Skills

Amateur Astronomers (per Google AI):
Amateur astronomy involves a range of skills, from basic observation and navigation to advanced imaging and data analysis. Beginners can start with learning the night sky, using binoculars or telescopes, and identifying constellations and celestial objects. More experienced amateur astronomers may develop skills in image processing, astrometry, and photometry. Additionally, “soft skills” are useful, including troubleshooting equipment and interpreting observations, taking the initiative to learn and observe, and patience in the face of challenges, such as cloudy nights.

As we acquire skills in our profession or hobbies over our lifetimes, these talents often become ever more specific and difficult to achieve. But it's important to remember that everything you've learned in your lifetime is continuously evolving, and it all began with the basics. My career in chemical engineering took the familiar path of disdain of the simple to “fit in” the most complex processes. You don't have to know everything about chemical engineering I think, to get the gist of what I mean, and I bet the same concepts apply to other job skills, from accounting to zoology.

One very simple idea in chemical engineering is that of a cooling water system. To begin with the design, you simulate sending enough cooling water to each heat exchanger to cool the fluid involved to the desired temperature. However, there are two imbalances that must be solved to have a real-world design. First is the energy imbalance, which is to say that although you may supply cooling water at a temperature to cool each exchanger, the exchanger hot side will have different fluids and different initial and final temperature requirements that may vary sizably over the different services demanded. A good way to begin fixing this is to look at the largest service of all and fix the return temperature at an initial set point. Let's say for instance you would have to supply 100 gallons a minute of cooling water at 80° Fahrenheit for the return temperature to be 100° F to effectively provide this utility service. The next thing to look at is the flow imbalance. You’re not going to get perfect return temperatures across the entire network of cooling water exchangers, but you can count on an unchanging cooling water supply temperature. Here again if you size the piping and valves to provide the cooling water flow rate required with this change in temperature, everything else will equal out. You can manipulate flow rates here and there using valves that choke off water supply to the exchangers that don't need as much, so that they have an effective duty.

You could make the case that applying principles used in engineering may help you understand how variable stars work. Of course, there are many different types of variable stars, but in general, they change brightness due to some underlying changes in the star system, just as cooling water networks change their behavior due to individual variations in cooling requirements. As we watch the changes occur over time, we can get a sense of what causes them, and how the different reasons interact. The connection here is to see the whole system. A simple eclipsing binary star may have only one source of variability (the eclipse), but the more interesting variables have many parallel effects on their brightness over time.

Another unit operation that reminds me of some of my amateur astronomy projects is a steam system. Steam is another distributed utility just like cooling water, although it has many more ways to modify a process. Steam gives us the opportunity to change phases, in other words, to boil water and condense steam providing a much larger temperature difference and greater heat transfer. Think of how boiling is a quicker way to cook than a hot water bath. We also use steam to provide motive power in the expansion of water into steam. Here, a locomotive or electric power plant, where steam forces motion than turns machinery, are good examples. In a way (bear with me here) the work done by steam turbines is like the energy requirements of orbiting planets and moons, even asteroids. I don't mean the universe is a steampunk fantasy world; instead, that the change of potential energy held in steam to kinetic energy expressed as mechanical work is comparable to that of the potential of gravity causing kinetic orbital motion.

These motions are quantified in the astrometry that we acquire of orbiting bodies through careful measurement of position in the sky and the time that position is taken. This part of astronomy has been going on for thousands of years, albeit with low precision for most of time. Positional studies are reasonably believed to be the primary founding principle of astrology, later to evolve into astronomy.

We also gather useful information that includes the brightness variations of planets, comets, asteroids, etc., as they orbit. Especially when coupled with the astrometric data, this photometry broadens our understanding even more. There are lots of reasons why these brightness changes occur, including:

1. the composition of the orbiting object, including surface markings or atmosphere
2. changes in the illuminating body – e.g., star shining on planet
3. the phase angle or lit portion of a solid body
4. effect of previously unknown exoplanet or asteroid moon transiting a star during an occultation
5. the degassing or ice sublimation activity of a comet depending on its age and composition.

You must think of many things when designing a steam system; it's not just mass or energy in and out you must consider (as with cooling water), there is also the effect of boiling and condensation used for work or heat. When investigating the positions and brightness of celestial orbiting objects, the same care is used to gather the data and provide plausible theories to why they act as seen. The scientific method applies across understanding how steam and planets work.

Per Google AI:
Chemical engineering *involves a blend of technical and soft skills. Technical skills include strong knowledge of chemistry, physics, math, and engineering principles, as well as proficiency in using simulation software and data analysis tools. Soft skills encompass communication, problem-solving, teamwork, and analytical thinking*.

I started this article after being frustrated by forgetting some simple steam system design ideas and how similar some errors are with engineering and astronomy. While writing this article, I found a rookie mistake that caused errors when I tried to image artificial satellites. Finding the errors led me to think about how always remembering to start from first principles, no matter what your career or hobby project may include, will give you the best chance for success over the long term.

By understanding the basis of astronomy instead of just telling a computer to “image M33!”, you can add the pleasure of being able to provide outreach and answers. Our grandfather clock has a moon phase indicator. This is set by matching the date of the current lunation with the current day in an almanac. These simple little facts can not only help improve our daily experience of astronomy but can even open conversations with other hobbyists and people interested in astronomy. Not everyone is going to be ready or even interested in observing the infinitesimal fraction of starlight blocked out by an asteroid occultation. They might not have the training, afford the equipment, or even a remote access that will help them determine whether or not an exoplanet is in the Goldilocks zone, where life may be possible. But if you’re enjoying a beautiful conjunction of Venus and Jupiter on a lovely summer evening, I'll bet you can find something to talk about or even while not talking at all. And, if you can explain why that conjunction happened tonight, the orbits involved, and our viewpoint, it will spread knowledge and interest in our hobby and the universe we call home.