image: www.nasa.gov/content/hubble-sees-a-smiling-len

episode 7 (2018 July) *Making stuff to do stuff*

Heather: Hello everyone! Welcome to the seventh episode of the RASC 150 History Podcast, in which we employ the tools of communication to communicate something of the nature and spirit of a former age, when, if you desired to possess that iconic attribute of the astronomer, a telescope, you would likely have had to make your own. My name is Heather Laird, I am a Director of The Royal Astronomical Society of Canada, and my co-host is the RASC Archivist, Randall Rosenfeld. Say hello, Randall!

Randall: *[some mumbled greeting, or other]*.

Heather: We are surrounded by tools and technology, so much so that we're at times seemingly unaware of their enabling—or hindering—presence in our lives. However you choose to communicate, you are using a technology, and the techniques which go along with it. Talking with a physically present non-texting friend at a café about the awesomeness of some random podcast on the history of the RASC is a technological act, as much as using a social media platform to do the same. And we have been immersed in a technological world for aeons. Thanks to Chelsea our engineer, we're using some very recent software and hardware to produce this podcast, but if we'd used two empty tins cans connected by string and recorded it analog with a pine needle onto a carrot, as Randall originally suggested, we'd still be using a technology. We make stuff to do stuff.

Randall: In 1949, the British Museum published Kenneth Oakley's *Man the Tool-Maker*, which became something of a best seller. In 2018 we'd prefer a different generic noun for "humans", but Oakley's title concisely states what has been seen as a fundamental characteristic of being us. Citing Oakley, but updating his language slightly for present sensibilities, he remarked that: *[quote]* "*Humans are social animals distinguished by "culture": by the ability to make tools and communicate ideas. Employment of tools appears to be their chief biological characteristic, for considered functionally tools are detachable extensions of the forelimb...Systematic making of tools implies a marked capacity for conceptual thought*" *[end quote]*. Well, we now know that other animals can make tools, and some scientists speak of other animals having cultures, but the strong self-

identification of our ourselves as *the* animal which makes tools, or uses tools, is still pretty basic to how most of us see ourselves reflected in our smart-phone screens.

Heather: Going back in time, and closer to our theme, Joseph Moxon, hydrographer to Charles II, and a maker and retailer of celestial globes, charts, and tools used by astronomers and other mathematical practitioners, stated in his *Mechanik Exercises: or the Doctrine of Handy-Works*: *[quote]* "*That...astronomy...[is an] excellent science, all that know…will confess...how could astronomy be known to any perception, but by instruments made by hand?*". That is, what would we know of astronomy, if we had no astronomical instruments? Or, in Oakley's terms, "Astronomers are social animals distinguished by "culture": by the ability to make and use astronomical tools and communicate astronomical ideas. Employment of astronomical tools appears to be the chief biological characteristic of astronomers, for considered functionally astronomical apparatus are detachable extensions of the astronomer"—h'mmm, that seems overly reductive, although for some RASC members one never knows.

Randall: As Heather said in the opening, there was a time when many, in fact, probably most amateur astronomers had to make some or all of their own instruments. The opposite is the case now, and has been since the mid-1980s or early 1990s. It is simply a matter of price—for a variety of economic reasons, chiefly the reduction of costs through the sourcing of skilled labour offshore, amateur astronomers in North America and Europe are effectively paying less for astronomical equipment than they have at any prior time. For eight tenths of the century and a half of the life of the RASC, its members did *not* enjoy ready and inexpensive access to commercially produced telescopes. And that holds for astronomers, amateur or professional, everywhere, from the time of the invention of the astronomical telescope. For nearly all of them, a commercial astronomical telescope was a luxury item.

