

# Typical Hangprinter problems

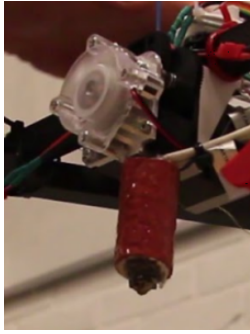
This collection is based on a lot of topics especially about Hangprinters. Repeatedly many people do the same mistakes building and running a Hangprinter due to missing knowledge or time. Bad mechanical installation and miscalibration lead to bad print results and may lead to severe damage of electronics or your whole neighbours and the building you live. Please keep in mind: "Think big" can be a solution. But big parts mean big amount of filament. That gets expensive. Do you really want to risk to print 500 Euros of filament with a printer which costs the same but is a mechanical and eletrical desaster?

**The biggest problems of Hangprinter belonging to calibration and print quality come from the used lines, the way they are mounted and their tensioning.**

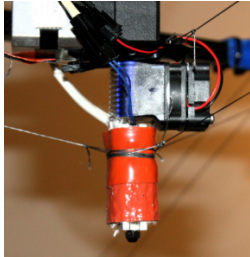
Maintaining sufficient and equal tension throughout the build envelope is hard. You lose all accuracy if a line goes even slightly slack or overtightened. If you tighten one line, all the others will also tighten. If you make one line slack the other lines lose tension as well. But all lines must stay tensioned well. If one line has much higher tension than another, you might see the effector stucks and lose positioning accuracy. It's a question of line buildup and it's compensation and to maintain a rigid line guiding with this feature. Note that the tension changes over Z coordinate drastically without compensating it. There are no force sensors to control the tension properly. Furthermore there are no sensors to let Hangprinter know it's real position (only relative coordinates by using Smart Steppers servo motors). So it has no means to measure where the effector is at any given time. Neither the user, nor the firmware, have means to confirm that the effector is at the cartesian position where we believe it is or should be. If the calibration was done poor it will lead up to centimetres of deviation in higher z directions or in outer sectors of ABC. The mis-calibration will make lines go slack or over tight when moving far away from the origin. Poor winding on the spools or chosing the wrong line type make the printer inaccurate. Another thing is to keep the levelness and stiffness of ceiling module, effector and anchors while the printer is printing. At least things like line constraining (single vs double lines) means less or more ringing due to more frequent vibrations while printing and we need to ensure perfect vertical D lines to remove unwanted gravity side effects from rotations/tilts around one or more axes.

## Overview of common issues

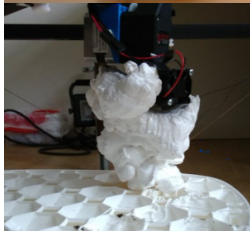
	Extruder fails	Ringing and poor quality	Heavy weight on ceiling	Weight on effector / Filament string force too high
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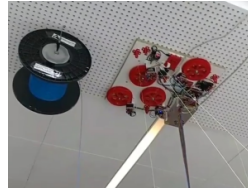
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Photos by Tørbjørn Ludvigsen (Twitter)



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certain centimeters of non-supported **cantilever** are a high risk for deformations. This is one of the most extreme szenarios what can happen.

often happens if one or some of the mentioned things in this table occure, like wrong print parameters (extreme print speeds, wrong cooling, wrong extrusion temperature, slack lines, overtightened lines, collisions with lines, ...)

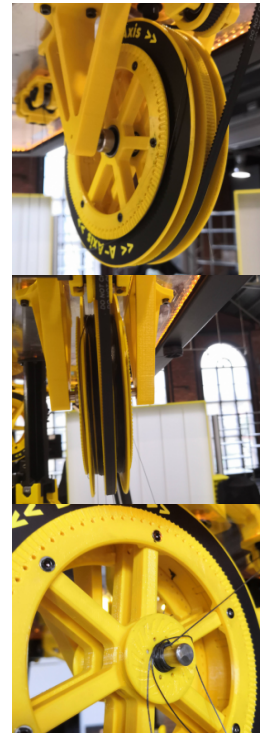
the filament tends to vibrate and it's additional weight for the ceiling. It's also a source for risky accidents when falling off. The only advantage is the better extruder feed.

