Institution: University of Greenwich

Unit of Assessment: (8) Chemistry

a. Overview

The University of Greenwich is a strongly research-informed institution. The Strategic Plan (http://www.gre.ac.uk/governance/vc/strategic-plan-2012-2017) sets out a five-year roadmap to increase the quality, volume, and intensity of its research activity. A particular goal is to develop by 2017 at least twenty research groups with an international reputation for research excellence.

The University of Greenwich School of Science is located at its Medway campus. Steeped in maritime history, the institution comprises six Edwardian redbrick and ivy-clad buildings dating from 1903, occupies some 1150m^2 of research laboratory space, much of it having benefitting from a £50M investment since 1996. Greenwich has linked with other local educational establishments – especially the University of Kent and Canterbury Christ Church University – to develop a world-leading educational campus, known collectively as the "Universities at Medway".

From September 2013, the School of Science joined with the School of Engineering and the Natural Resources Institute (NRI) to form the Faculty of Engineering and Science, to foster interdisciplinary research, to further to drive collaborations and to consolidate its interaction with the Medway School of Pharmacy (MSoP) (a joint University of Greenwich - University of Kent initiative). Research activity has evolved significantly since the RAE2008 submission into the pharmacy UoA, and now embraces many aspects of Science, from Forensic through Pharmaceutical and Sports Science to cognate disciplines such as Biochemistry and Biology. Pharmaceutical Chemistry is still a strong focus for the School, but recent appointees (Booth, **Dobbs, Griffiths,** Richardson, Ward – **bold** indicated being returned to this unit of assessment (UoA) are diversifying expertise. The underpinning activity is Chemistry in that this research has a basis in molecular science, focused on the acquisition of a molecular understanding to data, results and outcomes observed in experimental studies, allied to, and driven by, both professional and societal relevance.

Staff are organised into cognate research groups, or "clusters", three of which are being returned to UoA8; (i) Chemometrics & analysis, (ii) Biological Chemistry and (iii) Materials Chemistry. Sixteen members of academic staff are being returned to UoA8 in this REF period with a further four going into UoAs 2, 3 and 6. There is a cohort of up-and-coming academics who are being actively mentored, who make a substantial contribution to the wider activity. 16 technical and 4 PhD-qualified or -registered research officer staff underpin the endeavors of these academics. The environment is therefore dynamic and vibrant.

Specific developments that reflect the University Strategy for Research are:

- The cohort of researchers being returned in REF this time has increased by some 50% (12.3 to 18.6 FTEs) over the assessment period, through staff development activities and new appointments;
- Peer reviewed research output has increased by ~30% since 2008;
- Income generation through research and enterprise has increased significantly compared with the previous RAE period, amounting to £7.37M over the current REF period;
- Postgraduate research student completions have increased from 35 (RAE2008) to 43 (REF2012).

b. Research strategy

(i) Evaluation and Vision

In 2008, the School returned 12.3 FTEs under the Pharmacy Unit of Assessment, and had an overall quality profile of 20% 3*, 30% 2* and 35% 1*, with the research environment and esteem factors scoring poorly. Since then, investment in the School infrastructure and staff has been significant, and it is now felt that there is a critical mass of the activity within the School that falls within the Chemistry UoA. Pharmaceutical research is still a strength, but its significance and foundation has been refocused and builds heavily upon our Chemistry activity. However, given the

interdisciplinary environment being fostered within the School, there are inevitably a number of very talented colleagues who contribute significantly to the broad research base whose core activity is better matched to other UoAs, and research active staff whose scientific profile is not sufficiently mature within one given unit of assessment to warrant inclusion. These individuals are part of an established, long-term process to grow the research capacity of the school, supported *via* both strategic and competitive investment of nearly £1.2M Higher Education Innovation Funding (HEIF) and Research Capital Investment fund (RCIF) Supported Projects.

Our research vision is managed through the University Research and Enterprise Committee (R&EC), constituted from Faculty-, School- or Institute-based Directors of Research and Enterprise. Each Faculty operates a Research Degrees Committee which oversees Postgraduate Research programmes within that Faculty and reports to the University R&EC. Research activity is also guided by a Research Ethics Committee.

