Principia Medicinae Digitalis Sotoniensis

Essays on the Evolution of the UHS Clinical Data Estate 1980 -2024

The history of the University Hospital Clinical Data Estate from the 1980s to 2001

Essay Author and Editor

David Anthony Rew MChir FRCS

Consultant Surgeon, Southampton Hospitals

With a major contribution from Liz Horkin

Former lead for the IT programme, 1990-2000

Section 1 Essay 2, 6th October 2024

Publication Plan

The essays which comprise this series will be made available in the first instance on my professional website, https://www.wessexsurgical.co.uk as downloadable PDF documents for review, comment and as a basis for further contributions. They will be amended, updated and supplementary as necessary and as any new material becomes available. All those with knowledge and participation in the UHS digital programme are welcome to contribute, by communication with me through dr1@soton.ac.uk. Once the project is as complete as is achievable with the available contributions, final copies of each of the essays will be submitted to the University of Southampton ePrint server for formal publication.

Copyright

Section 1.

The History of the University Hospital Southampton Clinical Digital Estate 1980 to 2024

Contents

Introduction to Essay Two in Section One of this Collection.

This essay is the second of a series of essays in the first section which report the history of the unique Clinical Digital Estate (CDE) of University Hospital Southampton (UHS) from its origins in the 1980s to the current day. This knowledge largely survives in the recollections of those who built the system, with little having been formally recorded to date.

I have therefore drawn on those recollections wherever possible, and have sought to integrate them into a coherent narrative and reference volume for future system developers and managers at UHS and for a wider audience of health and computer professionals.

In this Essay, I have sought to capture the history of the first two decades of meaningful development of healthcare systems in the Wessex Region, from the late 1980s to and through the Millenium in 2000.

Local documents and plans from that analogue era have largely scattered to the four winds, so I have been very grateful to Liz Horkin, Alan Hales, Adrian Byrne, Ian Brewer and David Cable for their oral and written contributions.

These individuals have been among the longest serving members of the Southampton General Hospital informatics service in its various forms and under its various titles since the 1990s. I have sought to coordinate the timelines and recollections into a coherent narrative.

The ambitious and premature experiment in health systems computerisation in Winchester had collapsed in the late 1980s with considerable national political opprobrium and at huge expense before Southampton was drawn into it (Essay 1 Section 1).

However, it stimulated the seeds of dynamic changes in Southampton General Hospital in the early transition from paper to digital systems in the following decade, 1990-1999..

Liz Horkin, the first Director of Information Management at UHS, sets the scene.

Liz recalls that her journey in medical informatics in Southampton started in paper, and even in the 1980s paper was still seen as the medium term future of clinical record keeping. She recalls the old basement clinical records libraries at Southampton General Hospital.

"The main records library was flooded by the sluice drains on D wing at one point. There was effluent everywhere. We had to use a record recovery company from Cambridge to rescue paediatric cardiac surgery records. Those were the days!

I was working at SGH in or around 1987-1988 as a jointly appointed Nurse Tutor and Senior Nurse on the Surgical Directorate alongside Clinical Support Manager Douglas Pattinson. We were asked by then Chief Executive David Moss to go to Winchester Hospital to look at the Wessex Regional Information Systems/IBM Electronic Patient Record System. We had been tasked to roll it out at Southampton General and the Surgical Directorate was proposed for the pilot scheme.

We went up to Winchester to see The (US) Technicon Data Systems (TDS) deployment, as is escribed in papers by H Melville (1990) by Sittig and Stead (1994). This was a Level 3 Hospital Information System (HIS). Level 1 described a simple Patient Administration System (PAS). Level 2 described Departmental Systems which shared a Patient Index. Level 3 described informatics support for clinical activity. It included a comprehensive Order Communication System which was integrated with a ***Patient Administration System (PAS)****, with departmental systems, and with an electronic prescribing module.*

We planned that our new Level Three system would interface with Pathology and Pharmacy systems, and replace the Radiology system. The Pathology and Pharmacy systems were used regionally, so interface specifications would only need to be done once. The regional PAS was at end of life and it needed to be replaced. We were shown around Winchester Hospital and we were actually quite excited by the project. I had been keen on computerising Nursing Rotas when I was in Oxford and thought we could do a lot with computers.

I liked the Order Comms and clinical noting elements, but I found the drug round to be a bit laborious in the era before wireless networks. We both agreed that it appeared to be a

fantastic opportunity for SUHT, but we had no idea that it was shrouded in challenges and skulduggery! It appeared to us that the Winchester system offered a whole site solution that could be implemented in phases by clinical disciplines but not within a single specialty. David Moss was persuaded by the Regional Health Authority to work with the Royal South Hants Hospital as a unitary project.

I was appointed as the Full Time clinical co-ordinator for the project, with Roger Buchanan, Consultant Radiotherapist, as the Medical Lead. We also had a Project Manager from Pathology (Chris Ward) and Roger Boydel was seconded from IBM. This pre-history is relevant to where we went next.

Early Discovery and System Development Concepts at Southampton General Hospital

We appointed secondees from a range of clinical backgrounds to work as analysts, to create a map of services and transactions. These insights were then coded using Fortran (this was the language of choice in the aerospace industry) to create screens which end users would pass through by selecting items with a light pen. We all underwent training and started work on deploying the regionally led project.

I learned a lot about how each part of the hospital and how individual clinical specialties worked. I uncovered a myriad of small, unlinked, clinician owned data bases, research systems and similar with no consistency of data structure. In order to move the clinicians onto the Technicon Data System, we were going to have to code the data collection into TDS.

The Guiding Principle (the mantra) from here on in was to collect a specific piece of data (for example name, date of birth) once rather than on multiple occasions. There was some clinical buy-in but as key major functions had first to be built it was some time from replacing beloved local systems. Most stakeholders therefore were carried forward on the idea of an Order Communication System, so as to order Pathology, Radiology and other tests and to have an electronic report within the core patient record. Pathology was the first part of the intended Order Comms System (see Sittig et al 1994).

