THE AVIATION COLOUR PERCEPTION STANDARD

Produced by Arthur Pape

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Dedication and Aim

This page is dedicated to the millions of youngsters the world over whose ambitions to become pilots and enjoy the immense delights of aviation are thwarted by the colour perception standard.

We hope to instil hope for those frustrated by this "standard" which is based on unscientific nonsense and promoted by a small but vocal band of blinkered vision "specialists". These people understand little about either aviation or the miracle of perception.

Nowhere has the debate been more intense than in Australia, where for twenty years the author has fought against the standard. In the late 'eighties, the battle culminated in two landmark appeals to The Administrative Appeals Tribunal which resulted in the removal of restrictions on night flying for all Australian pilots with colour vision defects. The tribunal found after exhaustive examination of all the issues that colour vision defects do not constitute a risk to the safety of air navigation.

This web site will expose in detail why the Aviation Colour Perception Standard is simply wrong and unnecessary. It is intended to educate both those with normal colour vision and those with defective colour vision. It is hoped too that those charged with the responsibility for aero-medical standards will take the time to consider the arguments promoted here. There is no place in the regulating of the safety standards of aviation (or for that matter in any sphere of human activity) for anything based on bad science or ignorance.

The Author

My name is Arthur Pape. I am a Dutch-born Australian and graduated in Medicine in Melbourne, Australia in 1969. My flying career began in 1977, and I have gained the Australian Commercial Pilot Licence with Command Instrument Rating for Multi-engine aircraft. At time of writing I have approximately 1500 hours total aeronautical experience. I am a Designated Aviation Medical Examiner for the Australian Civil Aviation Safety Authority, and the Vice-President of AOPA Australia. My hometown is Geelong, Victoria, Australia where I have my own general practice. My aircraft is a much-loved 1976 Seneca II. I believe it is probably the record holder for nose gear failures: four in six years, but that is another story altogether.

I have defective colour vision.

In 1977 I started my inquiries into the aviation colour perception standard. When first licensed, I was prohibited from flying aircraft at night because of my colour vision deficiency. The reason given was that aircraft were fitted with coloured navigation lights that assisted pilots in determining collision risk, and that therefore individuals who could not reliably identify those lights represented a risk that justified their exclusion from the activity. Later, many more reasons were added, which are explained elsewhere on this site.

In due course I had opportunities to observe all of these uses of colour in aviation and I became aware of a disparity between what I knew I could perceive and what I was told I shouldn't be able to see. The colour perception standard became a major focus of mine from then on. What was it and what was it designed to achieve? On what scientific foundation was it built? Were there experiments or scientific studies that gave the standard scientific validity? These and many more questions occupied me for some ten years. All the while my knowledge of and experience in aviation was growing. I had access to sophisticated simulators where I was able to use the wonderful EFIS equipment of the B767. I flew in the real thing observing everything from the "jump seat". I knew what the pilots were required to derive from this equipment and I had no trouble in deriving the same and in exactly the same manner.

Simultaneously, I read the "scientific" stuff by the box full. The contradiction between the theory on which the colour perception standard was based and my personal observations and understanding grew ever wider.

My observations of other aircraft and lit obstructions in the night flying environment, of runways and taxi ways, of thresholds and holding points, of tower signal guns and of all of the matters that were supposed to be a problem to me but weren't, further reinforced my growing suspicion that my colour vision defect was likely irrelevant. But the conviction was still largely intuitive.

A major turning point came to me fortuitously when I met the then newly appointed Professor of Psychology at Deakin University, Professor Boris Crassini. He listened patiently to my concerns about the standard and about the scientific projects that were claimed to validate the standard. Boris is a perception scientist, with his major interest visual perception. He was able to confirm most of my suspicions and in due course he became a major inspiration. Through him and his colleague, Dr. Patrick Flanagan, I have come to understand much about perception and about the philosophy of science. But perhaps the most valuable lesson he gave me was to accept the fact I was a colour defective and to stop claiming I could "see the colours". This acceptance was an essential pre-requisite to the conduct of the appeals that were to follow. Boris' and Patrick's expert testimony before the Tribunal was rational, unbiased, flawless. Colour defectives in this country owe them.