Research activity is arranged around a "cluster model" which collects together individuals with cognate interests, and accordingly, individuals may be associated with more than one cluster. Of relevance to this UoA are three clusters whose focus may be summarised as;

- *Chemometrics & analysis* – the development of novel pharmaceutically relevant molecules and characterisation of their action; formulation of mucosal drug delivery systems; development of analytical methodology including high sensitivity differential scanning calorimetry, Raman and NMR spectroscopy, mass spectrometry, X-ray diffraction and advanced multidimensional chromatographic analysis; experimental thermodynamics; multivariate data analysis, artificial neural network/intelligence; (Antonijevic, Boateng, **Chowdhry, Dobbs, Everett, Griffiths,** Getti, Habtemariam, **Leharne, Mendham, Mitchell, Nielsen, Pang, Pullen, Snowden,** Tetteh, Wray, **Zand**).

- *Biological Chemistry* – proteomics, metabonomics (with a focus on the emerging area of pharmacometabonomics); wound healing & tissue repair drug discovery; cell biology directed research into efficient anti-viral and anti-cancer medicines based upon nano-scale molecular medicines; biophysical and spectroscopic characterization of organellar membrane proteins; vaccines/biodefense; the effect of small molecules on voltage gated ion channels and the associated computer modelling of biological activity from the atomistic perspective (Boateng, Booth**, Coleman, Dobbs, Everett, Griffiths**, Getti, Harbidge, **Leach, Mitchell, Pang, Pullen**, Richardson, Rickard, Tetteh, Thompson);

- *Materials Chemistry* – semiconductor materials for renewable energy technologies; solar hydrogen production; spectroscopic analysis of surfaces and thin films; preparation and characterization of novel nanoparticles, films and hierarchical structures for drug delivery; preparation of silicate clays, zeolites, cements, glasses and mixed-metal frameworks for use in construction; ion exchange, water purification and implantable biomedical materials; production of construction materials from waste, formulation of novel cement systems and the diversion of waste from landfill; novel surfactants and characterisation of their self-assembled structures; the use of surfactants and metal silicates in soil remediation and pharma materials processing (**Alexander,** Boateng, Booth, **Coleman, Chowdhry,** Douroumis, **Griffiths, Hills, Leharne, Mitchell,** Richardson, **Snowden,** Trivedi).

Over the next five years, it is anticipated that there will be sustained growth within the materials chemistry cluster, consolidation of the relatively embryonic biological chemistry cluster, and nucleation of research themes in forensic chemistry and the more fundamental aspects of nutrition science. This expansion will be driven by strategic intervention of senior appointments. Key metrics defined in the strategic plan include a target that 25% of staff will be publishing at the 3* or 4* level, and a near doubling of research and enterprise income and registered postgraduate students by 2017. To meet these challenging goals the School will need to expand its sphere of influence, and work much more closely with colleagues in Europe.

(ii) Strategy development

The strategic research agenda is being directed centrally but driven locally. In Q1 2012, the University initiated the recruitment of over twenty research professors, two of which are being returned here - **Dobbs** (synthetic chemistry) and **Griffiths** (physical chemistry). Further rounds of senior appointments are planned, with the School looking to appoint at Chair level in the area of bio- or inorganic materials chemistry, to support growth in biological and forensic chemistry plus nutrition. New posts attract modest start-up funding, including one or more PhD studentships, and join a school with a surprisingly well-equipped suite of laboratories. Such aggressive expansion underpins the University's aspiration to consolidate its market position as a provider of high quality education directed towards real-world and interdisciplinary applications.

All staff are annually line-managed, and independently mentored on a more regular basis, by senior members of staff. Key performance indicators are personalized and documented, and time is effectively managed through a consistent University-wide Balanced Academic Workload (BAW) model. Specific targets, identifying any necessary support, are thus set for all members of staff, and within a research context, include grant income targets (both applied for- and secured) and management of publication profiles. Prior to submission, all grant applications and the majority of publications must first pass through the mentor for approval, and this has further led to increases in success rates and higher profile publications. Regular monthly reports to the Senior Management Team (SMT) of research activity (including outputs) ensure that SMT has an accurate picture of progress towards target. Such "hands-on" facilitating of research has been extremely effective at Greenwich, evidenced by for example the publication and grant application histories of early career staff *e.g.* **Zand** (mentors *Chowdry & Snowden*). Whilst not technically ECRs, a significant proportion of staff (*e.g.* Boateng, **Mendham**, Trivedi) within the School were awarded their PhDs less than 8 years previously, and are now successfully developing their independence within a somewhat challenging environment associated with teaching pressures arising from small staff/undergraduate ratios. However, appropriate mentoring has led over the assessment period, to a 33% increase in the number of successful grant applications (and a corresponding doubling of average value). Post-doctoral research assistants are mentored in a similar fashion, reporting to the grant holder(s) and a project independent staff member.

