INTERTWINING THE TWO CULTURES IN THE YEAR TWO THOUSAND

Ken Stange
Nipissing University, Canada

Abstract: The purpose of this paper is to re-evaluate (as the millennium approaches) the relationship between C.P. Snow's 'Two Cultures': art and science. By a critical examination of current trends in the visual arts, mathematics, and science, the contemporary (and projected) status of this 'troubled marriage' is examined. The effects of three major computer-related revolutions are considered: 1) the microcomputer as a new, powerful tool for the artist; 2) the widespread interest among educated laymen in the startling, striking images and animations generated by exploring fractal concepts, chaos-theory, and other mathematically-based algorithms; and 3) the Internet with its potential for making McLuhan's global village a reality and initiating communication between people of very different backgrounds and training. Also considered is how the fundamentally visual nature of mathematics has been made visible by new technology which makes the long-standing claim of mathematicians that what they did was based on aesthetic elegance finally comprehensible to non-mathematicians. It is concluded that the schism between the two cultures of science and art has narrowed in the fifty years since C.P. Snow first diagnosed this unfortunate intellectual and aesthetic dichotomy. Recent grassroots interest in the images generated by computers (using algorithms based on chaos-complexity theory, ray-tracing, quantum mechanics, and fractal geometry) combined with the effect of global (and graphical) interaction made possible by the World Wide Web has done much to bring together the 'two cultures'—and to draw into the new amalgam many people formerly on the fringe of one or the other culture.

The Break-up

It is said that the Hottentots used a numbering system consisting of one, two, three, and *many*. Maybe I have some Hottentot blood, for these are the critical numbers that surface in this analysis of the current relationship of the arts and sciences: unity, the two cultures, the second millennium, the third culture, the three socio-technological revolutions—and the many implications of all the above.

Once there was one—one culture. We don't know the cataloguing system of the library at Ephesus, but it seems likely that it was all of a piece. Math and science were considered arts, not separate intellectual domains.

Then the Aegean waters of civilisation parted. Ancient Greek *culture* (in one sense of that multi-dimensional word) may have been split along Athenian and Spartan

worldviews, but there was then no schism, no Peloponnesian War between Art and Science. Aristotle, typical in his cultural attitude, wrote both *Poetics* and *Physics*. In the Golden Age, Art and Science apparently were happily married, their differences acknowledged, but these differences not hostile or irreconcilable. Since then things have changed dramatically for both, but even more significant than the changes within each is the irrational antagonism between them: their at least century-long separation, if not official divorce.

It is a difficult historical question to answer, where and when the rift first occurred. Da Vinci and Goethe and Durer obviously saw no contradiction in being interested in both science and art, but at least as far back as the English Romantic poets, (Blake was, we know, no fan of Newton), there was frequently expressed hostility between the two parties.

It is far less difficult to pinpoint when *acknowledgement* of the extent of this cultural rift was finally made public. In May of 1959, C.P. Snow, novelist and scientist, gave The Rede Lecture at Cambridge. Gradually at first, but soon exponentially, a wave of reaction, often extremely hostile reaction, rose in the intellectual community of England, then the Continent and North America. He later remarked that it was as if "a nerve had been touched almost simultaneously in different intellectual societies, in different parts of the world."

What was this exposed nerve he'd touched that could produce such a tidal wave of response? The name of the lecture supplies the answer: *The Two Cultures*. The phrase has become a part of the standard intellectual lexicon. The Two Cultures are, of course, Science and Art. C.P. Snow had the temerity to point out a nasty little fact that many knew, but no one had so baldly stated in public or in print: scientists and artists had parted ways, had split into two cultures, and were profoundly ignorant of—and often extremely hostile to—each other. He had effectively accused all intellectuals of parochialism: the deepest cut of all.

In his seminal essay Snow used the terms "literary" and "scientific" for the Two Cultures. By "literary" I believe he intended to include the arts in general; certainly art (in the broad, general sense of the word) and science (interpreted as including mathematics) is how 'the Two Cultures' are now defined in popular usage, even if Snow made few specific references to mathematics and the visual arts. My thesis is that the Two Cultures are finally again coming together, to both their advantages, *and* that they are doing so largely because of the reconciliation of '*subcultures*' of each, i.e., math and visual art, and, furthermore, that this reconciliation has been made possible by the appearance of a third culture: computer technology.

