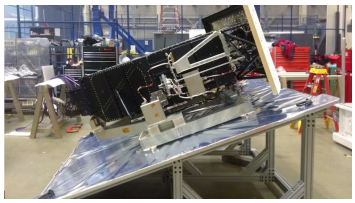
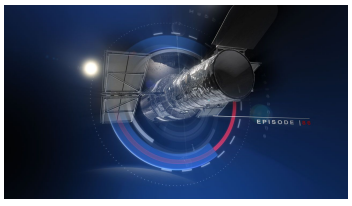
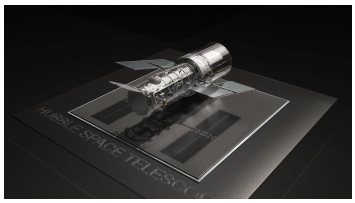
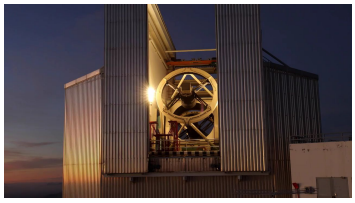
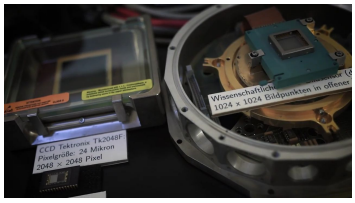
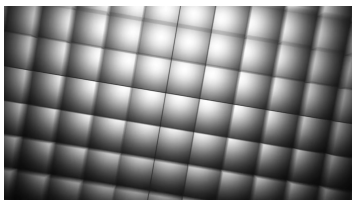
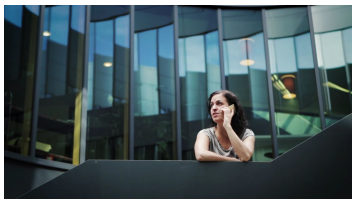
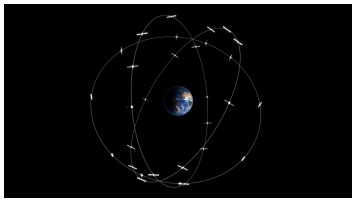
ESO, Karl-Schwarzschild-Str.2
D-85748 Garching bei München,
Germany
Telephone: +49 (0)89 3200 6855
Telefax: +49 (0)89 3200 6480
hubble@eso.org

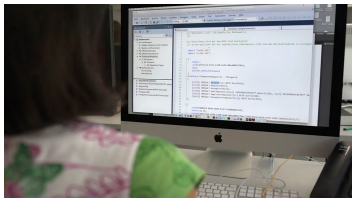
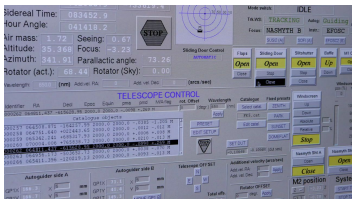
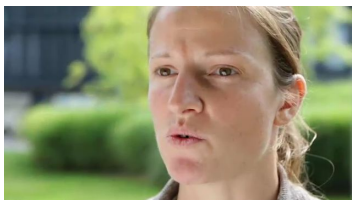
www.spacetelescope.org

Keywords:

Hubblecast Episode 95: The impact of astronomy on our technological world	**Visual notes**
00:05 [Narrator] 1. Technology lies at the heart of what Hubble is and does. As a result, the developments made in creating and maintaining telescopes like Hubble have influenced fields far beyond astronomy. From industry to medicine, from aerospace to the energy sector; modern-day astronomy has influenced every area of technology.	 
00:00 2. Intro	

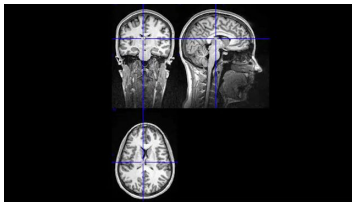
00:44 [Luis Calçada] *3. What practical uses are there for most people? You know, like real world examples?* [Olivier Hainaut] *Well, OK. First, we do fundamental physics. So that means that whatever we do is not to have an application like tomorrow. And something that has a direct application: is General relativity. Remember, Einstein, 1916, just one hundred years ago? He thought: General relativity. And for years it was useless. I mean useless for normal people. Now, nowadays everybody uses it daily.* [Luis Calçada] *And they would not believe where, right? Because they carry it in their own pocket.* [Olivier Hainaut] *GPS! GPS in your cell phone, that is a direct application of general relativity. More precisely: It would not work without general relativity.*	   
1:38 [Narrator] 4. Hubble is a sophisticated instrument, setting a gold standard amongst observatories. It required cutting-edge technology to bring it into existence in the first place; and continual improvements and upgrades, including five servicing missions, got it to where it is today. It is not surprising then that many technologies originally developed for Hubble and other astronomical instruments have found their way into other areas.	 
02:18 [Narrator] 5. Astronomical imaging technologies made a huge impact on medical equipment. Some of it, like CCD and CMOS-detectors also made it into everyday life. These	

