A celebration of three hundred years provides a fitting opportunity to reflect on some of the big and enduring questions in art and science, questions that have become ever more urgent as we plunge recklessly into a future with an inadequate set of navigational tools and dysfunctional brakes.

From a historical perspective the most unsettling aspect of the profound financial crisis that the world economies have faced in the last few years is a concerted failure amongst politicians and economists to think about radical alternatives that extend beyond purely economic issues. The reaction has been to use old financial instruments to make ramshackle repairs to the existing system rather than to scrutinise the premises of the system itself. The mantra of politicians remains consumption and growth. The only goal on offer seems to be sustained “progress” of a conventionally material kind, based on a tacit assumption that science and technology will continue to deliver solutions.

To pretend that I can offer a wholesale solution would be absurd, but I would like to draw upon my studies as a historian of visual things to think about the natures of continuity, change and progress from my particular perspective, and how this perspective might have some wider relevance. I should say that my initial training in the biological sciences inevitably colours how I view these topics.

Historians have an unavoidable investment in characterising change in the periods they study. If nothing changes, there is nothing for the historian as a chronicler to write about. This is particularly the case for the art historian. E. H. Gombrich called his magisterial survey *The Story of Art* (Gombrich, 1950). One thing follows another in a constant succession of changing styles, contents, genres and functions. In *Art and Illusion* (Gombrich, 1960) he

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characterised the perfecting of naturalistic art from the hierarchical styles of ancient Egypt to the rural realities of the English landscape painter, John Constable. There is more than a hint of “progress” here. However, if we set a pre-historic cave painting of a bull, with its astonishingly evocative suggestion of animal’s shape and motion, beside a Picasso drawing of a bull fight, we cannot but be struck by the perceptual, cognitive and representational commonalities. These commonalities cut across not only the centuries but also any adequate understanding of the antecedents and functions of the art of our prehistoric Picasso. Let us begin with brief study of a kind of continuity that resides within the era of recorded history in Western art and science.

2.1. Continuity

My example is one of my warhorses, namely the five regular or “Platonic” polyhedra, which are the only geometrical bodies that are composed of identical faces and are symmetrical about their vertices. For Plato – hence their name – they were the fundamental building blocks of the universe, corresponding to the four elements and the cosmos. Over the eras since the Athenians of the 5th century BC, they have come to feature at every scale, as our visual reach has progressively (note the term) extended into ever increasing realms of smallness and immensity. I will assemble some instances in order of size not chronology. The relatively recently discovered carbon molecule C60, called Buckminster Fullerine after the great American inventor and engineer, Buckminster Fuller, is configured as a truncated icosahedron, one of the semi-regular solids named after Archimedes, the alternating faces of which are composed from two of the polygons, in this case hexagons and pentagons with 60 vertices. Moving up a scale, we find that the capsids of some viruses work variations on the geometrical solids. Moving up again, we encounter under the sea the microscopic radiolarian with their geometrical skeletons, so beloved of Ernst Haeckel, the early German proponent of Darwin’s ideas. Next come the “six-cornered” snowflakes, about which Johannes Kepler wrote in 1611. It was also that dedicated Platonist Kepler who also proposed a model for the orbits of the planets based on a set of nested Platonic solids each inscribed in a sphere in his Mysterium cosmographicum in 1596-7. And in 2003 Jean-Pierre Luminet and his colleagues at the Paris observatory have proposed a model for the whole cosmos of a dodecahedron disposed in the four dimensions of a hypersphere (Luminet et al., 2003).

I am not concerned here so much to advocate the ubiquity or fundamentality of the regular solids and their variants in the design of nature as to stress the cognitive continuities that leads us to search out and delight in these basic forms. In these continuities the notion of “man as the measure of all things” (to cite Protagoras) is crucial. This can function at various levels
from the philosophical to the practical. The prime visual expression of the notion in its philosophical form is Leonardo da Vinci’s famous drawing of the Vitruvian Man in Venice, based on the writings of the ancient Roman architect, Vitruvius. The man’s outstretched arms and legs, shown in two positions, trace the circle and square within which man’s body can be inscribed. Inside his body are measures of “harmonic” proportions. It is on this system of measurements that the work of the artist and architect should be founded. In the 20th century, a comparable idea was expressed in Le Corbusier’s “modulor”, a proportional schema that also aspired to unite the Anglo Saxon foot and inch and the French metric system.