Both the visual arts and mathematics have undergone revolutionary changes in this century. A brief examination of these changes is prerequisite to understanding why the recent computer revolution has had such a powerful reconciliatory effect.

Living Apart and Growing

Since their separation both Science and Art have had exciting lives, *and* lives that are in many ways strangely parallel. This has been noted by several writers who are comfortable in both houses, one particularly cogent and fascinating treatment being Leonard Shlain's book: *Art & Physics: Parallel Visions in Space, Time & Light.* Shlain concentrates on the visual arts, but other writers have taken on similar analyses for the other arts, and all

of them are convincing—but only on one level. The correlational evidence is substantial, but the causal explanation remains elusive.

If the revolutions in science were one of the causes of the contemporary revolutions in art—for the causal arrow always seems to be pointed in this direction—one has to accept the mystical, unscientific concept of *action at a distance*. For Einstein's revolutionary new way of viewing time and space to have influenced Picasso and Magritte, Picasso and Magritte would have had to know about and understand relativity theory, something they clearly did not. The conventional way around this objection is to suggest that the new radical ideas of science were "in the air". The flippant response to this would be to point out that even now as we inhale, we're probably sucking in a molecule that once spent some time in Newton and that should surely cancel out the influence of any Einstein molecule. More seriously, the historian's idea of a *zeitgeist* may have some validity, but were the advanced, revolutionary ideas of the new century's science really part of the spirit of the times? I don't think so. How could they be? Yes, in this century's wonder years the Bourbaki mathematicians may have been drinking and conversing in the same Parisian cafés as Matisse and Hemingway—but *not* at the same table. Visual artists and writers and mathematicians of that time and place may all have spoken French, but the specialised languages of their specific passions were incomprehensible to each other. Because of the chasm separating the two cultures, most artists, even the most brilliant, were innumerate and scientifically illiterate. The advanced ideas of the new science were only comprehensible to a small group of people, i.e., the community of scientists. When Einstein became a celebrity, he was known more for his unruly hair, his violin playing, and his eccentricity than for his ideas; and, furthermore, when his ideas eventually did filter down into the non-scientific community, they were so distorted as to appear trivial at best, silly at worst.

In the case of correlations, where one can rule out a causal relationship between the two correlated variables, X & Y, one searches around for a Z that is the cause of the concurrent changes in both. Among the usual suspects are social change and technological change, but I'll leave it to the historian to try to get a conviction. Instead, I would like to turn now to an examination of the nature of the revolutionary changes in the two domains, visual art and mathematics, the two domains that I believe are now starting to act directly on each other, finally are starting to communicate.

Visual Art. Another triad! One somewhat arbitrary but useful taxonomy that can be imposed on the chaos of twentieth century visual arts is tripartite: 1) abstract; 2) neo-representational; and 3) conceptual.

1. Abstraction. The abstraction of painterly art was certainly the most dramatic revolution in Western art since the Renaissance and the introduction of single-fixed point perspective. How extremely radical this really was is evidenced by the hostility and incomprehension it still, almost a century later, induces in a substantial portion of the population. Why this should be so is difficult to understand, for the same people who decry abstract painting as pure charlatanism seem to be able to appreciate abstract patterned quilts, Delft or Meissen china, wallpaper, or any of a multitude of objects that are aesthetically interesting and totally abstract—apparently just so long as they aren't on canvas!

Things are gradually changing however, for the beginning of abstraction was the work of the impressionists, and now cheap Monet prints decorate the homes of people who have never felt the urge to visit an art gallery. After the impressionists, came the cubists,

the fauvists and others who painted people and things, but not photographically, not realistically. Eventually, of course, pure abstraction became the rage (in every sense of the word), and after it op art. Abstract art is, of course, with us still and surely always will be.

