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The Wealth of Institutions

Understanding research information

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Chapter 1
Introduction

Research-based institutions are in the knowledge business. They generate, process and store knowledge. They innovate, apply and disseminate. They produce the people who move across the economy enabling other organisations to exploit knowledge for economic and social benefit. Knowledge is the currency of research: it flows and accumulates, and institutions and individuals gain by displaying their Wealth of Knowledge.

When Adam Smith wrote the Wealth of Nations he laid the foundations of modern economic theory by understanding the flow of money in society. Now we live in a knowledge economy. In an era of public accountability, academic and research institutions must understand and demonstrate, as never before, their knowledge stock, its value and how they achieve returns. The foundation for success is the ability to marshal, interpret and act on the information that tracks the knowledge flow.

In this paper we review the evolving public environment for knowledge management and we consider how institutions have responded to the pressures and demands that this has brought. We then introduce some individual perspectives that exemplify challenges and good practice in the knowledge economy. Finally, we look to prospects for future research information management.

Chapter 2
Impact Agenda

In 1945, US science looked to 'the endless frontier'. In 1963, the UK's future was to be 'forged in the white heat of the scientific revolution'. But, by the 1980s, the oil crisis had drowned those hopes and 'for the scientists, the party is over'. The resources for public research in Europe and America were going to be distributed very much more selectively. That meant a major cultural shift for research, for researchers and for research institutions.

For the last quarter-century institutions have needed to look more and more carefully at their research resources, how they use them and what they get for their investment. Institutional oversight of research management has not been an easy change for researchers, who had always been a self-governing, expert group. But the evidence is that more detailed knowledge of the research process has generally led to improved outcomes.

Now the agenda appears to be shifting again. The focus of public policy has been on research excellence, though excellence meant different things in different places. Public investment requires public returns, however. Governments, and their agencies, have increasingly looked beyond the academic impact of research outcomes towards their economic and social impacts. Curiosity-led 'blue-skies' research is still widely supported but governments, funders, charities and industry all require the majority of research they fund to include tangible and measurable benefits for their stakeholders. This is the basis of contemporary research impact assessment.

Impact may be today's agenda but it is not a new concept. Even in the context of evaluating the outcomes of research, it goes back to Eugene Garfield's 1955 essay in Science. The recent rise in the wider use of the term is driven most by the UK's government inclusion of an 'impact' component in the REF (Research Excellence Framework). Governments and funding agencies around the world had been attempting to qualify and quantify this impact for decades. In the UK, the Department for Trade & industry sponsored many consultancy projects in the 1990s around research innovation and impact. In the US, the establishment of PubMed in 1996 was a response to a wish among many Americans that they should have access to health-related research that was funded as a result of taxpayer contributions.

For funders, the requirement for research activities to be described, tracked, assessed and understood has needed sophisticated approaches that have been developing since the 1980s. Government grant-awarding bodies in countries like UK, Australia, Canada, Hong Kong and New Zealand now require that desirable outcomes from research are measured and reported to account for the expenditure of taxpayer funds. They have therefore designed processes to provide support compliance.

For instance, the aim of the first UK Research Assessment Exercise (RAE) organised by the University Grants Committee in 1986 was to create a robust mechanism for the effective allocation of resources to excellent research. For institutions, this meant managing information about research work carefully before sharing it with funding bodies. Other countries followed suit with university-led research assessment in the Netherlands (1990s), an RAE similar to the UK's in Hong Kong (1993) and initiatives such as the Performance-Based Research Fund in New Zealand (2003) and the Research Quality Framework in Australia (2003, replaced by Excellence in Research for Australia in 2009). These exercises tested and stretched the information management capabilities of the target universities.

Outputs are not the only focus for assessment. US requirements for grant reporting have been shaped by "effort audits" to determine compliance with FMC73-8, a regulation enacted in 1973, and given new teeth in Circular A-21 (http://www.whitehouse.gov/omb/circulars_a021_2004). This regulation governs "Cost Principles for Educational Institutions". The "effort audits" by US Government Departments such as the Department of Justice and the National Science Foundation resulted in significant fines for some leading research institutions. For example, in May 2005, the Mayo Clinic was required to pay $6.5 million in settlement when auditors investigated research accounting and found the Government was being charged for research unrelated to the NIH grants that Mayo received. Most notably, the accounting system used at Mayo was found to be unable to monitor and manage charges. Evidently, new systems were needed in the university sector to avoid heavy fines, and in some cases incarceration of research staff with damage to individual and institutional reputations.

