Introducing Patrick Copland: 18th century Professor, Mechanic and Educational Innovator

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This is a story from the Scottish Enlightenment, well-known for producing Adam Smith’s innovative contributions to Economics, James Watt’s technology, James Hutton’s vision that founded modern Geology, Joseph Black’s insight into Chemistry, and innovative practitioners in medicine, philosophy, architecture, literature and other disciplines. Adam Smith and James Hutton have Institutes named after them, Watt the unit of power. It was an exciting time to be active in academic life in Scotland, even for those whose names would not appear in future history books. One such was Patrick Copland. Had he made one game-changing discovery, his reputation would have lasted, though he is still mentioned for introducing chlorine bleaching into Britain.

Copland was an innovator of a different kind. He was a distributor of knowledge, an educator, highly respected in his day for providing a vital link in spreading scientific ideas into society. In some ways I’m reminded of the even more eminent Sir John Herschel (1792 – 1871): hugely well known in the 19th century but there is no Herschel effect, or Herschel equation or Herschel phenomenon, so now largely forgotten in science except by historians. I do like John Herschel’s words “Science is the knowledge of many, methodically digested and arranged, so as to become attainable by one”.

Without such people digesting and arranging knowledge and spreading the word, innovation would often be slow to take effect. It’s a message that modern science is finding out is as important as discovery. In the UK, at least, public dissemination is now a key part of many research grant proposals. As we’ll see, Copland showed some of what could be done over two centuries ago.

Personal background

Copland was the only son of a Minister of the Church of Scotland. He was born and brought up in agricultural Aberdeenshire in NE Scotland. He attended the University of Marischal College in Aberdeen and graduated AM in 1766, aged 18. To be a successful educator one needs to have a passion that one wants to pass on. Copland’s passion was Natural Philosophy, in particular its application to everyday life, to agriculture, to manufacturing, to engineering. As a young scholar he may have taken up a post as a tutor, but what is certain is that eight years on, in 1774, he was asked to act as assistant to George Skene, the Professor of Natural Philosophy at Marischal College. In the following year Copland himself was appointed to the professorship when Skene translated to the chair of Natural History. It was a lucky break but no closet deal, for Copland’s chair was a Royal appointment by order of George III, King of Great Britain. Just how lucky he was can be seen by comparing with the career of the very able John Playfair, born within days of Copland, who had to wait another 30 years to get the Chair of Natural Philosophy that he particularly wanted in Edinburgh.
University. 1775 was really the beginning of Copland’s career as an educator, a career that would last 47 years, until 1822.

**The College background**

Marischal College had been founded in 1593 as a protestant university as a counterpoint to the neighbouring King’s College, founded under papal decree. Their Master of Arts degree syllabus had been revised mid 18th century and became a trend-setter from the 1750s that was copied in Europe and America. In this syllabus most of the third year of the four-year course was devoted to Natural Philosophy. The Scottish Universities specialised in providing education for the deserving, not the rich. They prided themselves on their open access to all in society, their minimal fees and the availability of bequest bursaries to support many students. Likely as a result of this policy, they seemed permanently short of money.

All undergraduates took the same courses whatever their intended career: minister of the church, civil servants, teachers, doctors, traders; the range of their professions was very wide. Private students were accepted by Professors for any course on payment of a fee in addition to the regular matriculated students. The specifically professional degrees of Law, Divinity and Medicine were post-graduate subjects.

In the wider context of European Universities, the two Universities in Aberdeen were particularly notable for drawing their intake from sons of local tradesmen and farmers. Education for a son was a matter of pride and honour as well as a likely passport to a better job. Within the student body there was by tradition negligible social segregation.

**Engaging with his students**

Copland was faced with an eclectic mixture of students who had already received courses in introductory mathematics and natural history but no other science. Talking to them *viva voce* is a step towards engaging their attention. This was Copland’s style, a contrast to the practice among other professors of dictating their notes, a technique that in my day was described as transferring the notes from the manuscript of the professor to that of the student without registering in the minds of either. Listening to one’s students is another pre-requisite for a good educator. One anecdote from his first year as Professor illustrates both changing times and his sympathy with students.