2. Neo-Representational. Abstract art came, saw and conquered—but not entirely. Abstract art now shares the stage with Neo-representational art, a category containing such strange bedfellows as the super-realists, the magic-realists, most surrealists, and artists of the fantastic. Two characteristics dominate this neo-representational art: one is the extremity of the 'realism', the so-called *super*-realism; the other is the willingness to 'represent' what does not exist, what is really not real at all—which of course means that calling this Neo-representational or Neo-realism is technically a misnomer. Dali, for example, draws with a skilled draughtsman's hand, but his 'realistic' clocks hang melting on tree branches in a landscape that never existed, just as Magritte paints tubas burning like candles. To a great extent, this reincarnation of realism is anything but real—it is virtual. But this art is executed with such skill that reality pales by comparison.

3. Conceptual. The third category of Twentieth Century art, one that draws even more hostility—and is far more revolutionary—than abstraction is Conceptual Art. Whatever the reason, the artist's ego suddenly expanded to fill the vast container that is the twentieth century, and with this also expanded his imagined role. The painter was no longer content with being a mere applier of paint; he envisioned himself as thinker and revolutionary. The Dadaists and the Surrealists were the two art movements most notorious for this egotism, although most of the works of the latter can be grouped with the previous category.

The undisputed father of Conceptual Art was the enigmatic Marcel Duchamp. In works such as "Fountain" (a urinal hung on a gallery wall and so metamorphosed into Art by its context) and "The Bride Stripped Bare by Her Bachelors, Even" (a painting on two glass panes that really is nothing more than a cryptic 'map' of a deliberately jumbled series of satirical, pun-laden, pseudo-scientific notes), Duchamp did much to take the 'visual' out of 'visual art'. After him, idea was all. For conceptual artists, the art object is of relatively little importance: process and concept are what really matter.

So these three form the Holy Trinity of Twentieth Century visual art. As I hope to show, all three have recently been influenced by math (albeit math usually cloaked in computer technology) and it is this interaction that is finally bridging the chasm between the Two Cultures.

Mathematics. Being neither mathematician nor math historian, I am way out of my depth in even attempting to comprehend the evolution of mathematics in this century. Nevertheless, foolishly stepping where even angels fear to tread, I'll venture a layman's opinion that the three areas of fractals, chaos theory and computing are the most wide-ranging revolutionary developments in modern mathematics, as different from what went before as abstract, conceptual and neo-realist art are from previous types of visual art. (I feel slightly more confident saying this after reading Ian Stewart's *Nature's Numbers*, for he says virtually the same thing.)

I hasten to emphasise that my choice of these three is based primarily on their wide-ranging influence: these mathematical revolutions *matter* to non-mathematicians. I know, for example, that the proof of Fermat's Last Theorem was profoundly revolutionary in a very different way—a more purely mathematical way—because it connected so many far-flung mathematical domains. When Wiles presented his famous three, three-hour lectures (that magic number again) it only became ever so gradually evident that all these

distant mathematical areas were converging on proving something that had eluded the best mathematical minds for 300 years. This is obviously significant, but its influence outside of pure mathematics is nothing compared to that of fractal geometry and chaos theory which have *both* captured the popular imagination *and* had profound implications for all the sciences – as well as, I believe, the arts.

1. Fractals. Oh what has Mandelbrot wrought!? Although the concept of geometric shapes complex and detailed in structure at any level of magnification was a known part of mathematics in the last century, it is only two decades ago that the eccentric Polish mathematician formally studied these 'monstrosities'. Fractal geometry, with its non-integer dimensions and its use of the so-called imaginary numbers, seems an unlikely topic to capture the popular imagination, but capture it, it surely did. And the reason is obvious. Fractals, with their frequently not-quite perfect self-similarity at magnifications extending to the infinitesimal, *are beautiful when graphed*. Fractals make beautiful pictures, which unlike conventional pictures consist of infinite variations on a theme.