The following are some of the government research assessment schemes that have driven the development and adoption of research information management systems.

Research Assessment Exercise (RAE)

First conducted in 1986, then repeated every few years until 2008, the Research Assessment Exercise was created by the University Grants Council (UGC) and run from 1992 by the four UK Higher Education Funding Councils. The RAE was conducted by peer review, with around 70 subject panels appointed by the Funding Councils from nominees put forward by professional and subject associations, who assessed and rated research in universities and HE colleges across the UK. These ratings 1 to 5 (later 1-5* and then unclassified-4*) indexed quality for grouped researchers (usually university departments) with the highest scores being awarded to units of assessment (UOAs) that demonstrated "quality that is world-leading in terms of originality, significance and rigour". They also fed into a formula to determine institutional funding. The last RAE, in 2008, examined 2344 submissions from 159 institutions, and determined the allocation of more than £3 Bn per year of government research funding.

The data submission required for the RAE affected reputation and funding. It rapidly provided a significant driver for the development of systems to manage data. Data sets included a number of mandatory elements that all required extensive, consistent internal data management to meet audit and validation:

- RA0, RA1 – staff details
- RA2 – research outputs (four per researcher)
- RA3 – research students and studentships
- RA4 – research income by major source
- RA5 – research environments and esteem

Environments and esteem were viewed appropriately for each panel. Environment included such things as industry links, presence of visiting academics particularly from overseas, and the number of research students. Esteem included editorships or books and journals, external prizes and fellowships, invitations to give papers and involvement in outside bodies.

The RAE was criticised for the administrative burden it created, both the instability and the stasis it was thought to cause, questionable measures which encouraged "gaming" of the system, discrimination as a by-product, shortcomings of peer review (particularly in subject areas at the edge of a panel's expertise), and the lack of a link to the impact that research might have outside academia. Some of these characteristics are in practice part of normal research administration and others were unproven but, in 2007, the Funding Councils were asked by government to consider its replacement.

Research Excellence Framework (REF)

Before the final RAE in 2008, plans were announced by the UK Higher Education Funding Councils to introduce a new system intended to slim down the administrative burden, address some criticisms and tackle the wider economic and social impact agenda.

The number of units of assessment was cut to 36 while the research profiling, from unclassified to 4*, remained. The key step, addressing impact, was the REF3 section on the "approach to enabling impact" from research by using case studies and examples. This added to previous data mandates and thus required substantial and innovative work by institutions to identify and describe relevant activity and to prepare appropriate studies for peer review.

The RAE and the REF have clearly been the major drivers for the development and adoption of comprehensive RIMS use in the UK since the late 1980s. Without an effective RIM system the administrative burden is indeed great and potentially nugatory. Assessment development will continue and further changes will add to the detail. While other concerns still exist – about gaming outcomes, poaching well-published academics close to benefit from their record, the validity of some outputs as a proxy for research excellence and the significance of "impact" as a measure across disciplines. Nonetheless, the need for comprehensive, timely and readily reconciled and validated research information remains fundamental.

Excellence in Research Australia (ERA)

Excellence in Research for Australia (ERA) replaced the Research Quality Framework in 2008 and is run by the Australian Research Council (ARC). Like the RAE/REF it uses publications and some peer review (mostly in the humanities) to assess the quality of research in the 42 universities. However, it uses a local system of profiling based on citation analysis to provide benchmarking reference points for journal publications.

The ARC declares its objectives to be to:

- Establish an evaluation framework that gives government, industry, business and the wider community assurance of the excellence of research conducted in Australia's higher education institutions;
- Provide a national stock take of discipline-level areas of research strength and areas where there is opportunity for development in Australia's higher education institutions;
- Identify excellence across the full spectrum of research performance;

- Identify emerging research areas and opportunities for further development; and
- Allow for comparisons of research in Australia, nationally and internationally, for all discipline areas.

Measures are similar to those of the REF and include citation analysis with the supplier in 2012 being Scopus. The ARC maintains a list of eligible journals for publications to count, but after a period attempting to rank these by quality they abandoned the effort for the most recent process. The Higher Education Research Data Collection (HERDC) is complied annually in Australia to inform ERA.