All members of staff are required to participate in the School seminar programme, which includes presentations ranging from senior external visitors to internal PhD students. Informal weekly "cluster meetings" ensure that there is good communication between colleagues, exchange of scientific ideas, sharing of examples of best-practise and dissemination of recent literature across a range of fields. The pooling of equipment and associated expertise, and a lack of barriers to their use, also leads to effective scientific collaboration, evidenced by the number of joint authored publications.

The University ensures that all its members of staff are able to work effectively and at their optimum, within a well-defined supportive environment. To this end, there are a number of events all staff must attend, ranging from a core induction programme for new staff (New Employee Welcome and Introduction *NEWI*), staff development workshops and related educational and professional development programmes as well as technical staff CPD training. The University is committed to equality of opportunity for all staff and students, and all must comply with the Equal Opportunities Policy. To support the policy, the university operates fair, open and transparent procedures for student and staff recruitment, assessment/appraisal and the attainment of awards.

(iii) Promotion of Research

Research at Greenwich is "inclusive". All members of research active staff belong to one or more of the associated clusters. Each cluster meets regularly to discuss their latest research, scientific developments in general, as well as progress against targets (*e.g.* number and profile of publications, grant application submission, invited lectures), to thus share ideas and to broaden collaborative activity across all members of staff. Senior staff who have strong consultancy interests promote inclusion of less established staff, and joint grant submissions and papers are strongly encouraged. Internal barriers for access to facilities are largely absent, with the infrastructure within the School being shared, addressing one factor highlighted in RAE2008.

There is a very strong "business" focus to research at Greenwich. Schools have embedded within them, business development managers (BDMs) whose role is to provide administrative support. The BDMs liaise with Greenwich Research and Enterprise (GRE) staff to cost projects at conception, oversee all submissions and ensure any intellectual property is appropriately protected, support that greatly encourages the application of our expertise, especially the younger staff. For example, recent patents submissions include glass-ionomer cements for hard tissue remediation (Booth), novel drug eluting stents (Douroumis) and novel routes to deliver antisense oligonucleotide drugs into mammalian cells using engineered, attenuated protein toxins (Richardson). Research and Enterprise is therefore strongly encouraged, as well as promoted and supported centrally, and to this end, the Vice-Chancellor has created a competitive scholarship fund for 40 fully funded PhD studentships per year.

All externally published research outputs are deposited in the Greenwich Academic Literature Archive (GALA), an open repository which is used to track and assist in the dissemination of research outputs from the University.

(iv) Future plans

Consistent with the University strategy of increasing the number of internationally recognised research groups, the UoA seeks to bring together and adequately resource research clusters with the potential to gain international recognition. During the assessment period, a hiring programme for research professors was undertaken with the aim of bringing into the University internationally recognised figures (**Dobbs, Griffiths,** Ward) to lead such groups. This programme is supplemented by the high-profile Vice-Chancellor's PhD scholarship programme, the provision of internal seed funding to facilitate cluster evolution and the development of new research capability. Such funding is provided on a peer-reviewed, competitive basis, with internal contracts let against specific deliverables in terms of research publication volume and quality and the gaining of external funding.

The School is considering a move to a 50% funding model, whereby the School will only part-support PhD studentships, the remaining 50% having to be derived from income secured by individual academics. This move will significantly expand the student cohort, build closer collaborations with industry, and increase the relevance of our efforts to UK science.

c. People, including

i. Staffing strategy and staff development

The University has committed to the goals established by the *Concordat to Support the Career Development of Researchers* developed by Vitae. To this end it is a signatory of the Concordat and has created a comprehensive Researcher Development Framework, which has been promulgated across the institution. Plans are in place for full implementation- including comprehensive research training programmes- from September 2013. Further, the University has extended this work and successfully applied for the HR Excellence in Research Award of the European Commission. This involved making substantial progress towards addressing and embedding the principles of the Concordat – and this is demonstrated through a comprehensive gap analysis and action plan (http://gre.ac.uk/hr/concordat).