2. Chaos And Complexity. Long before the mathematical domain of chaos and complexity theory had developed, people spoke of the complexity of modern life, of the chaotic nature of twentieth-century existence. The disturbing paradox of apparent randomness and unpredictability of events in the context of the firmly entrenched modern belief in determinism found resolution in chaos and complexity theory. One could have the cake and eat it too: determinism *and* unpredictability. And, as with fractals, chaos theory was a branch of mathematics that mathematicians seem to have previously found, well, *embarrassing*. Non-linear, iterative functions, like non-integer dimensions, are a *messy* business.

3. Computers Computing. And then there is the computer revolution in math. Part of this is the use of computers to do 'the dirty work'. I am of course aware that some purist mathematicians eschew computers and brand any computer-assisted proof as *inherently* inelegant. When in 1976 Haken and Appel resolved the Four Colour Map Problem using a computer, many mathematicians considered the proof not really a *proper* proof since it was not derived by *pure* mathematical logic. Be that as it may, the computer revolution made possible mathematical explorations previously impossible. The huge number of iterations required to investigate fractal geometry and dynamical systems was simply not feasible until computers. It surely is no coincidence that the growth of knowledge and interest in these fields parallels the growth of electronic computational power.

Enter The Third Culture As Mediator

It seems the computer has just slipped into this discussion. Well, enter stage left, the computer culture: the Third Culture. And it really is a 'Culture'. For those of us who use computers to do whatever it is we do, in art or science or in any daily activity, there is now a strong tendency to divide the world into those who know (and usually love) computers and those who do not know (and usually say they hate) computers. Strangely, sadly, this schism is probably almost as great as the one that has divided the artist and scientist most of this century.

What is stranger still is that computers, which are nothing more than tools, should so polarise opinion and in such often emotionally charged ways. What are computers, really? It should be obvious, but isn't, that all computers do is *compute*: a pretty mundane thing. (Of course, the original meaning of the word was a *person* who did computations for a

living, an unenviable job.) Although it isn't evident to the average user of computer applications, even the writer using a word processor is doing math. Computers only understand numbers (in fact, only two numbers, less even than a Hottentot), and a letter is just a number to your Pentium chip. This essay is, as far as my computer is concerned, a long series of zeros and ones and every tiny editorial change a whirlwind of calculations.

It rather takes the mystery out of computers to emphasise that a computer is just a drudge doing arithmetic, not a mathematician, but of course its power and significance is in it being an amazingly efficient drudge, and one willing and able to do virtually anything that can be reduced to manipulating numbers—which turns out to be almost everything. (And it is also worth remembering that mathematicians and mathematics power and train this workhorse.) Drudges are useful. The pyramids were a grand conception, but they would have been just that, only an idea, if they weren't actually built—by drudges. So let's now turn to three ways that delegating work to our silicon drudges builds a bridge between art and science.

The Computer Artist And Scientist. The first and most obvious effect of computers on the visual arts is the discovery that mathematical computations can be used to manipulate not just words but images as well. To accomplish this an image is reduced to a point in space (determined by two numeric parameters: the x and y axis), and its colour (determined by three parameters: hue, saturation and intensity). The late nineteenth century pointillist, Georges Seurat has much in common with the computer scientists who designed the current method of digitising images for the computer screen and could reasonably be designated the father of computer art. Turning pictures into numbers has had a profound effect on the contemporary visual artist.

1. The Silicon Draughtsman. Probably the most wide-ranging result of being able to translate image to number and vice versa is that the old prerequisite of draughtsmanship has been dropped. No longer are special, finely honed sensori-motor skills necessary for creating images, for being a visual artist. Even back in Leonardo DaVinci's time attempts were being made to achieve this goal; 'drawing machines' were constructed to do the dirty work of accurate proportional drawing. Unfortunately they didn't work all that well, so the more conventional tools of ruler and compass were more often used. However, the new computer 'draw' and 'paint' programs work extremely well. Neo-realists and surrealists can throw away their rulers and compass. A currently trendy word is 'empowerment'; well, the computer empowers everyone gifted with imagination to be an artist. If one can imagine the image, one can create it on the computer—even if one has palsy.

Furthermore, because the creation of images is so easy and inexpensive and *revocable*, the creation of computer art allows much freer play with composition. Don't like the colour? Change it. Don't like the position of an item in the image? Change it. No paint or time wasted. This is especially fascinating to surrealists who can insert and move around objects with complete abandon.