With growing confidence, I repeatedly put my viewpoint to the Australian regulators, to be met only with growing hostility. When all attempts at such reasoning were exhausted, I took the matter to the courts. I was responsible for two appeals, both of which were upheld. I felt vindicated.

But the colour perception standard has powerful supporters who will never accept the umpire's verdict. Some eight years after the Denison decision, they continue to ignore it. They continue to denigrate the Tribunal's decision, claiming it to have been beyond the jurisdiction, beyond the competence of the Tribunal. Egos and reputations suffered. The "knight in shining armour" expert is, even today, being sought who will set the records straight and restore the standard to its rightful lofty position.

What they can't bring themselves to do is to recognize why they lost the cases: the aviation colour perception standard is founded on bad science and bad logic. Not that the protectors of the standard are bad or dishonest but that their theory and scientific validation thereof is flawed and doesn't withstand critical scrutiny.

A Brief History of the Standard

Many years ago people with defective colour vision were barred from flying aeroplanes. The reason was that "colour" was "used" in aviation to signal matters of importance. Radio had not been invented. Aircraft were fitted with "navigation lights" just like the ships of the sea. Permission (clearance) to land, takeoff, taxi on the airfield were transmitted by the use of coloured flags or lights and colour defectives were demonstrably unreliable in interpreting such coloured signals. The navigation light system (red on port, green on starboard and white on stern, even the terms were those of ships) was believed to assist collision avoidance. What a catastrophe it would be if the failure to see the colours caused a mid-air collision. And so it was the the aviation world came to impose the Colour Perception Standard. The Paris Peace Conference of 1918, following WW1, was the forum that formerly introduced it.

Since that era, aviation has grown to be a sophisticated and commonplace mode of public transport. Over the years radio communication and navigation developed to ever greater reliability and usage. Aircraft grew larger and speedier. Colour was added to the "system", not by careful design but by haphazard additions, "because it was there". The list of "uses" of colour in aviation is now extensive indeed.

And as the aviation system was growing and maturing, so was the scientific understanding of vision, including knowledge of the basis of defective colour vision, and so was scientific understanding of perception. Specialties developed in Ophthalmology, Optometry and Perception Psychology, the "vision sciences".

But still the Colour Perception Standard remained. Sure, some countries made concessions in the face of growing uncertainty over its relevance. In time no-one seriously argued that the navigation light system could contribute to collision avoidance. The perception of collision risk in aviation cannot be "colour coded" any more than in tennis or football. And the use of coloured signal lights from ground to air fell into disuse because of sophisticated and universal use of radio. The Colour Perception Standard, in the early seventies looked to be ready for retirement.

There had been a staunch band of supporters of the standard (I call them the "Protectors of the Standard"), whose industry relied to some extent on the provision of colour vision testing, who needed to find a new "raison d'être" for the continuance of the standard, and the introduction of CRT-based cockpit instrumentation was just the item needed. Here was a new generation of sophisticated equipment, in which colour could be "used" almost without limit. What a saviour, and just in the "nick of time". The Colour Perception Standard could, it was supposed, be defended once more.

The defence of the standard needed to be based on "scientific evidence" that colour defectives would be at a disadvantage in the use of this new technology, and therefore the exclusion of these individuals would be in the interest of "the safety of air navigation". Yes, it had to be all about safety. Not pleasure, comfort, equal opportunity or civil rights, but safety.

Meanwhile though, colour defectives in growing numbers had joined the aviation pilot community. They hadn't experienced any of the disadvantages that the theorists had predicted. They did everything that pilots are required to do, and no-one noticed they were colour defective. They came to fly at night in growing numbers and they found themselves commanding aircraft with all the new technologies. Their colour defectiveness was irrelevant. By the standards upon which pilots are measured, the colour defective pilot's performance could not be distinguished from that of their colour normal colleagues. Their political experiences varied from one country to another. In the USA, the standard had "degenerated" to such an extent that colour defectives were able to find employment in major airlines and become captains of the latest jet airliners. They could fly their jets into other countries where stricter colour perception standards would have excluded them from being even the private pilot of a tiny Cessna.

In Australia, the aviation authorities struggled to understand the issues and to implement a standard that could be defended in the courts, where they were coming under increasing pressure to validate the standard with scientific evidence that it was relevant. With the advent of the Electronic Flight Instrumentation Systems (CRT-based cockpit displays), the opportunity was seized to conduct research that would demonstrate that colour defectives were less accurate and slower in the interpretation of the information displayed on EFIS equipment. The Standard would thus be "protected".

