

The story of standardisation

A history of ICAO and ICAO Document 9303

by Charles Chatwin

In November 1944, 54 States attended the International Civil Aviation Conference in Chicago. At the end of this conference a Convention on International Civil Aviation was signed by 32 States, setting up the permanent International Civil Aviation Organization (ICAO) as a means to secure international co-operation and the highest possible degree of uniformity in regulations, standards, procedures and organisation regarding civil aviation matters¹. Charles Chatwin explores the history of ICAO and in particular the various parts of ICAO Doc 9303, the technical standard for machine-readable passports, visas and other travel documents.

Prior to World War II, international aviation was a small-scale activity. The war, however, demonstrated the feasibility of moving large numbers of people and cargo by air, and as early as 1942, Canada, the USA and the UK led diplomatic work to plan for the post-war world. In 1943, a conference, chaired by the Prime Minister of Canada and attended by Roosevelt and Churchill took place in Quebec. Among many topics, the meeting discussed post-war aviation policy and the establishment of an organisation to deal with aspects of international aviation.

Chicago Convention of 1944

As the war neared its end, a much larger conference took place in Chicago in November 1944. Lasting 37 days, it resulted in the Chicago Convention of 1944 leading to the establishment of the International Civil Aviation Organisation (ICAO). The Canadian Government offered Montréal as ICAO's headquarters. The Convention developed the concept of Facilitation, which required States to establish immigration procedures to prevent unnecessary delays. This gave ICAO responsibility for the standardisation of passports in relation to air travel, and, in practice, to other methods of crossing borders. The Convention was formally ratified in 1947.

Achieving standardisation

Though the use of passports can be traced back over 2000 years, the middle of the nineteenth century saw them falling into disuse as the growth in international rail travel overwhelmed immigration procedures. This changed at the time of the First World War when security concerns demanded increased border control. In the 1960s and '70s, the dramatic growth in air travel increased the pressure on immigration procedures, repeating what had occurred with train travel a hundred years earlier. This time the elimination of passports was not an option and pressure grew to improve and standardise passports to speed the processing of passengers through airports.

In 1968 ICAO established a Panel on Passport Cards to achieve standardisation. The emphasis was on document security and proof of citizenship of its holder. The card concept had the disadvantage that there was nowhere to stamp or insert visas. It was, however, a stated objective in Annex 9 of the Chicago Convention that visas should be abolished.



Charles Chatwin read Chemistry at Oxford and became a Fellow of the Institute of Printing. After a period in general printing he began working for De La Rue, where he worked in general and technical management capacities related to security inks, holograms, cheques and identity documents. In 1987 he was asked to head the UK delegation to the ISO working group on travel documents. From 1997 until final retirement in 2008 he was responsible for the editing of the various Parts of ICAO Doc 9303.

Things began to change when, in 1975, the USA sent Frank Kubic as a technical delegate to work with Arno Seidelmann, ICAO's Chief of the Facilitation Section. Kubic, then Director of Methods Engineer in the US Passport Office, had a strong industrial engineering background. He became regarded as the Father of Machine Readable Passports, with Seidelmann seeing himself as the Grandfather. They, with others including Ted Radclyffe of the Australian Passport Office, developed what eventually became the passport standard.

Radclyffe was also a technologist, previously involved in the development of lasers. The US and Australian passports were of a similar size and format so there was a common base. For the detailed work, Kubic worked mainly with John Morris, of Ted Radclyffe's staff, to develop a draft standard. They did not believe that the elimination of visas was a realistic possibility and only envisaged the passport as a book.

Getting a standard adopted, initially by the ICAO community, and then the world, was not easy and there were many objections. The breakthrough came when the US State Department held a reception to mark the anniversary of US Independence on 4th July, the atmosphere providing a forum to secure the agreement.