Performance Based Research Fund (PBRF)

In New Zealand the research funding process is called the Performance Based Research Fund (PBRF). Research is funded based on an assessment of research performance. The PBRF model has three elements:

- Quality evaluation based on peer review of published outputs;
- Research degree completions; and
- External research income including other government assessment and funding schemes.

The eight universities are awarded funds on the basis of this exercise. In 2014 the PBRF is under review to take more account of research "user" perspectives, and to reduce the cost of the quality evaluation.

eRA electronic Research Administration in the USA

National agencies such as the National Science Foundation (NSF) and National Institutes of Health (NIH) maintain a uniform and project-led research assessment environment across universities in 50 states with a combined budget in excess of $35 Bn. There is no institutional level of research evaluation. This creates a superficially simpler system for research administration than would be envisaged in Europe with its agency, national and Commission-led levels of assessment. However, within the US the administrative demands are if anything more stringent.

US government healthcare funding agencies including the NIH and the Drug and Food Administration (FDA) use a common electronic submission and reporting tool to manage research information.

Managed by NIH, the system offers open access to research grant information: "eRA systems provide applicants, grantees and federal staff the tools necessary for electronic processing of grants. Used by NIH, AHRQ, CDC, FDA, SAMHSA and the VA, the eRA Commons and IMPAC II systems support the full grants life cycle from receipt to award to closeout... The eRA Commons is an online interface where signing officials, principal investigators, trainees and post-docs at institutions/ organisations can access and share administrative information relating to research grants."

The National Science Foundation uses an online system called FastLane as well as participating in grants.gov along with all other federal funding bodies.

The US also formed a multi-agency initiative called Star Metrics to gather information on outputs from Federal science investments, with the particular aim of standardising the framework for management and collation so as to increase the comparability of cross-agency analysis. Its initial phase was to track job creation and recruitment as part of the major US investment in infrastructure. Later it moved to develop a comprehensive database of research grants and projects. This phase was associated with a very large but somewhat undefined set of measures of the impact of federal science investment on scientific knowledge (using metrics such as publications and citations), social outcomes (e.g. health outcomes measures and environmental impact factors), workforce outcomes (e.g. student mobility and employment), and economic growth (e.g. tracing patents, new company start-ups and other measures).

It has been said that Star Metrics became a solution without a defined problem, and it has yet to realise its ambitious goals. It proves an interesting example of the massive challenges in consistent data gathering around the research process, even when professionally managed agencies with well developed information systems are involved. This evidences the need for flexible RIM systems with the capacity to evolve new capabilities as policy and management requirements change and develop.

Chapter 3
Research Administration and Management – a developing function

For universities, the increasingly complex demand for research outputs has been met by a growth of research management and administration as a core function. This started from the necessary gathering of standard and regular statistical reports, unknown in most UK universities in the 1980s, to the sophisticated system run by the most research-intensive institutions today. The shift has been from a system in which most researchers operated essentially on their own towards one where specialist staff support matching resources to funding opportunities, making links between faculty, research programs and industry, complying with government regulations and ethical or political requirements, and managing the challenge of globalisation and complex competitive and collaborative partnerships.

The development of the research administration function was required to meet external expectations, but it also served emerging internal needs as the research environment became more complex and individual researchers faced greater administrative and accountability requirements. Across different jurisdictions, a profession grew up to meet that need.

In the USA, the National Council of University Research Administrators (NCURA), the oldest and largest organisation for research managers and administrators, based in Washington but with global reach, grew in five decades from establishment in 1959 to a body of over more than 7000 members.

In Europe, the Association of Research Managers and Administrators (ARMA), based in Cambridge, UK, has over a shorter period become an organisation of over 2000 members. Andrew Chamberlain, ARMA Chief Executive, describes a profession still evolving: “Of 2500 or so members we seem to have almost as many job titles”.

The members of this profession have not just become more numerous, but many also hold a significant strategic role. It is not only their responsibility to manage project finance and reporting, and support researchers. Many are also in roles where they develop research policy; manage relationships with funding organisations; and plan strategically for the sustainable growth of the research function across the institution. They gather data and analyses to inform decisions about resource allocation and strategic vision and direction.

RIMS not only provide the vital tool that underpins and enables the day-to-day function of professional research administration, but also offer great possibilities for better strategy and faster decisions leading to more competitive performance and stronger growth.