The Aviation Colour Perception Standard is now once more in the spotlight, both in Australia and at international level. This year national representatives to ICAO are conducting a series of meetings to review the standard. The prospect of a stable and rational international standard being adopted are remote. The USA, Canada and Australia are so far down the path of liberalization that to turn back would be politically untenable. Representatives of the European Joint Aviation Authority, on the other hand, are lobbying for the strictest of colour perception standards. Of interest to me is that the arguments haven't changed. They continue to rely for scientific validation on the works of the likes of Cole and Macdonald.

The Protectors of this standard are still extremely active. There is much at stake for them.

The Fundamentals

Any regulations that seek to prohibit the participation of individuals in a lawful pursuit or occupation must be based on scientific evidence that is of the highest integrity. Such scientific evidence must have been subjected to the most intense and comprehensive critical analysis before being converted into binding and discriminatory law.

The enforcement of such regulations based on anything less constitutes discrimination no less repugnant than discrimination based on race, religion or sex.

The Aviation Colour Perception Standard is one such regulatory instrument, for which the scientific basis is deficient and flawed.

The "Protectors" of the Standard

The Australian debate on the Aviation Colour Perception Standard has seen a virtual monopoly on the "pro-standard" side held by the academic optometry profession. The Victorian College of Optometry, at the University of Melbourne, has had, it would appear, exclusive rights to the research dollars from the aviation authorities when it comes to vision research. The long-time head of that college, Professor Barry Cole, is well known from his publications in support of stringent colour perception standards, not only in aviation but in all forms of transport, as well as a host of other professions. It was his evidence that invariably led to the failure of appellants in the courts to obtain relief from the restrictions that the colour perception standard mandated. The dossier of communications (obtained under the Freedom of Information) between the professor and the Director(s) of Aviation Medicine over a period of ten years reveals the prime intent of the research to be to "Protect the Standard". Never was a conflict of interest more likely. Not until the Pape and Denison cases referred to in this document, did the scientific basis of the standard come under serious analysis, at least in this country. The works and views of Barry Cole were severely tested under rigorous examination and cross-examination.

The May 1989 issue of "Australian Optometry" had front page coverage of the decision in the Denison case. It reported accurately the Tribunal's decision. Yet as recently as June 1997, the official careers advisory of the Australian Optometrical Association persists in promoting the false advice that colour defectives should not consider careers in aviation, despite the sweeping changes that the Tribunal's decision in Denison had forced on the Australian Civil Aviation Authority.

Textbooks of Optometry from around the globe continue to promote the same nonsense.

Dr Barry Clark's (himself a Ph.D. in Optometry and colleague of Prof. Barry Cole) recent article in Avmedia, the Journal of the Aviation Medical Society of Australia and New Zealand, makes the most fleeting and inaccurate reference to the Denison AAT case. As stated elsewhere, the line of approach of these people is always to avoid detailed analysis of the uses of colour, preferring to argue in generalities whose logic, they might hope, will be self-evident to the readers.

It is plain that despite the comprehensive rejection of their views by the Australian Administrative Appeals Tribunal (which is a branch of the Australian Federal Court) they have learnt nothing from their involvement in the process.

All regulators who seek to rely on scientific "proofs" to validate discriminatory laws should exercise the most meticulous and critical scrutiny of the research methodology employed.

Defective Colour Vision: What is it?

The physiology and genetic transmission of defective colour vision is not a contentious issue and will therefore be covered here in only a summary manner.

Normal colour vision involves the activity of three pigments that reside in the cone cells of the retina of the eye. One pigment is maximally responsive to light at the red end of the spectrum, the next to light in the green region and the third to light at the blue end of the visible spectrum. When one of the pigments is either partially or totally dysfunctional, abnormal colour perception results. "Protan" dysfunction results from reduced red pigment function (Protanomalous = partial dysfunction, Protanope = total red pigment dysfunction). Green pigment dysfunction results in "Deutan" disorders (Deuteranomaly = partial, deuteranopia = total green dysfunction). Blue pigment dysfunction results in the "Tritan" disorders of Tritanomaly and Tritanopia.