electronic chips convert photons into an electrical charge, allowing cameras to respond to light with incredible efficiency. CCDs are crucial to Hubble. Its Advanced Camera for Surveys uses a CCD camera to capture images such as the Hubble Ultra Deep Field, the deepest visible-light image of the cosmos ever obtained. The decision to use super-sensitive CCD technology on Hubble played a huge part in the improvement and popularisation of these detectors. Similar ones have since found their way into personal cameras, webcams and mobile phones.	  
03:21 [Olivier Hainaut] 6. *By the way: also just one century ago, there was quantum physics. Complete revolution in the way we imagined the world. And without quantum physics a cell phone wouldn't work either.*	
03:34 [Narrator] 7. As familiar to us as our smart phones and digital cameras are our GPS gadgets. Through a system of satellites, operated by the US military, car drivers and smartphone users can pinpoint their location at any given time. GPS satellites use very bright and very distant astronomical objects to help them determine positions with high accuracy. Creating accurate maps of these bright objects, known as quasars, required close collaboration between the developers and astronomy. The European Union in collaboration with ESA is currently creating its own, pure civilian, satellite navigation system, Galileo, which will begin working at the end of 2016.	  

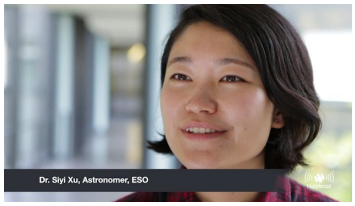
04:31 [Narrator] 8. It is not astronomy's hardware that has got it noticed in the wider world of technology. Hubble's instruments would be much less useful without the right software to analyse the data they collect. This software has been created using special programming languages. Interactive Data Language, or IDL for short, is one such programming language. Today it is popularly used in medical imaging and atmospheric physics. But the first IDL programs were used to analyse astronomical data and today astronomers still account for many new programs.	  
05:12 [Narrator] 9. IDL is not the only thing that medicine and astronomy have in common, far from it.	
05:22 [Dr Annalisa De Cia] *You know, there's visible light, there's radio, there's infrared, and these are all electromagnetic waves that astronomers like to use to observe the Universe. But at some point the x-ray was just missing. So an astronomer said: OK, we really need to do something about it and he developed the technology to observe the sky in the x-rays. So, he got the Nobel prize, which was nice, and we got the technology. So now we are all using it everyday whenever we go through an airport for the security or if you go to the hospital. So this is an example of a technology that is used on a daily basis, thanks to astronomy.*	 

06:04
[Narrator]
11. Advanced imaging techniques used by Hubble to see deep into space have now been used to allow doctors to visualise breast tissue without surgery.

Software developed for processing satellite pictures from ESA has been adapted to detect signs of Alzheimer's disease in Magnetic Resonance Imaging scans. And these scanners, along with many more used in the medical field, have benefited from the advancements to imaging technology brought about by creating telescopes like Hubble.

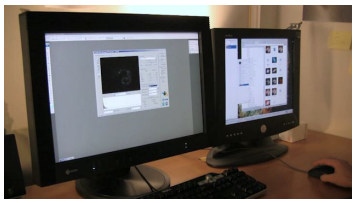


06:42
[Dr Siyi Xu]
12. *Stars twinkle, and that's a very big problem for the astronomers. In fact, the stars do not really twinkle, the problem is our atmosphere, because it moves around. And in order to correct for the movement of atmosphere, astronomers come up with a very smart idea, called adaptive optics. And the idea is either you pick a very bright natural star, or you use a very powerful laser and shoot to create a laser guide star. So the idea would be, you know how the perfect star's supposed to look like, and then you measure that either laser guide star or natural bright star in your telescope, and by comparing how these two look like, and doing a bunch of complicated maths, you can figure out an algorithm to correct for your image.*



[Luis Calçada]
But this technology has been transported into a medical application hasn't it?

[Dr Siyi Xu]
Indeed! So they have developed the laser operations, and in fact, I had such operations, which is called the LASIK, and the idea is very similar. Basically they figure

out what is the perfect eyeball shape supposed to look like, and they use the laser to help correct for that, and with that you will be able to see the world much more clearly and nicer.	
07:53 [Narrator] 13. This is just the tip of the iceberg. Technology originally designed to explore the Universe has contributed in hundreds of ways to our daily lives and has also fostered international collaboration. Whilst the pay-off in our day to day lives might not always be immediate, it is very real. From contributing to a diverse range of fields through technology transfer, to changing our perspective on the Universe we live in, astronomy continues to play a bigger part in our daily lives than we realise.	  
08:34 [Olivier Hainaut] 14. *We value a lot old observations. We want to keep them forever. Because if you do an observation it will never be redone, because the sky is changing. So, we have observations that are really old. Like 10, 20, 50, 100 years. So we have an image format: fits. It's not of very wide spread use, but it's extremely standard. Everybody uses it.* [Luis Calçada] *Something like jpeg, that most people know, or gif…* [Olivier Hainaut] *It's like jpeg, but everything is described in the file. So if you just get the file you know how you have to read it. And now some archiving for other fields than astronomy use it too. Like old libraries. The Vatican library is using our astronomical format. And you know, they have long term in mind. So, all the digitisation of the Vatican*	  

archive is now being done in that fits format which is universal for all astronomers. So think: I could receive a tape or CD or an image that was taken in United States 30 years ago and could share it with a Russian colleague. No problem of proprietary formats, no problem of version, it just works, it's just standard. Magic.	

Ends 10:07