The HL7 Interface Engine

We planned to create a unitary ***Patient Master Index (PMI)*** *across the PAS and key feeder systems. We worked with hospitals in Bath and Dorset who were also using Chart, which was the Regional PAS. The Regional Programme was using the Data Gate (later E gate) as the HL7 interface engine.* ***Health Level Seven*** *(****HL7)*** *refers to a set of international standards for transfer of clinical and administrative data between software applications used by various healthcare providers.*

These standards focus on the application layer, which is the conceptual "layer 7" in the globally recognised Open Systems Interconnection (OSI) model. The HL7 standards are produced by Health Level Seven International, which is recognised as an international standards organisation. An HL7 interface engine is therefore a central hub that receives, routes, and sends HL7 messages to the appropriate healthcare information systems. It simplifies integration by connecting healthcare systems.

There were clearly problems with the way in which the TDS team had started with a small hospital. For example, the numbers of Out Patient Department (OPD) slots that had been factored in within the core system were too few for a Teaching hospital or for the Royal United Hospital in Bath. All sites shared ideas and we also worked increasingly with a team at Arrowe Park Hospital in The Wirral, who were also deploying the system. We shared best practice in screen designs. For instance they had good Physiotherapy departmental screens and we had good Prescribing screens.

You can read in CRASH: Learning from the World's Worst Computer Disasters by Tony Collins and David Bicknell (Simon and Shuster 1998), how the Winchester project came to a grinding halt. In my view, the concept was viable –as was shown by its successful use in The Wirral until it was replaced by the Cerner system during the NPfIT programme. "

Liz continues: *"IBM had over-promised and under-delivered and the region had underfunded the work. The timescales were overly ambitious and it emerged that there were issues with contracts and fraud, so the project was pulled. In 1990 the project was investigated by the National Public Accounts Committee.*

At that point, the project was still in the build stage at UHS. We had only deployed it on site to project offices and training rooms; a new network had been planned with an IBM Token Ring. The Token Ring was a proprietary fast IBM network, linking workstations and servers. However, this network was superceded by Ethernet Local and Wide Area Network (LAN and WAN) technology and its supporting communications protocols.

At this point in Southampton, we had started to create interfacing designs between the PAS, PMI and Pathology systems as we were going to keep the Ferranti pathology system (Rew et al 2022) and develop an Order Comms interface (subsequently EQuest).

Developments in Southampton after 1990.

In Southampton, Liz recalls that *"we were initially expecting to work on coding the new TDS system to capture clinical information for future* ***Diagnostic Related Groups (DRGs)****. When the Region cancelled the RISP project, the TDS project team was stood down. However, some work was ongoing as the Resource Management Project had started to unfold.*

The Resource Management (RM) project

This was nationally funded and it needed to be deployed locally with hospital management buy in. Then Health Minister Roger Freeman had announced on Tuesday 20th February 1990 (Hansard 1990 Vol 167) that:

"The NHS Management Executive has been discussing the details of the (Resource Management programme for the coming financial year for which the Government have made available an additional £78 million.

Fifty more hospitals in England have been chosen to prepare and implement the main resource management programme in 1990–91. Since my announcement last March ... 100 hospitals have been selected to implement the main resource management process.

We are proceeding at a pace that the service can sustain in setting up project management teams and purchasing computer equipment. This is backed-up with guidance from the Management Executive on the best way to proceed".

The National Casemix Office (NCO)

"*This was established in 1994 in Winchester, to improve the understanding of healthcare activities at local, regional, and national levels. The Case Mix programme offered benefits in management report generation, contracting and waiting list management. A new Nursing Information system was integral to the RM programme and I was bought back into the project. I got on well with Paul Stafford and Paul Bates, who were contractors working on RM, and a plan was formed.*

We agreed that a mechanism was needed to get IT and computers to the wards. We could then look to a future of more complete clinical computing. We used the Nursing System requirements as the anchor, as this was nationally funded. We built on experience that we had had with a local IT initiative for nursing records that we named Florence.

At the early stages of the RM vision we had started to consider how we could get nurses more involved. A small local pilot project received funding and Ivan Foster developed an early nursing system which provided a simple rostering system and which also focussed on ward based work, resource allocation and clinical noting. Ivan later helped us develop the technical standards for our IT strategy and departmental system in Cancer Care.

The Florence nursing system was deployed in the Surgical Directorate as a pilot and it was helpful in understanding how nurses would take to using the ward based computer. The output from Florence could also be used to create management reports for the ward sister – and created a way of looking at resource intensity by patient group.

The Crescendo Nurse Management System

The National Resource Management Programme was extended to include a Nursing Information System, as Nurses were heavy users of the digital resource. The programme funded hospital wide nursing systems for RM sites. We undertook a European Journal procurement to create a list of suppliers who could be selected locally without going to a full procurement.

The Florence computer system had been useful but it was clearly not going to have the support of the national solution and the funding for roll out would not happen. We therefore procured Crescendo, which was one of a set of recommended national software solutions. This provided nurse care planning, rostering and work load modules. It interfaced with the PMI and it would eventually allow integration with some nationally sponsored knowledge data bases, including (for example) Wound Management guidelines.

Crescendo failed to secure professional traction. In her 2003 paper, Melanie Wilson (Wilson M 2003) demonstrates the mismatch between the intentions of the technical developers and the experiences of the intended users with a new technology on the wards.

The Local Area Telecommunications Network

"We also procured and deployed a Local Area Telecommunications Network, which linked the Southampton General and The Royal South Hants Hospital across the upgraded Wide Area / Ethernet Network. These two hospitals would soon merge as a single Trust. This was our first major decision, to abandon the Token Ring and the Banyan Systems Virtual Integrated Network Service (VINES) UNIX systems infrastructure.

We were an early NHS adopter of this type of network, and it laid the foundation for future developments with a resilient and future proofed solution. To deploy the Crescendo Nursing system fully, we needed at least two personal computers (PCs) per ward, and the network to run them on, which the Regional Health Authority agreed to fund.

"You can't collect clinical information anywhere but in clinical space"

The telecoms installation became the basis of our future plans for a clinically relevant system, as we recognised that "You can't collect clinical information anywhere but in clinical space". For the next few years, we looked to use whatever the current management or national initiative demanded to create ways of extending clinical information systems.

As the Resource Management Project Manager, I also had access to a lot of powerful training and development resources. These included the PRINCE project management techniques and the Information Technology Infrastructure Library (ITIL).