The senior academic team including the (vice-)chancellor, provost, rector and deans of a research institution is supported by the research administration, relying its management decisions based on good information and structured analytics and increasingly making use of RIMS to obtain detailed management data in the right form to support and enable smart decisions.

Principal Investigators – the academic grant holders running research projects – depend on RIMS to manage their research team, keeping work on track and reporting appropriately. Their grant managers can use RIMS to give funders timely and appropriate information. They can explore and rapidly match sources of funding to research opportunities.

IT managers take responsibility for managing and integrating the diversity of information systems used across the institution, and can exploit the capacities of well-developed RIMs to address the issues of integration, support and upgrading.

Librarians are equally important stakeholders in purchasing and managing RIMS because they embody the need to manage publication information and increasingly meet open access requirements.

Funders themselves use RIMS to manage the information they acquire from funded institutions, to plan future grant-aided programs to support strategic goals, and to match funding priorities to areas where they perceive opportunities of greatest impact.

The following perspectives from stakeholders explore the value RIMS can offer, triggers to purchase, and the drivers for their adoption and use.

Chapter 4
Perspectives

Research Administration and Management

Professor Glenn Swafford is Director of Research Administration at the University of Oxford, managing one of the largest research organisations in the world. Professor Swafford recalls that for many years, university administrations spent considerable time and money on HR and finance systems, but did not regard research admin systems as a priority. RIMS development was therefore a mixed picture in the twentieth century.

Early systems fell into three categories:

- Excel spreadsheets, still used widely by many universities around the world;
- Individual components, often single-purpose systems, built within a university to meet a particular need; and
- Enterprise level systems purchased from the commercial world and adapted to manage research activity.

Jesse Szeto, Senior Manager at NCURA Global, says that many departments still managed with paper-based systems involving complicated and time-consuming routing around the organisation right up to the last ten years or so. The earliest RIMS grew out of accounting packages, with many home-grown and specific to a particular institution. As research became a strategically important business, and communication with government systems became important, the demands on systems grew.

Professor Swafford remembers in the late twentieth century attending an NCURA congress and seeing long queues at a stand giving away floppy disks of the early MIT software package Coeus. In those early versions Coeus was designed to manage proposal and award information, but for the increasingly complex job of late twentieth century research admin this was a very valuable tool, and has continued to develop. Around the world other university teams were developing their own software to manage research information, and at Imperial College London a system that became Symplectic Elements was created.

Since those early software packages, the leading research information management systems have become more mature and reliable, effective at providing core reporting and management tools, and increasingly are becoming integrated with other essential systems. However this development has been slowed, in Professor Swafford's opinion, by the fact that universities could be better at explaining their needs, and by the lack in the initial period of commercial providers. For Professor Swafford, there is a choice between the large single system and the "best of breed" suite including systems for managing grants, ethics, applications, negotiating contracts, IP management and patents, and graduate student management. The ability to link and integrate these modules is emerging slowly.

At Oxford, Symplectic Elements was purchased primarily to help with REF compliance, and to tackle the difficulty in assigning publication outputs to appropriate individuals and teams. The next challenge is to find a way of interconnecting the 15 or more systems used to manage staff and information. Symplectic have been quick to engage users in developing features, according to Professor Swafford, but like all systems providers will need to recognise the need to build APIs to link with others because few customers will be prepared to build or buy a single "big system" solution.

ARMA CEO Andrew Chamberlain believes important emerging benefits from using RIMS are to demonstrate value for money in research, and in particular describe societal benefit more richly both within and outside an organisation.

RIMS also help an institution to work out budgets and track outcomes. The more sophisticated systems also help ARMA members with their functions. These days ARMA members are involved in project management, sourcing funding, providing core reports to funders, helping with recruitment of individuals and creation of teams, identifying research partners particularly for multinational grant projects, budgeting, managing laboratory building, and strategic planning.

"Few in the UK are currently using RIMS for strategic planning, though this is growing," says Chamberlain. "At the moment REF is the leading function for members, though systems offer new opportunities, and once directors can get a whole organisation view they have the power to direct resources and make new choices. Currently the sector-wide angle is missing because the consequences of REF are paramount. Some people are losing their jobs. Institutions are becoming more competitive. There is a massive business need to pay your way and grow. Harvard, Yale and the Ivy League have led the way."