The practical use of parts of the human body to produce a system of measurements is common to almost all cultures. Leonardo’s Italy was typical with its braccio (arm) and palmo units. In the Ashmolean Museum in Oxford, there is a fractured relief sculpture from the 5th century BC of a man whose outstretched arms measure out a fathom, while the sole of a foot above his left arms provides the length of a pes. Arms, feet and so on were of obvious convenience and utility for measurement, since we have them with us all the time. Obviously some standardisation was needed if precision was required, and this is what the carved relief was designed to achieve.

I think we can carry this somatic aspect further into processes of visualization. Our bodily instincts for scales, material and motion work in close sympathy with our visual and cognitive powers in a way that invalidates Descartes mind-body duality. It was these deeper somatic-cum-cerebral instincts that operate before articulate verbal formulation to which Einstein was referring his letter to Jacques Hadamard:

> The words or the language, as they are written or spoken, do not seem to play any role in my mechanism of thought. The psychical entities which seem to serve as elements in thought are certain signs and more or less clear images which can be ‘voluntarily’ reproduced and combined [...] this combinatory play seems to be the essential feature in productive thought before there is any connection with logical construction in words or other kinds of signs which can be communicated to others. (Hadamard, 1945, pp. 142-143)

Obviously if we set Albert Einstein’s and Jean Pierre Luminet’s understanding of space-time beside those of Leonardo da Vinci or Johannes Kepler, we can reasonably speak of progress, in that the mathematical and conceptual frameworks for our modern understanding involves levels of technical sophistication far beyond that of earlier ages. We are surrounded by examples of technological progress, not least the computer on which I am writing this paper. Indeed, indefinite progress, linked to endless economic growth, is the paradigm behind our capitalist economies. Whether such forms of progress extend beyond material criteria and into less measurable factors such a human well-being is very much another matter.
2.2. Progress in the Arts?

The answer is yes, in certain specific kinds of way. If we look, as my mentor E. H. Gombrich did, at the growing sophistication in the pictorial devices of naturalism – taking the brief of art in a certain historical context as the illusionistic imitation of nature – we can clearly say that the available techniques did indeed progress. According to the formula adopted by Gombrich, the “making” increasingly emulated the goal of “matching”. This is not to say – and Gombrich certainly did not claim – that Leonardo da Vinci is a “better” artist than Giotto di Bondone because he had devised enhanced techniques for the imitation of nature. And few would claim that a portrait photograph is artistically superior to the *Mona Lisa* because it looks more “real”. If we look at, say, a Venus by Botticelli and one by an academic painter in the 19th century, such as Bourgereau, we can say that the latter is far more “photographic” in its naturalism. Botticelli’s nude is linear and flat by contrast. But the Botticelli picture has proved to engage spectators over the centuries far more than that by the 19th century master. The earlier painting seems to invite the spectator’s imagination to collaborate to a much greater extent in completing the image than the more veristic rendering. A faceted nude by Cezanne can in this sense be said to work in a way more like a Botticelli Venus than one by Bourgereau. Thus, we can say that western art progressed with respect to the brief of the imitation of nature but not in terms of artistic excellence.

There is another sense of progress that we can see at work in the visual arts, namely in the growing sophistication of our critical apparatus over the centuries. This is nicely captured in Hunter’s cartoon of a bemused spectator in a national art gallery, in which the successive minimalising of the pictures has been matched by a progressive maximalising of the labels (Figure 2.1). Clearly we have much more verbal equipment and developed techniques of analysis available to us than was current in the Middle Ages. Indeed the category of “Art”, in the sense of “Fine Art”, was not available as a category in earlier eras. Looking at the hosts of spectators in art galleries, many of whom are not as puzzled as Hunter’s glum head-scratcher, we can say that great progress has been made in what used to be called “art appreciation”.

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Again, we would not be safe in claiming that our ability to say a lot about a blank canvas means that it is a better work of art than the Mona Lisa. We can of course, given our current historical and critical techniques, say a great deal about Leonardo’s famed portrait, as I have done myself on more than one occasion. The difference is in the mode of entry to what we now think of as “works of art”. We can get into the Mona Lisa easily enough. We recognise that it shows a woman in front of a landscape. It began life, after all, as a functional portrait of Lisa del Giocondo, even if it was gradually transformed by Leonardo into what can be called a philosophical image. A modern minimalist or conceptual work of art dispenses with the figurative entry and can claim to go straight to the “art”, relying on the spectator to be aware of the rules of the game. This is not to say that Leonardo was painting works that were really abstract, but rather that the naturalistic dimension that was wholly integral to his image was been dispensed with in abstract painting. The progress here is thus determined by the role of the spectator as much as that of the artist. Our brains are being directed to do something different from what was expected of Lisa’s husband.