The more weight on effector the slower you can travel. A heavy effector can be bad. But a light weight effector can be bad too. A light effector can be greatly influenced by the filament string the extruder tries to grab and to extrude while printing. If the filament feeding is poor (high friction or sticking) it might happen that the effector climbs up the filament string ignoring it's vertical D lines. The effector will start to tilt and to lift the nozzle. The perimeter fails and the hotend extrudes into air. This ruins the print. It looks like Munchausen pulling himself out of the swamp by the hair. This can be fixed by printing slower, making the effector heavier or adjusting the filament feeding quality for example. At Trikarus we were able to print with a 5 kg spool standing on the ground. 8.5 kg were too heavy to use. So we need some special feeding device.

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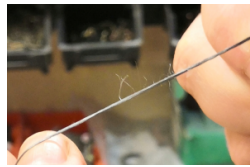
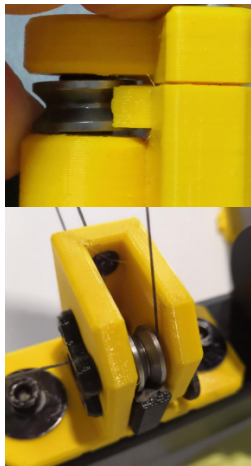
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that images shows effects due to **bad calibration** and/or **bad line winding**. While printing the spools might wind up unevenly. The D lines must be vertical all their way and the line outlet and inlet points have to match between ceiling and effector.

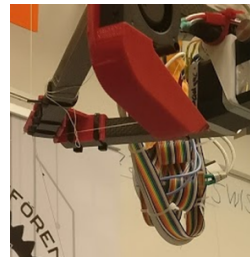
elastic lines destroy calibration. Reason: high stiffness is required. Do not use low quality lines!

A wobbling ceiling plate which lifts up and down 1-2 mm or more leads in print quality loss. The movement system parts like effector, ceiling plate and anchors have to be as rigid as possible. Large frames will start **vibrating** if not enough places exist to secure movable parts due to **tolerances**

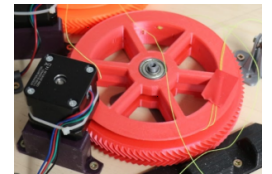
De-spooling due too long move into wrong direction (line tensions is zero or virtual negative value). This is one of the **major** issues of Hangprinters while running or calibrating them.



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(Info) Photo from <https://twitter.com/fredhedenberg>



(Info) Photo by Tørbjørn Ludvigsen

V shape tends to snap / shear off if there are certain angled reached. If you can please change them to U shape bearings. Cheap bearings have a huge angle tolerance by the way.

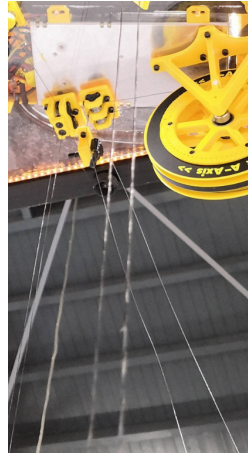
rough surfaces will quickly force the lines to get worn until they rupture.

too long and/or too thin cables can bring broken connections, dirty signals, failing electronics and much more. It's a high risk for **failing prints** or for **burnout** of certain components like controller.

That type of drive works but it's loud, if needs to be greased a lot and leads to more quickly lose steps. Especially if you use **under-sized small Nema 17** motors it's a source of frustration

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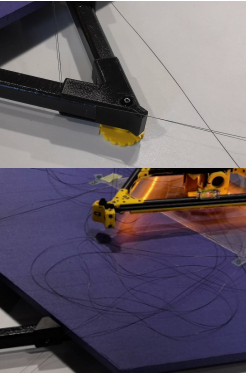


Wobbling lines, e.g. caused by slight collisions, machines vibrations or by accidentally touching the lines, badly effect the print result. You can get ringing, shifting of the vertical print shells and other side effects.

