Principia Medicinae Digitalis Sotoniensis

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

Section 1 Essay 7

A brief history of APEX and UHS Apps, 2011-2024

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Edited by David Rew 10th 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 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.

Section 1.

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

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Dave Waghorn Introduces Himself

I studied for my maths degree at the University of Southampton, where I developed an interest in logic, algorithms, programming, mathematical modelling and simulation. This led me to seeking a career in software development on graduation, but my career was to take a slightly different path. I worked with a temp agency for a couple of years. My first permanent job was with Southern Water, where my role involved the management of safety certificates for equipment at all the water supply and treatment works and pumping stations. I ended up developing some software to run the team's antiquated flatbed scanner and effectively automated most of my job.

18 months later, I secured my first graduate job, working in the NHS for the Hampshire & Isle of Wight Workforce Development Confederation. My primary role was as a workforce planning analyst and again I found myself developing software to automate many of the processes and manage our data. I moved on to the national Workforce Review Team (WRT) as a data modeller, where I took on more software development projects and made my first foray into web application development. The WRT was eventually privatised, and I sought a role back within the NHS, which is how I joined University Hospital Southampton as an information technologist - and again ended up being a software developer!

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Preface

This is the seventh of a series of essays which are intended to capture the history and context of the unique Clinical Digital Estate of University Hospital Southampton (UHS) from its origins in the 1980s to the current day.

In this essay, Dave Waghorn describes his wide experience of developing a very large suite of applications for UHS using the Oracle APEX system, and more generally in working over three decades in a complex and austerely resourced public sector programming environment. APEX will not be familiar to most users of UHS clinical data systems.

The essay is written in the first person in his own words, subject to some minor editing for which I take responsibility. Dave brings great value to this history of "UHS Digital" for the insights into some of the challenges of such work in the raw. He also highlights the pride that follows from the continuous and incremental development of software systems and components for which there is no prior road map and where the environment and demands are constantly changing. This can be no better illustrated than in his account of the disruption that ensued on the arrival of Covid-19 in early 2020, and of the dedication and flexibility that saw the rapid role out of a wholly new set of applications to mitigate the local impact of the disease.

When complete, this project and collection of essays is intended to form a coherent reference history which will explain how the UHS Digital System came about, how it evolved, and how its addresses many challenges of clinical informatics through its component design and integration.

I have drawn on the recollections of those who built the system wherever possible, as a reference volume for future system developers and managers at UHS and for a wider audience of digitally enabled health and computer professionals. I am grateful to the University of Southampton for the facility to use the powerful ePrint Server as a vehicle for incremental publication of the interim chapters as they are completed.

David Rew: Series Author and Editor

Dave Waghorn's Account of his work with UHS Apps

An Introduction to UHS Apps

UHS Apps is an internal brand name for a portfolio of products that form part of the Electronic Patient Record (EPR) at University Hospital Southampton (UHS), and that have been built primarily using the software development product Oracle APEX.

I'll start with some background, context and definitions and then get into more of a chronological timeline. I'm not going to cover the story behind *every* APEX App but I will try to focus on those that move the narrative along or are of particular interest.

An introduction to the Oracle APEX Development Platform

Oracle APEX is an enterprise level Low-Code Development Platform (LCDP) from Oracle Corporation of Austin, Texas. LCDPs provide a development environment which is used to create application software. This is generally done through a Graphical User Interface (GUI). An LCDP may be used to produce operational applications, or additional coding for specific situations. LCDPs reduce the time spent in coding, to accelerate the development of business applications. In consequence, a wider range of people can contribute coding and governance skills to the development of an application. They also lower the initial cost of setup, training, deployment, and maintenance.

LCDPs trace their roots back to fourth-generation programming languages and to the rapid software application development tools of the 1990s and early 2000s. They are based on the principles of model-driven architecture, automatic code generation, and visual programming. They therefore advance the concept of end-user development The term "LCDP" was first applied in June, 2014 (see Wikipedia).

It is important to distinguish between APEX itself, which is Oracle's software development product, and UHS Apps, the products which we build using APEX.

APEX can be used for developing and deploying cloud, mobile and desktop applications. The platform is a web-based integrated development environment (IDE) with a range of features which include wizards, drag-and-drop layout and property editors to simplify the process of

building applications and pages. Orale APEX was previously branded as "Oracle Application Express" and, before that, "HTML DB", "Project Marvel", "Oracle Platform" and "Flows". I shall refer to it as APEX.

Under its original name of "Flows", APEX was created by Oracle developers Mike Hichwa and Joel Kallman. It was initially intended as a tool for creating a web calendar for internal use within Oracle in the year 2000. The product grew from there and was used to develop several internal applications within Oracle Corporation, before being released as HTML DataBase (DB) version 1.5 in 2004. HTML DB was released as an optional, no-cost component of the innovatively named Oracle Database.

A licence to use Oracle Database permitted the use of HTML DB for no extra cost. The name was changed with version 2.1 in January 2006 to Oracle Application Express, which was immediately shortened informally to APEX. In May 2022, with version 22.1, Oracle APEX became the product's official name. The full release history of APEX can be found at: https://apex.oracle.com/pls/apex/r/apex_pm/apex-community/history

Conventional web application architecture would involve three types of server - albeit sometimes hosted on the same physical machine: database servers, application servers, and web servers. These usually correspond to three "layers" in the software itself: data, logic, and presentation. The purpose of the database server would be purely to store data. The application servers send and receive data to and from the database and contain the logic - usually written in a traditional code-heavy programming language - to process that data and send it to the web server.

The web server stores some presentation information, such as images, style sheets, and client-side code, and uses all this to send a complete web page to the end user's machine. The end user interacts with that web page and as a result sends data, via the web server, to the application server - where that data is processed, and anything that needs to be stored in the database is then sent to the database server.

APEX has several characteristics that make it very different from traditional web application architecture. Instead of a separate programming language on a separate application server, APEX uses Oracle's own programming language - PL/SQL - and all of the application logic is stored in the database and runs on the database server. Similarly, all of the theme and client-side information that would traditionally be stored on a web server is also stored in the database.

APEX still utilises web servers to interface with end user's web browsers, but they have no "moving parts" - all of the definitions, files and processing live inside the database itself. This minimises the requirements for web servers and eliminates the need for application servers altogether. Because the application logic runs much closer to the data source, without the need for any network traffic between database and application, the result is generally a faster and more efficient product. The penalty is that an APEX application uses slightly more database processing power than a traditional web application.

Perhaps most importantly though, APEX has been developed to be an "LCDP". Bespoke PL/SQL code can be added for complex application logic, but most straightforward activities, such as designing the structure of a page, defining data entry forms, reports, calendars and other standard controls, can be done with little or no coding at all. Therefore, individuals with little technical knowledge can create a basic APEX application very quickly; "basic" here meaning:

- a fully secure, complete product with a modern, responsive user interface;
- containing detailed reports which the end user can sort and filter;
- with forms that send and receive data to and from the database;
- and that contain all the standard form controls with which users would be familiar, including text entry, date-pickers, drop-down boxes, checkboxes, radio buttons, and so on.

The global use of APEX grew quickly and a community of APEX developers grew around it. It is now the world's most popular LCDP. There are numerous case studies about it at https://apex.oracle.com/en/solutions/success-stories/. For example, every point-of-sale system for Lloyds Pharmacies within Sainsbury's Supermarkets are built on APEX, as is the entire EPR system at York and Scarborough Teaching Hospitals NHSFT.

In 2022, Oracle purchased Cerner, one of the largest Electronic Patient Record (EPR) systems in global use, and announced plans to replace the system, feature by feature, using APEX. (see: https://www.rittmanmead.com/blog/2024/02/transforming-cerner-with-oracle-apex/).

The Local History of Oracle APEX Applications at UHS

Most core EPR systems at UHS use an Oracle database, including the (e)CaMIS Patient Administration System (PAS); the CHARTS EPR wrapper; and the Symphony Emergency Department system. UHS pays for the Oracle Database licences and receives APEX at no additional cost.

2010-2011: Introduction of the Information Technology role at UHS

In 2010, Southampton University Hospitals Trust (SUHT, now UHS FT) decided to create a new job role: the information technologist. Two appointments were made. Rob Stockbridge covered Clinical Divisions A and C, and I covered Clinical Divisions B and D. We worked from the IM&T offices. We came with a wealth of NHS and technology experience; Rob had just finished working on the roll-out of a new EPR across a mental health and community trust, while I came from a national workforce team where I had worked as a data modeller and software developer, and I had also managed a team of information analysts.