One of his private students in his first year was James Stephen, grandfather of the founder of the encyclopaedic Dictionary of National Biography and indeed a great grandfather of Virginia Woolf. To his horror he realised that the end of session exam was to be in Latin: what else in a traditional British University? Stephen raised a petition to Copland to have the subject examined in English, not only almost the language of teaching (Copland talked freely in what
might be called educated local dialect) but by then also the language of textbooks on the subject. Copland was completely sympathetic and persuaded the Senate to change its centuries’ long tradition. Stephen was particularly grateful and raised a subscription from the class to present Copland with an engraved solar microscope, unfortunately not now in the University.

Teaching by demonstration

One of the features of University teaching in Copland’s day and indeed for a very long time after, one I experienced myself in mid-20th century, was the freedom to make up one’s own course consistent with the perceived level of education, without interference from overseeing committees or external bodies. Teaching by demonstration was Copland’s trademark. With demonstrations he illustrated the principles of natural philosophy, the behaviour of nature, showed working models of practical machines and entertaining pieces with a scientific twist. In the 18th century, lectures with demonstrations were the stock-in-trade of itinerant performers talking in one town for only a few evenings at most before moving on. Giving a complete university course in this way was an innovative trend that Copland developed.

Copland wrote (in 1790) “When I had the honour of being appointed to this office in 1775, I found the Apparatus in great disorder, and extremely defective.” He turned his hobby into his job and equipped a workshop in the College, set to work and repaired the old apparatus and ‘executed several new ones, particularly for Electricity, and the late discoveries on air – for explaining which we had none.” Copland seriously undersold himself in this quotation. Over the years he made hundreds of demonstration pieces. His work in wood, metal and glass is indistinguishable from the best instrument makers. He was a craftsman professor. An inventory made at the end of career includes over 500 entries, mainly for demonstration apparatus.

Raising money – a modern approach

For the first 28 years of his professorship Copland had no patronage and little income other than his salary from the College. Equipment costs money, even when making it yourself, and personal time is not unlimited. He adopted the very modern attitude of looking all around for funding for his mission. In 1780 he tapped the local union of artisans, the “7 Incorporated Trades” for 5 gns “towards purchasing the machines wanted for the Marischal College”. In 1781, he drew up a public appeal in the name of the College for astronomical equipment and, he added “also in the Purchase of such MODELS of MACHINES, as shall be judged best adapted to promote a Knowledge of the Principles of Mechanics, and thereby the Improvement of the ARTS and MANUFACTURERS of our Country”. The astronomical aim was brilliantly successful and resulted in building the Castlehill Observatory at a prominent site a few hundred metres from the College, equipped with some of the best instruments of the day from Sisson, Ramsden, Troughton, Dollond and others¹. I’ll say a bit more about the observatory shortly.
Applying for grants was not the way forward in the 18th century but it was a step Copland took. Copland repurposed his interest in models of machinery into applying in 1783 to the Board of Trustees for the Encouragement of Manufactures in Scotland. The application secured him £50 per year. Copland employed a young man, John King, who had just finished his watchmaking apprenticeship, and installed him in the College, where Copland lived, to help him make models of machinery. He was paid £43 per annum. Copland himself said that King’s workmanship “I have found equal, both in wood and metals, to that of the best London artists”. I’m tempted to claim that John King was the first University technician making scientific instruments in-house in a UK university. King stayed on until 1790 or 91.

An unofficial inventory of the fruit of King and Copland’s mechanical work of the 1780s exists by the chance survival of a letter from Copland to the Danish scholar Grímur Thorkelin in 1790. There are 39 models in the list. “All these models are neatly executed in mahogany, brass and steel, they are on a pretty large scale, and whenever possible, are made working models, that is, to perform the work of each machine in miniature, before the class.”