PRINCE is a structured Project Management method which is certificated and which follows a quality circle process. It moved projects away from closed technical situations and involved end users and champions in agreeing IT benefits and deliverables. The system continues to be available in the PRINCE2 format for online professional development (see https://www.prince2-online.co.uk).

The Information Technology Infrastructure Library (ITIL).

"ITIL originated with the UK Government's Central Computer and Telecommunications Agency (CCTA) in the 1980s as a set of detailed practices for IT activities such as IT service management (ITSM) and IT asset management (ITAM) that align IT services to the needs of the business.

ITIL describes generic processes, procedures, tasks, and checklists which can be applied by an organisation toward strategy, delivering value, and maintaining competency. It is used to demonstrate compliance and to measure improvement.

ITIL was particularly enlightening for me. As an ex-ITU sister I expected IT to be structured and properly documented and I found that the local NHS infrastructure was not so well structured.

The Information Systems Strategy of 1991 and the origins of the Electronic Patient Record

The original Information Systems strategy was written in 1991. It focussed on how we would now resolve the legacy systems problems that should have been resolved by the Wessex HIS project, in that:

- We had an ageing and unsupported PAS,

- We had a Pathology system which was supported by a man travelling around the world on a motor bike, running on hardware that was no longer available, so we had to purchase some second hand decommissioned computer kit from oil rigs (The Ferranti System).

- We had a radiology system on its last legs, which was a particular priority.

We concluded that it was unlikely that we would ever again get the funding for a "big bang" project. We looked at technology adoption in other industries including finance and airlines.

We concluded that we should incrementally build a "level 3" HIS or Electronic Patient Record (EPR) as it became known.

We would do this by using industry standard technologies rather than old NHS legacy data bases and we would create a single PMI as the core: – one patient = one ID number – with no duplicates.

Within the RM project we had selected an Oracle based Case Mix system (Rusnak JE 1987), as did the Wales Health Board. The Clinical & Financial Information System (CFIS) was a proprietary US based Case Mix solution which combined the ability to collate clinical information and financial costing information to create resource reporting. The original engine for this was the Diagnostic Related Group (DRG) model, which grouped ICD codes into resource similar groups.

Within the UK RM initiative, there was a programme to develop a UK version. We used OPCS codes for surgical procedures, whereas in the US they had an extended set of ICD codes. This model was initially known as UK Case Mix and later became HRG's or Healthcare Resource Groups.

Towards a Strategy of System Integration

The RM project should have been entirely clinical, but the emergence of contracting created an imperative for good management information around what we did so the Finance and Management tools were crucial to the Trust. Clinical Coding became an essential tool, and over time we went from four clinical coders to a team of around 12 employees.

The focus on contracting became both a blessing and a curse. Financial management lay at the centre of the future of what would become Southampton University Hospitals Trust. In the Finance Directorate, Alan Butler was responsible for delivering the wider IT strategy, although at that time individual systems were administered under their own Directorates . This created the necessary momentum.

As a small team of 'contractors and seconded staff' we had gained a lot of knowledge through our procurement of the digital communications network and Case Mix and Crescendo software, both of which were 'Open Systems'. We also acquired relational data bases, including Oracle (from the Oracle Corporation), with Microsoft Structured Query Language (SQL) server applications. These acquisitions brought coherence to a plethora of NHS systems, antiquated operating systems and a lack of standards in term of coding and of mapping data.

Our strategy was to focus on a cohesive technical platform that lent itself to more and more integration. Previously systems might have been bought that were rich in functionality but they were islands in technical terms. We aimed to use industry standard technology and we planned to standardise as far as possible on one of two emerging 'industrial' standard Databases – At that time Oracle was our preferred system , but we had SQLserver as a secondary relational database.

The Ethernet network, with a fibre-optic back bone and dual ring design ensured that we had resilience. Dual-ring topology comprises two communications rings in a network. Each ring works independently. If one is disabled, the other ring ensures continuing data flow.

We also introduced an email system within the IT department in 1993/94, initially using the Microsoft Windows 'Pegasus' system. We moved to the 'Groupwise' system, which was rolled out across the Trust, to be succeeded by Microsoft `Outlook'.

The Strategy of Incremental Implementation of the Southampton EPR

Our thinking was that as each component of our new solution came into being the project would be functional, even if further projects were not funded or took longer than anticipated. We did not want to invest large amounts of money, time, effort and enthusiasm to see everything crash again. The watch word was ***incremental.***

There was a lot of debate across the wider NHS as to optimal IT solutions. Many hospitals were looking to the evolving commercial market for Order Comms and a combined PAS system.

The whole issue of how we moved forward in terms of providing HIS / EPR was a hot topic across the NHS Informatics world. I even took part in a public platform debate with my peers from Kensington Chelsea and Westminster Hospital on the topic of "Big bang, versus single solution v incremental". My case was that we had been bitten by a Big Bang approach (as of course we would be again when NPfIT failed for almost the same reasons as Wessex – I know I was there – see later).

Our incremental approach had some great wins and was going in the right direction but it was not immediately a great success. It proved to be 'bleeding edge' rather than "leading edge". The technology took time to catch up with our thinking. as did our understanding of what we were trying to do.

Reflections on Updating our IT strategy in Southampton: The First Decade

"Our first strategy in 1990/91 had been mainly words and vision, with little of the necessary technology to carry it forwards. We had set out with two accountants, a Nurse and some key clinicians to flesh it out. We used trusted third parties including Ivan Foster and individuals within other consultancies including Admiral and Gartner who were working with us elsewhere or through contacts at Region.

The first 10 years of our programme was mainly spent on procurement of key essential infrastructure, and building the case mix system, and contracting for resources. The network procurement, the Case Mix and the Nursing system projects were followed by a major project to replace the PAS.

Replacement of the Patient Administration System

The NHS had a large number of legacy PAS which offered no advantages over our existing NCR Corporation Chart PAS. Newer commercial solutions used legacy technologies so we looked wider and acquired an Australian system, developed by IBA Health Group Ltd. This system was ported to Oracle and it had potential to bring elements of a level 2 HIS with a simple Order Communications moving towards our preferred level 3 status.

Buying the PAS was also interesting, as we were breaking the mould in going outside of the known NHS family of such systems. The Region was concerned but the company managed to acquire an Australian backed financial guarantee which got us over the line. They later established a UK base in the Midlands and became a supplier within the UK market.