Heavily used fireline loses its black smokey gloss-look and flattens/widens up a little bit. If the lines rip do **not knot** the ripped ends. The knot will cause error in movement system and might mess up the winding quality on spools.

Self-twisting lines reduce the life time

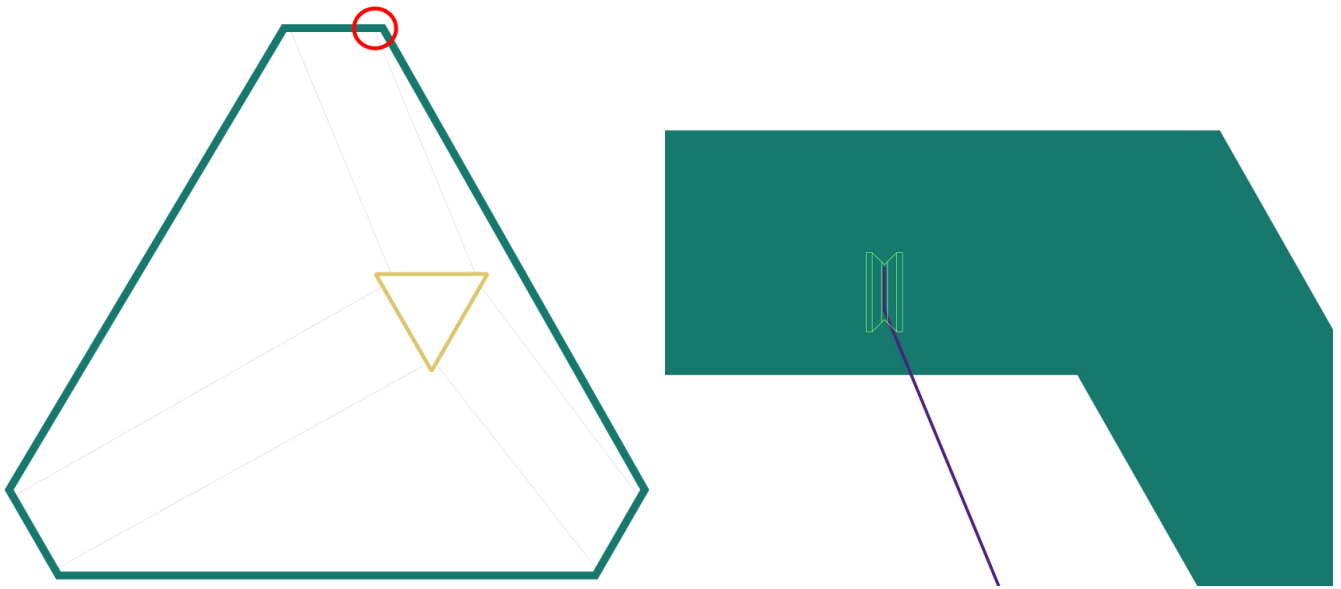
collision between filament or power cable and the printer assembly, or the lines and the assembly (arms, gears, hotend, ...). It could knock off the print from the platform.

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	<p>Printer powered off which led to self-lowering effector. This untightens the lines which fall to the ground. This is a risk of jammed line salad</p>	<p>In case the compensation factors were miscalibrated the printer might not move correctly because the line tension gets too high. It highly limits the reachable height. Without property compensation you cannot print large.</p>	<p>Printing big will cost big. This slices model failed and resulted in wasting ~150 grams of filament. And the model in the video was only a small model.</p>	<p>skewed installation of ABC lines (unequal line lengths of lines between bottom anchors and effector) might give improper print results (e.g. printed cube is not a real cube anymore)</p>