Castlehill Observatory

Astronomy caught the public imagination in the 1780s, almost as now. Itinerant astronomy lecturers drew audiences as they toured the country, books aimed at the public ran to successive editions.

Copland equipped the observatory in 1782 and 1783 after spending many months in London visiting astronomers and instrument makers. As far as his observatory was concerned, apart from being a teaching aid, for which it was rather over-equipped, positional astronomy became the main theme of its use, with the navigation instructor Andrew Mackay being appointed as its superintendent. I’m not sure how ‘public’ the observatory became but I think it’s fair to say that it was the first semi-public observatory in the country equipped with early modern instruments. It preceded by several decades 19th century semi-public observatories equivalently fitted out in Edinburgh and Glasgow.

Copland had presence. He was described as a tall and handsome man, always dressed in coloured clothes. A private letter to another of the Marischal College professors suggests that Copland acquired or cultivated the image of a bit of a magician. “The thunder and lightning are in general attributed to the Hocus Pocus tricks, which Professor Copland has lately been playing at the observatory and elsewhere. ... The mob are greatly incensed against him, the
very women would surely attack him in the streets, were it not for a small vial of Electrical
matter, which he is said to carry about in his Breeches pocket4”. Indeed among his equipment
was an item described as Compound Leyden phial (retaining its charge long) for shocks and
for the electrical exercise. Maybe this reputation had some grounding.

The observatory was clearly a landmark in the city, firmly associated with Copland.
Launching an unmanned balloon from the site in March 1784 (the first in Scotland) brought
him more publicity that would have done no harm when it came to advertising his new venture
of offering an extensive course of evening lectures for the public.

Copland’s public lecture course

Copland’s reputation as the best lecturer in the College might have remained restricted to many
of the two thousand students he taught over his career but in his day it extended much wider,
on account of the public lecture course he initiated some ten years into his career. The first
public lectures were advertised for the winter of 1785. Two features distinguished his
course from other courses given in the 18th century. One was its aim at “artisans in the
mechanical profession” as well as “such gentlemen as are inclined to renew their
acquaintance with these studies”; the second was the length of the course. In Copland’s
words, “The Course consists of about seventy Lectures from one and a half to two hours
each, according as I see the attention of my hearers continue”. In aiming at artisans, it
was at least 10 years ahead of Garnet’s pioneering lectures in Glasgow and George
Birkbeck’s follow-on course5. Copland’s charge of 1 guinea for the course was about a week-
and-a-half’s salary for a journeyman, no mean fee but small compared with the cost of lectures
aimed exclusively at gentlemen and ladies, where a guinea would take you to about a dozen
lectures if you were lucky or for that sum you might be able to entice the lecturer to give a
private lecture.

People did come to his public lecture course. His successor said that his typical attendance was
about 60. He gave the course roughly every two years for 28 years. He made a name for
himself and nothing succeeds better than having a good reputation. He wasn’t the only
Marischal College Professor offering extra-mural courses, for one can find others on
Mathematics, Chemistry, Tropical and Military Diseases, Latin and Arabic. Copland’s course
was the longest and I suspect the best attended. The remote location of Aberdeen, about 200
km north of Edinburgh by rough road, may have contributed to the perception that if public
education was to be offered, it had to be done by locals without relying on travelling lecturers6.
Offering is one thing, but audiences clearly wanted such classes and they were repeated.