Replacing a PAS was a major undertaking, but it did not provide utility for the Clinicians who were by now under pressure to undertake more Clinical Audit and to participate in more specialty research. Many clinicians were keen to transform their working environment and to create their own local speciality records using commercial systems. Some of these were promoted by the Royal Colleges, and some clinicians were also under pressure from a plethora of small system suppliers to buy specialty specific solutions.

Going it Alone: Thinking the Unthinkable!

At this point, by fortunate coincidence, I met with Alan Hales, who proposed the idea of HICSS. Alan had come in to look at a clinical system for a clinician as a contractor and he had come to us to discuss it. We were soon on the same wavelength. Alan was from an engineering background. He was completely in tune with what we were trying to do and he also understood the clinical process. He understood "design and build" methodologies using current technologies so we came up with the notion of doing something which was unthinkable in the NHS IT management climate at the time. We elected to build a local software solution rather than go to market.

We would aim to build a modular clinical solution which could be speciality based. Core components such as the PMI interface, and the Pathology interface would be developed once. Services such as discharge letters and reporting tools would also run across all modules, but the local clinical data capture would be bespoke for each specialty.

We had replaced pathology at this point with a system called Masterlab from Berkeley Ltd, a Scottish company which was contracted to Bull as the prime contractor. This system is founded on the Unix based IBM Unidata database system".

Alan Hales' Recollections of the 1990s Programme

Alan Hales, our independently contracted and very long serving IT Systems Consultant to UHS, takes up the story from Liz Horkin:

"My first interaction with Southampton was in 1997. Southampton had completed an assessment and found they had over 200 disparate, disjointed clinical systems written in various programming languages and styles. Many of these were considered likely to be problematic after the turn of the Century in 2000AD for a variety of reasons, including:

*-The issue of "**the Millenium Bug**", the two digit years used in time-interval calculations.*

- Many systems had been written by doctors and students with little or no documentation and no source code. We realised that these applications were going to fail at some point because upgrades in the leading computer operating systems would mean that those programs would stop working without tortuous workarounds.

- There was little or no consistency in the applications. The validity of the encapsulated logic was unclear and we were not sure whether it continued to correctly reflected contemporary protocols, or what clinical risks it posed.

A new Way Forward, the First Proof of Concept of an Integrated System

Alan continues:

"I had designed and developed a wide range of applications in scientific, commercial and financial organisations and had practical skills and experience of web-based applications as well as an established background in relational databases (i.e. Oracle, Sybase, DB2 etc) and object oriented programming techniques.

I recognised the need to establish a core clinical application foundation upon which specialist clinical applications could be developed, operated and supported. I also recognised a commonplace problem with deployment of software to Personal Computers in the era of client-server computing that had emerged since the mid 1980s".

During the late 1990s, Adrian Byrne was working as an IT Manager at UHS, initially on informatics projects around pathology services, from where he became increasingly involved in the strategic planning of the Hospital's IT programme. He was promoted to be the IT lead for the Trust in 2004. Adrian recalls that:
"The tendency was to rely on the PC to do the processing, client side. It led to a lot of applications running on a machine, where libraries would be updated at different intervals. This became known as DLL Hell.

DLL Hell describes the complications that arose in working with dynamic-link libraries (DLLs) used with Microsoft Windows operating systems particularly legacy 16-bit editions, which were all running in a single memory space. It was such a widely recognised challenge that it has acquired its own (extensive) Wikipedia page.

From this point, there were two possible approaches. One was to let the work be done back on the server as in old green screen days, and the other was to run the software on the PCs, based on a virtual machine approach. This was typically the Citrix solution (Citrix Inc, Ford Lauderdale, Florida), which effectively gave each application/user a separate virtual machine. However, it is very expensive in licencing, difficult to manage in terms of things such as printing, and doesn't take us forward at all in technological terms.

Later techniques are more tiered. Typically, they have a standard user client in the web browser, some middle logic in web servers, and a separate database server environment. This is much more scalable and manageable".

Alan Hales continues:
"There are other key factors that emphasise the inherent strengths of web-based architecture. The client-server model required organisations to invest progressively in more powerful PCs, more memory, faster processors and other upgrades, because client applications were often inefficient and every PC had to run the applications.

With web-applications, the PC has only to run a browser, although some web-developers do far too much client-side processing and again create a need for high-end PCs and

workstations. This tendency should be controlled by good IT developer management, but this is not always the case.

Client-server solutions also often required the purchase of licenses for all manner of drivers and other client-side application components, which could amount to a lot of money for larger organisations, such as UHS.

Client applications were also tied to the operating system of the client PC in the days prior to the Java virtual machine, which itself creates operational challenges. Such choices created real dilemmas at a time when organisations were being prompted to choose between Unix/Linux solutions and Windows. This is less of an issue now as most organisations have settled on Windows.

Very early on, I saw the potential of web-based applications. I committed to the methodology several years before it became mainstream, having previously been somewhat of a client-server guru. My strategy was therefore to develop a web-based architecture which was integrated with the secure, stable Oracle database environment which was already established at Southampton and for which there was technical know-how. The new environment would be integrated with the recently implemented core hospital systems, including the PAS (Patient Administration & Patient Master Index), and Radiology (another departmental system operating within an isolated software bubble) The Suppliers were:
*Interfaces - DataGate E*Gate (DataGate Inc, Jacksonville, Fl)*
PAS – IBA (IBA Group, now in Prague, Czech Republic)
Radiology – Detente, under a prime agreement with IBA
Pathology – Berkeley (Berkeley Softworks Inc, Berkeley CA, later Geoworks Corpn)

UHS pathology reports were written and stored in a Ferranti Computer System from January 1990 to mid-1997. These were transferred to the Clinisys (previously Masterlab) Labcentre system when the SUHT Laboratory Information System (LIMS) went live in 1997.

Liz Horkin and I agreed that I would develop two applications within a common framework as a proof of concept. These modules were a Vascular Surgery module and a Renal Failure

module/application. There was also consideration of an endoscopy module and a diabetic module.

I had sufficient understanding of human biology and medicine to appreciate that the processes and data for surgical and non-surgical healthcare are significantly different, although they share a substantial core of common elements, the patient being the most obvious.