## Bearing shapes and angles

The guidance of V shape bearings is okay and for Trikarus the maximum line angle per bearing is 30 degrees (15 degrees per direction) due to its regular construction frame (60 degrees divided by two). The angles at the anchor points and at the effector change while it is moving. It won't reach the shear off angle of ~45 degrees (tested with different amount of line on the bearings perimeters and pulling forces). Usually the regular stress of lines will not exceed ~22.5 degrees because there will not be enough tension to do this and/or not that big print platform. Reaching those coordinates without platform underneath does not make sense. To have a more regular tensioning please use U shape bearings for the moving sections. They will perform better. An idea could also be to use

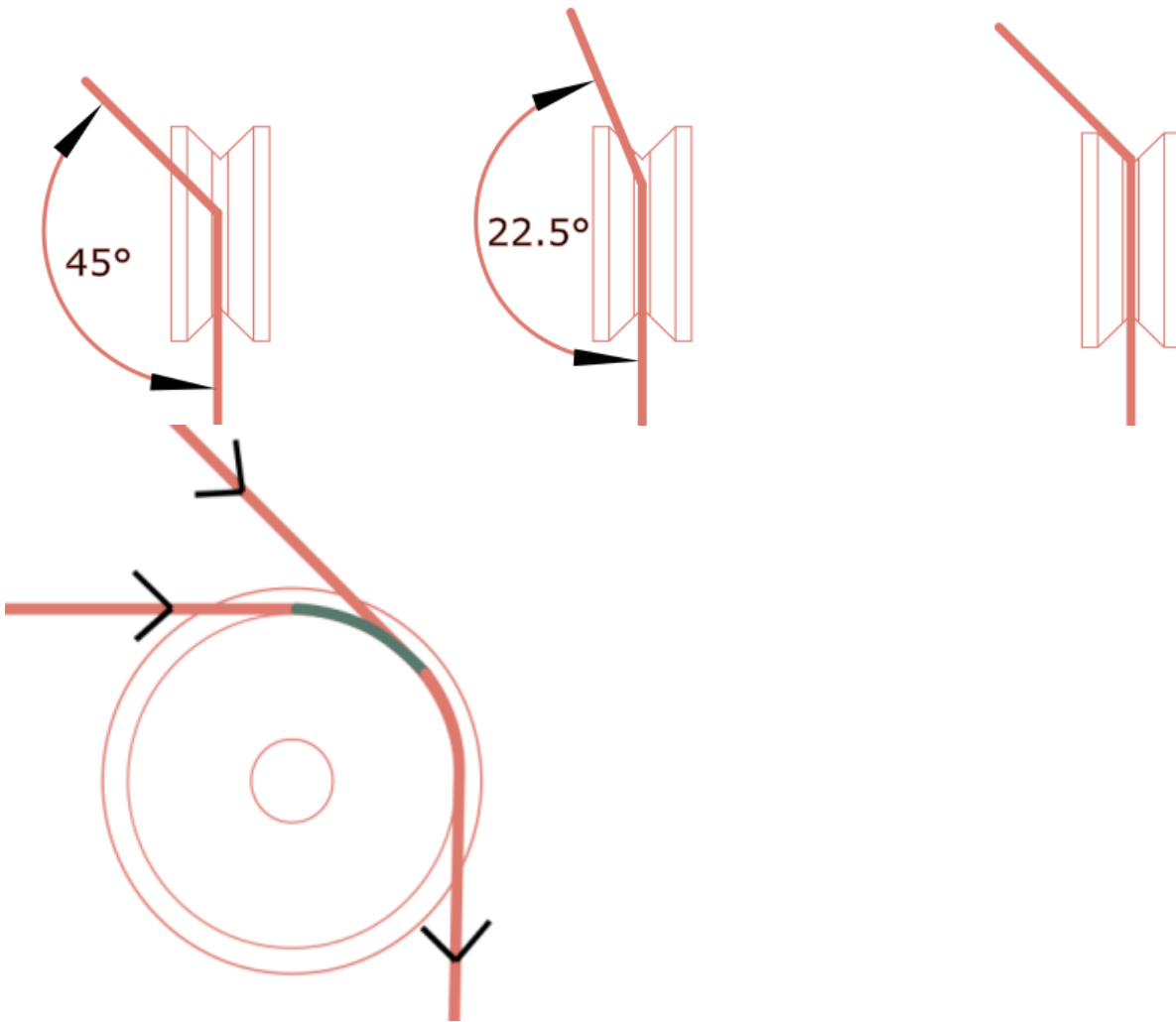
ceramic inserts to allow 360 degree movements of the line without slipping off.