One of the major challenges is to create a culture in an organisation where RIMS data is maintained correctly and completely by researchers in every department. Many of the strategic or reporting needs at the higher macro level can only be realised if there is compliance at an individual micro level. The best way to do this is to make RIMS part of the research workflow, for example by building in reputation building and publication sharing tools and making systems data maintenance not only a matter of policy but also a part of research workflow.

David Ngo, Assistant Vice President of Sponsored Programs Administration at UT Southwestern, describes the benefits of working with RIMS as follows:

- "Making things more streamlined: systems help with handoffs, roles/responsibilities, etc.
- "Creating transparency: systems help answer the questions: "Where is this at?" "Why isn't this done?" "Is this done?"
- "Driving consistency: systems help force consistency and ensure everyone does their part.

- "Reducing audit risk: systems allow for checks/reviews to be done; as signoffs are needed and recorded, the systems also help enforce policy/procedures.
- "Creating efficiency: systems help the user do their job quicker; for example, a system field might be an auto lookup, which saves the user from having to manually lookup or go to another site to find the information; systems also have workflow/queue/lists that will tell the user what is awaiting their action.
- "Improving reporting: these reports can be pretty powerful; for example, if we notice that a specific NIH center always cuts our proposal budgets by a certain rate, and awards at a lower proportional rate, we will want to know why. With the data being a first flag of a problem/trend, we perhaps could begin outside investigations to understand why these cuts are being made. It could be the answer is that the cut is an NIH center mandate, or it could be a certain Program Officer's initiative, or it could be our budgets are too high or not high enough, or it could be related to the field (basic/applied/nanotech), etc. With this information, our leadership can begin to strategise on solutions to mitigate impacts."

Ngo also offers thoughts about implementation: "Multiple systems need to talk to each other to maintain ease of use and data integrity. An IT manager can be great to have on the technical side; you may also want to consider having a functional lead to align. Or if you need multiple functional leads, a governance working group might be a strong idea."

Senior Leadership

Strategic use of RIMS is becoming possible, offering significant benefits including the following, As Universities gathered this information about their activities, and those of its employees, the senior leadership gain:

- The ability to manage the research environment to improve researchers' productivity;
- A way to raise the profile of work across the institution as well as at departmental level; and
- Tools to refine the allocation of resources to different departments and teams

Effective RIMS must support the different management styles employed between and sometimes within universities: the requirement to know centrally what is going on, and to deploy resources accordingly; while simultaneously offering a bottom-up approach to help academics succeed. But to be really successful RIMS should, in Professor Swafford's words, "cobble together information from other parts".

Professor Swafford describes the core requirements at institutional level from RIMS:

"It is as simple as being able to identify individuals working across the university. How am I to know the difference between the Tom Smith who is professor in one department and Tom Smith, the new post grad student in another? Our aim is to never ask twice for the same information, and to use it many times to support research activity. Effort expended in managing information needs to be outweighed by the value it creates. We want information to be trusted, include quality data, and useful for making decisions. It must be easy and quick to collect data, and to share it widely across the organisation and beyond."

"If managed correctly we can use information to match staff to potential grants. We can also identify areas of expertise, and this is done far more accurately by linking to publications than by attempting to categorise centrally. For example, I may give someone a label of social psychologist when they think of themselves as an anthropologist. A team might be categorised as working on climate change when in fact their expertise and work is in climate modeling.

"A good research information system will capture relationships correctly first time and maintain them correctly. For instance matching supervisors to students, or attaching grants to individuals and groups."

RIMS need to provide support for standard management reporting, so users can assess research strengths and make strategic plans. For instance, Symplectic Elements is optimised for SQL queries and supports SAP Crystal Reports and Microsoft Reporting Services. Statistical analysis and customisable staff reports are simple to produce.

Researchers

The principles of well-managed research data are well known, and form part of the training every research student receives during induction in many universities. For example, the research data management training course MANTRA developed at the University of Edinburgh offers a very comprehensive list of benefits to the researcher, including compliance issues: http://datalib.edina.ac.uk/mantra/researchdataexplained.html.

At the University of Oxford benefits of good research data management are spelt out on the Research Data site for all staff (http://researchdata.ox.ac.uk/home/introduction-to-rdm):

"Data management is a key part of responsible research. Good practice in managing your data will ensure benefits ensue for you, your fellow researchers and the wider public.

