HORACE Production Facilities - past, present and future

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Overview

A "Product" can be defined as the result of natural growth. It is interesting that the definition includes the word growth, as that implies expansion and this is something that has definitely been seen over the last few years. This paper will try and explore some of the factors that have influenced this growth, the drivers of change, as applied to the Horace Production system.

As with all actions a change should have a purpose, a reaction to some demand and it is therefore reasonable to see Horace's customers as the primary source of demand. Other factors have also influenced the changes, such as new inputs or changes in hardware and software technology that have been used to improve performance for instance, but ultimately any change falls back to the customer who requires it.

This paper will therefore explore changing customer demands over the last 8 or so years and in doing so describe the changes in facilities, both inputs and outputs.

Customers

The Horace production system has essentially two classes of customer, users and recipients. Those that interact with the system to exploit its functionality and those that are the recipients of products produced on and by the system. Over the years both of these customers have changed significantly.

Customers as recipients:

It is hard to describe in detail the changes to recipients, but a certain amount can be deduced from the change in the nature of the products being generated. In the early days of the Horace system many of the remote customers of products had simple receiving equipment by today's standards. Although the Internet and e-mail facilities were available they were not in common use and the most technologically advanced receiving systems were probably fax machines. The majority of customers however would still have been using telex and hence the dominant product was text based. The explosion in the PC market, and the consequential reduction in hardware costs, has meant that remote customers now look for graphical versions of former text products and this has led to increasing demands on the system to develop and enhance the facilities to allow for these types of products to be generated. Where it would have been sufficient to receive a graphical representation of the current synoptic situation on a single side of paper through a fax machine, end customers are now looking to incorporate the products they receive with products they generate. They therefore need to receive them in a format that is compatible with their systems so they can add further value tailored to their own line of business. One of the early requirements of the Horace system used by the Royal Navy was the need to be able to exchange graphical displays with another navy system. This was resolved by the use of an agreed specific interchange format, requiring maintenance on both sides, an expensive solution by today's standards.

Movement from textual to graphical products also assumes a certain level of meteorological intelligence and awareness. In a text product the forecaster can spell

out the situation and forecast in some detail and although there is still the possibility of some confusion, it is less open to local interpretation than a graphical product. Now with the growth of graphics there is a need to present the content clearly, both legibly and meteorologically. Consequently the production system must respond with enhanced product quality and increased facilities (e.g. legends to explain line styles). The move from the fax machine to PC receivers also introduces the opportunities for colour and motion and even audio to be exploited. Most end users will now take their products electronically and use local software tools to display them. These tools will now provide high-end graphics that support numerous interactive capabilities, such as colour slicing, translucent displays and animation.

Customers as users:

By considering the changing environment of the recipient it is clear that a change is also required in the user of the system. Over the 8 years or so that the Horace system has been in operational use a number of changes have occurred.

The early Horace system that underpinned the generation of text messages and paper based fax products provided functionality that was necessary in support of those activities. To allow the users to create and disseminate text messages a text editor application was developed (Fig. 1). This included normal word processing together with meteorologically specific functionality, such as a dictionary of key words and associated macros that automatically expanded the abbreviations. Although the Horace system is not a main message switch the tool also included the functionality to amend routing information. The latter is a legacy of the time when users needed to be familiar with which bulletin headers were appropriate for which customers and many products are still referred to by their bulletin names today. It is likely that the trend in the future will be towards improved product naming, with the routing information being extracted from a managed database.

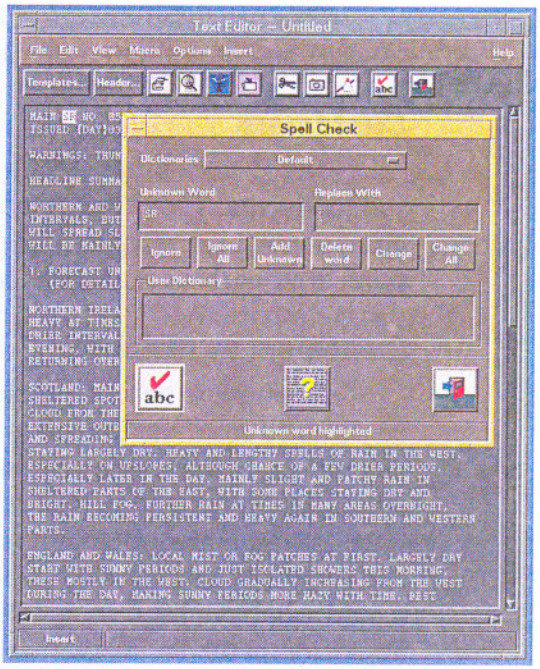


Fig.1 The Horace Text Editor

Another feature of the time was the dependency on paper. Much has been said about the paperless office through the developing computer era, but it is still a requirement of today's systems that they are capable of printing displays. Paper is such a portable medium that it is proving hard to replace. Despite this the Horace users have come under considerable downward pressure to reduce their use of paper and this has been reflected in the increasing demand for Internet compatible formats as well as automatic facsimile functionality. The latter has been available from the Horace system since about 1994. The first phase of Horace though was focussed almost entirely on replacing the wide range of printers and dedicated software with standard software interfaces and faster, cleaner printers. Out went the pen plotters and in came colour laserjets. The emphasis, though, was still on producing high quality paper copies that could be analysed manually using pen and ink and used as underlays to standard products.