Machine reading of documents

The machine reading of documents was in its infancy. There were only three established precedents:

1. the magnetic stripe used on financial cards;
2. the magnetic character reading used on bank cheques (requiring the use of a special typeface and magnetic ink);
3. the relatively new technology of Optical Character Recognition (OCR).

A key factor was that some States had rules ensuring that their citizens should not be required to carry a document containing information about them that the holder could not read; this ruled out the magnetic stripe. Magnetic character reading, though still used on cheques in 2011, was already obsolescent, and OCR was therefore the obvious choice. At that time OCR required the use of a special typeface and printed characters that absorbed infrared light as the detectors were only sensitive to IR.

Informal meetings took place of a small manageable group of about ten people from countries such as Australia, Canada, France, Germany, the UK and the USA. The basic structure of the Machine Readable Zone (MRZ), proposed by Frank Kubic, was finalised. It was originally envisaged that infilling of the personalisation data in both the MRZ and the Visual Reading Zone (VIZ) would be done using a standard typewriter equipped with a machine readable typeface. The newer OCR-B typeface was selected in preference to OCR-A as being more humanly readable. Of the characters in the OCR-B typeface, only A - Z (upper case), 0 - 9 and the filler character < were to be permitted in the MRZ. Names were to be presented in the form *Surname Given Names* with a filler character between each name. After the realisation that double surnames did not fit into the proposed format, it was decided that the end of the surname would be indicated by two filler characters.

Problems encountered

As the group developing the standard were English speaking of Anglo-Saxon origin and ICAO's Air Transport Committee favours the use of English, the VIZ and MRZ structures were specified accordingly. Later problems would become apparent because the approach took no account of Arabic, African and Asian name formats, the use of scripts other than Roman, and the importance of diacritical marks in some languages. There were also early MRZ reading problems with the different laminate films used to protect the data page. Also, passports infilled using typewriters were found not to have the positional accuracy of the Machine Readable Zone (MRZ) required by the readers, which were still under development by a number of companies. The development of purpose-designed printers was initiated.

ICAO Doc 9303 Part 1 First Edition

Although ICAO meetings remained informal, Ted Radclyffe recalls that each decision had to be referred to the various national representatives within ICAO. Eventually, a document which contained the fundamentals of the present standard for passports with machine readable data was agreed upon and approved by ICAO's Facilitation Committee. This was published in 1980 as ICAO Document 9303, and is now known as the First Edition of ICAO Doc 9303 Part 1.

Diagrams in the First Edition show a data page with four rounded corners. As the text contains references both to a book and a card, within ICAO there was clearly a view that the visa problem would be solved. This was definitely not the view of Ted Radclyffe and Frank Kubic.

The First Edition rigidly defined the dimensions and positions of the information fields in the VIZ, including the portrait. The MRZ was similarly defined. Otherwise it is somewhat short in detail; for example the three-letter country codes were to be found by referring to ISO 3166. This convenient approach ended when Germany asked for its code to be D, or rather D<, and not the code specified in 3166. Special requirements for codes for stateless persons, refugees and UN personnel arose as well, resulting in subsequent editions including a table of codes. Also, the location of check digits, and their method of calculation were established; these are still in use.

In 1985, Rod Heitmeyer was appointed ICAO's Chief of Joint Financing and Facilitation Management. Heitmeyer was to play a key role in the development of MRTDs for the next twenty years. Under Heitmeyer, Rene Pouliot succeeded Arno Seidelmann as Chief of Facilitation, and they both worked with the International Organisation for Standardizations (ISO) to ensure that Doc 9303 achieved recognition as an ISO Standard. ISO established a working group titled JTC1/SC17/WG3, which examined Doc 9303, and endorsed it as ISO Standard ISO/IEC 7501. Having done its work WG3 was dissolved.

ICAO Doc 9303 Part 1 Second Edition

The Standard was being adopted, albeit slowly. Countries coming new to the Standard were encountering problems, mainly of detailed interpretation. About this time, in 1986, ICAO formally established the Technical Advisory Group on Machine Readable Travel Passports TAG/MRP, (later Travel Documents: TAG/MRTD). Rod Heitmeyer arranged for the first formal meeting of the TAG in June 1986 to begin work on updating the specification.