- Funding and regulatory body requirements are met.
- Research data remain accurate, authentic, reliable and complete.
- Duplication of effort is kept to a minimum.
- Research data keeps its integrity and research results may be replicated.
- Data security is enhanced, thus minimising the risk of data loss."

Individual researchers can also exploit the value of RIMS to:

- Manage work including collaborations across departments, universities, countries, continents;
- Publicise work more effectively;
- Receive kudos and manage reputation dynamically;
- Showcase work and share publications; and
- Use work in other contexts, for instance in teaching.

The Elements system from Symplectic, for example, offers research staff the opportunity to capture their teaching and other work. It is important for many staff, in the USA in particular, to capture data about their time teaching courses, supervising students and correcting examinations.

This is because a large part of their faculty assessment is based on their teaching activities. A new Elements module allows researchers to create, capture and display teaching activities alongside their research outputs. Like other modules, all data captured in the Teaching Activities module is accessible via Elements' in-built reporting functionality, the API and in the Reporting Tools database. This means clients can create customised reports with the data and save themselves significant administrative effort.

Elements also provides support for reputation management systems, by keeping profiles up to date (for example Elements integrates with ORCID and supports VIVO, the web-based discovery tool for researchers and Profiles RNS). Elements also integrates with Altmetric, the impact visualisation tool for published research, and by so doing gives a measure of social impact of work.

Librarians

Core to the choice and use of RIMS are the library staff. Increasingly demanding requirements from funders include the mandate for open access, with slightly different rules but a core set of requirements depending on the grant giving body. Systems are now being used to manage publications metadata from across the web. For instance, Symplectic's Elements searches journal databases to bring in papers published by researchers across a client institution. External data sources include Web of Science, Scopus, CrossRef and open science networks such as figshare; providing comprehensive coverage of STEM disciplines with growing support for the social sciences and humanities. Researchers can also import previous work to Elements from Google Scholar or Mendeley in major formats such as RefMan, Bibtex and Endnote.

In addition RIMS need to support institutional repositories. Again Elements provides direct access to over 4 million OA full-texts and 26 million abstracts through integrated data sources such as Europe PMC and arXiV. The Elements interface can be extended to the institutional repository with out-of-the-box support for all major open repository technologies (DSpace, Fedora and EPrints). Elements also allows researchers to deposit with customisable copyright advice and OA statuses from Sherpa/RoMEO, with full embargo support and filtering by RoMEO color.

Another benefit of rich staff information from RIMS is the ability to optimise and organise subscriptions, allowing libraries to make their budgets go further without wasting funds on journal subscriptions that are irrelevant to staff needs.

Funders

Dr Liz Allen is Head of Evaluation at the major UK-based non-profit medical research funder Wellcome Trust. The Trust spends well over US$1bn each year supporting research to improve health. In her view funders have separate needs but pretty standard requirements. In recent years the impact agenda has driven behaviors.

Over a decade ago, the agenda was rather different. Most funders were set up to get grants out, and there was less tracking, with perhaps an annual report or an end-of-grant report, but no more. The move to online reporting from paper allowed much more structured and useful information to be made available. Outputs (published papers) are easy to track through portals such as PubMed, and narrative project reports can be managed and archived. In Dr Allen's view, however, it is hard to police "effort" in research: "we can link work to money, check if it is on track, learn from and use research, lessen audit, but can't tell the value or effort from quantitative work."

Instead RIMS offer huge value in providing a source of intelligence to influence funder strategy. Wellcome Trust use Uber Research, a specialist decision support system for science funding bodies, to map the health research world for strategic purposes. This offers a way to get portfolio reporting, to map the NIH portfolio against other funders, and to look at top universities in an area and research by institution. Wellcome identify peer reviewers, look for underfunded areas and root out duplication, and consider new funding niches. In short it drives their strategy.

In pursuit of this mapping tool using research information, standards and "translations" of research classifications are now being sought and developed. The future of RIMS will be shaped accordingly, and Dr Allen has been part of this effort: http://www.health-policy-systems.com/content/10/1/28/abstract.

IT Manager or Systems Administrator

Implementation of any system is a challenge, and interconnected systems such as RIMS can cause great difficulties, not least because of the range of different users and uses.