Several challenges immediately became clear to us. The UHS IT systems at the time only covered core functions. This left a large technological deficit across the organisation, given the specialist nature of many departments, where generic, homogenised solutions would not fit the clinical workflows. However, funding was tight, so we could write business cases to procure new systems for which we could not then obtain funding.

Moreover, given the specialist requirements for most departments in a complex tertiary hospital environment, "off the shelf" solutions often did not exist. We would need to develop new solutions from scratch. There was also a lack of capacity and agility in both the in-house development teams and in the Trust's technology partners. This meant that any new developments and even those of the highest priority - could not be turned around quickly.

Many clinical units were therefore seeking their own technical solutions, and often in the form of unsupported and potentially insecure Microsoft Access databases, Microsoft Excel spreadsheets, FileMaker Pro databases, and on scraps of paper. They were also commissioning various pieces of work from external developers or companies without IM&T's knowledge or approval.

UHS therefore faced an urgent problem with increasingly fragmented and insecure patient records, a plethora of relatively niche but vital technological needs, and a lack of funding and capacity to fill any of those needs. We were caught between a rock and a hard place: clinical divisions were desperate for technological solutions. The IM&T department could not respond and struggled to reign in the "free for all" technology market that seemed to be taking hold. We needed something that would allow us to quickly develop and roll out multiple bespoke solutions for bespoke needs, while keeping the data securely within our Oracle EPR databases, and at no additional cost.

2011-2012: The birth of the EPR database for Clinical Research (CRES)

The clinical divisions and care groups were beginning to appreciate their new IM&T contacts, but there was no designated technologist for Trust HQ. Rob and I worked together to fill some of those gaps, particularly with Human Resources, Training & Development, and with Research & Development. The R&D team in particular saw the benefits of such a role and went about sourcing funding for their own joint appointment. Lynne Mills joined the team, with a focus on supporting R and D. This meant querying data from the clinical systems beyond the creation of one-off point-in-time data extracts. Lynne needed to develop reporting tools that would allow her colleagues to query the data whenever they needed.

Lynne engaged with Tak Tang, who managed the Trust's team of Database Administrators (DBAs). DBAs manage the day-to-day running and maintenance of the Oracle databases. Tak had been reading about Oracle Application Express and in particular about its Interactive Report feature. This allowed a developer to write an SQL query so that end users could manipulate the results with functions such as sorting, filtering, adding conditional formatting and custom calculations, and so on. This was exactly what Lynne needed.

Lynne also occasionally needed to collect additional data, and in particular, for a clinical study relating to irritable bowel disease. APEX allowed her to create a web application to do that. Tak set up a new schema in the clinical EPR database for **C**linical **Res**earch - CRES, and installed APEX on it, as the basis for Lynne's further work.

In conversations in the office, at team meetings, and at regular line management one-to-ones with David Cable, our reporting officer, we matched the technologists' need for a rapid application development tool to Lynne's awareness of APEX. I was granted access to CRES within APEX to further test its utility at negligible cost, thus maximising the benefits of our existing systems. Rob and I therefore realised the wider potential of APEX in UHS in the development of the following systems.

Trauma Pre-Admissions

Around this time, we were working on projects around patient flow into the hospital. Rob was working with the Child Health team, looking at referrals and patient tracking for several of the paediatric specialties. I was working with the Trauma and Orthopaedics (T&O) team, who wanted to digitise their surgical admissions TCI ("To Come In") cards and pre-assessment processes.

During June and July 2011, I worked with the admissions lead in T&O, initially to develop a Microsoft Access database to meet their needs. I later created a web-app equivalent of that database in APEX. I also met with colleagues in the EPR team to discuss the standards and requirements for a clinical software system with wider applications. I was pointed to portfolio of national standards which included the NHS Common User Interface and I therefore ensured that APEX was compliant with those standards from the outset. This already set APEX apart from other clinical systems in the Trust.

We also discussed the release processes and ongoing support for APEX applications as part of the UHS EPR. I agreed to demonstrate new products to the other team members and they would support them alongside the other clinical systems. I completed a standards-compliant prototype pre-admissions system for Trauma, and sent the link to the prototype

in the test environment to the T&O team on 19th January 2012, and to the EPR support team on 2nd February. The EPR team tested the system and provided useful feedback.

The Trust formed a new Patient Services Centre In March 2012 and the T&O admissions prototype did not proceed any further. Nevertheless the power of APEX as a rapid EPR development tool had become apparent, and the precedent was established that APEX Apps would be tested and supported by the EPR team as full components of the EPR portfolio. We aim to keep archive copies of all of our software applications, but the original trauma pre-admissions App has sadly been lost to the mists of time.

The Stroke Application

The Stroke team contacted IM&T in November 2011 about the new national Sentinel Stroke National Audit Programme (SSNAP) dataset which Trusts were required to submit from April 2012 onwards. At that time the Stroke team used a Hospital Integrated Clinical Support System (HICSS) module, but this did not collect or report on all the data items that were needed for SSNAP.

It soon became clear that an in-house APEX build was the front-runner for a successor system. This was a major challenge, because the SSNAP dataset contains hundreds of data items, most of which needed to be recorded at the bedside. The national team also made several changes to the dataset during that time.

A prototype APEX application for capturing the SSNAP data and producing the required data for upload to the national system was created by May 2012 and further developed, in response to changing datasets and user feedback, until the end of August 2012.

However, around that time, the national SSNAP team announced that they would be providing their own web application for capturing the data, so eventually the decision was made to utilise that instead of the APEX product.

Formal Acceptance of the APEX system by the Trust

Neither of the T&O or SSNAP applications made it to production, but the potential of APEX was now very clear. The user feedback from both prototypes had been very positive. Lynne and I were quickly learning how to develop high quality clinical applications that would meet the burgeoning needs of the Trust, with fully integration and support as part of the EPR. The opportunity was therefore taken to the IM&T Development Group, which reported into the Information Strategy Steering Group (ISSG). This in turn was attended by the Trust Executive who was responsible for IM&T, and who fed into the Trust Executive Committee and ultimately the Trust Board.

On 27th January 2012, I reported my work with Lynne on APEX to the Development Group. We discussed the Trust's need for a rapid development tool. Other attendees were receptive, comparing it to other software in the Trust at the time and describing it as "a lot more functional". It was described as "an alternative to eDocs" - and questions were asked about how APEX should be resourced to take it forward. I agreed to build a demonstration application for the next meeting on 24th February 2012. At that meeting, we discussed the full adoption of APEX and matters relating to standards, patient safety, information governance, security and so on. The trauma pre-admissions project was given the go-ahead.

By the meeting of 20th April 2012 there were a couple of APEX applications already running and the question of resourcing for support was again raised at the Development Group. The response was that the system would be "supported strategically". This phrase has caused some confusion over the years, but it is generally understood to mean that APEX was now officially a part of the UHS EPR strategy . At the 24th May 2012 meeting of the ISSG, a process was agreed regarding APEX support and infrastructure.

The APEX Paediatric Irritable Bowel Disease Application

Our records show that the first clinical App to go live that involved data entry was for paediatric IBD. This was developed by Lynne to support a research study, but it remained in use after the study was complete. It was released to the production servers on 29th May 2012 and, as of mid 2024, it is still in use.

The APEX Rheumatology Biologics Application

“Biologics” are powerful and expensive immunology based medications used to treat a variety of disorders. They are effective at treating their target diseases, but they can have unpleasant and distressing side-effects. UHS was therefore funded to set up a specialist clinic for rheumatology patients, specifically to review the patients' use of biologics and, if possible, to reduce dosage and frequency while still effectively treating the disease.

As with the Stroke team, the Rheumatology team was already using a HICSS module, but the Biologics clinic required more detailed data collection and reporting. The clinical team put together an interim paper proforma, which could not be incorporated into HICSS in time for the new clinic to begin. David Cable therefore suggested that we explore creating an APEX application for them.

I created the Rheumatology Biologics application and presented it to Chris Holroyd, the lead consultant for the clinic; to Kim Perry, the assistant director of Finance; and to Caron Underhill, the lead pharmacist, and after some minor modifications the system was ready to go. It launched on 31st May 2012, just two days after the Paediatric IBD system. It was the first APEX application to be used directly in outpatient clinics in the presence of the patient

This system has been modified and expanded over the years. An innovation that the clinical team find particularly useful and of their own design is a visual representation of a timeline of the medications and of their disease activity scores. This timeline is used to support a conversation about how the medications are affecting their disease, in terms of side-effects and alternative treatment options. An example is shown in Figure 1.