Only the chemistry classes and the natural philosophy classes of Copland continued until well
into the 19th century. When Mechanical Institutes for the education of workers became the
rage in the early 1820s, Aberdeen’s was quick to form and unlike many others it survived and
indeed thrived over the 19th century. I think it’s fair to say that Copland’s classes, continued
over decades, provided the bedrock on which this success was built.
Today we face problems remarkably similar to those of 230 years ago. Scotland’s population in Copland’s day was overwhelmingly tied to the land and agriculture but technology was developing farm machinery and the clearance of unproductive land; industrialisation was changing the face of spinning and weaving; pile-drivers, cranes and modern machinery were enabling civil engineering and building at an unprecedented rate and for better or worse tedious jobs were being mechanised. Copland perceived, as did others, a need for scientific understanding, not only to make sense of developments of the time but to facilitate invention. Today we have the rise of robotics, the almost ubiquitous addition of electronics to what used to be relatively simple devices, the use of sophisticated medical diagnostics and the promise of genetic developments that could affect everyone. The need for scientific understanding is not much less today than it was in Copland’s time. A King’s College, London, study recently concluded that the scientific capital of over 25% of UK youth was low, a polite way of saying that they had little understanding of basic scientific concepts. A further two-thirds were rated as having only medium science capital. Copland would have faced worse figures, had he had them. He didn’t claim he could solve society’s issues but his response was to try to reach people otherwise not in the system and to provide a course strong in demonstrations.

**Consulting physicist**

I have mentioned in passing Copland’s introduction of the much superior chlorine bleaching to Britain. It is not difficult to find examples of academic scientists acting as consultants in the 19th century: Michael Faraday, William Thomson and Gabriel Stokes come to mind immediately. 18th century examples are rarer. In 1792, Copland with his colleague Prof Hamilton were invited by the Town Council to advise on the provision of fresh water for the city. After wearing out some boot leather their work was considered so useful that both were awarded the honour of Burgesses of Guild of the City, a title for which even the most influential citizens normally had to pay significantly.

![Troughton’s 5-foot precision reference measure as purchased by the City of Aberdeen](image)

As early as 1802, Copland proposed one of the very first sand and gravel slow filtration beds for a town. Unfortunately, the town did not construct it. He also advised them on setting up accurate standards of weights and measures, advice they did follow. With a non-university collaborator, he measured the height of the Deeside hills and mountains years before the Ordnance Survey came to that part of the world, using a mountain barometer and the known lapse rate of the atmosphere. He assisted the Ordnance Survey when they did make their primary geodetic triangulation of the area and also Jean-Baptiste Biot’s survey expedition to measure the shape of the Earth. In a city that had two universities in which the professors were by and large men of religion, literature, poetry, Latin and Greek, Copland did a lot to make people realise that Professors could also be very useful.

**Copland’s reputation**

Copland’s work as a public educator was admired well outside local circles. He was a founding Fellow of the Royal Society of Edinburgh. The engineer John Smeaton was
enthusiastic about his course for artisans. The polymath Thomas Young had visited Copland in 1795, admired his equipment and when appointed Professor at the Royal Institution in 1802 found himself in a similar position of trying “to form a connection between abstract science and mechanical practice”, as he put it in a letter to Copland. Thomas Telford was equally impressed by Copland, with whom he corresponded on several subjects in 1801/1802, remarking “The country owes you much for the good you have done especially by your judicious lectures accommodated to the capacities of Mechanics, and your ingenious experiments. This mode ought to be adopted in every seminary of learning.”. Perhaps it is no surprise then that in 1803 Copland received a Royal Pension of £100 per annum through the offices of the then prime minister, Lord Sidmouth, “as a reward for the great service he had been in that part of the Country to Tradesmen and to the public by his lectures and his skill in forwarding the public improvement of the Town”. Patronage at last, from on high.

I’ll mention just two further influences. Thomas Webster had been a pupil of Copland’s in the late 1780s and himself had set up what he describes as the first ‘school for mechanics’ in England in the 1790s. He then joined Count Rumford as an architect for the proposed Royal Institution and had incorporated into the building a gallery for working mechanics, saying that he knew from previous experience how important it was for the progress of art to educate this class of people. Thomas Garnet, who had also started an evening class for working men in Glasgow, was appointed as the first RI Professor and lecturer. For reasons unknown, both Garnet and Webster left the RI in 1802, Thomas Young being the appointee who, as mentioned, was already familiar with Copland’s work.