2. Metaphotography And The Appropriation Studio. One of the major causes of the turn of the century movement away from realist painting was the invention and refinement of photography, which was seen as 'appropriating' the painter's mandate. Ironically, the computer is now mating the compositional aspect of painting with photography, and *image* 'appropriation' has become central to this hybrid art form. Images can be 'captured' with many different traps: on film by conventional camera; on disk by digital camera; on computer by scanning hardcopy images, getting input from video, or by downloading from the Internet. No matter how the image is captured, it can be processed, developed, by a

computer in all the ways a photographic image can (as well as in many, many more totally new ways) in a virtual dark room—and again with the cost in time and materials minuscule compared to that of pre-computer days. Image enhancement algorithms such as false colour, edge detection, and sharpening, originally developed by mathematicians and scientists as research tools, are now as familiar to the computer artist as they are to the scientist. The extent of this image processing power is perhaps most dramatically illustrated in software that will take a photographic image and modify it to look like an impressionist painting or a line drawing or a watercolour—or even 'Van Gogh' it!

3. Virtual World Building. It could be argued that with the labours of draughtsmanship and superficial style so completely and easily delegated to the computer, the visual artist is free to concentrate on the most important aspect of the creation of an image: composition. The ability to 'select' any part of the whole image and manipulate its size and appearance and then move it anywhere within the picture is certainly the most striking difference from 'by-hand' composition. But even more dramatic, and more exemplary of the merging of mathematics and visual art, is the development of ray-tracing programs which allow one to design three-dimensional objects, map their surfaces with other images or texture, and then position a virtual camera and virtual lights and proceed to render a flat image. The same 3-D image can be rendered into an infinite number of different two dimensional pictures. (It is interesting that these works often have the same haunting quality as magic-realist paintings.) The experienced artist working with the software to do this kind of art is as comfortable with Cartesian graphical manipulations as any mathematician.

The Mathematical Graph As Art Object. The second, more subtle but very profound way that computers have brought together the artist and the mathematician is in making explicit the fundamentally aesthetic nature of math and science, in demonstrating in brilliant visual terms the common ground of beauty and elegance which art and science share.

Many mathematicians have repeatedly remarked to me that mathematics is fundamentally visual. This statement seems nonsensical to the innumerate, no matter how otherwise intelligent or literate. Probably the most common response from visual artists (or, for that matter, writers) when confronted with anything that is the least bit mathematical is: “Sorry, I was never any good at math. I can’t even balance my cheque book.” (Of course, many mathematicians make the same claim to accounting incompetence, but in their case it is probably at least partially just to dissociate what they *really* do from arithmetic; I’ve met more than a few mathematicians who gleefully claim to not know the multiplication tables.) If, however, you can get past a layman’s initial prejudices, misconceptions, and even phobia, about math, it isn’t difficult to show how intimate are the visual and the mathematical.

I am not a mathematician, but what little I do know certainly substantiates the intimacy of the image and math. Case in point: I am told that there are more topologists than other species of the genus *mathematicus*. One might say that topology is a discipline without numbers (so much for math as arithmetic!) which deals with shapes and dimensions and unscaled objects. What could be more visual, more inherently visually interesting than a mobius strip, a Klein bottle, the morphing of a donut into a coffee mug!

I teach some elementary statistics and here, too, the visual is fundamental to understanding: the graph is ubiquitous. Try to understand a normal distribution without visualising a bell curve. Or correlation without a scattergram.

Then there is geometry. Once upon a time the relationship of the visual arts to geometry was so patently obvious it hardly needed remarking, but as the visual arts moved away from the representational, the relevance of geometry has become somewhat less obvious. When the methods of single-point, realistic perspective were discovered during the Renaissance, the interest in geometry was virtually universal among painters. Even in ancient Greece, some knowledge of mathematics was expected of any artist, for mathematical relationships were considered beautiful in and of themselves: the importance of being true to them in the creation of art was thus self-evident. The recurring obsession with the Golden Section is just one example of this.