The wealth of information collected by the system has helped the clinical team to support several different research studies, including some research of their own. Chris was kind enough to name me as a co-author of a paper published in the American College of Rheumatology in October 2013: "A Strategy For Selecting Individuals With RA For Reduction Of Anti-TNF Therapy Using Combined Clinical And Ultrasound Assessment."

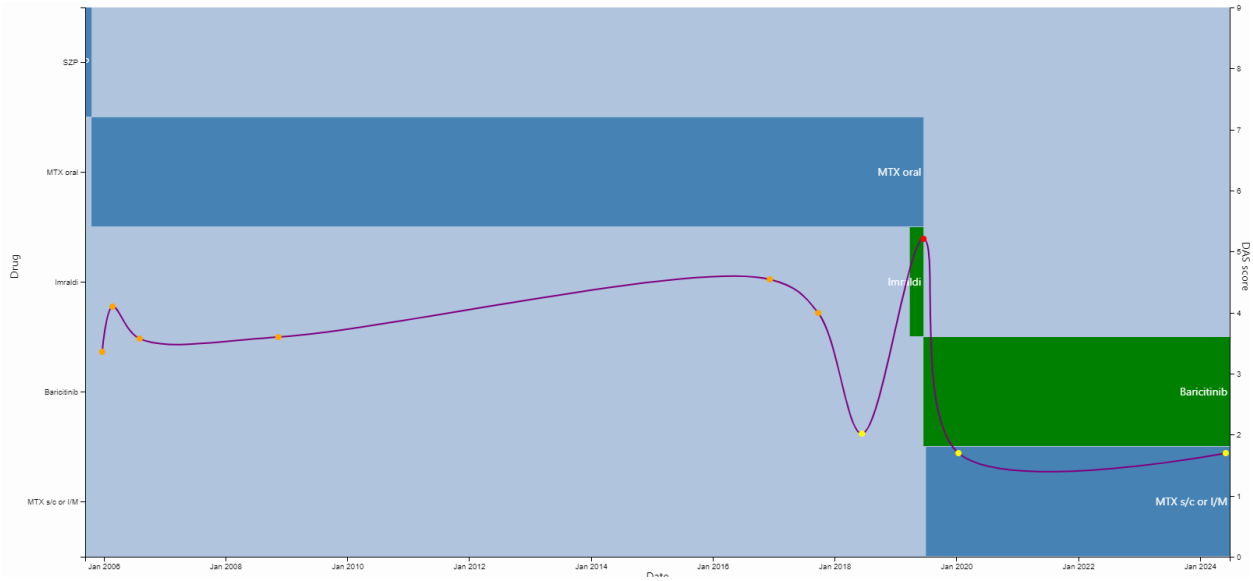


Figure 1:7:1 An example of a timeline structured disease activity chart from the APEX Rheumatology Biologics application. Disease activity (purple line) over time is plotted against medication. This patient's arthritis worsened under the drug Imraldi but improved on Baricitinib.

Some years later, another new clinic, the Early Arthritis Clinic, needed to collect similar data to the Biologics App. In some cases patients would need to transfer from the EAC clinic to the Biologics clinic, ideally with all of their data. The EAC requirements were therefore built into the Biologics application.

The APEX Ward Forms App: The Dawn of Inpatient Noting.

An exemplar which related to the better management of information flows around patient discharges and “bed blocking”. One of our first tasks as Information Technologists was to address what were then called “Delayed Transfers of Care” (DToC) and the wider challenges of complex discharges. The NHS website tells us that a complex discharge - as opposed to a minimal discharge (never a "simple" discharge!) is one where the patient needs anything other than "little or no care" after they have left hospital:

www.nhs.uk/nhs-services/hospitals/going-into-hospital/being-discharged-from-hospital/.

Patients who are ready to leave hospital from a clinical perspective but who cannot be discharged safely because their post-discharge care is not yet in place are sometimes, unfairly, labelled in public as "bed blockers". They are a major impediment to the smooth operation of any acute hospital; if patients cannot be discharged, they occupy beds that new patients cannot occupy. Discharge delays therefore have a direct relationship with admission delays and upon emergency department waiting times. Hospital finances also suffer from the reduced chargeable activity. There are also risks to patients from staying in hospital, including hospital acquired infections and the mental health toll on them and their families.

Some of the saddest cases of which I was aware concerned patients who were nearing the end of their lives, whose only, simple wish was to die peacefully at home and not on a hospital ward. Such patients would nearly always still need some care provision in their final days, and so they would be waiting for that care provision along with all of the other complex discharge patients. Far too often, they died in hospital.

Discharge delays affect all care groups. Back in 2011 the Integrated Discharge Bureau, ICB, was managed as part of one care group, Medicine for Older People within Division B. The ICB was the collection of teams from UHS and community organisations who were tasked with sourcing appropriate care for patients who were approaching discharge. It therefore fell to me as the relevant information technologist to solve the problem.

The workflow around complex discharge was - and still is - mainly set at a national level. At that time, the rule was that acute hospitals would assess whether a patient would need post-discharge care as soon as possible after admission, and send a "section 2" form to the patient's local social services team. This team should immediately begin to assess the patient’s future needs with the ward and clinical teams and hence to source appropriate post-discharge care.

When the patient was medically fit for discharge, the hospital would follow that up with a "section 5" form to indicate the care provision should be activated to enable the discharge to take place. The section 5 had to be signed by a doctor. These forms were completed on

paper on the wards, and faxed to the discharge bureau. Not all wards had fax machines, in which case they would complete the form and a nurse would walk to a neighbouring ward in order to fax the paperwork. At the receiving end, the single receiving fax machine would frequently run out of paper or ink, leading to missed referrals.

Worse still, the referrals that were sent and received were often illegible or incomplete, so the team would need to contact the ward to amend or resubmit the forms. A data entry clerk would type up the contents of the forms into the only IT system in use. This was a fairly simple database that had been built in-house by the fledgling IT development team, but then the paper documents would be physically passed to the social services teams in the bureau.

Every day, the team manager would print out the full list of all the patients still in the hospital and manually count how many of them were delayed. Although in theory any patient with a Section 5 form was delayed, a local agreement was in place whereby patients would only "count" after three working days - and if a form was submitted after 2pm, it would be treated as if it was submitted the next working day. Other trusts had their own versions of those local agreements - meaning the collated numbers that were sent to the Department of Health and subsequently published were next to useless for comparing one hospital to another.

The section 2 and section 5 forms mainly contained information which we already knew and that was stored in our systems. The patient's name, address, date of birth and other demographics; the date and reason for admission, and so on. Nurses would write out the information, fax it to the bureau, and then someone would type up that same information - that was mostly already in our computer systems somewhere - into another computer system.

From the ward and clinical team's perspective, once they had submitted their section 2 and section 5 forms, they had no idea what was happening to their patient’s case unless they phoned the discharge bureau for an update. Between fighting the fax machine, duplicate data entry, counting the numbers and answering these phone calls, the discharge bureau - a

team of about four people - didn't have much time left for actually planning and arranging patients' discharges. Something had to change.
Our first attempt involved an unused "Smart Forms" feature of eCaMIS but after testing that option for a few weeks it became clear a different approach would be needed.

We then looked at eDocs, which was the then current UHS clinical document system. eDocs had been created as a document-creation application whose products were stored in the database as single BLOBs (yes, that's actually a technical term - it's short for Binary Large Object) or CLOBs (slightly less fun but more accurate in this case - *character* large objects) of markup. As such, extracting useful data from these documents was arduous and it consumed considerably more processing power than querying structured data. We tried to develop a way to pull data from section 2 and section 5 documents from eDocs into the discharge bureau's database, but could not find a workable solution.

We then turned to APEX. On 29th June 2012, two new Apps went live: Ward Forms was launched on Ward G6, and a system called Discharge Bureau was made available in the Bureau itself. A third App, "Ward Forms Signature", supported the others by providing a way for doctors to use their password to "sign" the Section 5 forms while another user was logged in.

Ward	Extension	Edd	Date Form Submitted	Consultant	Form Status	Form Status Date	Lives Alone	Accomodation Type	Consent Type	Admission Reason	Diagnosis	History	Assessments Reqd
G6	4670	19-Jun-2012	19-Jun-2012	MAN	ACKNOWLEDGED	20-Jun-2012	Y	Own home with support	No signature - verbal consent agreed	fall	AF	Dementia Patient has ? OD POC- will need increase.	Re-start care package

Figure: Part of a data extract from the very first digital Section 2 form to be completed for a real patient

Ward Forms contained sufficient validation to ensure forms were fully complete, but also pulled as much information as possible from other systems to prevent the need for nurses to re-enter that information. Both Apps were an instant success; ward staff loved how much quicker and easier it was to complete the forms online than it was to do on paper and tackle the fax machine; the discharge bureau loved that every form was fully legible and fully complete.