2.3. New Brains for Old

There have been hyperbolic claims for the way that new media are reshaping and re-tooling our brains. There is no question that we are being subject to huge increases in the volume of images and acquiring the speed to cope with them. Brains are very plastic things. Indeed, the whole premise of education is based on the assumption that we can teach people to think more effectively, to make better use of the brains. Sports coaching relies upon the ability of the brain and body acting in concert to perform at a superior level after well-judged instruction. It has been documented that the brains of London Taxi
drivers, who have to acquire an extraordinary memory of London streets (called “the knowledge”) before they can be licensed, show special development in the posterior hippocampus (Carr, 2010b). The downside is that the anterior part is smaller than in standard brains. I think few, outside the ranks of cab drivers, would claim that they represent a higher life form. I think the same can be said of computer “nerds”, who accomplish digital feats that are way beyond anything I can conceive. What is happening in parts of our brains is rather like what happens to the biceps of a weight lifter. The muscle is basically the same as mine; it has just been trained to work to an exceptional degree. My view is that the basic proclivities of our brains are and will remain pretty much as they have been for many centuries but they can be selectively trained to deliver extraordinary things with respect to certain kinds of task.

These gains involve minuses as well as plusses, as in the anterior and posterior hippocampuses of the taxi drivers. The speed at which we now devour images – and we are all “image junkies” by nature – means that something is lost as well as gained. If we compare a recent James Bond film with Hitchcock’s Psycho of 1960, we can see what is happening. In the Bond film no shot is on screen for much more than a second, whereas Hitchcock allows his camera, placed in a limited number of positions, to dwell patiently on a single view for many seconds, even waiting for something to arrive into the frame. Douglas Gordon’s extraordinary installation 24 Hour Psycho (1993) allowed us to see better the remarkable visual and narrative gaps in Hitchcock’s masterpiece. It is into these gaps that our imaginations rush. We think, in the famous scenes of the stabbings of the errant women and of the anxious detective, that we have witnessed violent deaths. In fact all we are shown are suggestive fragments into which we project a horror more vivid than if it were literally described. In the Bond film by contrast, little is left to left to our imagination. The camera only needs to look for an instant at a building before it blows up. There is no space for a build-up of sustained tension.

What has happened in these few decades in all aspects of our visual lives is that we are left with little space to think, to contemplate. Thinking in empty spaces is both demanding and potentially unsettling. It is easier to go from one thing to the next and so on without taking time to question ourselves and others than to undertake fundamental scrutiny of big questions. Big questions are the true province of the arts, humanities and basic sciences. These domains are not much in political favour at present, when things are judged by our paymasters in terms of utility and economic output. For me, as a friend of the sciences, it is alarming to see so many good scientists, who are driven by deep questions, jumping on the bandwagon of utility to claim that they are generating technological outputs that will drive economic progress. This opportunism might help with short-term funding but in the longer term scientists will discover that they have surrendered the fundamental definition
of the worth of science as a means of understanding the world. They will fall
painfully under the wheels of the political bandwagon.

Unless scientists join the humanities in proclaiming the great human
worth of the sciences and arts at the deepest level – as the most magnificent
mental achievements to which human beings can aspire – the academy as a
whole is heading for disaster. We should collectively proclaim the need to
probe the unknown and even the unthinkable. Science and art both begin
where knowledge ends.

The former US Secretary of Defense Donald Rumsfeld’s much-derided
“unknown unknowns” have much to recommend them, albeit in a context
and serving an end very different from the one he envisaged. This is a territo-
ry that involves dark matter as well as illumination. Explorer’s boots are
very different from comfortable pairs of bedroom slippers. The new
knowledge may result in tangible benefits, in terms of such things as new
technologies or enhanced medical understanding, but the quest should not be
directed solely or even predominantly by these utilitarian goals. Indeed, it
may well be one of the results of new knowledge to question the whole con-
ceptual and practical basis of progress in its various utilitarian definitions.
Can we achieve a definition that is locked into the idea of human well-being
rather than reliant upon increased consumption?