In the realisation that math is *graphical*, the conceptual artist and the abstract artist rediscover how much they have in common with mathematicians. The beauty of fractal images (mere graphs, but graphic art!) lures the artist, and the audience for art, into the world of mathematics. The conceptual artist discovers a new world of concepts with which to play. The abstract artist discovers new ways of abstracting, abstracting in the same way that nature does—something the human eye seems predisposed to see as beautiful. And all those who appreciate visual beauty gain new insight into how it can be found in what has too long been considered a grey, cerebral landscape, that of abstract mathematics.

The Internet As Gallery And Symposium. Last but not least is the Internet revolution of the last decade, which surely has affected more people than the previous two factors together. It is a truism that the great advances in civilisation have been the result of cross-fertilisation of ideas from different cultures, the glory that was Ancient Greece being archetypal.

Communication has never been easier than today. Electronically-posted pre-prints, email, and list servers open up lines of communication never dreamt of a few decades ago. Perhaps this is all epitomised in 'surfing the Net'. This activity is so unstructured, because the Internet itself is so unstructured, that one can't help but be exposed to things one would never have otherwise encountered. Two analogies come to mind.

The first is a large party, where the guests are of every imaginable cultural background and worldview, having every imaginable *passionate* interest. The latter is of particular importance: the construction and installation of Web pages requires a commitment, so what one finds out in cyberspace are the products of a passionate interest in something. As every teacher knows, the one thing most likely to instil a person with an interest in a subject is another person's unbridled *enthusiasm* for it. And of course, it is hard to maintain prejudices based on ignorance at such a global party of enthusiasts.

The second analogy is to a huge bookstore where the books are free *and*, most importantly, where the books are filed almost randomly. One can wander forever, discovering the most strange and wonderful things. In a conventional bookstore, most of us, being creatures of habit, only visit those sections that reflect our established interests. Most poetry lovers are unlikely to browse the science section—and so never stumble upon the poetry of modern physics—with all its charm and quarks. Not so in the Web Shoppe, where every cyber-corner turned, every recommended link clicked, can present you with a 'page' from a book you'd never have normally considered perusing.

Much maligned Marshall McLuhan is being vindicated. His 'global village' is becoming a reality. In the pre-computer revolution days when he was playing prophet, it is understandable that he thought this change would result primarily from what has turned out to be a far less influential technology, that of television. At least he intuited what few

in his time had: that the next millennium is going to see the whole human race more inter-connected, more in intimate communication, than ever before in its history. Furthermore, the communication on the modern Web is primarily visual, with the visions being the result of science and math.

Conclusion: Conflict Resolution

So it seems there is good reason to be cautiously optimistic: since most of the conflict between the two cultures is the result of ignorance, it seems reasonable to assume that as this ignorance is replaced with understanding, these apparent conflicts will gradually dissolve. As the new third factor of computer technology plays a larger and larger role as disseminator of both art and science, and as the images made possible by computers (uncomplainingly toiling away at their math assignments) seduce both artist and scientist, the members of these two cultures are going to wake up one morning to find themselves again in bed with each other—and not such strange mates as they would've thought. Math, as realised on computers, may well turn out to be the millennium's cultural match maker.

Biographical Information:

Ken Stange is a Lecturer in Psychology (at Nipissing University in North Bay, Ontario) whose courses include 'The Psychology of Art' and 'Computer Methods In the Social Sciences'. He has published research papers (and both commercial and academic software) in the areas of physiological psychology and statistical methods, but he is also the author of six books of poetry, one novel, and one artbook featuring and explicating his 'computer art'. His visual art, which integrates poetry and 'conventional' realistic images with images generated by mathematical algorithms, has been exhibited in many juried solo and group shows and is represented in numerous public and private collections in Canada. He also has initiated and maintains several extensive Internet WEB sites: the online art and science netzine *Nebula* (http://stange.simplenet.com/nebula); a 'Psychology As A Science' WEB resource *PsycSite* (http://stange.simplenet.com/psycsite); and an online gallery of his own visual art (http://stange.simplenet.com/psycsite). One of his long-standing interests is the often turbulent relationship of art and science.