Our intention was to run the pilot just on ward G6 for a few months. However, while I and the discharge team were on the ward teaching the nurses how to use it, staff from neighbouring wards were coming along with their paper forms to fax them down to the Bureau. Seeing the system, they asked to be allowed access themselves, and after consulting with the care group manager their wish was promptly granted.

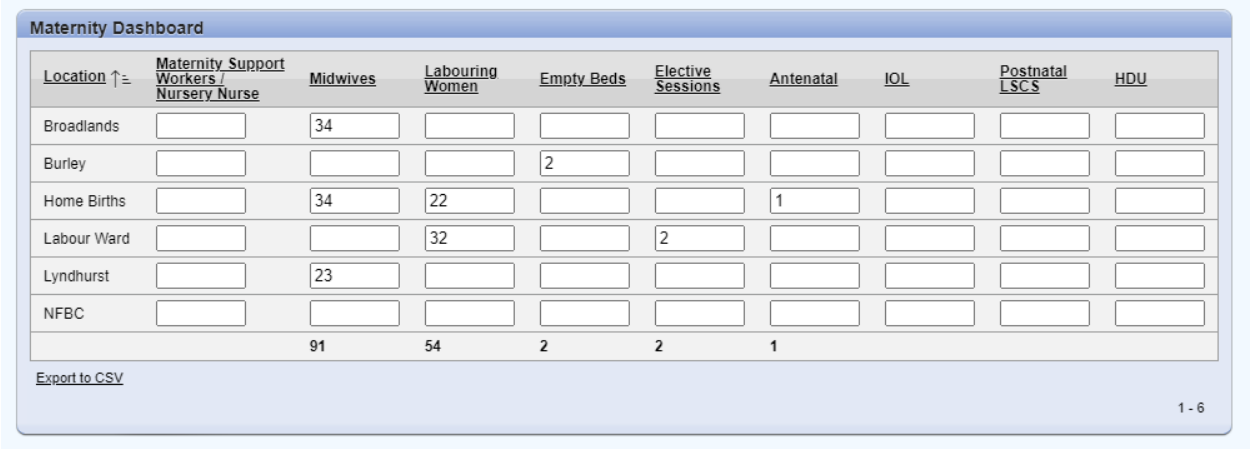
The system was live across the entire care group within a week and across the Trust within a couple of months. There were only two pieces of negative feedback: the cardiac bed managers had a different workflow to the rest of the Trust and needed some help in integrating the new system into it; and the neurology wards let it be known that they wanted to go first next time!

The ward system was named "Ward Forms" because the intention was always to try and handle all of the ward-based paperwork, not just the discharge forms. As a result the system was expanded to address safeguarding concerns, bariatric patient referrals and repatriation forms shortly afterwards, although the bariatric referrals App never went live.

The selection of discharge forms also expanded to include NHS Continuing Healthcare (CHC) assessments, Fast Track referrals for patients nearing the end of life, Healthcare Needs Assessments and others. The true success of the project was not fully realised until a year or so later, when the fax machine in the Discharge Bureau was switched off and removed.

Maternity and child health

We intended to use APEX to replace small bespoke databases and spreadsheets in relatively niche areas, but in practice it was used for much larger-scale projects. These included in-depth clinical applications which we were full of intricate calculations and fancy data visualisation, and trust-wide systems that impacted upon the entire hospital flow. However, concurrently, Rob's work with the Child Health and Women and Newborn care groups was bringing to light some smaller scale requirements which were much closer to the expected use of APEX. The first of these was a Staffing Dashboard for the maternity department, showing activity and staffing across the wards and departments.



Maternity Dashboard

Location	Maternity Support Workers / Nursery Nurse	Midwives	Labouring Women	Empty Beds	Elective Sessions	Antenatal	IOL	Postnatal LSCS	HDU
Broadlands		34							
Burley				2					
Home Births		34	22			1			
Labour Ward			32		2				
Lyndhurst		23							
NFBC									
		91	54	2	2	1			

Export to CSV

1 - 6

Figure: The Maternity Dashboard: test data on the live system

The Maternity Dashboard went live on 28th August 2012, and is still live today. It has never been fully used in practice, and it has never been updated since that initial release, but nor it has ever been decommissioned;. At this point it would almost be a shame to uninstall it!

Rob's work in Child Health established the requirements for several fairly small-scale Apps to keep track of patients. These included a monitoring system for epilepsy patients which recorded their diagnosis and any contacts with the patient or their family that the team have had. It was released on 15th October 2012. A surgical procedure log for Paediatric Neurosurgery followed on 6th December 2013.

2013: APEX becomes a first-choice solution

Hospital Chaplaincy Encounters

The digital strategy for UHS at around this time has been variously described as a "best of breed" or "integrator" approach: to source the best systems for each purpose, within affordability constraints, and to integrate them. In-house development was always a last resort, if no commercial offering was available that fitted the bill. This was very much the approach with the hospital chaplaincy team.

Whatever your religious or spiritual beliefs, hospitals have always tried to care for the "whole person". For patients who are nearing death and their families, spiritual matters often become a priority. Sometimes it's a case of a patient who wants to marry their loved one before they die, or parents of a dying child who wish to see them baptised. In each of

these cases, supplying that service can have a significant psychological impact both on the patient and their family - and the absence of such a service can cause distress. For patients without terminal conditions who are devoted to practising their religion outside of hospital, the chapel, prayer rooms and chaplaincy team enable to continue with that - again, making their hospital stay more comfortable and less stressful.

There are nevertheless detractors in society who insist that hospital chaplaincy services should not exist at all, and demand evidence of the work they are doing via Freedom of Information requests. Aside from that, just like any team in a money-stretched organisation, the chaplaincy team have to prove their worth and their cost-effectiveness. And to do that, they need data.

The chaplaincy team had been told to use the Ulysses Safeguard system to record their activity. Safeguard is the Trust's incident reporting system and the team found it didn't really meet their needs for reporting spiritual care activities. We searched in vain for a commercial system that would fill this niche, so the decision was made to proceed with an APEX development.

Chaplaincy Encounters was first released at the beginning of January 2013. It is the first application in the portfolio that was built specifically for a Trust HQ department instead of one of the clinical divisions. It also marked a turning point in the attitude to APEX within both the technologist team and IM&T more generally. Up until now, APEX had always been considered as a last resort, with lots of time spent exploring other potential options before defaulting back to APEX for a workable solution.

We reached the point where and if a user's set of requirements looked like an APEX application and sounded like an APEX application, it would likely be an APEX application. As a result, more direct time and effort could be spent on delivering APEX solutions that worked. 2013 was to become a busy year.

Headquarters and Emergency Department

With resources still limited, APEX was not publicised across the Trust. However, knowledge of it was spreading through the organisation by word of mouth, or as people moved around between departments. In those days, "Medicine and Emergency Care" was a single care group, covering what is now Medicine for Older People and Emergency Medicine. Vanessa Arnell-Cullen was the care group manager. Having seen the success of the discharge system, she was keen to see what could be done closer to the front door of the hospital.

Ambulance turnaround was a key metric for the Trust, as we did not want ambulances waiting outside the hospital to hand over their patients when they could be on the road, serving others. However those ambulance waiting times were perceived as becoming a serious problem and, at the time, there was no way of measuring them. There was a feeling among managers that turnaround times were being exaggerated and misreported.

The Ambulance Turnaround App was therefore released on 24th January 2013. It was a very simple App to log the arrival and departure time of ambulances to ensure more accurate data collection.

The following day, the Human Resources (HR) Caseload App was released. This App was designed to support the employee liaison team in managing disciplinary issues and staff grievances, and it was the first APEX App to not relate specifically to patient care.

On 4th March 2013, the Safeguarding Adults App went live. The Safeguarding Concern Form had already been built into Ward Forms, but the safeguarding team required a way of managing the safeguarding cases that resulted from those forms. Hence the production of this separate application for them. The Concern Form remained part of the complex discharge system for some years before it was migrated into the Safeguarding App itself.

13th June 2013 saw the definitive release of the Emergency Department Breach Reporting App. The aim of this tool was to support the management of the infamous four-hour wait target by documenting a specific reason for each breach, to enable some root cause analysis and remedial action planning to take place. The App fell out of use a couple of years later.