The University takes equality and diversity very seriously, and has a dedicated equality and diversity champion at University level who leads on any initiatives in this area for the Human Resources Department and has taken a leading role in the initiatives described above. All UoAs are required to observe the University Equality Framework Line managers are trained in current practice and are responsible for ensuring compliance and being pro-active in identifying areas of issue. (http://www2.gre.ac.uk/about/policy/equality).

Succession planning is also important and it is custom practice that potential future leaders of research groups and departments are encouraged to undertake several of the leadership development programmes offered by the HR Learning and Development team.

Early career researchers (ECR) are identified on joining the University and provided with support via a comprehensive ECR network. The network supports the career development and

management of ECR staff and contract researchers within the University. It was set up in 2009 as a direct response to the aspirations of the Concordat and in accord with the previous Roberts Report and funding stream. In order to allow a maximum number of appropriate staff to benefit from internal training and opportunities, criteria for early career researchers at the University are inclusive and allow both academic staff who have obtained their PhDs within the last 5 years and academic research staff to participate. In addition to access to specific training and mentoring initiatives, the network facilitates communication and networking between ECRs across the University creating a strong and cohesive support community. The network runs an annual competition to identify ECRs with particularly high potential and the winners are given high-profile early career research excellence awards which include financial support for their research. The awards support their career development and contribute to the research work of their UoA.

In addition to support for the development of research groups, the University is also strongly supportive of developing research capability at the level of individual staff members – so that they can better contribute to the overall operations of their Group. Mentoring and peer review schemes operating in the UoA have been described previously, but the University also provides competitive peer-reviewed access to internal funds at the individual level – again through the internal seed funding system. This funding is largely derived from QR funding allocated to the University – and is the main mechanism by which this money is re-invested to seed increasing research activity and quality across the institution.

Staff are able to bid for School-level internal funds (£2K/max) to attend one scientific conference per year to enable engagement with the research community. Staff development is further enabled by the mentoring and appraisal processes, such that when a skill shortage or training need is identified, attendance at the appropriate event is organized by a School based manager. The University runs a large number of generic research training programmes e.g. GOLD (Greenwich Opportunities in Learning and Development - a process that stimulates professional development through peer and mentor dialogue, and through critical reflection) to encourage an atmosphere of on-going professional development.

ii. Research students

The School runs a number of taught postgraduate qualifications, these being traditionally very popular with overseas students. Over the assessment period, the School recruited/graduated over 600 MSc and PGDip students, of whom 47% were female, and 40% were Overseas.

The University (and School) is committed to high quality training of PhD students/post-docs within an interdisciplinary environment; 43 PhD candidates have successfully graduated since 2008, with 3 more writing up. Student progress is regularly and formally monitored by both the Research Degrees Committee and the University Research and Enterprise Committee. Each student is expected to present their work to the wider group and cluster – and have it subject to peer review and feedback - either at a Faculty research seminar or a postgraduate research day. This provides the opportunity for them to test their emerging work on a critical but supportive audience. All students have two supervisors, one lead, the second to act as mentor. In addition, students are expected to follow a selection of taught Masters modules that are relevant to their research.

d. Income, infrastructure and facilities

Over the assessment period, research and enterprise related income to the School has amounted to £7.37M, largely from industrial/consultancy sources (~80%) reflecting the applied nature of our research base. 95% of the REF-eligible income through the School is being returned to this UoA, amounting to some £1.6M in total, comprising £1.4M direct and a small but increasing component of £0.27M in-kind income.

The School of Science is equipped to contemporary standards for conducting research in all the substantive areas of research within the chemical sciences. Modern laboratory space exists to cater for all aspects of modern wet (including gravimetric/titrimetric/chemical analysis) and synthetic (organic and inorganic) chemistry, and dedicated laboratory space is set aside for the chemical analysis of foods and carbonation chemistry. The breadth and quality of the instrumentation in the School of Science is impressive and underpins our activities, and research

staff are supported by dedicated technical support staff that manage the facilities;

