The Discovery of Pluto

Engineers can count their blessings that they could retire their slide rules long ago; however, it might be worthwhile to take a look backward and see where the real blessing lies.

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I had the pleasure of visiting the Lowell Observatory in Flagstaff, Arizona. The observatory is perched atop a hill in Flagstaff, a small city at an elevation of about 7,000 feet above sea level. When the observatory was first built, Flagstaff was much smaller, with fewer street lights and less nighttime illumination. Today, the city has grown, and the glare is too bright for any meaningful astronomical observation. The work has been relocated to a distant, darker butte out of town in the desert. But the original observatory with its old telescopes and facilities remains for tourists to visit. It is a beautiful site, with a pleasant campus surrounded by a high-altitude conifer forest. This is the site where astronomers discovered the last planet in our solar system — Pluto. The methods they used in the 1930s seem primitive today. A comparison between the past and present helps illustrate the great advances in technology that we have experienced and now take for granted.

The discovery of Pluto took place in two phases. It all began with the suspicion by astronomers that there must be a ninth planet because the solar orbits of the first eight planets were not quite right. The application of Kepler's Law predicted certain types of orbits, and the measured orbits of the known eight planets did not match the predictions. It was expected that another planet was exerting gravity that influenced the orbits of the inner eight planets, leading to the search for "Planet X," the ninth planet.

In the first phase of exploration, mathematicians performed thousands of calculations to try to determine the mass and location of the missing planet. The volumes of the original calculations are on display at the observatory. These relatively simple trigonometric and algebraic calculations can be performed today using a spreadsheet or MathCad in perhaps a few minutes. In the 1930s, it did not take a few minutes; rather, it took months of painstaking, manual arithmetic, with careful pencil markings, slide rules and volume after volume of calculations and checking. There were no computers or expectations that the calculations could be done any other way than longhand.

This phase in the discovery process seemed painful enough to me. At some point, it was determined that the calculations were complete, and it was time for the next phase to occur. Based on the predicted locations, astronomers set out film plates exposed to telescopic images of the night sky to find the new planet. The exposures of each plate were separated by two or three days. The idea was that because a planet would move differently than a star, its image could be identified by comparing images from

different nights and looking for a point of light that did not match up as a star would. The process of comparing the images was done in something called a blink comparator. The observatory had set up a display of the original device so we could observe the method. The way it worked was that you would first see a quick blink of the film plate on the left, and then a quick blink of the film plate on the right. Staring into the device, the picture would flash back and forth — blink of light after blink of light. You had to find the one point of light out of hundreds that did not match on both film plates. Gratefully, the display we looked at had convenient arrows showing the point of light that was determined to be Planet X — Pluto. With the arrow placed on the map of stars, it was easy to see that one tiny point of light that did not quite line up the way the other hundreds of points did and, therefore, must be a planet. The convenient arrows were not, however, available for the poor gentleman (instead of "gentleman," I was thinking of a word here that starts with "b") that had to sit for one year with the blink comparator, flashing hundreds of film plates, back and forth, back and forth, trying to find a needle in the starstack. Today, we could digitize the images and have a computer compare them and determine any differences in a matter of moments. A year of frustrating, boring, tedious work today would be completed in seconds.

Seeing the exhibit, I thought about how different our lives are today, and how our expectations have changed. It is not just in discovering Pluto, but in every aspect of technology and how we apply it. I was preparing to teach a freshman introduction to civil engineering class. I planned to present a lecture on the strength of materials. A colleague loaned me an old textbook written in 1951. He found this book at a rummage sale and purchased it for a quarter. It was musty but readable, with good examples and still-relevant themes. The book presented a series of simplified derivations. For example, there was a problem on the axial loading of two bars with different cross-sectional areas and different moduli of elasticity. The layout and solution of each problem was predicated on the assumption that you could not use a computer. In 1951, while computers had been invented, they were top-secret, punch-carding, room-filling machines that had less computational power than the personal computer I now use for work. It was not for another decade or so before civil engineers could start to imagine practical computer applications like STRUDL and COGO. So, the text was carefully developed with this in mind. There was even a helpful chapter in the back to assist you with your slide rule.

All sorts of things were done this way without computers, whether it was discovering Pluto or designing monumental suspension bridges. Today, how this past work was done seems like monumental drudgery. We have been liberated by the incredible computation power at our fingertips. This new tool has become second nature, and now the old work-arounds and methods fade into history, to end up as exhibits about finding Pluto, and as collections of dusty old slide rules. Considering what people spent their lives doing then, the way we are able to work today is so amazing. Yet in the work-arounds and the necessity of the old methods, there was a certain grace and embedded level of technical excellence. The manual work was so hard and tedious that there was little margin of error for misapplication. In comparison, there are times when I wonder about how we use and appreciate the technology with which we have been blessed today.

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