I devised the first clinical data-model concepts which are still underpinning the current CHARTS applications today, and to which we will return in later Essays. These concepts of interventional and review-based events, which are supplemented by many other core entities, together define the electronic health record to a considerable degree.

IT/Computing from 1970 onwards was very much a mathematical and logically based discipline and few requirements analysts, database designers and programmers had a scientific background (i.e. chemistry/biochemistry and life sciences) which forms the foundation of clinical theory.

The systems, Information Technology and Applications developments across the NHS in 1997 were predominantly non-clinical. IT professionals were comfortable with handling patient demographics, numbers of outpatient clinics attended, number of procedures performed and broad-brush coding as for the ICD and OPCS clinical classifications standards.

(The International Statistical Classification of Diseases –ICD- was first mandated for use in the UK in 1995. It is now in its 10th Revision (ICD-10). It is produced and maintained by the World Health Organisation (WHO)).

However, IT professionals generally struggled with anything that required insight into clinical diagnostics, diagnoses, treatments anything more than labels or categorisations, the definitions of which, they often did not know or understand.

In consequence, progress with clinical computing was slow and haphazard. Most clinically oriented applications were developed by medical staff who did not have a professional computing education. Consequently, they created systems that were technologically diverse, non-scalable, lacking in good data-modelling and so on.

I was very ably assisted in the early stages by Angelo, a highly competent contract programmer, and by Kevin Hamer, who would go on to become the team leader/manager of the UHS My Medical Record programme.

The two prototype applications were delivered in 6-9 months and they evidenced the various aspects of the strategy that Liz Horkin and I had formulated. The applications shared core system data, but they required complex and one-off interfacing techniques because generalised messaging such as HL7 had not really evolved beyond basic patient data at this time.

The pathology and radiology systems had been designed with no thought about data sharing with other systems, so we had to work with whatever existed. Southampton was nevertheless provided a rare and enabling working environment place where we could develop these ideas through a small group of open-minded IT staff who had already started to think about broader data models.

A key example of this far-sightedness was the "Clinical/Financial Information Systems (CFIS) and Casemix" application, which was originally an Oracle supplied application. It was later to be redesigned and developed in-house in Southampton by Ian Brewer and Richard Brooker.

The "Casemix" system did not extend to true clinical computing, but it did support clinical coding and upward reporting of cases. It thus had a solid foundation that could sit under an evolving clinical computing environment. The data-modelling of the administrative data had been done well and supported the core computing functions of the organisation well."

Adrian Byrne's Recollections of developments in the late 1990s

During a wide ranging conversation in December 2023, Adrian Byrne reflected on the impact on the UHS digital strategy of a range of centrally made decisions and plans at Government and Department of Health level back to 1992, when a series of Resource Management Projects were established with a focus on Patient Administration Systems, Nursing Systems and Casemix.

Casemix is a national system which is run by the National Casemix Office. It supports payments to healthcare providers, and it informs the National Tariff Payment System. The data which it collects also informs epidemiological studies and service planning, benchmarking and performance management. It is underpinned by the Healthcare Resource Group (HRG) classification system for hospital care, episodes and spells, and specifically for Admitted Patient Care, Non-Admitted Consultations, Emergency Medicine, Adult Critical Care, Paediatric Critical Care, Neonatal Critical Care and Renal care.

HRGs match patient events that are judged to consume a similar level of resource and allocate a five figure alpha-numeric code to each group. HRG coding is underwritten by the Grouper national software system, which is updated annually. The coding was in turn informed by the ICD-9 (International Classification of Diseases, 9th Edition) system of disease codes until 1999, when ICD-10 was introduced to include mortality codes; and by the OPCS classification of interventions and surgical procedures.

At the operational level in individual hospitals, income is therefore clearly and wholly dependent on the accuracy, efficiency and completeness of the administration of Casemix and HRG data. However, these processes also provide scope for optimising income in complex service provision.

The implementation of HyperText Markup Language (HTML) protocols and Oracle

Adrian recalls that the key choices for the direction of travel in the late 1990s were driven by the foresight and determination to build the future Data Estate around internet and HyperText Markup Language (HTML) protocols. At that time the internet was evolving from

“Web 1”, the display of pages, to “Web 2”, which permitted ease of interaction with web content, and hence the ability to conduct transactions across the Web.

Internet Browsers in the 1990s

There were two key players in the Internet Browser market: Netscape and Microsoft (Internet Explorer)*, the latter company being more heavily invested in the development of the enabling technologies of the public internet. In general terms, systems were proprietary, and the purchase of any particular system locked the purchasers into that technology.

The Visual Capitalist X/Twitter feed provides a very powerful animated visualisation of the changing influence of internet browsers over the period of 28 years to from 1994 to 2022 https://twitter.com/VisualCap/status/1650726331884158977 . This work is attributed to @JamesEagle17 as part of the Visual Capitalist’s Creator Program and specifically it is named “The rise and Fall of Popular Web Browsers since 1994”. See also https://www.visualcapitalist.com/cp/the-rise-and-fall-of-popular-web-browsers-since-1994/

The Oracle Relational Data Base Management System (RDBMS)

Databases sit at the heart of any organisation. The Oracle Relational Data Base Management System (RDBMS) was first released by Larry Ellison’s Software Development Laboratories in 1977, and it has continued to thrive through serial updates and evolutions over since. By 1998, it contained Native Internet Protocols, and it could be run as a virtual private database.

Oracle was also functionally linked to the Java object orientated programming language (OOPL) (Sun Microsystems), which was finally acquired by the Oracle Corporation in 2010. Object Orientated Programming organises software design around data (objects) rather than around functions and logic.

Adrian recalls that the decisions were therefore made to acquire:

1. the Microsoft proprietary web enabling systems, including Internet Explorer as the browser; the Microsoft Visual Studio environment as a software development tool; Microsoft Active Server Pages (ASP) as the first language (1996) specifically designed for

programming with dynamic web pages; and Microsoft Active X Contols, which allowed the development of small applications (for example Calendar display) in web systems.