The heredity of the Protan and Deutan groups is X-chromosome mediated and the Tritan group is autosomally transmitted. Together, the Deutan and Protan groups account for almost ten percent of the male population and just under one percent for the female population. There may be some variation in the incidence between races. the Tritan group is much rarer and is not detected by standard colour vision testing.

Readers interested in further explanation of the inheritance and physiology of defective colour vision should refer to definitive vision textbooks or encyclopaedias on the subject.

What Can't Colour Defectives Do?

Colour defectives have, as a result of the dysfunctional colour receptive pigment in their cones, diminished ability to discriminate between colours. Colour (or "Hue") is that property of light determined by its wavelength. Whereas colour normals may discriminate between many colours (perhaps thousands), colour defectives are able to discriminate between many less. Colour vision testing procedures rely on this reduced discrimination ability to detect and grade the dysfunction.

It follows therefore that colour defectives cannot pass colour vision tests. This includes tests which rely on pattern recognition where elements of the pattern are constructed from dots whose colours are taken from the "confusion zones" for colour defectives that can be calculated on chromaticity charts. The Ishihara test for colour vision is the best known and most widely used test of this kind. There are many other sophisticated tests for colour defective vision and the scientific basis of those tests is well established. Colour defectives are "wavelength cripples". But they are not "colour blind".

It follows also that colour defectives cannot reliably identify and name colours as well as the colour normal does.

Finally, it follows that colour defectives cannot as easily as colour normals extract information from systems where wavelength coding is used to non-redundantly encode information. Much rests on this particular point when we examine the use of so-called "colour coding" in aviation systems.

What Can Colour Defectives Do?

Apart from the reduced ability to identify and name colours and to discriminate between colours, passing colour vision tests and extracting information from non-redundantly wavelength coded systems, colour defectives can do everything else. Simple as that!

THE DISABILITY OF DEFECTIVE COLOUR PERCEPTION IS CONFINED TO REDUCED SENSITIVITY TO THAT PROPERTY OF LIGHT DEFINED BY ITS WAVELENGTH.

Colour defectives have the same capacities as colour normals to perceive form, motion, depth, luminance contrast, and so on.

They have the same capacities as colour normals for complex perceptual-motor skills that form a part of the myriad activities of daily living, playing sports, motion in three dimensional space, and flying aeroplanes.

That colour defectives can fly aeroplanes is self evident. There are many thousands doing so in the United States and in Australia.

Furthermore:

- There is no evidence that colour defectives in these countries fly aeroplanes with less skill or decreased safety.
- There is no evidence that colour defective vision has ever been a factor in the cause of an accident in civil aviation, and as far as I can ascertain, in military aviation (the military are not as open to scrutiny as they ought to be).

"Scientific" Evidence or "Sleight of Hand"?

The Aviation Colour Perception Standard is based on a tenuous thread of logic that may be summarized thus:

1. Colour is used extensively ("ubiquitously"!) in the aviation environment, both inside and outside the cockpit, to code important information.
2. The use of colour enhances the performance (in both speed and accuracy) of tasks and object recognition for colour normal observers.
3. Colour-defectives are less able than colour normal users to use the colour-coded information as reliably or as speedily.
4. Restricting the benefits derived by colour normals from the use of colour coding, in order to accommodate colour-defectives is not an attractive or practical proposition.

5. Colour-defectives should therefore be screened out of the user population by rigorous colour vision screening and testing.
6. The Aviation Colour Perception Standard should thus be vigorously maintained.

The "protectors" of the standard, without fail, avoid addressing the specific questions that stem from the above broad proposition:

1. For each instance in the long list of colour usage in the aviation industry, WHAT INFORMATION IS IT THE PILOT IS EXPECTED TO EXTRACT AND INCORPORATE INTO THE FORMULATION OF APPROPRIATE RESPONSES OR BEHAVIOUR?
2. In each case, DOES WAVELENGTH CODING ENHANCE THE ACQUISITION OF THAT INFORMATION REQUIRED BY THE PILOT? IF SO, HOW?
3. If the answer to (2) above is affirmative for any instance , IS THE COLOUR DEFECTIVE PILOT DISADVANTAGED BY VIRTUE OF THE DEFECTIVE COLOUR VISION?