Reviving ISO working group WG3

ICAO is a UN Specialised Agency and only government employees may serve on its committees. ISO is an

association of countries' standards bodies, its working groups mainly composed of employees of commercial firms. There was merit in ICAO making use of the expertise available in companies producing MRTDs and related equipment. By mutual agreement ISO revived WG3 in 1988. The Canadian Joel Shaw, then of reader manufacturer AIT, became Convenor.

WG3 began to meet twice a year, discussing and recommending many matters of detail for inclusion in the document. These did not alter the basic concept of the standard but provided clarification or responded to specific problems that States encountered on implementation. One example of clarification was to do with the so-called Hell Boxes. These defined the rectangular areas within which the lines of MRZ text should appear, and were developed by Dr Hell, a German WG3 delegate. Also, there were differences between the ICAO standard presentation format and that of ISO; ISO agreed to defer to ICAO practice.

WG3 at one point had to deal with an attempt by a photographic company to pack a meeting to change the specification. The company wanted to remove the requirement for the MRZ text to be infrared absorbent. This was because they wanted to infill the personalisation photographically but the dyes in their process did not absorb IR. Their proposal was strongly opposed by the Germans, who had built in the IR absorbency into their passport protection against copying. About eight employees of the company attended, assuming each had a vote. However, with one vote per country the proposal was rejected. The company did not seem to object too strongly as one of their attendees remained a member of WG3, making a useful contribution over many years.

Approving the Second Edition of Doc 9303 Part 1

In March 1990 a formal meeting of the ICAO TAG/ MRP took place, chaired by Ted Radclyffe. After much negotiation behind the scenes it was agreed that six WG3 members could attend the meeting as observers. One of these would be the Convenor, who would be the only one to speak and to respond to questions. This meeting formally approved the publication of the Second Edition of Doc 9303 Part 1 and also initiated work on visas, which was to lead to Doc 9303 Part 2.

ICAO Doc 9303 Part 2

By the late '80s, several countries were using visas in the form of a label affixed to a page in the passport, usually using self-adhesive paper but with no standardisation on size or content. The USA launched the first machine readable visa, developed by Barry Kefauver. The format of this visa generally followed the layout of the MRP, including a portrait, measuring 120 x 80 mm, just to fit within an MRP page. Australia introduced a similar, but not identical, document. Immigration experts pointed out that these visas

Box 1

First immigration TAG member

In 1989, Ken Richardson, of UK Immigration joined the TAG; the first immigration TAG member. He strongly believed that those who used MRTDs in the field should have an equal voice to those who issued them. His primary interest was on the standardisation of a machine readable visa.

obscured the passports' perforated numbers. At that time, many countries were perforating the passport number throughout the thickness of the book to prevent page substitution; holding the closed book up to the light enabled a check that all pages were perforated with the correct number. A visa placed on a page over the number invalidated this security feature.

Introducing visa standards

In 1992, after much negotiation between countries, and with input from WG3, ICAO visa standards of two sizes were established and published as ICAO Doc 9303 Part 2. The larger MRV-A was based on the US and Australian documents, though both, to their credit, made adjustments to their layout. The smaller MRV-B was ID2 size, (105 x 74 mm); to be positioned in the MRP without obscuring any perforated numbering of the MRP. No standard position for the perforate number was ever specified, the number was frequently obscured defeating the object.

Though the MRV-A was smaller than the MRP, the number of characters in each line of the MRZ was the same as in the MRP: 44. But the MRV-B only had space for 36 characters. The name field in the upper line and the field reserved for optional data in the lower had to lose 8 characters. This gave rise to the possibility that a long name which fitted into the 39 characters available for the name in the MRP would not fit into the 31 characters in the MRV-B. Indeed some names are longer than 39 characters, leading to the need for name truncation rules, which appeared in later editions of all Parts of Doc 9303.

