully push printhead 1 up a little bit.
   - Carefully push printhead 2 back into place.
   - In the “Utilities Menu”, select “Home printheads”.
   - In the “Utilities Menu”, select “Raise printheads”.
   - Control if the difference between the printheads is less than 2 mm.
   If it is not, return to 2a or 2b, if it is, proceed to step 3.
3. Use the following sequence to fine tune the height of the printheads:
   - Adjust set screw on the right side of printhead 2.
   - In the “Utilities Menu”, select “Home printheads”.
   - In the “Utilities Menu”, select “Raise printheads”.
   - Control if the printheads is completely level. If not, repeat the sequence.

8.2.8 Display flickering or displaying random characters
The issue is most likely electrical interference from the air compressor. To fix this, do the following:
1. Turn off the INKREDIBLE 3D Bioprinter and the air compressor.
2. Disconnect the air compressor from the power outlet.
3. Connect the air compressor to a power outlet running on a different fuse.
4. Turn on the INKREDIBLE 3D Bioprinter and continue bioprinting.

8.2.9 Control knob is not responding when pressed
The issue is most likely that the knob was pushed all the way in, so it’s already in the “click”-position. To correct this, pull the knob gently towards you.

8.2.10 Printhead 1 is missing the probing sensor at the end of the “Home Axes”-sequence
At the end of the “Home Axes” sequence, the nozzle in PH1 touches the probing sensor attached to the printbed to calibrate the nozzle length. If the nozzle misses the probing sensor, then the probing position must be corrected to continue with the calibration process. Follow these steps to find the probing position for each axis:
1. Navigate to the “Utilities Menu” and enter by pressing the control knob [8].
2. Select HOME AXES and let the INKREDIBLE 3D Bioprinter carry out the sequence. If printhead 1 does not trigger the probing sensor, trigger it manually by hand by pressing the sensor 3 times when the needle is about to touch the sensor.
3. Adjust the Z position of printhead one until it is right above the probing sensor by following these steps:
   - In the “Utilities Menu”, select “Move Axis” and enter by pressing the control knob [8].
   - Turn the knob to jog the Z-axis to position Z+5.0 (The position for each axis will be written in the LCD display).
4. Adjust the X position of printhead one until it is right above the probing sensor by following these steps:
   - Select “Move Axis” and enter by pressing the control knob [8].
   - Select “Move 0,1mm” and enter by pressing the control knob [8].
   - Select “Move X” and enter by pressing the control knob [8].
   - Jog the X-axis by turning the control knob [8] until PH1 nozzle is in the centre of the metal cantilever of the sensor.

5. Adjust the Y position of printhead one until it is right above the probing sensor by following these steps:
   - Select “Move Axis” and enter by pressing the control knob [8].
   - Select “Move 0,1mm” and enter by pressing the control knob [8].
   - Select “Move Y” and enter by pressing the control knob [8].
   - Jog the Y-axis by turning the control knob [8] until PH1 nozzle is to the round part of metal cantilever of the sensor.

6. Return to the “Utilities Menu” and select the option “Set Probe Position” by pressing the control knob [8].
7. Restart the INKREDIBLE 3D Bioprinter.

8.2.11 Pressure monitor not displaying correct pressure
The issue is most likely that the 0-level for pressure has been offset. To fix this, do the following:

1. Press and hold the buttons on both sides of the middle button on the pressure display until the pressure monitor’s 0-level has been reset.
9. Warranty and guarantee
9. Warranty and guarantee

We guarantee that you will receive our product tested, working, fully assembled and ready to use. Every bioprinter is covered under the Conditions of Carriage by FedEx, and can be read using this link:

http://www.fedex.com/hu_english/services/terms/

We will also personally insure every bioprinter sent under Declared Value Insurance, also optioned by FedEx. If, in the case there is a problem with the INKREDIBLE outside of the FedEx terms, it is not the result of neglect of the purchaser and the incident occurs and is reported within 3 months (90 days) of the purchase date, conforms to all the rules of the warranty hereby included and the customer provides the original proof of purchase/serial number, then CELLINK will work out the problem on an individual basis as each problem must be addressed this way. In the rare case of a specifically diagnosed and proven DOA (dead on arrival) part (detailed description and documentation required), CELLINK will most likely send a replacement part to you. In the case that a customer has already been through all these previous options stated and is still not satisfied with the results, the customer has to have the bioprinter sent back at their own expense. Once a return is received (for example a returned bioprinter), CELLINK will then send back a new unit at our own expense. Proper packaging is required in the rare case of a returned product or part, and the product itself must arrive back in the condition in which it was originally received.