"Research" by or on behalf of the "protectors of the standard" invariably incorporates the following strategy:

1. Use naïve subjects who will undergo a brief tutorial on the technical terms (NEVER USE EXPERIENCED PILOTS!)
2. Set tasks that are operationally (from a pilot's point of view) simplistic or irrelevant
3. Convert the test equipment into a DE-FACTO COLOUR PERCEPTION TEST
4. Selectively analyze the data to provide the desired result

The Cole and Macdonald papers are a prime example of this technique, and may be summarized thus:

In phase (1), two groups of optometry students were used to determine whether the use of colour in EFIS displays enhanced speed and accuracy of information retrieval. One group was exposed to coloured displays, the other to black and white renditions of the displays. The tasks were not ones that pilots would perform. They were puzzles. ECOLOGICAL VALIDITY was absent.

In phase (2), various groups of colour defective observers, drawn from the college's patient lists, were subjected to the same puzzles, but only on the coloured displays, and their response times compared with those of the colour normal group who had been tested on the coloured displays. A token gesture was made to adjust response times for differences in age, sex and educational levels between the colour defectives and the colour normal students. The mean age for the colour defective groups were significantly higher than that of the colour normals. No attempt was made to properly match the colour normal and colour defective test subjects for these crucially important factors.

The response times were measured in terms of milliseconds. The researchers had never travelled in the jump seat of a B767 (whose instrumentation was used) to observe how pilots use the equipment. They betray no hint of understanding the thorough checking and rechecking process that is so much a part of safe and competent piloting.

The conclusions drawn were that colour use enhances accuracy and response times for colour normal observers, but that the degree of this enhancement decreased with increasing complexity or clutter of the display. It is significant that the colour defective group was not tested on the black and white displays to determine if they might also benefit from the use of colour. Predictably, colour defectives made more errors and longer response times, but because of the failure to match the groups for age, sex and educational level attained, the conclusion that the variable of colour vision was responsible for the difference in these results could not properly be drawn. The observation that on at least one task the protan groups performed unexpectedly as well as the colour normal group raised no suspicion as to the theory being tested.

This research project received very close attention from the AAT in the Denison case and was rejected by the tribunal for the reasons stated above, and rightly so. There is simply no scientific equivalent of the rigors of the court room, where examination and cross-examination put the proponents of theories to the ultimate test. Such was the case with this project and it fared very badly.

Yet this project is still quoted in the debate, even today, as demonstrating that: "Colour vision deficients are slower than colour normals at responding to redundantly colour-coded EFIS displays, and they make more errors. Protanopes are especially disadvantaged in responding to red 'fail' messages". Make no mistake, the research demonstrated no such thing.

Fundamental principles governing the conduct of research were not adhered to in this project. It is not for me to advance this observation further, but simply to point out that the claimed results are therefore totally unsupported.

WHERE "SCIENCE" IS USED AS A TOOL TO SUPPORT STANDARDS THAT, WITH THE FORCE OF LAW, DISCRIMINATE AND TRUNCATE OPPORTUNITIES, THE ETHICAL RESPONSIBILITY OF THE RESEARCHERS AND THE SPONSORS ALIKE IS ONE OF ENORMOUS MAGNITUDE.

What Pilots Do and How They Do It.

Everyone knows pilots fly aeroplanes! Probably anyone can learn to do it, but they need first to learn the basics of aerodynamics, navigation, power plants, meteorology and the rules of the air. The level of learning increases when higher licences are aimed for. Secondly they need to develop some perceptual-motor skills that aren't at all intuitive. These skills are learned and rehearsed until they do become to a large extent automatic.

With increasing competence, demonstrated to appropriately qualified examiners, the pilot will eventually find him or herself in a position of command, where responsibility is assumed for the safe and successful outcome of the flight.

From the moment of conception of a particular flight, the planning starts, in anticipation of the conditions that might be encountered. Weather briefings, the drafting of a flight plan, the calculation of fuel required, the intermediate way points are proposed, and the intermediate and destination landing points will be considered. The aircraft's performance characteristics will be studied. The more careful the pilot, the greater the degree of preparation. Escape routes in the event of bad weather or other unforeseen circumstances may be considered.