Effective reading zone

The layout of the data was originally rigidly defined. When the European Union developed its standard visa under the Schengen Agreement, a need was found for some additional data. ICAO agreed in the 1994 Second Edition of 9303 Part 2 to reduce the rigidity of data placement in the VIZ, enabling the Schengen visa to conform. The MRZ was, of course rigidly defined. A portrait was initially optional, only becoming mandatory in later editions. It was important that the visa be placed within the MRP so that the standard passport reader could read the visa's MRZ. This led to the

development of the Effective Reading Zone (ERZ) which specified an area within which the machine readable data on all MRTDs was to be confined. This did not yet appear in the MRP standard which was amended in a later edition.

ICAO Doc 9303 Part 3

From the 1960s, a number of States agreed that either a State's ID card or a specially issued card could be used to cross a border. In the 1990s, ICAO decided that a standard was required to enable machine reading of the data on these cards. Two sizes became common:

1. a size approximating to ID-1 size used in North America and elsewhere (105 x 74 mm);
2. a size approximating ID-2 such as the then current French or German ID cards used to cross borders in Europe (86 x 54 mm).

The sizes are approximate because the sizes specified in ISO 7810 have rigid tolerances to enable cards, such as bank cards, to be used in slot readers of for example ATMs. Such cards are made achieving highly accurate dimensions employing sophisticated punches. Cross border cards were then made using cruder techniques ending with punching to shape using a hand operated tool which was incapable of achieving the precise dimensions required by ISO 7810.

The smaller size 1 Official Travel Document, the td-1, did not have enough space on the face to include all the mandatory data, so the MRZ was placed on the back, with the face containing the VIZ. The MRZ takes the form of three lines of 30 characters, the bottom line being the name field. The larger size became the Size 2 Official Travel Document (originally called the TD-2, it was later renamed td-2 when the upper case TD became a generic term for travel documents) The specification provided for all interoperable information, including the MRZ to appear on the face, the reverse being available for optional use by the issuing State. Like the MRV-B, the MRZ has 36 characters in each line with 31 available for the name.

WG3 and the TAG developed the Standard which was published as the First Edition of ICAO Doc 9303 Part 3 in 1996. Part 3 allowed States increased flexibility in the layout of the VIZ, continuing the trend started in Part 2.

ICAO Doc 9303 Part 4

ICAO published Doc 9303 Part 4 at the same time as Part 3. Part 4 described a Crew Member Certificate. For years seamen have had a certificate which they use instead of a passport to travel between home and ship at the beginning and end of tours of duty. ICAO wanted a similar document to cover aircrew. It used the format of the td-1. It was to be issued by the holder's

employer, i.e. an airline. While some countries did issue such documents, they were not widely accepted as they were not government issued. Part 4 was abandoned and later editions of Part 3 show the Crew Member Certificate as an Appendix to the td. It is little used.

ICAO TAG Working Groups and ISO Task Forces

The detailed work of drafting the Second Edition of Part 1, the first two Editions of Part 2 and the First Edition of Part 3 was the work of ISO WG3 and full credit must be given to its Convenor Joel Shaw, who spent many hours ahead of the meetings preparing drafts which the WG3 members then merely had to discuss. The final drafts from WG3 then had to be submitted to ICAO, who had the final responsibility for publication.

By 1996 a considerable work load had developed:

- A standard for the extra data to be stored on the document relating to biometrics was needed.
- Parts 1 and 2 of 9303 had to be revised to incorporate layout flexibility of the VIZ.
- Recommendations for the transliteration of names in non-Latin scripts into the limited characters allowed in the MRZ needed to be made.
- Countries who had not yet adopted the Standard, had to be encouraged to adopt standard MRTDs.