- Mass spectrometry is a significant strength of the School, which has a suite of eleven mass spectrometers from single quadrupole, ion-trap, through triple quadrupoles for quantitation and accurate mass time-of-flight (TOF) mass spectrometers. The most recent acquisition includes a cutting edge Waters Synapt G2 ion mobility quadrupole TOF mass spectrometer that is able to rapidly separate molecules by size and charge in the gas-phase, which in conjunction with Direct Analysis in Real-Time (**Pullen**) is being rapidly adopted in the field.
- Molecular (reflectance IR/UV-visible/circular dichroism/fluorescence spectroscopy), vibrational (Raman mapping/SERS) and magnetic-resonance (500, 2x 400 and 300 MHz spectrometers - both liquid and solid studies) spectroscopy;
- A trace metal analysis lab housing a WD-XRF, 3 ICP-OES and 2 ICP-MS instruments, one of which is coupled to a 213 nm laser ablation solid sample introduction system. In addition to providing a modern, comprehensive facility for researchers (**Zand, Coleman, Hills** & Wray) it is also a key component of our ISO 17025 accredited Analytical Services Laboratory (Directed by Wray)
- Agilent HPLC and GC instrumentation laboratory home to several instruments (5x GC; 9x HPLC), along with related bench-top techniques such as CHNS elemental analysis (x2), AAS (x2) and chemical/molecular biology experimentation (tissue culture for drug testing, cytometry, immunoassays, confocal microscopy and high speed centrifugation);
- Characterisation of solid samples is underpinned by X-ray diffraction and electron microscopy, both TEM and SEM;
- Specialized facilities for pharmaceutical analysis/chemistry (e.g. tableting, dissolution studies, Nanosurf EasyScan 2 atomic force microscope, two Malvern Zetasizer Nano ZS for measurement of size and zeta potential of colloids and nanoparticles/proteins, rheometers.

Several members of staff also make extensive use of Science and Technology Facilities Council (STFC; http://www.stfc.ac.uk/home.aspx) supported central facilities, such as the ISIS Neutron and Muon Source, Rutherford Appleton Laboratory; Institute Laue Langevin, Grenoble; Diamond Light Source, The HECToR Supercomputer *etc* (**Alexander, Nielsen, Griffiths, Pang,** Richardson) in the characterization of molecular assemblies, to date amounting to some £0.27M equivalent income being returned to this UoA. This expertise is also made available to collaborating external research groups as part of the drive to increase the multidisciplinary nature of the work in the UoA.

e. Collaboration and contribution to the discipline or research base

The School enjoys strong links with colleagues in a number of world-class institutions both nationally and internationally, and has a number of significant EU grants (*e.g.* **Griffiths** is part of a 16 partner consortium developing novel mucus penetrating drug delivery systems ("Alexander" FP7-NMP-2011-LARGE-5, **€**4.3M).

Senior members of staff have well-recognised research credentials, their long-term contribution to the field measured most conveniently in terms of h- and i10 indices (*e.g.* Chowdhry 33, 89; Everett 23, 44; Griffiths 29, 64; Leharne 20, 37; Snowden 30, 72). Keynote and invited lectures delivered by the researchers within this UoA include;

(i) **Leach** "Addressing autoimmune disorders in the CNS: Sodium channel blockers as neuroprotectants" *One Nucleus, Life Science Leadership Series*, CNS and Aging, 2012 (Cambridge);

(ii) **Dobbs** "20 Years of Organic Chemistry and Beyond", *Organic Chemistry, Present and Future*, Louvain-la-Neuve, 2013 (Belgium);

(iii) **Zand** "Nutritional quality of infants and young children's diet in the UK: Calculating the optimised "Eat well" plate", *2nd International Conference and Exhibition on Nutritional Science & Therapy*, 2013 **(**USA);

(iv) **Leharne** "Nanoparticle stabilised emulsions: Do they offer remedial opportunities?" *Second International Conference on Humic Innovative Technologies,* 2012 (Russia);

(v) **Griffiths** "The Blackart of Formulation; Competitive Interactions in Polymeric Surfactant/Anionic Surfactant/Cosolvent/Cosurfactant Systems?" *Surfactants in Solution,* 2010, (Melbourne);

(vi) **Mendham** "*Experimental and theoretical studies of cyclic di-amino acid peptides in the solid state*", 30th European Congress on Molecular Spectroscopy, (2010) Italy;

(vii) **Pullen "**How can 3D structure help you obtain a deeper understanding of MSMS pathways?" 7th International Symposium on MS & Related Techniques in Advanced Analytical Science (2013), Manchester.