Before flight, the aircraft will be thoroughly checked for defects. Engines will be ground run and performance checked against published criteria. Control surfaces will be extended to their full range. Still on the ground, the prevailing wind will be assessed and used to select a departure runway. Passengers will be briefed on steps to evacuate in case of emergency. The pilot will mentally rehearse the steps to be taken in the event of engine failure during or shortly after takeoff. Checks, double checks and more checks. That is the pattern. Good preparation indeed. The greater the familiarity with each and all the factors that may affect the flight, the less the chance of being caught unawares. IFR traffic in the area is mentally plotted even before takeoff. Great stuff. Very professional! Hardly the stuff untrained college students can learn in ten minutes, is it?

After takeoff, airborne, the pilot goes through the careful steps so diligently learned in the training programme. After-takeoff checks, climb power settings, and so forth. Practised, familiar, "second nature". The aim is to get to the destination enjoyably, safely, and economically. The protection of the aircraft, passengers and crew is paramount.

To achieve this some fundamental tasks are to:

1. Not hit any other aircraft (collision avoidance)
2. Not hit any part of the ground or structures thereon, apart from in the controlled landing manoeuvre (maintain obstruction clearance)
3. Keep a sharp lookout
4. Monitor performance of airframe, engine and navigation instruments.

All this and more is planned, rehearsed, studied. The flight involves knowing from where you came and to where you are going.

When the unexpected does occur, the response, usually pre-considered, needs to be careful and appropriate. Not at all like in the movies. Depending on the nature of the unexpected condition, most will require careful identification and corroboration with other indications. Check and cross check. That's how it's done.

No room for knee jerk reactions, because they are almost always inappropriate, and can lead to lethal consequences. Planning, anticipation, identification, confirmation, check and more check and frequently. These are the tools of the good pilot. In the end, action to correct the problem or avoid the threat. Get the picture? Problem resolution requires action, but no action to take place until the problem is unambiguously identified and confirmed.

(This scenario is a far cry from the experimental model that Cole and Macdonald so impertinently used to "prove" that colour defectives are slower and make more errors in acquiring information from EFIS displays. What utter naivety on their parts!)

The detection and avoidance of contact with other aircraft and fixed obstacles is an important component of a successful flight. How are they achieved? By day, in good visibility, luminance contrast against the background and motion parallax are the indispensable clues to detection of collision risk. What about by night? Well its exactly the same. The presence of lights on the aircraft provide the luminance contrast and motion parallax the clue as to the risk of collision. The brighter the lights, the easier the task of detection and tracking. This, I invite the reader to consider, is so incredibly self evident. By day or night in zero visibility (i.e. under the Instrument Flight Rules) total reliance is placed on radio communication, radio navigation and such aids as radar. But whether by day or night, whether in VFR or IFR, the mental or visual "situational awareness" is one of relative position (horizontal, vertical and lateral) and relative motion (horizontally, vertically and laterally) in the three dimensional medium that belongs solely to aviation.

The role of colour coding in assisting the pilot in determining the distance to, the relative bearing in the three planes and the relative motion of the target object is easily shown as being non existent. The role of the coloured navigation lights as presence lights for the purpose of detection and tracking is vastly inferior to the that of flashing beacons and strobes.

What about obstructions? Fixed obstructions are visible if they are lit by night and simply invisible if they aren't. The mere presence of a light indicates the existence of an obstruction.

Its distance and bearing cannot be coded by wavelength of light (except in astronomy). Its just so simple. The pilot should avoid contact with any lit object, and any object that has a fixed relative bearing in all of the three planes will be hit. Do not fly under a light unless you're sure its another aeroplane (which is wavelength independent) and avoid collision with any light by manoeuvring yourself to increase the relative angular motion of the light in your field of view. It is fundamental geometry, let alone a fundamental component of many activities that involve complex perceptual-motor skills (driving, ball sports, contact sports, taking a walk, grabbing a door knob).

Exactly the same geometry applies to achieving controlled contact with ground in the process of landing the aeroplane, only the aim here is to minimize the relative motion in the vertical and lateral planes to achieve a stable approach. Relative bearing and relative motion are such fundamental elements of practically everything we do in the way of locomotion, that like the many learned skills, they come to be processed automatically. Certainly in aviation, understanding of the concepts of relative bearing and motion, and of vectors are central to almost every aspect of conduct of flight and navigation.