2.4. A New Model

At the height of the recent economic crises, leaders of the world economy
have repeated stated repeatedly that we must return to a situation of
“growth”, whilst urging cuts in public expenditure. The word and the goal
could not be surrendered even when it is virtually meaningless in the face of
the realities. Growth of what? Unemployment, certainly, and inflation prob-
ably. Does the long-term goal consist of growth defined by consumption,
output, personal spending or saving, Britain’s prosperity measured against its
competitors, the “markets”, or what? Do some or all of these things deliver
greater well-being, even that nebulous thing called happiness? No politician
really wants to face the fundamental questions about non-utilitarian progress,
since economic growth is the unthinking mantra they all espouse.

It is a question that the arts, humanities and sciences can and should ask,
without pretending that we presently have answers. It is not hard for both
scientists and historians to show that human beings are not equipped for
stasis. We need a feeling of change and development, not in the sense of
disruptions to our own lives but a more general feeling that things are getting
better and that there are new and enjoyable things of the horizon. If nothing
changes from minute to minute, from day to day and so on, we easily get
bored. In my territory of the visual arts, we would be very bored to find that
artists now had no more to do than paint paintings and sculpt sculptures that
had already been done. We are always looking for something new, a fresh human insight. This applies to music, literature, theatre and dance. The new might arrive as a big bang or it might comprise a small voice that quietly makes us look at things anew. The scientist’s search for the new is essentially the same in motivation and scope.

Might the much-needed new model of progress be based on the kinds of progress we have noted to occur in the arts and in the basic sciences? They are forms of progress that are not predicated upon infinitely extended consumption of finite resources, or upon the “take-home” pay in our pocket. Some aspects of such progress might provide ways of increasingly prosperity without conventional consumption of resources, and improved well-being through medicine. We might also understand more about the quotient of happiness of which we are capable in our lives. This quotient is clearly dependent on a certain level of material comfort, but extreme levels of wealth do not seem to produce greater well-being. Within the new definition, growth in the material sense would not be the implicit or implicit goal. Might it be that the arts, which have never been so tethered to economic growth as the sciences, can take a lead in achieving this redefinition?

I am not pretending that this is the answer. Rather I am thinking out loud about an agenda, currently nebulous and somewhat out of reach, that we can take on together within the academy, whatever our disciplines. We are after all educators, and can potentially have a profound impact on the next generation of people who will move into all walks of life, including politics. In order to do so, we need together to reformulate our own paradigms of continuity, change and progress. We need to help reshape the goals of society. We cannot do it in disciplinary isolation from each other.

2.5. Comments by Ulf Göranson

We have heard a fascinating paper by our Member Professor Martin Kemp of Oxford on the continuity, change, and progress in visual imagery. To jump, in the oral presentation, from Kepler’s geometrical models to modern footballs and find connections seems to me a perfect example of the thrilling ideas that have been introduced in our Society through the centuries.

Professor Kemp made very interesting observations on the continuous developments in science and in art. He stressed the need to observe the limitless ability of the human brain to introduce new ideas but warned us against modern trends of isolating the natural sciences from the humanities and of hunting short-time successes in research directed mostly to please funding institutions.

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Looking back at the founding century of our Society, the limits between various fields of academic life were certainly not so strict as today. But one of the purposes behind the Society was, nevertheless, to give representatives of different university subjects an opportunity to exchange ideas and results in the clear understanding that inter-disciplinary discussions always promote progression.

A leading theme in Professor Kemp’s paper was the visualization of scientific results. I will try to give an example of how two of our Society’s most famous members made some efforts to do that, albeit with little success. The members were Anders Celsius and Carl Linnaeus (ennobled von Linné). They were not only members but also in immediate succession Permanent Secretaries of the Society, Celsius from 1729 to his early death in 1744 and Linnaeus from then on to 1767.

Anders Celsius was a physicist and astronomer, the first professor in Uppsala to wholeheartedly accept Newton’s theories. Several years abroad gave him an important network to cooperate within, and his meticulous meteorological studies led him to construct the thermometer, for which he is probably best remembered by posterity. I do not know if he, in his astronomical research, like Kepler, whom Professor Kemp mentioned as an example, adhered to geometrical theories based on Plato. Illustrations of a more visualizing nature are not easy to find in his works. Beside the text, there are mostly diagrams and tables. My example is, instead, the title page of one of his dissertations, certainly written by the Professor himself, since the most important task of the candidate for the degree in those days was to defend the numbered statements ending the rather brief text (see Figure 2.2).