Heather: How much of a luxury item? Around 1900 the firm of Alvan Clark and Sons, out of Cambridgeport, Massachusetts, was offering an astronomical refractor with a 100-mm achromatic objective lens and basic accessories on an equatorial mount for around $330 USD, which works out to roughly the same in CDN dollars of the time. Thomas Cooke and Sons, based in York, England, charged about £90 for a similarly appointed instrument, which works out to about $440 CDN dollars. The sticker shock for us occurs when we look at wages in Canada then. The average blue-collar worker earned $375 CDN dollars, and the average white-collar earned $875 CDN dollars. Oh, and those are the wages for men—women made half

that, or less. So, if the average Canadian blue-collar worker was lucky enough to purchase a new instrument by Alvan Clark and Sons, it would cost him nearly his entire wages for a year. A woman would have to devote two-years' worth of her wages to the purchase. A comparable instrument by Cooke and Sons would eat into the following year's wages for the blue-collar worker. The white-collar worker would have to devote something like 40% to 50% of his year's wage towards the telescope purchase. Given that one can't live on starlight alone, whether you were the average production worker, or a supervisor of production workers, an astronomical telescope represented an unimaginable cost outlay for most Canadians a hundred-and-twenty years ago. As a proportion of income, in modern terms, the 100-mm achromatic objective, equatorially mounted refractor would cost more than $25,000 in current CDN dollars! But they don't cost that now; at present, you can purchase an approximately equivalent new instrument for $1,000 CDN dollars. The cost for the refractor is an order of magnitude less in 2018 that it was in 1900. Is it little wonder that Society members took to making their own equipment?

Randall: Listeners will recall from earlier episodes, that the founders of the Society in 1868 were drawn equally from the working, and the modest middle classes; few of these men could casually devote 40% to 100% of their salaries to the purchase of a telescope. From the very start, or multiple starts of the RASC, members either contemplated making their own instruments, or moved from contemplation, to action. Mungo Turnbull was one of the original eight who did so. About his telescope-making activity, one anonymous writer in the Ontario *Journal of Education* wrote in 1870: *[quote] "A few years ago astronomical telescopes were rarely to be seen among us. Now both refractors and reflectors are in constant use. Two of the reflector class, we are glad to state, have been made in Toronto, by Mr. Mungo Turnbull, during his spare hours after his daily toil as a cabinet-maker. One of them is a metallic speculum, of the Herschelian kind, and of 7 inches aperture; the other is a Newtonian reflector, of nearly 12 inches aperture, with silvered glass specula. This latter instrument was show at our late Provincial Exhibition, but could not be tested or judged under the circumstances. Such tests, however, have since been applied as proves that it is an exceedingly powerful instrument. Practical observers know that there are certain objects which afford good tests of the optical qualities of an instrument, such as the small blue attendant of Vega; the debilissima of SIr John Herschel in the constellation Lyra; the components of Gamma Andromedae; the four stars forming the trapezium in the nebula of Orion, the Moon, Jupiter, &c. A few gentlemen, familiar with these objects, last week tested Mr. Turnbull's reflector, and the results were of the most satisfactory character. The different colours in the belt on Jupiter were seen*

distinctly; as were also the fours stars of the trapezium and the others we have mentioned. The construction of such an instrument reflects the very highest credit upon Mr. Turnbull's ingenuity and perseverance. It contains all the latest improvements, and from the particular way in which they are silvered, its mirrors were found to give about one-third more light than the old kind. We have no doubt that Mr. Turnbull would be very happy to see any who take a lively interest in his favourite science; and would be happy to allow experts to test his instrument in any reasonable manner" [close quote]. When Turnbull was making his instruments there were few written instructions for those willing to acquire the skills to make telescopes, and there would have been likely no one in Toronto he could have turned to for instruction. Like William Herschel, he would have been thrown largely on his own devices, so to speak.

One interesting aspect of Turnbull's work is that he was on the cusp of the technological change from making reflecting telescope mirrors out of speculum metal, to making them out of glass. Glass was very much easier to work. Turnbull's reflectors would have been among the first made in Canada. Unfortunately, none of them seem to have survived to the present.

Another one of the original eight who formed the Society in 1868 *was* a professional optician, Charles Potter, who'd been trained in London. Unlike Turnbull, whose latter attempts to become a professional maker of scientific equipment can only be described as pathetic, Potter's professional career in his chosen discipline was prosperous. He became, in fact, one of the purveyors of professionally made astronomical apparatus that few amateurs could afford.

Potter was unusual among the Society membership in that he was probably the only one to have received professional craft training in scientific instrument prodution. There is little evidence to indicate that he passed any of that on to his fellow Society members—but why would he have done so? It might have lessened business, and given a rival a beginning.