On 26th June 2013, the Site Escalation App went live. This app enabled ward clerks to log issues for the attention of the Site Operations Control Room staff, without having to telephone the control room with each matter and chase for details. As well as logging these escalations, the App enabled the control room staff to indicate whether or not the escalation was appropriate, and to respond to the ward clerks with an appropriate message. The app was project managed by Rachel Bailey in the Transformation team. Rachel later moved to the Complex Discharge team and she was instrumental in the further development and management of that system.

Case Management and Scheduling

By the second half of 2013, APEX was well established across the Trust. Several of the Apps released to date related to variants of case management, where a referral would come into a team and they would use an APEX App to manage their response to it, such as with the Adult Safeguarding and Chaplaincy systems. A number of smaller scale Apps for Child Health followed along a similar track. The Paediatric Neurology App was released in August 2013 to replace a paper based system, in response to the Safe and Sustainable Review. The App contained case load management and contact logging features. The Paediatric Referrals App, a tool for managing referrals coming into Child Health and related communications, followed in October 2013.

In August 2013, the first of a new type of APEX App was released. The Obstetrics Diary App replaced a paper diary for managing theatre bookings for inductions of labour, caesarean sections, and other obstetric procedures. This was the first of many calendar-based applications to go live. It was also notable because this was the first of the Apps to be used outside the UHS internal network. It was made available to users on the Solent and Southern networks to allow access to book procedures from the New Forest Birth Centre and from community midwife clinics.

The digitisation of paper forms, as demonstrated successfully with the complex discharge and safeguarding systems, continued with the introduction of the APEX-based Trauma Rehabilitation Prescriptions App on 5th September 2013. Originally only dealing with adults, the system was later expanded to cater for paediatric trauma patients. It produced the

clinical documentation necessary for the continued rehabilitation of regional trauma patients on transfer from Southampton to their local District General Hospitals.

Medical Devices Training

The Medical Devices Training System was launched on 2nd October 2013 after many alternative solutions had been explored. This system allowed staff across the Trust to quickly record training that they had received on medical devices, with supervisors able to check and verify the entries, and flexible reporting tools. It included facilities to upload data from the Employee Staff Record (ESR) to allocate employees to the relevant staff groups and cost centres within the organisational structure. It was also a powerful way of grouping sets of devices and linking the device groups to the relevant staff groups.

APEX Developments in 2014

New APEX Apps were being produced at a fairly steady rate, but it was also important to support and maintain those that were already live. 2014 began with modifications to the Complex Discharge system, including the release of a new App to support the use of Care Home Select. This was an external company which had been contracted to speed up the allocation of patients to care homes.

It was followed shortly afterwards by the Discharge Appointments App. This was an initiative which was led by the Transformation Team. It allowed ward staff to set a "discharge appointment" for when patients were expected to leave hospital.

Many software requirements are driven by the need to satisfy national data collections, which is often necessary to maintain clinical accreditation and licensing. The National Audit of Cardiac Rehabilitation, NACR, is one such collection, for which the Cardiac Rehab App was created and released on 1st April 2014.

Also in 2014, Lynne Mills moved on to a new role. Colin Newell joined the research and development team to take her place. Colin developed a clinical research App for Intestinal Failure, which is still titled "Colin's Intestinal Failure App". It was released on 14th May 2014. The year also started without an Information Technologist for divisions A and C, as Rob

Stockbridge had moved on to a new role. Justin Sanders joined the team in May 2014 as Rob's temporary replacement, before moving on to an operational manager post in the Trust at the end of the year. Once again, funding constraints prevented recruitment to the vacant post.

The Paediatric High Care Outliers App was released in June 2014. This App was designed to keep track of patients who would ideally be situated in a high care environment but, due to capacity constraints, were instead situated on lower acuity wards.

Radiology Whiteboards

One of the biggest APEX developments of 2014 was The Radiology Whiteboard System. This was designed to help manage the workload of the CT and MRI scanners. It replaced physical whiteboards in those units, but it also enabled the radiology managers to have central oversight of what was happening in each unit; to move patients between units to respond to changes in supply and demand, and to prioritise patients. It also allowed the CT and MRI units to update each patient's status, so that ward staff and clinicians could keep track of what was happening to their patients.

The Radiology Whiteboard System pulls requests from eQuest, which has since been renamed CHARTS Requesting) directly into the system, thus eliminating the need for requests to be printed and physically carried around the hospital to the various units. The Radiology Whiteboards App is also notable as it was the first APEX App to be actively publicised beyond the development/technologist team and the team which was directly using it. The Informatics managers happily shared news of it as a success story of the department for that year.

Four further Apps were released in 2014: the Thoracic SCTS (Society of Cardiothoracic Surgeons) App, which was designed to support performance data collection; the Ambulatory Care Diary, which was the second calendar-based system to go live; the ward breach reporting App, enabling AMU staff to log delays concerning downstream ward transfers; and the Respiratory Centre Diary. The latter quickly became the most actively used App in the portfolio, which it remained for several years.

Development of APEX in 2015-2016:

The Care Act, Restructure, Upgrades and Relocation

The Impact of the Care Act

The new Care Act of 2014 completely overhauled the complex discharge processes at a national level. It replaced the section 2 and section 5 forms with new "assessment notices", "discharge notices", equivalent withdrawal forms, and new workflows surrounding them. Under the leadership of Clare Handley, Dave Griffiths and Dan Baylis the Complex Discharge Apps were redesigned and rebuilt from scratch.

The redesign brought more of a focus on the discharge process, and ward users now stepped through "wizard-style" screens to move patients along the pathway. The new system introduced a messaging system which allowed users to flag messages that needed acknowledgement by four main teams: the Ward and Clinical teams, Therapy teams, the Discharge Bureau teams, and The Site Operations Office. A separate App was created for each of those groups, to provide different views of the information that was needed.

It soon became clear that some parts of the discharge process involved key decision points, and that after implementing the Care Act requirements from April 2015 onwards, there needed to be flexibility to modify processes . which were baked into the software. This led to multiple development requests and it became clear that we would need to create a way for senior end users to define and update the processes in the system to match working practices, complete with all the necessary decision points and collected data .

This work eventually led to a new, combined system with configuration tools that allowed system managers to define discharge pathways. These actions consisted of steps which could be defined to record information and automatically to trigger subsequent actions on completion. This resulted in a highly configurable pathway and task management system.

Staff Relocation

I still met with divisional and care group leads on a regular basis, but most of my day-to-day work now consisted of supporting and developing APEX Apps, including meetings with the users of those Apps to iron out requirements and to provide training and support. Office space was at a premium and the Informatics department was looking at alternative ways of accommodating its workforce.

The Trust hired offices at Unity 12, near the city centre, and started to work out which members of staff did not need to be on the hospital site to carry out their jobs. My technology post was one of these, and I was moved - along with some members of the information team and the genomics project team - to this satellite site. This further underpinned the evolution in my role from being the "face of Informatics" to a much more "behind the scenes" emphasis.

Upgrades to the core APEX Software

In April 2015, Oracle released Application Express 5. This included some important new features. In particular, APEX 5 introduced the Universal Theme. This was a far more modern user interface which fully utilises responsive design to ensure the same software can run on any device with any screen size, from small mobile phones through to large whiteboard-style screens. We were keen to incorporate these new features into our Apps. , UHS upgraded to APEX 5.0 and we started to apply the new theme to our Apps portfolio.

Restructuring of the Information Technology Roles

Throughout this period, the technologist post for divisions A and C remained unfilled. I was instructed to continue to focus on divisions B and D, with work for the other half of the hospital either being picked up by the Informatics managers or placed on the department's risk register. However, in practice, there were many clear cases where supporting the care groups in these divisions was necessary.

Towards the end of 2016, the department decided on a new strategy, but instead of recruiting a like-for-like replacement for Rob and Justin, a new "assistant technologist" or

"technical support analyst" role would be introduced. I was named a "senior technologist". I would lead a team that would cover the whole Trust.

From the outset, a big part of the role would be further APEX development, so the job description was quite wide ranging - including some of the people skills necessary for the original technologist role as well as the technical ability needed to be an APEX developer.

New APEX Apps during 2016

New Apps released during this time included Unplanned PICU Admissions, Paediatric Outreach, the Neck of Femur dashboard, and the Allergy Audit system, as well as significant updates to nearly all the existing Apps in the portfolio.

Development of APEX from 2017 to mid 2019: Building the Information Technology Team

By early 2017, APEX was well established as a vital part of Southampton's electronic patient record systems, with over 100 live Apps which touched every care group in the hospital. The EPR team were responsible for scoping the requirements, testing new builds, and supporting the live applications. However, I was based at Unity 12 and the EPR team were based at Southampton General Hospital, which impeded face to face discussions.