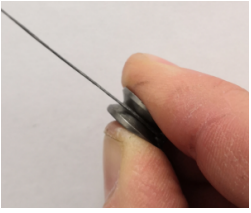




shear off

regular stress

unreal string guidance

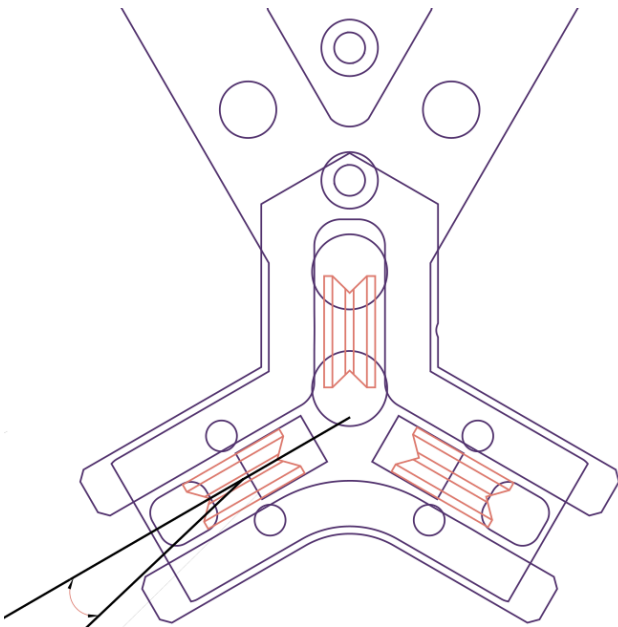


# Some visualizations of different angles

0°	15°	25°	35°	45°
				

## Please have a close look on your construction when building line guides

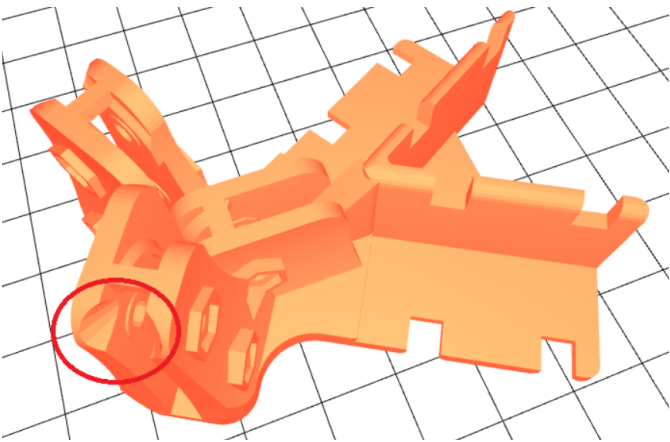
Even if your bearings allow a good angle double check your construction. Otherwise problems may occur like this. The line could collide with effector housing or anchor housing while the effector is moving to extreme positions.



The smaller the angle at the effector the smaller the print radius will be. For some early prototype corners of Trikarus some quick and dirty drawings gave the following results (values only valid for our used machine dimensions):

Effector bearing angle	Maximum print radius with collision
17 deg	~ 725 mm
16 deg	~ 687 mm
15 deg	~ 648 mm
14 deg	~ 608 mm
13 deg	~ 568 mm

The results say: if you want to reach a good print radius (e.g. 1 meter) than the allowed angle has to be much bigger. You may add some cutouts to your assembly like this:



The recent Trikarus prototype finally solves this problem by using ceramic inlets.

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Version #1

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