Jesse Szeto of NCURA cites the development of RIMS at the University of Wisconsin – Madison, where PeopleSoft accounting system was used, and later the PeopleSoft Enterprise Grants Management RIMS was added. One size doesn't fit all, and customisation is needed right from the start. Idiosyncrasies abound in educational establishments and research institutions, with hierarchy wildly different in each place. Some departments are bigger than whole schools, some schools exist without research while neighboring medical schools have billions of dollars in research budgets. It is a challenge for any system to accommodate this variety and variance in size and complexity. The University of Wisconsin – Extension alone has 70 offices in the 72 counties with each having different logins and servers and user requirements; a challenge for any IT department!

Interconnection and the use of APIs, as well as standard data and exchange formats, are contributing, but the challenges for implementation and maintenance are still a significant issue which means the IT department is an important RIMS stakeholder.

Chapter 5
Conclusion: Future Trends

The seeds of future change are foreshadowed in the continuing development of user requirements and technical capabilities. Within this we can identify a number of key drivers.

New reporting requirements from funders

Changes in funder reporting requirements will continue to drive the development and further adoption of RIMS. One recent example cited by Jesse Szeto of NCURA is the introduction of regulations to require the reporting of financial conflicts of interest by NIH, which have led to changes in RIMS to support that requirement. For example, any professor funded by an NIH grant must now report travel sponsored by a third party – such as a pharmaceutical company. The enforcement of this requirement has sent institutions scrambling to create or amend policies, to make sure systems support them, and to train staff in the new duties this places upon them.

Pressure on costs

The cost of managing research data and information continues to be an issue, but when systems evolve to bring data maintenance into the research workflow then there are savings. Cost can also be reduced by better integration, avoiding the need to maintain the same data in more than one system. However funders are also able to require fuller datasets, and that they be made publicly available. The direction of travel indicates that funders also demand more insightful (and expensive to produce) measures of impact, rather than citations or publication output measures.

New academic tools for integration

New reputation tools such as Kudos (www.growkudos.com) require sophisticated support and development work from all RIMS providers. Wider use of existing tools like VIVO will make it more important for systems across the world to support this aspect of work, if they are to retain support from researchers.

Complex institutional boundaries

Andrew Chamberlain of ARMA points out another emerging issue for RIMS: “institutions no longer have neat boundaries, instead we have complex institutions with devolved research departments and spin-off companies – are they in or outside the scope of RIMS? One example is Salford Software, a wholly owned company at Salford University. Is this inside the scope, or outside?”

New forms of research data

Research data management used to mean managing publications. Now in many fields it means managing a much more complex range of information types, including large data sets, multimedia information, teaching materials and structured models. What’s more, they need to be curated effectively to make sure that correct versions are being shared and used by other research collaborators. RIMS must react to this requirement to capture and manage more complex research data. For example, Symplectic Elements’ Teaching Activities module captures details alongside research outputs and makes it available in reports. Elements is also integrated with figshare, a cloud-based repository for files of all kinds.

Emerging standards

As agreed standards emerge, RIMS will need to adopt them to retain position. For example, the Consortia Advancing Standards in Research Administration Information (CASRAI) is a non-profit standards development organisation, consisting of research funders and institutions worldwide collaborating to ensure seamless interoperability of research information. CASRAI are working to develop and maintain a common data dictionary and advance best practices for data exchange and reuse between research teams, institutions, and funding agencies throughout the entire life-cycle of research activity. Further details of their work, which is essential for RIMS developers to accommodate, are available at http://casrai.org.

Other projects underway include “Snowball Metrics” – a project to develop metrics involving eight higher education institutions plus Elsevier, the science publisher, independently of other organisations with potentially distinct aims such as funders and government groups. The Snowball Project partners state that “The aspiration is for these metrics become global standards that enable institutional benchmarking, support institutional decision making, and cover the entire spectrum of research activities.”

Advantages in responding to emerging challenges

It pays for a RIMS developer to have a detailed understanding of higher education institutions, and many come out of developments in-house. For example, Symplectic has its roots in Imperial College London, and as such has been able to use the “insider awareness” of its developers and its origins.

It is also an advantage for RIMS to be part of a portfolio of developments for the research market, so that innovation can be triggered from various directions, and integration comes built into solutions. For example, Symplectic’s Elements system is part of the Digital Science community; and by working with other portfolios such as VIVO, figshare, ORCID and CASRAI allows Elements to innovate at a much faster pace than some competitors.