2. The Oracle Data System and the associated Structured Query Language (SQL) for searching relational databases.

Critically, these systems also offered controls to security which were are a crucial enabler of all modern computer systems. Adrian recalls initial challenges with achieving connectivity with the many “private” databases which were held by individual clinicians and units across the Hospital. There was necessarily a drive to integrate these legacy databases in a logical framework which facilitated shared ways of working and consistency to store all clinical data against the core patient record.

He notes that: *“The connectivity issues in my memory were using ODBC to connect Microsoft to Oracle. It all seemed quite proprietary or primitive. You had to use very specific versions as they were not "open". We did not really try to connect to databases that were there other than the large stuff mentioned. Our plan was to replace them with new modules”.*

Adrian recalls that in the matter of Casemix, and HRG coding, an investigation of the payments for cardiac services at UHS in the late 1990s highlighted serious underpayments for complex service provision. This highlighted the need to optimise the data management and reporting systems feeding from UHS into the national information systems.

“I also remember that on one occasion the Grouper changed and all of a sudden income for a knee operation dropped through the floor until we added back in a code for an individual piece of equipment or procedure that was used.

We were very aware that you had to be agile and have full clarity in the way things were coded and passed through to the national systems, the Secondary Use Service (SUS). Data from this is passed also to Health Episode Statistics (HES) and ultimately comes back in terms of your outcome performance in the Good Hospital Guide - the HSMR and SHMI data.

Ian Brewer therefore took on the roles of owner of the substantive data model, and Oracle Head Analyst, Tak Tang made major contributions to adapting the Oracle system for HICSS, the Hospital Integrated Clinical Support System. However, the key to this program was the work done by Alan Hales in building an innovative unifying prototype of HICSS as a consolidated data platform."

Adrian also recalls the early contributions to information integration of hospital consultant clinicians Brian Leatherdale (Diabetes); Mary Rogerson (Renal); Chris Canning (Ophthalmology), Praful Patel (Gastrointestinal Endoscopy) and Iain Simpson (Cardiology).

The Recollections of Ian Brewer

Ian Brewer has spent much of his career at UHS in key roles within the IT Directorate. He recalls that:

"I started my career in 1984 working as a computer technician (and classroom assistant) at of high schools on the Isle of Wight, before moving to the IOW College of Art and Technology to develop and manage their student records systems. In 1991 I was informed I was being made redundant after several years on fixed term contracts.

I spotted a job at the SGH as a Casemix system manager and saw that they were looking for Oracle database administration, and Unix system management experience. - I had honed such skills in my last job. To my pleasant surprise I was offered the job. I figured I could cope with the 2 hour+ commute from Shanklin old village on the far side of the Island each day for a few months until something permanent came up on the Island. Little did I know that Southampton would show me that my hobby could actually become a proper career.
In 1990/91, the Resource Management project was established within the Hospital Finance directorate to implement a Casemix resource management system, and a nursing information system to support electronic care-planning. Liz Horkin was the project manager.

Within a year I was running a small technical team as the IT function grew out of the Resource Management project team that was established to implement Casemix and the Crescendo Nursing Information System.

In 1992, the Corporate Information Services department formed within what then became the Finance and Information directorate. Liz H became overall manager, and later Director of CIS and then Director of Informatics when the Informatics directorate was formed as a separate entity to Finance.

Within CIS were two sections; Information Services under Ruth Gardiner (nee Grant), and Information Technology, with Rob Storey being brought in as IT Manager.

Also in 1992, the Oracle Casemix system went live with Clinical Studies and Contract Monitoring. The originally planned Costing system (PLICS as it would now be known) was abandoned in favour of contract monitoring. The Crescendo nursing system also went live.

In 1994, Nigel Armstrong took over as the IT Manager. Plans to implement an integrated Patient Management System, including replacement of the NCR Chart PAS, a Radiology management system, and a maternity system continued into 1995.

In 1995, we implemented the IBA Healthcare Unicare PAS and Quadramed (Detente Omnisys) Radiology system. Indeed, IBA Healthcare were prime contractor for the whole Patient Master System, which went live in March 1996 and which replaced the NCR Chart PAS. All data from Quadramed was migrated to the EQuest Results Server in 2010. The implementation of a maternity system was abandoned as no suitable solutions were found."

The Introduction of the Trust Integration Engine (TIE) to the Data Estate

Ian notes that this period also saw the introduction of our first Integration Engine, Software Technologies Corporation (STC) Datagate. An Integration Engine works like a telephone exchange within the data management system. It is designed to receive and distribute internal or external messages. Healthcare Integration Engines manage text, images, XML documents and other secure file types and they are common to many organisations beyond healthcare. The most recent iteration of the Integration Engine in the UHS system is the Ensemble product from Intersystems Healthcare (Cambridge Mass).