This was also still the era of fixed standards for data presentation. Users liked to have consistent looking products on their desks that would be generated routinely on

the clock. Consequently the requirement was for system-wide configuration that provided little in the way of user interaction. Much time was spent agreeing on formats and then the system was left to run. It has been interesting to see this requirement initially reflected in the screen presentation of data.

There is clearly still the need for standards, the Horace system has and always will present observations using a standard WMO plot model, but increasingly the requirement from the user is for greater flexibility. User-defined plot models were introduced, for example, in 1998 as a result of user demand and whilst graphical displays provide access to considerable amounts of information, the assimilation of this information by the users can be optimised if they are allowed to configure its presentation the way they feel most comfortable.

It is becoming increasingly evident that many of the complex graphical presentations that have for some time been used by the Horace user are now requirements of the end customer. To this end the Horace production system has evolved to allow the displays that the forecaster sees in front of them to be converted into products that can be disseminated. One of the early initiatives in this area came from the aviation community who required graphical products of weather parameters that affected flight safety and comfort. This led to the development of the graphical toolkit that today forms the Significant Weather package and with it the automatic dissemination of facsimile products from one computer to another. Subsequently many other meteorological objects can now be drawn "on-screen" and combined with raw or forecaster-modified Numerical Weather Prediction (NWP) model data to produce analysis or guidance information.

Access to a range of drawing tools, together with the global capability that Horace is founded on, has led to increasing demands in the quantity of products. End users are not normally content with standard products, but prefer their own tailored look and feel. Complete global products present the detail at too courser resolution to be useful. These demands have encouraged a growth in the geographical diversity of products and hence the time spent on their production. To counter this automatic systems have been developed to reduce the forecaster time by presenting them with "first-guess" products based on model output and looking like the final products that will be sent. Tools are then provided to modify the basic data before the final product is disseminated. These tools provide functionality to interact with text, objects or grid point data, the three fundamental parts of all products produced on Horace. It is important from an efficiency point of view that they can alter first-guess products easily and consistently. Increasingly re-use is becoming important and to that end all objects are gradually being saved in a global database such that a subsidiary process can inherit the input provided by earlier work and hence reduce duplication of effort.

Facilities/functionality

Given the customer context Horace has responded over the years providing an increasing array of tools to assist the forecaster in the generation of products. The early releases concentrated on support of the hardcopy activities and text processing. Extensive functionality was built into the chart plotting facilities to enable consistent production of paper charts that could be used for analysis purposes. These developments improved hardcopy delivery times giving the users the alternative of receiving the products earlier on their desks, and hence more time to analyse, or to include more data on the chart. The text editor tool allowed users to have a production facility on the same screen as other text applications displaying the meteorological data they were analysing. Templates and access to former products on-line helped

generate consistent end-customer products and spell-checking and formatting functionality gave a standard presentation style.

As Horace evolved over the subsequent years so graphical presentation of data became increasingly important. The users had been familiar with many applications on a mainframe system. However that system suffered from many users sharing the same processing power and the limitation that each application had control of the display. With the local workstation system came high performance, multi-window displays and the opportunities to overlay different sources of meteorological information. Satellite imagery displays were some of the first applications to take advantage of the improved performance and for the first time users could view global imagery and interact with it (e.g. using colour slicing techniques). The previous fixed geographical products were now projected onto user-defined maps and projections with the flexibility to zoom in or out and pan around. Imagery however is essentially just another data source into the production process and the next evolutionary step took place when this was combined with all the other data sources in one main application (Fig.2). It was then possible for the user to combine in time and space all information relating to a developing situation in one display rather than to cross-reference between applications.