The illustration shows the astronomical observatory in Uppsala – in 1740 not yet fully completed – a building that still exists but for various reasons was far from ideal when it came to make observations of the sky. Nowadays it is embedded in the commercial centre of the city. In Celsius’ days, however, it must have been an image of successful progress, and very much so since the question of building an observatory had been deliberated for more than half a century before the many good instruments collected were given a permanent and relatively usable edifice. Also of interest is the citation Celsius places over the top of the building: Sic petitur coelum, i.e. so man can reach the heaven. It may sound very presumptuous. But it is a citation from Ovid in his Fasti (chronicles), where it has nothing to do with astronomical observation to map the universe. The thesis was one in a series to describe the constellations of the Zodiac, here Aries, the ram.
Figure 2.2. Title Page of an Uppsala Dissertation in 1740

What Celsius lacked in visual artistry or at least showed little interest in, was compensated for by his skills and exactitude in experiments and his ability to collect data from others and analyse them. This was clearly shown already in his young years with his important publication on *aurora borealis*, the northern lights.

*Carl Linnaeus* (von Linné) was similar to Celsius regarding their capacities for perception and textual explanation. Linnaeus was the master of sharp, short and exact descriptions. No more than 13 Latin words should be used to distinguish one species from another. In Swedish, he is considered the founder of a smooth and image-rich style when he wrote about the life, trade, and nature of different parts of the country on his many documented
Travels, ordered by the Government as a means, in line with 18\textsuperscript{th}-century mercantile thinking, to promote the national economy.

If we can say with certainty that Linnaeus wrote in an elegant and exact way and in various styles to scientific and general audiences, we could ask if he was also able to illustrate his text with drawings from his own hand? My answer is a definite no. The example given makes you think it is a child’s quick sketch of various birds (Figure 2.3). But it is his own way of illustrating the distinctions in his pioneering systematic work \textit{Systema naturae}, first published in 1735 when he was only 28 years old and residing in the Netherlands for several years. The reason for going abroad from Uppsala was clearly to come into personal contact with leading scholars but also to publish in a place where the results would be spread more widely and effectively than from a northern outpost. Linnaeus was no doubt sure of his own long-lasting qualities, but he had also the more short-term desire to achieve immediate success.

The picture of the birds illustrates how to systematize the birds correctly, according to Linnaeus model. The first distinction to observe was the form of the beak, then to divide birds with the same beak according to the form of their feet. If that was not enough to identify one bird species from another, the form of the crest and finally that of the tongue would be decisive. This quite naïve image was never published. It may, however, be an indication that Linnaeus’ way of thinking was similar to that of Einstein, cited in Professor Kemp’s paper: images came before the words.

Linnaeus’ universal task in \textit{Systema naturae} was to give a systematic division to the whole of Nature: the three kingdoms of minerals, animals and plants. It was a huge undertaking and really successful only in the area of the plants. When others before him had tried various parts of the plant in their modelling efforts, Linnaeus decided that the sexual organs should be used. Astonishingly quickly, his method was broadly accepted by botanists all over the world, though the leading French authority G.-L. de Buffon was long his strong adversary. Linnaeus was aware that a precise illustration in images of the various constellations of the sexual plant organs would assist in bringing his system wider acceptance. But this time he realized his own shortcomings as a visual illustrator. Instead he turned to an experienced German-Dutch artist, G. D. Ehret, with whom he cooperated in later projects and explicitly considered to be the only reliable flower painter. Did this estimation have to do with the fact that Ehret never forgot to show rather exactly the number and form of the stamina and pistils in his beautiful flower pictures?

There are more sketches by Linnaeus, both in Uppsala and in other institutions holding materials from his hand. All images are similar in their primitive and far from artistic appearance. One good example is when he tries to depict a Lap carrying a small boat over his head while moving from
one lake or stream to another. The picture looks more like a mushroom than a man with a special way of dealing with a means of transportation.

**Figure 2.3. Sketches of Birds by Carl Linnaeus**

Professor Kemp’s paper gives rise to many thoughts and further deliberations on the role of visual imagery within the arts and the sciences. My two examples from giants not only in Uppsala and our Society but also interna-
tionally recognized as highly progressive scholars may illustrate that they probably thought in images but were not able to fix their images themselves. They were men of text and tables, and at least Linnaeus knew, like Kepler, that a skilled and artistically produced image was of great assistance in promoting new ideas.

2.6. References