There were also significant constraints on workforce capacity, such that APEX was increasingly excluded from EPR processes and from Training. The result was that many members of the EPR team had little to no knowledge of the product set. To some extent, there was a systemic failure to recognise that APEX was part of the EPR team's remit, even though I was still part of the EPR team at that point.

Funding from the NHS Global Digital Exemplar programme

The success of APEX Apps had nevertheless caught the attention of other NHS organisations who were keen to either learn from the experience, or to explore whether it would be possible to buy and install the Apps which UHS had developed for their own hospitals. More generally, the Wachter review of 2016 led to the NHS Global Digital Exemplar programme, which encouraged Trusts such as UHS to invest in digital solutions for other Trusts to follow.

UHS was successful in its bid to become a Global Digital Exemplar trust, bringing with it significant funding (around £10M) for digital projects. UHS invested these funds in various ways, including the funding of assistant technologist / technical support analysts to join me in a restructured technologist team.

The GDE funding was a one-off, but the hope was that the new appointees would be able to prove their worth to the point that the Trust would decide to continue funding them on a permanent basis. Recruitment began early in 2017 and two talented new members of the team were appointed; Tim (surname?) moved across from the EPR team and Mark (surname?) joined from the education technology sector. The rate at which we could build and deliver applications increased almost immediately.

The first App to go live in 2017 was for our own internal use. Along with the office space at Unity 12, UHS had hired a room to be used as a meeting room and for hotdesking, so the team produced a simple App for booking these resources.

The Fractured Neck Of Femur Forms

The drive to digitise inpatient forms continued with specialist forms for Trauma and Orthopaedics. The first APEX form allowed specialist nurses who were qualified to prescribe fascia iliaca blocks - a local anaesthetic nerve block to relieve pain post surgery - to record their prescription and administration. The set up of the hospital's principal prescribing system did not allow for this information to be recorded. The second APEX form was the Recovery Discharge Checklist, for use by anaesthetists to record post-operative patient movements from the recovery suite back to the wards.

The APEX VTE Root Cause Analysis Form

Whenever a patient suffers a venous thromboembolism (VTE) or pulmonary embolism (PE) in the hospital, the Trust must investigate the root cause. The investigation process involves both the central VTE team and divisional and care group governance teams among others, and the APEX App aimed both to improve the coordination between these various groups and to present all relevant information for the multidisciplinary team review. The App was released in April 2017 but was only used sporadically.

The UHS Lifelines App

The UHS Lifelines (Version 3) Application was incorporated into APEX on a trial basis in 2017. APEX was the first element of the CHARTS EPR to incorporate UHS Lifelines into the live product, but Lifelines did not incorporate APEX data in its outputs.

The APEX Mixed Gender Breaches App

To protect the dignity and safety of patients, placing inpatients in the same bay as members of the opposite sex is seen as a "never" event. Hospitals are required to monitor and report any instances where male and female patients are located on the same bay in a ward, and to investigate why this occurred. Ward staff use the Mixed Gender Breaches App to record these breaches for further analysis by the patient safety team and by UHS Insight for central reporting.

The APEX Long Lengths of Stay App

During the winter of 2016-17, the concept of a "stranded" patient was introduced. Hospitals were required to update NHS England on a regular basis with the numbers of inpatients with a length of stay of seven days or more and the reason for their continuing hospital stay. To meet this requirement, the Stranded Patients APEX App was rapidly developed and deployed. As that winter progressed, further metrics were required by NHS England and the App was updated accordingly. It was subsequently renamed the Long Lengths of Stay App,

Much of the data required for stranded patient monitoring was similar to that required for NHS Improvement's SAFER Patient Flow Bundle, which UHS were in the process of adopting. As a result, the Stranded Patients App was modified further to capture some of this additional information, and to pull related data from other systems in the Trust. UHS data sources included the Doctors' Worklist component of CHARTS and the Ward Electronic Whiteboards, which had been built by Alan Hales and which were still in the process of being deployed in early 2018.

Alongside the Emergency Care Improvement Support Team (ECIST) data collection, the Stranded Patients App was developed into a reporting tool to present information that had been entered on the ward whiteboard system. A selection of email reporting and escalation

tools were also built in to allow users to subscribe to reports on particular patients at ward, team, care group or Trust level. For example, a charge nurse might receive a report showing all patients on their ward with a length of stay of more than seven days, and Trust Executives might receive a list of patients who have been in the hospital for over 100 days.

More recently the Stranded Patients App has been adapted to incorporate the Minimal Discharge Report, listing patients who are medically optimised for discharge and who have no onward care needs. In 2024 the ECIST list was replaced with NHS England's new (but remarkably similar) "Reason for Discharge Delay" list.

The APEX Obstetric Anaesthesia Headaches App

This App was introduced in February 2018 to help monitor and manage these and other complications from epidurals and spinal anaesthesia. Anaesthetist Dr Richard Isaacs was aware of patients who were suffering severe headaches following anaesthetisia for obstetric procedures.

APEX Reaches Maturity in Mid-Late 2019: Becoming UHS Apps

By 2019, the technologist team was a full time software development team. Tim (surname) moved back to the EPR team in a management position, to be replaced by Sara Coe. Mark returned to the education sector, to be replaced by Harriet (surname?). Edmund Rada and then Andy Timbrell joined the team; for a brief period Carlos (surname?) also joined us.

In the summer of 2019, UHS decided to buy back the CHARTS system with its development team from EMIS Ltd and to pursue further development work in-house. EMIS had made it clear that the CHARTS product was not seen as part of the company's strategic future, and UHS had long been frustrated at the cost of development of CHARTS and the lack of control over the product's roadmap.

The CHARTS development team joined the IT department from EMIS, sitting alongside the "Technical Solutions" development team and the Integration team to form an IT Development department. It made sense for the APEX development team to join them.

However, the APEX development team were moved into the IT operations team alongside PC Support, Server Support, and the Database team. This marked the end of the former technologist team and a new role for the team in pure software development. Our role in scoping and prioritising new developments, testing the updated software, and promoting the product, remained with the EPR department. A rebranding of our role also took place.

From July 2019, our product set would be called "UHS Apps", to distinguish it from the name of the Oracle APEX system. Newly recruited developers were also with the UHS Apps team for training, at which time Jayson Gomba joined the UHS Apps team.

The Digitisation of Inpatient Noting across UHS

Following the success of Ward Forms back in 2011, the Trust was now ready to attempt to digitise the rest of the inpatient paperwork. The first target was the plethora of ward nursing assessments, for which the Trust examined two possible solutions: the SafeTrack system, and the other was UHS Apps. The developers of both systems were provided with a specification for the Malnutrition Universal Screening Tool (MUST) and tasked with creating prototype software for competitive demonstration on a live ward for a limited time.

The pilots took place in the Autumn of 2019 and UHS Apps was the chosen for the platform. The prototype applications were withdrawn from use and a huge scoping exercise followed. This included visits to other hospitals and examination of all of the paper documents which were in ward use. The development team and the project team worked closely together through the Scrum agile framework. This was to be the development team's biggest priority for the next few years. However, other systems development proceeded in parallel. Other new Apps that were released during this period included:

The Trauma Risk Management (TRiM) App.

Trauma Risk Management (TRiM) is a recognised process for assessing, delivering care and reporting on psychological trauma following unexpected and serious events. It offers a framework and approach which works for both individuals and organisations. It has been developed, researched and used by military teams, and the emergency services in particular.

UHS had invested in TRiM as part of its commitment to staff support, especially following situations which have the potential to cause significant psychological distress and trauma. There is a UHS TRiM team consisting of staff across specialities who have been trained as TRiM practitioners and managers and can support staff in this way, after an incident. This App supports the TRiM team as a case management and reporting system.

The Acute Surgical Unit (ASU) Diary App

An electronic diary system was developed for the acute surgical unit, for use on h a wide range of devices, including phones and tablets as well as at desktop computers.

The Southampton Stock Control System (SCSS) App

This App was built for the pathology department to manage stock and purchasing and released on 15th July 2019. It also managed stock issue and quality control for locally produced products.

The Non Invasive Ventilators App

This App replaced an Excel spreadsheet for the processing of referrals to the NIV service, diagnosis and treatment.