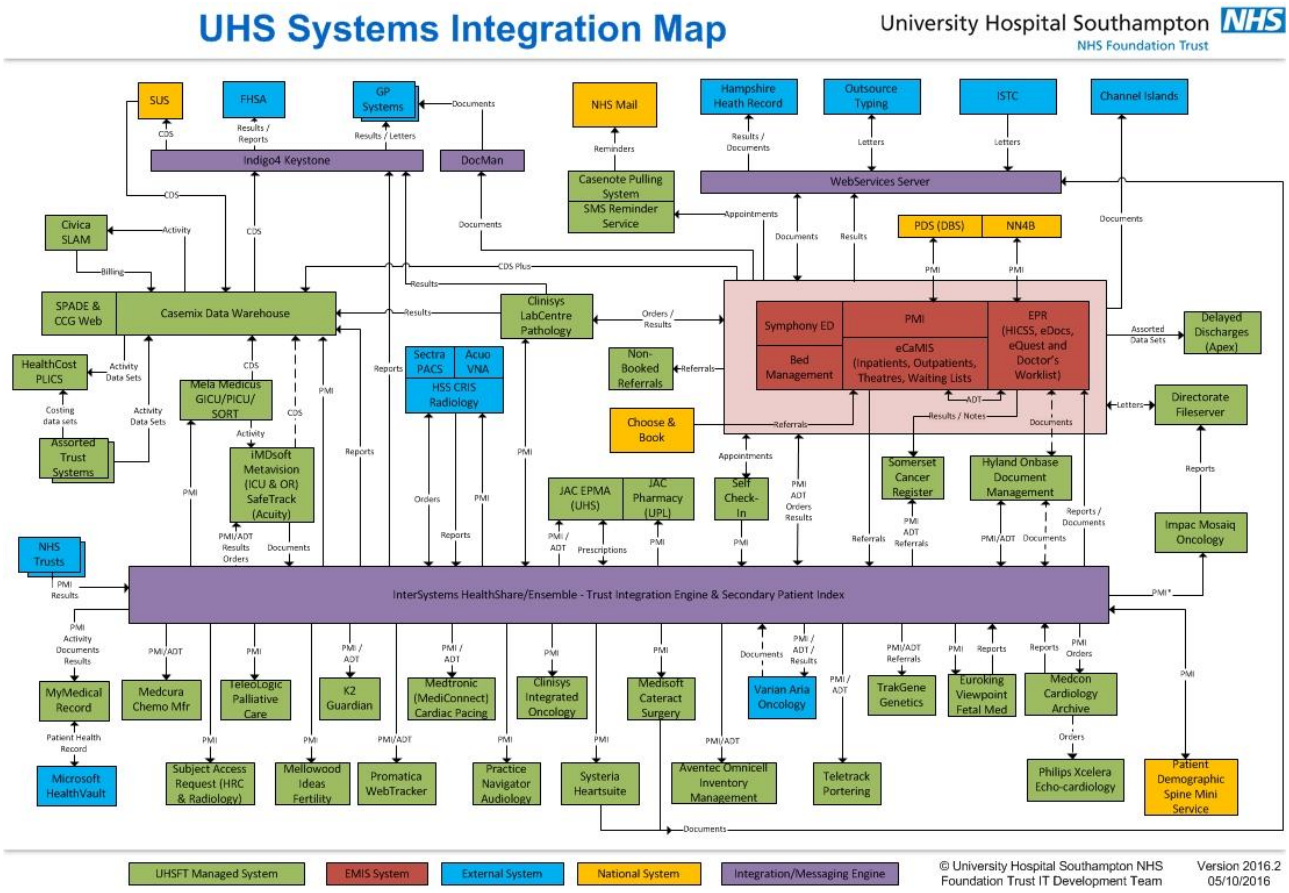

Figure 1 is a diagram which Ian Brewer created many years later to illustrate the complexity of the UHS Clinical Data Estate. The Integration Engine, highlighted in purple, is central to this system.

Alan Hales comments on the strategy pursued by SUHT/UHS with the TIE:

"Most Trusts employ TIEs, but Ian was well ahead of the game and probably instrumental in UHS now having a TIE that is more extensive and far reaching than most other Trusts. The pros of using a TIE are significant in providing a universal "message broker" between disparate systems using libraries for common protocols (e.g. HL7v2, HL7v3, FHIR, DICOM etc) that don't need to be maintained in-house. It doesn't come cheaply, but neither would doing the same thing in-house so cost is probably neither or a pro or con.

The cons of the TIE approach need to be understood by those developing future strategies. These include the use of uncommon tools from the TIE product suppliers, with proprietary technologies and the rather esoteric InterSystems Caché database environment. This requires significant re-training of core computing personnel.

Ian is well placed to advise on this aspect of the project because he will have written numerous business cases for the TIE over the years, with the switch from E-Gate to Ensemble and the clustering (duplicate processors) of the hardware.

Ian Brewer continues:

"In 1996 we also initiated a project to replace the Ferranti Argus based Pathology system. Adrian Byrne and Mike Ives join the trust as the Pathology Project Manager and as the IT Operations manager respectively.

In 1997 I formed the IT Development team from a combination of IT and Information specialists. The primary aim was to demonstrate to the Trust (and to the Dept of Finance in particular) how much effort was needed to do an in-house development of Casemix, and contract monitoring in particular.

Also in 1997, Nigel Armstrong left and was not replaced. Mike Ives ran IT Ops, Adrian Byrne ran the Pathology system replacement for the Ferranti system and Masterlab (latterly renamed to LabCentre) was implemented. Mike Lawrence ran Networking.

Liz Horkin made me the unofficial "Professional head of IT" when she needed a figurehead of IT to be rolled out. "Corporate Information Services" had grown significantly by 1997. My personal circumstances had also changed and the long commute from the IOW had turned into a local commute when I moved to the mainland and 10 miles down the M27!

I was asked to establish a small development team to focus on developing solutions in-house for IT problems the Trust was facing. That function grew slowly, alongside the operational IT infrastructure team who looked after the core hardware, software and networking under the leadership of Mike Ives.

We started the integration of more of the Trust's systems, along with early iterations of our business intelligence capabilities, based around the Casemix system that I had run.

In 1998, Liz reinstated the IT Manager role, to which Adrian Byrne was appointed. Work began in earnest on assessing the potential impact of the infamous Y2k bug, whereby there were widespread legacy date coding would crash many software systems at midnight on 00/00/(20)00.

Our deep dive into the resilience of the Trust systems revealed some 270 "small" systems (many of which were running whole clinical services), whose "owners" had not wanted central functions such as IT to have involvement in them.

As soon as Y2k became an issue, they were rushing forward to raise their corporate importance. It became evident that we would not be able to support the necessary development and/or replacement of every system. We therefore developed a plan to create a solution in-house. This was to build around an integrated Patient Master Index (part of the UniCare PAS implemented in 1996) and with access to pathology results via the integration with the new Masterlab solution.

HICSS was born in 1999. I recall that the original modules were developed by Alan Hales to support renal failure and Vascular Surgery.

In the end, the Y2K bug amounted to very little in the Trust, although it leaves me with a memory of seeing in the new Millennium standing on the back stairs of the Old Nurses Home with my late wife, watching the distant fireworks in Mayflower park while waiting for the panic phone calls from all over the hospital. They never came! A planning job well done, or possibly just a stroke of luck!

Mike Ives and I continued to work closely together until his retirement in 2019, at which point his Infrastructure department and my development department were brought together to form a single IT department, and my current role came into being.

My role continued to evolve, and I suppose that is a large part of why that temporary role I took back in 1991 became a three decade career. I've had a few comments from new starters who have joined since the start of the Covid pandemic, having come from the private sector (typically furloughed staff) about how they realised that they might have been

working for big corporations on decent salaries, but had come to question whether their job was really giving them satisfaction and a sense of giving something back?