I won't labour the point any further. Take a look at the list below, kindly provided by Dr. Barry Clark, and think about each one, one at a time. Ask what it is that colour might contribute to the task that confronts the pilot: recognition and then responding appropriately to the information derived. In each and every instance the presence of colour can be reliably demonstrated to be superfluous to what it is the pilot is hoping to achieve. To argue the case here for each instance of colour usage would extend me well beyond the scope of this web page. But not so the AAT, which took 28 days in the Denison case alone to work painfully through the list, examination and cross-examination, to the point of exhaustion of all the evidence. No wonder the "Protectors" are upset. The whole campaign of protecting the standard relied non-redundantly on detail avoidance.

Colour Usage in Aviation

Dr. Clark states that "colour coding is ubiquitous in aviation, with many cases of functional colour coding". In support of this broad generalization, he provides an extensive list, which is quoted verbatim:

- Anti collision beacons and strobes are red or white.
- Navigation lights are red, green and white.
- Rotating/flashing beacons are red and/or blue on ground emergency vehicles.
- Airport ground support vehicles have amber rotating beacons, along with red tail and brake lights, and amber turn signals, and white reversing lights used by road vehicles in general.
- Red, amber, white, green and blue lights are used on runways, taxi ways and parking areas.
- Obstruction lights are usually red.
- Visual landing aids may include red, amber, yellow, green and white lights.
- Cockpit and cabin lighting in military aircraft may be one of red, white, green, NVG-compatible blue-green (Type A) or white (Type B) systems, or a mix of any of these.
- Conventional panel instruments often carry coloured numerals, arcs and sectors, typically red, yellow, white, green or red.

- Attitude and Directional Indicators may have brown and blue hemispheres.
- Annunciator panels carry red warnings and amber cautions.
- EFIS displays may use white, red, green, amber, blue, magenta, as sometimes brown, yellow, blue-green, violet, purple, pink and mauve.
- Air to air refuelling displays on the tanker exterior use red, amber and green lights.
- NVGs at present have a monochrome green display that leaves a brown after-image.
- Aviation maps and charts are often printed in four or more colours chosen from red, brown, amber, yellow (infrequent), green, blue and purple, with black/white backgrounds and delineations.

Significantly perhaps, he does not mention the tower signal gun (Aldis Lantern), which employs red, green and white to convey instructions to non-radio aircraft. This use of colour forms the basis of the "practical test" used in the USA to allow waivers against the standard.

Pilot Assessment and Licensing.

The process of becoming a pilot, as outlined above, is one of learning the knowledge base and acquiring the manipulative skills. In this regard it is little different from the acquiring of a medical degree or becoming a plumber. Learning, training and assessment by experts in the field are common to all. The experience of colour defective pilots is no different. They follow exactly the same procedures and utilize exactly the same clues for every aspect of the process. They are at no disadvantage, and if the examiner were not told, there should be no indication that the pilot he is examining is a colour defective. Such is my own personal experience and that of the hundreds of colour defective pilots I have had contact with. They do everything exactly the same way as their colour normal colleagues. They cannot be told apart from their colour normal colleagues, unless and until they are confronted with a colour perception test, either real or de-facto. Remember, that is the one thing colour defectives can't reliably perform. Piloting an aircraft is not a colour perception test. It is a test in utilizing knowledge and skills to guide a complex machine through three-dimensional space and all that that entails.

The colour perception standard is supported and imposed largely by bureaucrats and academics who have little appreciation of the details of what pilots do and how they do it. They are bound to an ideological theorem that does not withstand close scrutiny. After years of being revered as an icon, an article of faith, the colour perception standard now has to be "protected" against the tide of colour defective pilots who demand to be judged on their practical performance by people qualified to assess their skills.

It is nothing short of shear arrogance on the part of the "Protectors" to claim their wisdom on this matter should carry greater weight than the instructors and examiners of airmen on whose judgement the "safety of air navigation" truly depends. More so the arrogance when the tide of public judgement, through the agency of the courts, turns to recognition of the mythological nature of the standard.