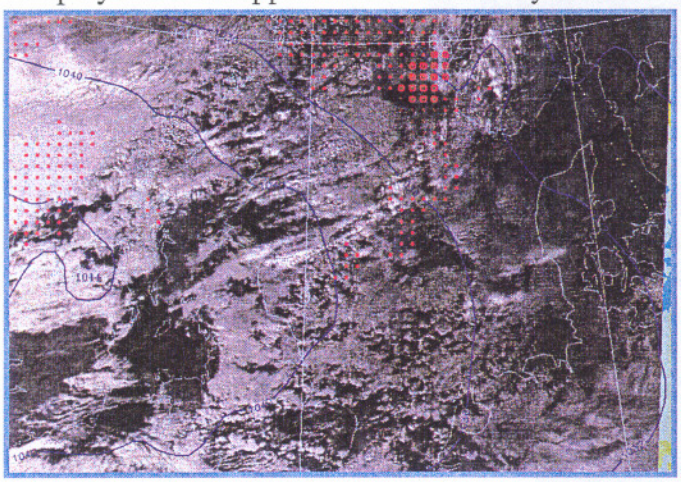


Fig. 2 Typical display showing dynamic rainfall(symbols) and MSLP(isobars) overlaying a Polar Orbitor visible image

All this advanced display capability is no good if it can't be turned into higher quality products and so the Horace production system was further enhanced to add a graphical toolkit that allows the users to underlay their products with these combined displays and draw symbols or add text over the top. This combined with the dissemination enhancements allowing direct facsimile broadcasts from the workstation finally brought the visualisation and production functions onto one platform. The stage was then set for full exploitation of the system.

As has already been mentioned the Horace system is truly global and the demand on the user for greater production efficiency increased both from expanding markets as well as the rationalisation of the production processes. In order to meet these demands it has been necessary to explore ways in which time can be saved in the analysis stage. The toolkit

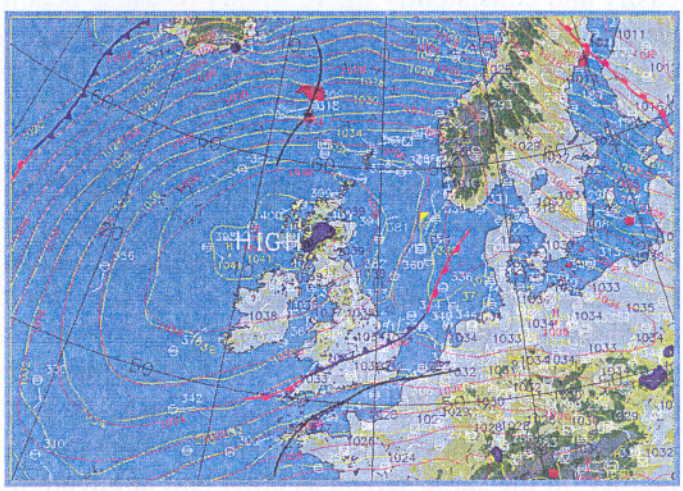


Fig.3 On-Screen Analysis, showing analysed isobars (dark) with raw NWP (light). The shaded areas indicate where the OSA and NWP differ by >2hPa

can arguably provide the user with the ability to draw fronts or annotate charts with the same speed as a pen, but the time-consuming task of drawing contours would still remain unless the software could replace it. The limiting factor here was not the contouring algorithms, though, but the raw data that were being contoured. Hence new tools were developed to interact in innovative ways with these data. For analysing large quantities of observational data the On-Screen Analysis (OSA) tool (Fig.3) was developed to convert a scattered distribution of observations into a regular grid. Raw NWP model data were not of acceptable quality to be used to generate automatic forecast products and so the On-Screen Field Modification tool was developed to enable the forecaster to modify these data in a 4-dimensionally consistent way before being incorporated with fronts to form the final product. Automatic chart titling and labelling was included to again reduce the time required by the forecaster and allow them to concentrate on adding real meteorological value.