Further Development of UHS Apps in 2020: and through the COVID-19 Pandemic

Following the success of the MUST pilot, the team focus in early 2020 was upon setting up the new Inpatient Noting application and clearing any other outstanding work to make way for it. The departmental move from EPR to IT also brought with it other changes. We moved from an in-house tool for managing the development process to the Atlassian (Sydney, New South Wales) Jira system for agile project management and software debugging. We explored the Scrum Framework and the Manifesto for Agile Software Development to aid teamworking. This involved a switch from a continuous Kanban-style system to working in software sprints, with the team's first sprint beginning on 29th November and ending on 13th December 2019.

We were working on several large projects, including a scheduling system for Endoscopy, a clinical system to support the Primary Ciliary Dyskinesia Team, and a comprehensive system to support the Cystic Fibrosis Pathway.

Meanwhile, although the responsibilities for supporting UHS Apps systems - including scoping, testing, operational support, publicity and other communications - had in theory stayed with the EPR department as part of the development team's move to IT, in practice the EPR teams were reluctant to take on the work that the former technologist team had been doing on their behalf. A significant build-up of backlogs of work for scoping and testing developed.

The Arrival of Covid-19 in early 2020

The first COVID-19 cases in the UK were confirmed in January 2020 and it soon became apparent that digital solutions would be urgently needed to help the hospital cope with the pandemic. It was equally important that the momentum for the Inpatient Noting project was not lost. As a result, most of the team continued working on those outstanding projects and Inpatient Noting, while much of my focus switched to developing solutions to assist with the pandemic. We moved to remote working when the first nationwide lockdown was announced on 23rd March 2020.

The Covid Related Nursing and APEX Care Home Patient App

The first of the Apps rapidly built to support UHS with the COVID-19 pandemic was released on 11th March 2020. The aim of this App was to easily identify patients who normally live in a nursing or care home. The App consists of a configuration tool for listing postcodes associated with these residences, and a report showing all current inpatients whose home postcodes match any on that list.

The APEX eRouting App

The hospital urgently needed to review all upcoming booked outpatient appointments to determine whether those appointments could be conducted by telephone or video instead of in person, or postponed to a future date, or even if the patient could be discharged altogether. As a result there was a requirement for a rapid, easy to use decision-making tool

for clinicians to use, alongside reports to function as work lists for the administrative teams to implement the clinicians' decisions. The appointment triage tool was released on 12th March, and subsequently enhanced to produce data extracts that could be loaded into the Synertec (Wellington, Somerset UK) document management software for sending letters to patients, letting them know of the changes to their appointments.

The Triage Tool was also notable because it was the first UHS Apps product to be fully integrated with CHARTS. The CHARTS development team had moved into UHS premises a few months previously, and they were now free to develop interfaces with UHS's in-house systems for the first time. They developed a route whereby clinicians viewing the Outpatient Worklist feature in CHARTS could seamlessly and securely open the UHS Apps triage form, without needing to log in again or to re-select their patient.

The triaging of appointments in advance helped to reduce the number of patients needing to visit the hospital site, but clinicians who worked away from the hospital site were faced with a new problem. The outcomes of outpatient appointments were normally recorded on paper routing slips, and while there had long been a desire to replace those with a digital alternative, that project had never come to fruition. It was now urgently needed. The Appointment Outcomes Form was rapidly developed and was made launchable directly from the CHARTS outpatient worklist.

What should we do with this patient next?: The Triaging, eRouting, and Grading Apps

Clinicians working remotely also needed to manage incoming referrals. Previously, this referral grading had been a paper process, with all of its limitations. The referral documents would be printed out and annotated by hand, with administrative teams booking the appointments or rerouting the patient as directed by those annotations.

Work on the digital solution was split between the CHARTS and UHS Apps development teams. A New Referral Grading Worklist was created in CHARTS, and the Grading Form was built into the UHS Apps eRouting App . There was a seamless transition from one system to the other.

The Pathway Updates tool

The three functions - Triage, Outcoming and Grading - were essentially asking the same question of clinicians: "what should we do with this patient next?". The options included:

- discharge the patient,
- book an appointment,
- or admit an inpatient.

However all three decisions were triggered by other events, including:

- an upcoming appointment,
- an appointment that has just occurred,
- or a new referral.

Clinicians also wanted a way to record information on an ad-hoc basis, not necessarily directly linked to a specific appointment or referral, and so the Pathway Updates tool was also developed, also with the ability to launch it directly from CHARTS.

The eRouting app was subsequently split into individual apps for the four functions - Triage, Outcoming, Grading and Pathway Updates.

COVID-19 Discharge Planning

During the Pandemic, the government published emergency legislation and guidance, which effectively did away with the Care Act 2014 requirements for complex discharge patients, instead creating a national "Discharge to Assess" model (D2A). This had been piloted in a small number of hospital trusts prior to the pandemic to speed up hospital discharge. Simplistically, instead of carrying out assessments in hospital to determine the discharge and care plan, the patient would be discharged to an interim setting for those assessments to take place. The Government also suspended the Delayed Transfers of Care reporting requirements.

The expectation was that these changes would be temporary, and that the hospital would be moving back to assessment notices, discharge notices and DTOC reporting when the pandemic was over. Therefore instead of incorporating all these changes into the Complex Discharge App, I developed the temporary COVID-19 Discharge Planning App, which was a much simpler system with a minimal dataset. This was released on 31st March 2020.

The Out of Time Follow-Ups App

There are well-publicised national targets concerning how quickly a patient must have a hospital appointment after being referred by their GP. Broadly speaking, they are 18 weeks for most referrals and 2 weeks for a suspected cancer. There was no such emphasis on follow-up appointments after that first visit. As a result, hospitals were incentivised to postpone follow-up appointments in order to make capacity for new bookings that were in danger of breaching the 18-week target. This meant that where a clinician had indicated a follow-up might be needed in, say 3 months' time, the reality was that patients might be seen again much later.

This phenomena of patients being seen for their follow-up appointment beyond the time in which the clinician had indicated, is called an Out-Of-Time Follow-Up. It affects some specialties more than others, and in some cases has had very significant impacts on patients' health. It affects all hospitals, but at least two cases relating to UHS had made the news, where Ophthalmology patients were left with permanent sight loss that could potentially have been averted if they were seen sooner.

The team had been working on the Out-Of-Time Follow-Up App for several years by the time it was released on 12th May 2020. Prior to the release of this App, out-of-time follow-ups were logged in a Microsoft Access database. As there was a solution of sorts in place, replacing it with a more robust solution was not a priority, and so it took some time for the replacement UHS Apps product to be released and adopted.

The Covid Staffline Service App

The early phase of the COVID-19 outbreak in 2020 had a severe impact on front-line staff. Testing for the virus was in its infancy and no vaccine yet existed. Protective equipment was sparse and sometimes inadequate. Visitors were not allowed into the hospital. Staff witnessed patients dying alone, and sometimes those patients were their own colleagues who had contracted the virus while doing their jobs.

UHS was quick to respond to the wellbeing crisis that was accompanying the virus outbreak. The Staffline service was established to provide psychological support to UHS staff, and

required a system to log the details of support conversations and manage the service's workload. The StaffLine Service App was released on 21st May 2020.

Population testing for Covid-19

Testing for COVID-19 usually involved swabbing of the upper nostrils or the throat and it was an uncomfortable experience. Other testing methods were being developed that were as effective, including the taking of a saliva sample, which could be analysed in a laboratory. Professor James Batchelor at the University of Southampton led a project to implement a saliva sampling and testing service in Southampton. A veterinary laboratory had been commandeered from the Department of Food, Agriculture and Rural Affairs (DEFRA) for the project, and administrative staff were sequestered from their usual jobs to provide a service to log the test results and contact any participants who tested positive and provide support and guidance.

James assembled a small team of software developers to produce the systems to support the process. The genomics development team, together with an external developer, would provide the laboratory results server and the main lists of participants. UHS Apps would provide the contact monitoring and track-and-trace features.

The initial Apps went live on 1st July 2020 with the service being piloted on staff and students of the University of Southampton. It was subsequently rolled out to schools across Southampton, with each secondary school going live alongside the main junior schools that fed into it. However, DEFRA wanted their laboratory back, so a new pathology lab was built at the Chilworth Science Centre to support the service.

Test scheduling

For anyone who was not a participant in such a testing programme, COVID-19 testing was set up at a number of drive-in centres across the country. UHS established such a centre at Adanac Park, and the centre required a booking system to run it. The UHS Apps test scheduling system was released on the same day as the Population Testing System - 1st July 2020. As well as testing at the drive-in centre, UHS was required to test every patient before they came into hospital. An additional testing centre was therefore established at

Southampton General Hospital, and the scheduling App was modified to cater for both test centres.