Several members of staff have made notable contributions to the chemical field that are not necessarily evident in citation metrics;
(i) **Everett** conceived the concept of metabonomics (Concepts in Magnetic Resonance, 12 (5), 289-320 (2000), and named and defined it together with Jeremy Nicholson (Imperial College, London). He is a co-discoverer of pharmacometabonomics (Nature 2006, PNAS 2009, EU patent granted in 2011), the ability to predict the effects of drugs prior to dosing *via* metabolic profiling, and demonstrated pharmacometabonomics in humans for the first time which showed a remarkable microbiome influence over drug metabolism in humans previously unknown. He previously led the Pfizer team that restructured their screening file between 2009 and 2010, on the basis of a new concept of molecular redundancy, this major project resulted in the elimination of over 1 million redundant molecules from the screening file and a very considerable $9-figure write-off. He is also the inventor of a novel, highly efficient form of high throughput screening (HTS) - Plate-Based Diversity Screening, PBDS - now the standard form of hit discovery in Pfizer.
(ii) **Pullen** has pioneered the use of mass spectrometry (developed open-access, co-developed LC-NMR-MS, and is expanding the use of DART) for the study of drug discovery, for which he was honoured with the British Mass Spectrometry Lectureship in 2011/2012;
(iii) **Snowden** was Chair of the Academy of Pharmaceutical Science of the United Kingdom (2008-2010), and apart from extensive external examining duties at PhD level, is the current undergraduate external examiner in Physical Chemistry at the University of Hull;
(iv) **Griffiths** has served extensively on several Society of Chemical Industry (SCI) professional body committees, including Chairs of the Rideal Trust (2009-), Colloid and Interface Science Group (2007-2011) (he introduced the mid-career McBain medal whilst Awards officer) and the Early Career Support Subcommittee (2009-). His pedagogical experience is reflected by citations as textbook reviewer (Atkins' Physical Chemistry, 8th edition; Atkins & de Paola's Elements of Physical Chemistry, 4th edition and Chemistry^{3} by Burrows, Holman, Parsons, Pilling and Price, 1st edition).
(v) **Hills** is a member of the European Science Foundation Review Panel (2006-present), co-chair of the Kent and Medway Contaminated Land Forum, as well as a Past Chairman of the Cement and Concrete Group, Institute of Materials (IoM3). He is a contributor to the Carbon Sequestration Leadership Forum (CSLF) Task Force Report on the Utilization Options of CO_2, being presented to the Worlds Environment Ministers in Washington DC, in November, 2013. He has received a number of awards for his research, e.g. National Winner of the Shell Springboard Challenge (2008), The Times Higher Award for Outstanding Contribution to Innovation and Technology (2010) and UK Recycled Product of the Year (2013) for the artificial aggregate C8Agg.

Several colleagues (Alsbury, Booth, **Coleman**) are active in Outreach, in particular driving the creation of The Medway Science Centre (https://www.facebook.com/groups/154201858012574), a project to establish a hands-on educational science centre for Kent, now officially supported by Greenwich as the partner university. It is envisaged that the centre will cover all STEM subjects.

Many members of staff have served or continue to serve over the assessment period, on learned body committees **(**Booth, **Dobbs, Griffiths, Nielsen, Snowden,** Wray**)** and journal editorial panels (**Dobbs, Griffiths, Pullen,** Richardson, **Snowden, Zand**). Finally, members of staff are attracting the attention of the popular press for their work, **Zand** (http://tinyurl.com/9msm8p3; http://tinyurl.com/bv29eg2); **Griffiths** (http://tinyurl.com/9f2nbru); Richardson (http://tinyurl.com/9spnz77) and the School has a track record of encouraging its staff to write/edit books *e.g.* Pecorino (http://tinyurl.com/92nr3d8), **Leharne** (http://www.clu-in.org/conf/itrc/dnaplpa/).

In summary, the School of Science is home to a number of research active "clusters", centred around Chemistry, and co-populated by scientists engaged in bio- or pharmaceutically orientated research. These clusters also include a group of up-and-coming colleagues who are not being returned to this UoA this time, but who form an integral part of the vibrant academic environment. These colleagues are being actively mentored and will become individually recognised in time.