What happened to Copland’s demonstration apparatus?

Most of Copland’s demonstration apparatus was made by himself or at least paid for by himself, notwithstanding John King’s contribution. Copland courses concentrated on the basic principles of physics along with the machinery of the age and good demonstrations of basic principles don’t date. Indeed, you can find in today’s catalogues of teaching apparatus from Philip Harris, Leybold, Edu-Lab and other suppliers, among the electronic gadgets there are demonstrations just like Copland’s, only made of plastic and chrome instead of glass, brass and wood.

In Copland’s last year, when he was terminally ill, aged 74, Marischal College had a real problem in that teaching by demonstration was becoming the paradigm of the age but the instrument cupboard would have many empty shelves if Copland’s family inherited all his apparatus. The College had contributed their 3 guineas a year, largely for maintenance, and had purchased items for teaching practical mathematics. They had an excellently equipped observatory thanks to public donations and they had some fruits of John King’s labours but that was all. In 1822 an inventory was made of the items on Copland’s charge and they were inspected for their condition and valued, bearing in mind most were well used. A copy of the inventory was made by his successor in 1823. The inventory ran to over 500 entries. In spite of pleading penury over the ages, the College decided to raid the library fund and purchase most of Copland’s equipment for about 700 guineas. This equates to at least 15 years salary for a skilled artisan in 1822.

Copland never published his notes or wrote them up as a book. To some extent this is understandable since the signature of his teaching was his prolific use of demonstrations. His apparatus was described at the time as “the most complete and extensive philosophical apparatus in the Kingdom.”
Neil Arnott

One pupil of the many pupils who was inspired by Copland was Neil Arnott. Arnott went on to forge a career as a successful doctor, physician to Queen Victoria no less, and as a social reformer. In 1827 he published his *Elements of Physics or Natural Philosophy*, General and Medicinal, explained independently of technical mathematics that ran to five editions in as many years and kept going with a 7th edition 49 years later. His book is a gem, embodying the spirit of Copland’s lectures – hugely practical in its applications with multiple examples for each point. Arnott was also a founder of the University of London. Another of the founders called for a copy of Copland’s inventory of equipment and received it in 1828. Arnott explicitly acknowledged his debt to Copland. In his will Arnott donated an annual prize to the University of Aberdeen for practical physics and I had the honour of being its recipient in my final year, a tenuous but nice link to Patrick Copland’s influence over the centuries.

In brief

Neil Arnott summed up the role that Copland played, not directly singling him out in this

instance but in the words of the introduction to his *Elements of Physics* he said: “But there is a change taking place in the world, connected closely with the progress of science, yet distinct from it, and more important than half of the scientific discoveries – it is the diffusion of knowledge among the mass of mankind”. Diffusion of knowledge was what Copland was about, beginning some 50 years before Arnott wrote his introduction. The sharing of scientific knowledge is now embedded in the United Nations Bill of Human Rights. It takes passionate people to make this happen and I would like to see them remembered in history alongside those who make discoveries.

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1 As well as the Sisson and Ramsden equatorial telescope mentioned in the text the instruments included a transit telescope by Ramsden, a quadrant by McCulloch and Troughton, a refractor by Dollond, a principal clock by Marriott, an astronomical clock to James Ferguson’s design, an orrery and other teaching aids.

For the English language reader, books such as James Ferguson “Astronomy Explained”, ran to 12 editions from 1756, and James Ferguson “The Young Gentleman and Lady’s Astronomy” ran to 8 editions from 1768; George Adams “Astronomical and Geographical Essays” ran to 6 editions from 1789; Benjamin Martin “The Philosophical Grammar” aimed at ‘the British youth of both sexes’ included astronomy and ran to at least 18 editions over some 50 years. In the 1790s, Margaret Bryan’s “Compendious System of Astronomy” and John Bonnycastle “An Introduction to Astronomy in a Series of Letters” were the first of a range of books that would be popular in the 19th century.