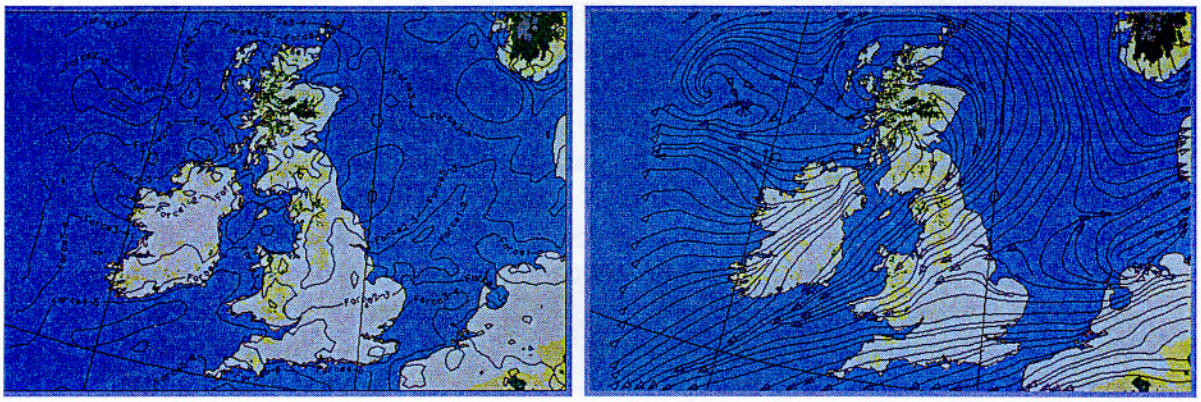
Product formats

The range of products available from a system will always be a function of the user's ability and the level of functionality available. Horace provides training courses to address the first point. One of the aspects of the original design of the Horace system was that it would not be tied to fixed geographical areas or inflexible product styles. This is an interesting dilemma, as greater flexibility requires extra effort to maintain consistency. A balance has to be struck and in the early days the tendency was to use system-wide configuration to control the content and look of the final product. However these products were largely for internal use, the external graphical products were still mostly hand-drawn and of variable quality. Text products were controlled by standard templates and more consistent. As facilities have been developed so the capabilities of graphical production have led to higher quality graphics and consistent standards of presentation. The content has also been expanded to include oceanographic products and with the advent of web technologies so time can be added as an additional dimension with animation now available as an output format.

One key class of product which has always been of high priority is the timely issues of warnings of severe weather. These have traditionally been issued as text and as such an output from the text editing function. New developments have recently looked at how the user can enhance this process by focussing on the analysis stage and using scanning applications to raise alerts if certain conditions are met. One of the future developments is to build into the scanning applications greater meteorological intelligence and hence the automatic production of first-guess warnings to alert the forecaster. It is anticipated that this will lead to more warnings being issued at earlier lead times that will help to raise customer awareness and reduce the subsequent impact of any event.

Product Re-use

As has been mentioned earlier, the first main products for external customers available from the Horace system used the text editor as the main generation tool. This clearly is a largely manual approach where local graphical representations of observed and forecast data are converted into the written word. Although there were a few simple tabular products that could be automatically generated from incoming model data, for the most part it was impossible to re-use one data display in another. It was not until 1997, when internal efficiency drives encouraged the development of sophisticated tools, like On-Screen Field Modification and On-Screen Analysis, that



ig 4a and b. Alternate views of 10m wind
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true re-use became available. Now graphical products can be generated automatically from large quantities of observed data, as contoured fields or in other more appropriate ways, e.g. streamlines for wind analysis or isotachs (Figs.4a and b). The underlying data has been separated from the visualisation process and hence is available for re-use with other products or applications. On-screen Field Modification allows the user to alter the timing and evolution of forecast MSLP charts (maintaining 3d consistency) in such a way that numerous other products can be created from the same set of modified NWP. These two stages together with the development of an extensive range of graphical drawing tools has now given the user the ability to convert displays that they have been able to see on-screen into products that can be disseminated to remote customers. On-screen Analysis has allowed them to analyse considerable quantities of observational data in a timely fashion and quickly compare them to underlying model background fields that focus attention on the key areas. It is then possible to closely analyse particular observations that are giving an alternative message to the NWP. These observations can then be quality controlled and these adjustments stored separately and applied later if required. All the objects drawn using the toolkit are automatically saved and available for other users to incorporate in their products, including interpolating onto other map projections.
In this way a consistent database is created of raw and forecaster corrected data that can be used and re-used as the basis of any product.

Future

By considering the changes in the production facilities over the last few years it is possible to project future trends. The early production facilities were provided to support mainly paper graphical and digital text based products. Any graphical displays were developed entirely for internal use. The next step was to move into digital graphical production for the external customer with interactive graphical capabilities provided to the user to build their product. The main production process, although screen-based was still manual. More recently we have seen greater use of semi-automatic production facilities, where versions of end products are automatically generated and the graphical interaction limited to their modification. Another recent trend is re-use of data, leading to a write-once culture that minimises duplication.

It is likely that these trends will continue with the consequence of more automated products dependent on customer requests, they will become the ones interacting with a database of quality controlled information.

Customer formats have changed through time. Whilst in the early '90s many were happy to received purely textual information, increasingly they are expecting graphical, with text annotations. The change from flat 2d faxes to animated colour products in web formats adds new dimensions and it is conceivable that future products may consist of combined fields of meteorological data that are rendered by the customer system rather than them receiving a graphical image. This will allow them to exploit their product further. This is already the case with the exchange of aviation weather objects in which the feature is fully described in meteorological terms (using the WMO BUFR code format) and the visualisation left to the receiving site.

This trend towards customers adding value will be further enhanced by the use of compatible formats. The Horace production facilities exploit the flexibility of the Computer Graphics Metafile format and although Horace is a UNIX-based system, products have been passed onto NT systems for display and inclusion in their local production processes.

Traditionally one of the limiting factors why paper has been retained for so long is its portability. With the increasing growth of mobile phones and digital personal organisers customers can receive products on paper-free systems. It will therefore be important in the future to be able to provide a range of products for these systems.