The Outpatient Harm Review

There is a contractual and national performance requirement for hospitals to report patients who were waiting over 52 weeks for an outpatient appointment. UHS had 60 such patients in March 2020 who failed the 52 week target, but due to the pandemic the numbers rose dramatically. The Trust reported 618 such patients in June. Hospitals were required to complete A Harm Review on each of these patients, and a system was required to collect and collate the results. The Outpatient Harm Review App went live on 5th October 2020.

The Staff Vaccination Scheduling App

In the Autumn of 2020, effective vaccines for COVID-19 were made available for the first time. By this point, several staff members UHS had died from the virus and the need to vaccinate the healthcare workforce was obvious and urgent. A system would be needed to book staff for their vaccination and to allow staff to book themselves in. It also needed to record the contra-indication questionnaire results, and the prescription and administration of the vaccine itself. A rapid turnaround was key, so the system needed to be fast and responsive, with each booking lasting just two minutes.

Vaccines were also offered to UHS contractors and partner organisations, so the system needed to allow them to be booked in, and to notify everybody of their bookings. For this, the system needed to interface with a third party product for sending appointment information and reminders by SMS. The system also needed to link staff records to the individuals' patient records for the first time, so that the vaccination could be appropriately recorded on their medical records. The initial vaccines would consist of two injections, a set time apart; so the system needed to ensure the second vaccines were booked within the correct time window. Above all, the system was needed quickly!

The vaccine scheduling App went live on 30th November 2020, with UHS staff able to access a self-booking portal from January 2021. The emotional hit of seeing the appointments

change colour as scores of staff members booked themselves in for this life-saving treatment within the first few minutes, was overwhelming.

2021: Learning to Sprint

2021 brought with it new challenges. The COVID-19 outbreak was far from over but with many members of society striving to return to some sort of normality, there was a lot of talk of "the new normal". In working remotely and cutting out the time needed to commute to and from a workplace, and the time needed to travel between the Unity 12 Building and the hospital sites for face-to-face meetings, the UHS App development team found they were far more productive, and had far better access to each other and colleagues in other teams, by working remotely.

Having temporarily paused some work to concentrate on supporting the pandemic, demand was now sky high for delivering products that had originally been earmarked for release during the previous year. What's more, expectations were sky high; the team had shown how responsive and agile they could be, turning projects around in a matter of days or weeks sometimes, and some stakeholders expected that kind of pace to continue.

The IT department were also looking to catch up on lost time following the restructure that brought the UHS Apps team into the department. The team now reported to Tak Tang, who was keen to introduce the team to the Manifesto for Agile Software Development and the Scrum Framework. The team had already started using elements of this and, during the course of 2021, adopted more and more of the values, principles and practices outlined by Agile and Scrum.

We were all saddened by news of the death from COVID-19 of Joel Kallman, one of the originators of APEX in 1999 and later a senior director at Oracle, Joel had taken an interest in what we were doing with APEX in UHS and was proud of what we had achieved with the platform.

New APEX UHS Apps Releases in 2021

The Mechanical Thrombectomy App

This App was somewhat unusual in that it needed to cater for a regional service, including some patients who were not registered with UHS. It served as a day-to-day clinical system, with reporting capabilities, to monitor the flow and outcomes from referral through procedure, post-procedure and up to six months afterwards.

The Smoking Cessation Referrals App

This App was created to record and report on the smoking status of inpatients, and to support the smoking cessation service with their case management.

The Safeguarding Children App

The paediatric version of the Safeguarding Adults App that had been released many years earlier was launched on 1st November 2021. This App included The Safeguarding Proforma, which is a hefty document that is partially populated from the Concern Form. It also introduced the "public case view", a concept that was later also built for the Adult Safeguarding App. This allowed users outside the safeguarding teams to view information about a case that the team had deemed suitable for wider consumption, while ensuring confidential information remained limited to those who needed to see it.

The COVID-19 Vaccination Prescriber Rostering App

The COVID-19 Apps were not done with yet! This was a simple rostering and calendar App to plan prescriber cover for the vaccination hubs. It was later modified to support the scheduling of staff who had volunteered (or been sequestered) to assist with the proning (turning face down) COVID-19 patients in the intensive care units.

2022: A New Structure for the Digital Services Team

By 2022 the team had made good progress with adopting the Agile values and much of the Scrum framework for software development. The key missing link for fully adopting Scrum was the key role of Product Owner, who was also needed to support the team's former colleagues in the EPR department, which had since been renamed "Digital Services".

Although many responsibilities fell elsewhere *de jure*, they very much were on the development team's shoulders *de facto*. This included:

- meeting with stakeholders to establish their requirements,
- scoping and writing up those requirements,
- prioritising them alongside all the other work on the backlog,
- developing the software to meet those requirements,
- carrying out code reviews and technical testing to ensure the robustness and standards-compliance of those solutions,
- carrying out functional testing of the resulting products,
- coordinating end-user testing with the stakeholders,
- carrying out clinical risk assessments on the products and the business processes surrounding them,
- writing safety cases and coordinating their approval and sign-off with the Trust's clinical safety officers,
- organising the change control authorisation and communications around releasing the updated products,

and providing first, second and third-line support to end users of the live systems.

If there was a fault with the software, the team had to deal with it. If there was a clinical risk that needed to be managed, the team had to manage it. If there were conflicting priorities - and of course there always were - it fell on the development team themselves to work out which projects were of higher value to the Trust. When users stopped using systems, often without telling anyone, the responsibility of noticing that and working out what to do with the patient data that had been recorded, again fell with the team.

In 2022 that things began to change for the better. Having raised concerns about the situation using internal channels across many years, it was actually a social media post that finally gained managers' attention and saw the implementation of necessary changes.

The EPR Operations team now also supported the UHS Apps product set, leading eventually to the closure of the separate UHS Apps helpdesk. This gave the users of Trust systems a single place to raise any issues relating to any of the Trust's EPR products.

UHS engaged the services of a certified Agile coach who offered a training course on Scrum to anyone who was interested. Although the coach was employed primarily to work with the Business Intelligence team, the course enabled the UHS Apps team to improve their implementation of the framework.

In July 2022, the team was again restructured, this time moving from IT Operations into IT Development, and at last being properly recognised as a software development team.

2023-4: change at the top... and below

In 2023 Adrian Byrne retired as UHS's longstanding chief information officer. His successor, Jason Teoh, was appointed in good time and this brought a further restructuring of the department, and a rebrand. The "Informatics" name which had replaced "IM&T" many years before was now being dropped in favour of the "UHS Digital" brand.

The UHS Apps team found themselves in another new department. All the development teams were moved into a new "Digital Systems Development" department alongside a new team, the "Digital Systems Design and Delivery" (DSDD) team, which was formed out of the old EPR Development team. As part of the restructure, the new DSDD team would take on the responsibilities for discovery, scoping, testing and release management across all EPR systems. For the UHS Apps team, this mean that we could at last focus purely on the "day job" of software development.

Most of our work is now focussed on delivering incremental changes to existing systems rather than in the development of completely new Apps. Most needs are already covered by the existing portfolio of applications, so new features tend to be added on to them. The working relationships across the Digital Systems Development department have improved immensely thanks to the new structure and to the better defined purposes for the teams within it.

As of August 2024, Inpatient Noting is now live on all adult wards across the hospital, with new changes rolling out frequently. A business case to fund the ongoing support and development of Inpatient Noting was declined in 2023, meaning that the project team

continue to support it on a best-endeavours basis while a new business case is being put together for permanent support within DSDD and EPR Operations. We continue to use the Scrum Framework as best we can and to work according to the Agile values, to incrementally improve the development process, the products and our services for patients".

Essay Summary

Dave Waghorn's invaluable contribution to this collection of essays clearly demonstrates a number of key features of the UHS Clinical Data Estate story.

-It demonstrates just how many administrative and clinical processes and functions are appropriate for digital transformation across a complex organisation such as a University Teaching Hospital;

- It demonstrates the value of having a development team which is intimately co-located with the clinical workforce;

- It demonstrates the value of well designed and flexible software systems which permit staff to build new and practical systems with minimal coding skills

- It demonstrates the value of developing and running the core EPR and clinical systems (as embodied in the CHARTS portfolio) in parallel with the administrative systems (as embodied in the APEX programme).

In the next Essay, I will consider the complexities of the analysing and structuring the source documentation of the UHS clinical record collection in the epochal transition from a largely paper based clinical organisation to a digitally predominant NHS Global Exemplar organisation in from 2013 onwards. This work was driven externally and nationally to secure digitally advanced NHS in the shortest possible time and in the absence of any operational or clinical precedent.