CELLINK is not in any way responsible for any consequential losses or downtime whatsoever caused by a problem in the performance of our products. CELLINK is not responsible for additional customs fees and tariffs. CELLINK is not responsible for delivery delays or the inability to deliver from the carrier. CELLINK is not responsible for damages resulting from improper handling during delivery. The warranty also does not cover any damages brought about because of an accident. All warranties are voided if the product has been moved from the original country of purchase.

The guarantee and warranty does not cover any alterations or repairs made by a second or third party. We are always eager to work with you personally to fix any problem that may arise in the most efficient fashion meeting it’s specific case, but we do not suggest you to “rig” up something outside of the recommended guidelines in your user manual unless personally instructed by us to do so. CELLINK provides no guaranties on the safety or performance of modified INKREDIBLE 3D bioprinters. We are also not responsible for incorrect voltage being used, environmental conditions (moisture, fire, water, flood, lightning, ext.), or any other form of neglect on the customer’s part. If you are unsure about something, feel free to contact us prior to using the INKREDIBLE.
CELLINK is not responsible for damages caused by the use of old information, as we are a forward looking company and information/manuals/users guides and suggestions are continually being updated, as we plan to manufacture and to evolve our products into many future generations as the technology develops. The latest documentation is always available on our website:

www.cellink.com

The guarantee and warranty covers critical components only. For example CELLINK will not replace a bioprinter because of a perceived blemish in the paintjob. The critical components/replacement parts do not carry a warranty themselves and are only covered in the initial 3 months warranty starting on the purchase date. Components not included in the warranty include: timing belts, linear ball bearings, rods, and the build platform. Moving parts, although of the highest manufactured quality, must be properly maintained, serviced and/or oiled, and the failure to do so will result in progressed wearing and tearing. The heated build platform itself will be subjected to unavoidable scratching and wear upon use. If you wish to order replacement parts, they are available in our online store, or by contacting us personally by telephone or email. There is no warranty issued when exotic printing material is used with the INKREDIBLE and doing so is not recommended by us at CELLINK. Foreign materials can damage the system. The warranty does not cover operating the bioprinter at not recommended speeds and settings.

In the case that a repair is determined to be outside of the warranty and the buyer decides to send back the INKREDIBLE for repairs, the buyer will ship the INKREDIBLE at their own expense. The costs to repair the INKREDIBLE will also be at the buyers expense.

Concerning unauthorized returns:
Returns not pre-authorized will not be eligible for repair, replacement or refund. Do not send it back to CELLINK unless you have contacted us first and we have pre-authorized you to do so.

Concerning Refunds:
A refund is possible only with the INKREDIBLE 3D Bioprinter itself and will not be offered for any filaments, or spare parts. If within two weeks (14 days) after receiving your INKREDIBLE 3D Bioprinter you are not completely satisfied, we offer you a refund option.
You ship it back at your own expense and after we receive it, we will deduct a 10% restocking fee from the total refund of the price of the INKREDIBLE 3D Bioprinter (excluding the tax and other fees). There will also be a thorough inspection of the bioprinter, and upon finding any damages deemed on the part of the buyer, other deductions from the refund would be made accordingly. Deductions will be made for any wear perceived to the bioprinter, including scratches. The 14 day period after receiving the bioprinter will be concretely determined in calculation with the FedEx tracking information.

Limitations:
This guarantee and limited warranty are sole and final as they stand in reference to INKREDIBLE, CELLINK and it’s products where permitted by law. Any implied warranty or fitness is limited to this 3 months (90 day) warranty starting from the date of purchase. CELLINK waives all liability for any incidental, exemplary, punitive, collateral, indirect, consequential, or special damages. CELLINK will determine on sole discretion whether an issue is covered under the warranty or not.

Concerning any problems or enquiries, please contact us at: support@cellink.com
Returned parts/products can be sent to:
CELLINK AB,
Arvid Wallgrens Backe 20,
Gothenburg SE-413 46,
SWEDEN.
“You cannot create new science unless you realize where the old science leaves off and new science begins, and science-fiction forces us to confront this.”

- Michio Kaku