ICAO Technical Advisory Groups (TAG)

ICAO set up three TAG Working Groups:

1. New Technology (NTWG), led by Gary MacDonald of Passports Canada, would handle future developments;
2. Document Content and Format (DCFWG), led by John Mercer then of the US State Department, would work on the wording of Doc 9303;
3. Education and Promotion (EPWG), led by the Swede Staffan Tilling would ensure greater use of the Standard.

ISO Task Forces

At a meeting in Australia ISO WG3 mirrored ICAO with three Task Forces:

1. TF1: New Technology, led by Barry Kefauver, formerly of the US State Department;
2. TF2: Harmonisation - as it was thought the main work would be bringing the three Parts into line - led by Tim Merchant, also ex-US State, but at that time of De La Rue;
3. TF3: Transliteration - as this was thought to be its main task - led by Mike Ellis of Dynjab Australia, who had been working on transliteration and truncation for some time.

In 1998, Joel Shaw decided that the preparation of drafts for TF2 meetings would pass to the Task Force Leader. In addition, WG3 proposed the idea of



achieving harmonisation between the three parts by establishing common specifications applicable to all MRTDs. After two years work, this was rejected by the TAG. Many refinements and clarifications were made, among which was a section on document security written by Keith Mayhew of the UK that now forms a component of each part of 9303.

Increased data storage, biometrics and document verification

By 1994, increasing concern had arisen over imposters trying to travel using stolen, altered MRTDs. This led to a demand for MRTDs to store one or more biometrics of the holder, which would enable an immigration officer to verify that the presenter of the document was the genuine holder. It was also considered desirable to provide the option of a means of verifying that the document was genuine.

As a result editions of all three Parts of ICAO Doc 9303 appeared from 1997 incorporating options for:

- Increased storage

Data storage using barcodes, magnetic stripes, and contact Integrated Circuits (ICs) were mentioned for cards, with only barcodes considered suitable for passports or visas. Co-existence, the possibility of using more than one storage technology on an MRTD was considered. Contactless ICs were not considered as the technology was not sufficiently advanced.

- Biometrics

Biometric options included hand geometry, fingerprint, signature verification and facial, iris and voice recognition. This could have resulted in immigration officers requiring at least 18 different readers to deal with the various options. Chuck Baggeroer of Datacard began work on the Logical Record Format, later to be changed to the Logical Data Structure, specifying the way the data would be stored on using each technology.

- Document verification

Guidance on document verification was also vague,

merely indicating that a substance or concealed structure feature could be incorporated into the document, details of its presence being stored in the data storage medium. Reliance on a substance always has a limited life, since sources of supply cannot be controlled indefinitely. Structure features need to be changed regularly to prevent counterfeit. This topic was never resolved until the advent of the contactless ICs.

Capacity for extra data envisaged

Only 2D barcodes, from the list of storage media, could even begin to have enough capacity for the extra data envisaged. At a NTWG meeting in the UK in late 1998, contactless ICs were first raised. Such ICs were becoming available with a 2kB capacity and 8kB was projected. There was a debate, lasting over many meetings, to select a biometric, considerations including reliability, effect on immigration time and privacy. Face recognition was eventually chosen as being the least invasive, with fingerprint and iris recognition as optional supporting technologies. All three technologies had competing suppliers, each with patent coverage. The NTWG was unwilling to select a supplier who would then have exclusive rights to MRTD biometrics. So images of the face and finger or iris, would be stored on the IC, enabling each State to select the supplier of its recognition technology. This required a minimum of over 20kB for the image; fortunately 32kB contactless ICs were appearing.

New groups

Three new groups were set up by the NTWG, the first, led by Terry Hartmann of Australia Passport, to plan the ways in which the biometric data would be captured, stored and processed. The second, led by Barry Kefauver of the US, finalizing the specifications of the Logical Data Structure (LDS) and the mapping of the LDS to contactless IC technology. The third, led by John Davies of UK Passport, was to develop the security scheme and the private/public key infrastructure (PKI) so that States

Figure 2
Document Content and Format Working Group (DCFWG) - one of ICAO's Technical Advisory Groups (TAG) - meeting in Argentina.