Heather: In the provision of resources for amateur telescope makers, matters didn't improve much till the early 20th century. The outstanding figures of what came to be known as the "Amateur Telescope Making" movement, or ATM, were Albert Ingalls, a writer for *Scientific American*, and Russell W. Porter, a remarkable technical draftsman and designer of machines, who would eventually join George Ellery Hale's staff in Pasadena designing the Giant of Mount Palomar. Porter was inspired by Leo Holcomb, who in turn took inspiration from Albert Hassard, a

Toronto lawyer, amateur telescope maker, RASC member, and friend of C.A. Chant. As you'll recall, Chant was featured in one of our earlier podcasts.

Hassard can be considered one of the godfathers of the ATM movement. He wrote of some of his experiences in a retrospective published in the *Journal of the Royal Astronomical Society of Canada* in 1917: *[quote] "Ever since I can remember I have taken an interest in the stars...About the year 1903, I bought a two-inch object glass, and the mechanical genius of the General Secretary of our Society* [, J.R. Collins,] *constructed it into a telescope...About the year 1907 I commenced work on a 9 $^{1/2}$-inch reflecting telescope. I had previously no acquaintance with this kind of work, and gained my information through different articles, scattered over numerous publications. Ultimately, however, after many trials and adversities, the instrument was completed. The work on it took nearly a year of my spare time. My father helped me, in the mechanical part, and nearly the whole instrument, including blacksmithing work and everything, were done at home; the stove being turned into a forge, and a piece of railroad rail and a broken flat iron into anvils. After making the 9 $^{1/2}$-inch telescope, I made a 6-inch glass and found it a much easier task, while the instrument was most satisfactory indeed. Subsequently I made a number of other telescopes, including a 12-inch, a 15-inch, an 8-inch, and two 4-inch instruments, as well as grinding, polishing and figuring a number of other mirrors of different sizes and apertures" [close quote]*.

If you were to open Chant's book, *Our Wonderful Universe* of 1928 to page 117, you'd find a picture of Hassard standing with one of his telescopes in Toronto. One hopes the light pollution wasn't as bad back then! It's pleasing that Chant chose a picture of Hassard and one of his telescope projects as the image of successful amateur telescope making. It's an image which was widely distributed around the world.

Randall: The problem of amateurs telescope makers having to reinvent the wheel was largely overcome by one of the lasting vestiges of the ATM movement. The three volumes of *Amateur Telescope Making*, published with many changes between 1926 and 1980. A "rationalized" edition is still in print, although I prefer the somewhat organic arrangement of the contents in the original editions. They're wonderful volume to leaf through if you ever get the chance, particularly the copies with evident signs of use—annotations, chemical stains, and insertions. Within their reddish-brown cloth covers one could find sufficient instructions to bring the novice to the completion of a 6-inch reflector, as well as numerous more taxing projects, such as refractors, eyepieces, Schmidt cameras, Maksutov telescopes, Springfield mountings, spectrographs, spectroheliographs, sidereal

clocks, and so forth. Related to them were the "Amateur Scientist" columns edited by Ingalls in *Scientific American*. Ingalls really liked the RASC, and many RASC members contributed material to the *Amateur Telescope Making* books, and to the "Amateur Scientist" columns. The RASC contributions were particularly important for the columns during the Second World War; RASC contributors past active military service overseas faithfully provided ATM content while Ingalls' younger contributors were otherwise occupied.

In *Scientific American* for 1929 for example, RASC members Moore published on a mirror grinding machine, H. L. Rogers reported on his very impressive project producing a portable 12-inch reflector, A.R. Dunlop gave examples of how amateurs could use they instruments they produced, such as in his double-star challenge, and for monitoring of solar white-light activity through recording sunspots in drawings, and W.E. Harper saw his list of reflectors with primary mirrors larger than 16 inches praised, which had originally been published in the *Journal of the Royal Astronomical Society of Canada*.

One of the outstanding contributors to Ingall's column during the war years is Cyril Wates of the RASC Edmonton Centre, with eighteen different contributions to the *Scientific American* telescope making column.