We might not be the front-line staff who so rightly get the praise in the media for battling through often horrendous situations to do their very best for patients, but there is something deeply satisfying in being one of the "back-room-boys" who quietly keeps our systems running, and develops and delivers new solutions that hopefully make those front-line staff's working lives just a little bit easier. And so here I am, 32 years later with a rebadged title of Associate Director of IT and recognition of the role of Chief Technology Officer for the organisation.

In summary, we have so far shown how forward planning and effective leadership from the early 1990s in Southampton created the context for meaningful progress towards an effective local form of the hospital EPR during the 2000s.

We have also survived the grand attempts at designing a national computerised health environment which under-achieved through the same decade, as embodied in the experience of the UK NPfIT programme."

Recollections from David Cable (Interviewed on 5th Jan 2024)

David Cable is another long serving member of the IT team at SUHT/UHS. As a senior manager in the service, he has played a major enabling role in many of the of the original projects and systems described in this book.

David recalls that he graduated in 1992 with a degree in Geography and English, with which he went to work for the London Ambulance Service (LAS) as an Information Department Assistant with responsibilities for data input on ambulance response times. This was the era of punch card data entry into mainframe computers, and desktop computers with 286/386 processors.

An automated despatch process for ambulances was implemented on 26th October 1992, and within a week it had locked up completely, forcing a reversion to manual systems. A

detailed account of this episode, its history and aftermath was recorded by Darren Dalcher of the Forensic Systems Research Group at South Bank University in a paper titled Disaster in London: The LAS Case Study, published in April 1999 (Dalcher D 1999)

David left the LAS in March 1994 for a role at SUHT, with the PRINCE (PRojects IN Controlled Environments) programme. PRINCE was derived from an earlier project management methodology, PROMPT (Project Resource Organisation Management Planning Techniques).

In 1989 the UK Government's Central Computer and Telecommunications Agency (CCTA) had adopted a version of PROMPT as a national standard for information systems (IT) project management, including hardware, security and professional development and knowledge of IT systems among central government staff. The CCTA was subsumed into the Office of Government Commerce in 2000, but PRINCE2 survives as a structured project management and certification system in various national and international programmes.

The specific requirement in Southampton was for an information officer to use a project management system to implement the PAS, Maternity and Radiology IT systems.
Between 1994 and 1996, a PAS was purchased from IBA Health Ltd, An Australian Company, and a Radiology system was purchased from DETENTE Systems Pty Ltd, also an Australian company, which was taken over in 2004 by the Quadramed Corporation. It was not possible to source a suitable Maternity system at that time.

David's role evolved into the Radiology Project Manager, but he notes that the experience with these acquisitions and the frustrated attempts to source a single supplier for the IT programme. This started the thought processes around building integrated systems in house.

Through 1999 and 2000, David had a further role in delivering classroom based IT training a largely IT-naive workforce at SUHT, passing on generic skills such as the use of a computer mouse, and the correct way to label specimen tubes to minimise data input errors. He reflects that the challenge of the optimum delivery and measurement of IT skills training

and uptake has never been satisfactorily resolved, whether through printed manuals, on line interactive teaching, video presentations or all day induction courses for new staff.

Essay Summary

The contributors to this Essay have generously reconstructed from personal memories an oral history of the first decade in the evolution of the UHS clinical data estate, with all of its complexities and challenges, for which contemporary documentation is scarce.

This was a period of technological evolution when computing systems were rapidly evolving globally, and when the correct assumptions and investments would set the conditions for future major developments in healthcare computing.

In the next Essay (1:3), I explore the development of the Southampton Clinical Data Estate over the decade of the Noughties, 2000 to 2009;

- Through which the Internet became a global means of instantaneous communication and information distribution;
- Through which the concept of the Electronic Patient Record matured;
- And through which key systems were introduced and inter-connected at UHS.

Essay 2 References

Collins T and Bicknell D. Crash – Learning-Worlds-Computer-Disasters
Simon & Schuster Ltd; New edition (1 Jun. 1998)
https://www.amazon.co.uk/CRASH-Learning-Worlds-Computer-Disasters/dp/0684816873

Dalcher, Darren: Disaster in London: The LAS Case Study, April 1999: in the Proceedings of the IEEE Conference and Workshop on Engineering of Computer-Based Systems (ECBS '99). DOI:10.1109/ECBS.1999.755860
(www.researchgate.net/publication/3792694_Disaster_in_London_The_LAS_case_study)

Denham J MP. Wessex RHA (Computer Project) debate of Monday 15 March 1993 Hansard Volume 221: UK Parliament Records

Hodge, Melville H.: History of the TDS Medical Information System of TDS Health Care Systems Corporation, Santa Clara pp 328-344 (June 1990)
In Blum BI and Duncan K. A history of medical informatics. Association for Computing Machinery, New York ISBN: 978-0-201-50128-5 DOI: https://doi.org/10.1145/89482

House of Commons: The Sixty-third Report of the Committee of Public Accounts on the Wessex Regional Health Authority Regional Information Systems Plan, Paper No HC 658, c/o Public Information Office, House of Commons Sessional Information Digest in 1992-1993,

Rew DA, Hales AA, Cable D, et al. New life for old cellular pathology: a transformational approach to the upcycling of historic e-pathology records for contemporary clinical uses Journal of Clinical Pathology 2022;75: 250-254.

Rusnak JE. Case Mix Management Systems: An Opportunity to Integrate Medical Records and Financial Management System Data Bases. Proc Annu Symp Comput Appl Med Care. 1987 Nov 4: 698–702. PMCID: PMC2245163.

Sittig, Dean & Stead, William W. (1994). Computer-based Physician Order Entry: The State of the Art. Journal of the American Medical Informatics Association: JAMIA. 1. 108-23. 10.1136/jamia.1994.95236142.

Wilson, M. (2003). Rhetoric of Enrollment and Acts of Resistance: Information Technology as Text. In: Wynn, E.H., Whitley, E.A., Myers, M.D., DeGross, J.I. (eds) Global and Organizational Discourse about Information Technology. IFIP — The International Federation for Information Processing, vol 110. Springer, Boston, MA. https://doi.org/10.1007/978-0-387-35634-1_12