Figure 3
Frank Cubic (left), the so-called father of Machine Readable Passports and Ted Radclyffe of the Australian Passport, one of the co-developers of the passport standard.

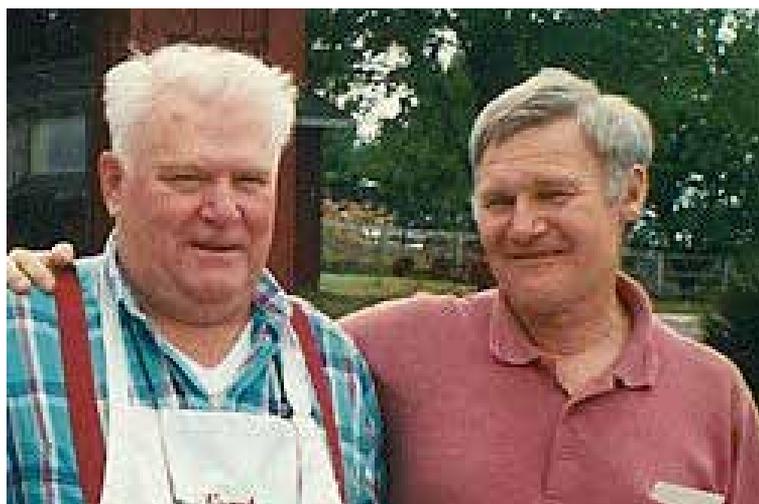




Figure 4
New Technologies
Working Group (NTWG) -
one of the ICAO Working
Groups reporting to the
Technical Advisory Group
(TAG)- meeting in New
Orleans.

could securely share the electronic keys necessary to enable one State to verify the authenticity and integrity of the data stored on another State's document. Chuck Baggeroer of the US was the project editor for the LDS Technical Report and Tom Kinneging of the Netherlands was the project editor of the Technical Report specifying the security scheme and the PKI.

least 18 combinations of technologies were acceptable, as mentioned earlier.

The pressure was on for a new MRP specification covering face supported by finger or iris with contactless IC storage. It took some time for this to happen and the NTWG began to issue '9303 Supplements' to enable States to respond to the new requirements. The Sixth Edition of 9303 Part 1 was eventually published in 2006, followed by a Third Edition of Part 3 in 2008.

The NTWG was the centre of this activity and has gradually taken over responsibility for the entire operation. ISO WG3 continues to work in conjunction with the joint working between ICAO and ISO, which proves to be very productive. Of those who set this operation in motion back in the 1970s, Arno Seidelmann is long retired. John Morris sadly died two years ago. Ted Radclyffe is still very active in retirement, having built and now flying his own plane. Frank Kubic, now 85, stood for the US Senate in 2010; regrettably he was not elected.

¹ http://www.paris.icao.int/history/history_1944.htm

Box 2

WG3 Folklore

In March 1990 a formal meeting of the ICAO TAG/ MRP took place, chaired by Ted Radclyffe. After much negotiation behind the scenes it was agreed that six WG3 members could attend the meeting as observers. One of these would be the Convenor, who would be the only one to speak and to respond to questions. It was a full scale ICAO meeting with simultaneous translation. Some of Ted's comments reduced the translators to helpless laughter. The phrases 'Nip and Tuck' and 'Tough Titty' have remained in WG3 folklore ever since.

New MRP specifications

These processes would probably have taken several years to bring to fruition, but for the terrorist attack on the World Trade Center in September 2001. Within weeks, the USA decreed that States who wished to remain in the US Visa Waiver Program would have to have started issuing biometric passports in accordance with ICAO Doc 9303 by October 2004, later extended by a year and then to 2006. At the time, the current edition of Doc 9303 Part 1 did not favour any specific biometric or data storage technology, indicating that at

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