Heather: Mention of Wates brings us to another aspect of amateur telescope making. Some of the really good amateur telescope makers provided equipment for professionals, and some of them became professional makers of astronomical equipment.

Towards the end of his life, Cyril Wates gave the University of Alberta in 1943 its first significant astronomical telescope, a 32-cm primary mirror Newtonian reflector on an English mount, with a 10-cm rich-field finder. Not without a sense of humour, Wates nicknamed the primary instrument "Dignity", and the finder "Impudence". Wates never became a professional maker of scientific instruments.

One RASC member who transformed himself from amateur telescope maker to professional, was John Brashear. He became the outstanding American maker of astronomical optics of his generation. His firm provided the first set of optics for the 15-inch refractor of the Dominion Observatory in Ottawa in 1905, and the original optics of the 72-inch reflector of the Dominion Astrophysical Observatory, which is celebrating its centenary this year.

Randall: Many RASC centres had active telescope making groups; that of the Toronto, Victoria, and Regina Centres, to name a few, were outstanding. Even if the resulting telescopes were mediocre, the amateurs who made them would have benefitted form the process next time around, they could have experienced some pride in having made their instruments, and, in making their instruments they would have simultaneously created and maintained a community of amateur telescope makers. Someone who makes an instrument, or significantly adapts one, arguably has a different relationship to his or her tools of observation, than does someone who purchases her or his equipment. Those differences would be intriguing to explore, although we don't have time to do so here.

And then, thirty five, or forty years ago, the whole thing seemed to vanish, at least in hindsight. The established telescope making groups in the RASC Centres disappeared, and people who had made their own equipment began to replace it with off-the-shelf commercial apparatus. The active local communities of amateur telescope making atrophied, and an almost right of passage to becoming an amateur observer receded into history. Doubtless in may cases the commercial instruments were better, but not always so, but gone was a source of experience and knowledge through craft practice. There are losses and gains with every change in technology. An amateur who made a telescope in her or his youth, but who exclusively uses commercially produced equipment now, may very well have a better or more intuitive understanding of how the equipment works, than an amateur who has never made a telescope.

Heather: The ATM movement has never entirely died, and that is a good thing. The long-established telescope maker conventions are still thriving, such as Stellafane in Vermont, keeping alive the heritage of Porter and his collaborators. Anyone who is interested can still buy the materials to make optical equipment. Books and articles are still produced on making telescopes. Some RASC Centres still have active amateur telescope makers. The Kitchener-Waterloo and London Centres come to mind. But fewer, dramatically fewer of us are involved in this activity.

This change is not only discernible in the RASC. The same thing befell the British Astronomical Association. The commercial Schmidt-Cassegrain revolution swept away the often impressive looking home-made Newtonian installations of the BAA members, a little after it had happened in North America. *Sic transit mundi*.

Randall: There are currently several outstanding examples of RASC members who started out as amateur makers of astronomical equipment, and then went on to

commercial success. Doug George of Diffraction Limited, the producer of MaxIm DL, the late Paul Boltwood, inventor of the Boltwood Cloud Sensor, and Peter Ceravolo of Ceravolo Optics. A non-commercial example is Attilla Danko, the developer of the very useful and reliable Clear Sky Charts, with Allan Rahill of the Canadian Meteorological Centre. And Jim Chung has capably kept the spirit alive, as anyone can sample through his *Astro-Imaging Projects for Amateur Astronomers: A Maker's Guide* of 2015. One thing you'll doubtless have noticed about this list, is that many of the projects are software or have software components. Some of the activity of making stuff to do stuff in astronomy has shifted to writing code. And there's nothing wrong with that, because technology changes, constantly.

How the amateur making of astronomical equipment will develop next is anyone's guess. It is unlikely to completely disappear. And the effect of a trade war on the practice might be interesting.

Heather: Thanks to everyone who tuned in, and we hope you enjoyed this podcast. If you have any questions, please visit www.rasc.ca/rasc-2018-podcasts for contact details.

Our next podcast is scheduled for a month from now, and is on The Republic of Letters, and the Invisible College.

Our sound engineer is Chelsea Body, and our theme music is by Eric Svilpis.