I am a colour defective physician. The role of colour coding in medicine is far greater than it has ever been in aviation. Red flecks of blood in a brown stool are beyond my capabilities. Histology could never be my forte, as it uses non-redundant colour coding to convey important information. But in essence, the impediment of defective colour vision has no significance to the way I practise my medicine. When in doubt on a colour related matter, I ask a colleague or the patient. They love to help this "wavelength cripple". The inconvenience is trivial. I know my limitations and I manage very well.

The Administrative Appeals Tribunal

Australia is indeed a lucky country in many respects. It is, in comparison to many others, an open and very democratic country. The Administrative Appeals Tribunal is a branch of the Australian Federal Court. Individuals who feel aggrieved by the decision of a regulator to refuse a licence or to vary or cancel a licence may take the matter to the Administrative Appeals Tribunal to have the decision reviewed independently. The Administrative Appeals Tribunal is empowered to "stand in the shoes" of the decision-maker. Thus when an appeal is upheld, the Tribunal's decision has the force of law, just as if the original decision-maker had come to the same decision.

There were three cases that the AAT considered from 1985 to 1989. Links to the relevant decisions are provided.

The first case determined established that the AAT did indeed have the power to hear the appeal, and set the scene for the later two cases. The time gap was due to the fact that the costs of the cases were borne largely by myself.

The Pape Case (1)

The second case involved the examination of the substantive issues relating to the aviation colour perception standard. On legal advice, the case was limited in aim to making any in-road against the restriction on night flying that colour defective pilots were subjected to. In that aim it was successful. However, the Department of Aviation refused to extend the benefit of the decision to any pilot other than myself. Other petty obstructions were placed by the severely "miffed" authorities, but eventually overruled by return to the AAT. This necessitated the conduct of a third and comprehensive test case that would achieve, if successful, universal relief for Australia's colour defective pilots:

The Pape Case (2)

The third case, with the support of both the applicant and the CAA, was conducted as a comprehensive review of all the evidence pertaining to the Aviation Colour Perception Standard. By agreement, the evidence submitted in the earlier case on the role of colour coding of navigation lights was not repeated, but was transposed into the substance of this hearing. Between the two cases, the total number of days devoted to the submission of oral and written evidence was approximately forty. Not a single instance of the use of colour in civil aviation was ignored. The evidence was comprehensive and was subjected to intense and critical analysis. The Tribunal performed its function with meticulous impartiality and thoroughness. It performed what amounts to the most thorough and comprehensive examination of the issue ever conducted anywhere on the globe to that point in time and since:

The Denison Case

The result was a resounding rejection of the proposition that defective colour perception poses any threat to the safety of air navigation.

Summary

The evidence heard at the Administrative Appeals Tribunal was comprehensive and focused on detailed analysis of what pilots do and how they do it and what, if any, role colour played in the process. It was the first time in the history of aviation the "problem" of the colour perception standard had been so meticulously put to independent scrutiny.

The resultant liberalization of the Australian version of the colour perception standard raised, and still raises eyebrows within the global community of "protectors" of the standard. Most react without even having read the decisions and reasons. Responses have ranged from "ignore it", "denigrate it", "do it again, and we'll show 'em", and in rare instances "let's take a closer look at this". The majority chose to ignore it. But the process is unstoppable. The colour perception standard is based on the myth that important information (for pilots) can be coded by wavelength without the considerations of context, shape, size, position, luminance, all these factors that by definition will render wavelegth information redundant and superfluous. The piecemeal analysis of each and every instance of colour usage is tiring and sometimes challenging. But that's no excuse not to do it.

There are now sufficient numbers of experienced pilots in Australia alone who have colour defective vision and who form a ready pool of willing test subjects to resolve the nagging doubts some may genuinely have as to the wisdom of abandoning the standard. Measure their performance in real life aviation tasks, and use the same criteria as are applied to assess the performance of colour normal pilots. Avoid the trap so often employed by the serious and dedicated protectors of converting the task into a de-facto colour vision test. That approach always begs the question and is simply poor science.

If I could afford it, EFIS would be a welcome addition to my own aircraft's panel. I make no suggestion that colour not be used. I, a dichromat, a deuteranope, love it. Though "wavelength crippled", my sense of colour enriches my life immeasurably.

I welcome constructive feedback and even criticism of the ideas put in this publication, and wherever possible, I shall endeavour to reply honestly and openly to both.