For example, through Symplectic, Altmetric can add information to people’s CVs or aggregate data at an organisational level. In addition figshare data can add information as appropriate about usage of tables, figures and a wider range of datasets. Senior management can also find value in tracking usage across the institution. Also part of the Digital Science community is ReadCube, a free, cross-platform desktop application that enables researchers to create and manage their personal content library, and intuitively discover new literature in their field through daily recommendations. The possibility of having full text available from the repository and monitoring the way in which the papers are used by others will offer great value.

Glossary
Terms

AHRQ	US Agency for Health Research and Quality http://www.ahrq.gov
ARC	Australian Research Council http://www.arc.gov.au
ARMA	Association of Research Managers and Administrators https://www.arma.ac.uk
CDC	US Centers for Disease Control and Prevention http://www.cdc.gov
CERIF	Common European Research Information Format, a standard managed by EuroCRIS http://www.eurocris.org/Index.php?page= featuresCERIF&t=1
CRIS	Current Research Information System – synonym for RIMS
DELNI	Department for Employment and Learning, Northern Ireland http://www.delni.gov.uk
ERA	Excellence in Research for Australia, the research assessment programme in Australia http://www.arc.gov.au/era
eRA	electronic Research Administration, systems used in USA for grant information management by government agencies http://era.nih.gov
ERP	Enterprise Resource Planning, as in ERP system (business management software)
FDA	US Food and Drug Administration http://www.fda.gov
HEFCE	Higher Education Funding Council for England www.hefce.ac.uk
HEFCW	Higher Education Funding Council for Wales, distributing funds for education and research http://www.hefcw.ac.uk

HERDC	Higher Education Research Data Collection – Australia's annual collection of research data https://education.gov.au/higher-education research-data-collection
NCURA	National Council of University Research Administrators http://www.ncura.edu
NIH	US National Institutes of Health http://nih.gov
OA	Open access, as in OA mandate, OA publishing
PBRF	Performance Based Research Fund, New Zealand's process for assessing and funding research http://www.tec.govt.nz/Funding/Fund-finder Performance-Based-Research-Fund-PBRF-
PI	Principal Investigator – Lead Professor in a research area or project
QR	quality-related, or quality weighted research, as in QR funding (see RAE)
RAE	Research Assessment Exercise – predecessor to the REF http://www.rae.ac.uk
REF or **REF2014**	Research Excellence Framework – UK system for assessing the quality of research in UK higher education institutions http://www.ref.ac.uk
RIMS	Research Information Management System
RQF	Research Quality Framework, predecessor to ERA in Australia
SAMHSA	US Substance Abuse and Mental Health Services Administration http://samhsa.gov
SHEFC	Scottish Higher Education Funding Council, now merged with further education and known as the Scottish Funding Council www.sfc.ac.uk
VA	US Department of Veterans Affairs http://va.gov

RIMS
Examples

The table shows a range of current systems. The descriptions are sourced from their developers.

RIM System	How they describe the system
Thomson Reuters Converis	Thomson Reuters Converis specialises in the development and implementation of Current Research Information Systems (CRIS). Our flagship research information system, CONVERIS® 5, supports universities, other research institutions and funding agencies comprehensively in collecting and managing data throughout the complete research life cycle. http://www.avedas.com/
Elsevier Scival Pure	Scival Pure facilitates an evidence-based approach to your institution's research and collaboration strategies, assessment exercises and day-to-day business decisions. http://www.elsevier.com/online-tools/research-intelligence products-and-services/pure
Epistemio	Epistemio Outcomes helps research groups and institutions to gain time and focus by improving the management and reporting of their lists of publications http://www.epistemio.com/
InfoEdGlobal	InfoEd Global is the world's leading provider of software to support Electronic Research Administration. http://infoedglobal.com/
PeopleSoft Enterprise Grants Management	Oracle's PeopleSoft Enterprise Grants Management software is an entirely web-based solution that manages the full life cycle of research administration, including proposal generation, transitioning proposals into awards, award tracking, facilities and administration processing, comprehensive bill generation, and flexible financial reporting. http://www.oracle.com/us/products/applications peoplesoft-enterprise/service-automation/peoplesoft grants-management-065800.html

RMAS	Our vision was that this would be a modular, cloud-based service to support any university's research management and administration functions irrespective of its current position. http://www.rmas.ac.uk/
rSmart	rSmart makes open source software enterprise-ready, easily deployable, and fully supported for colleges and universities. Our solutions include financial, HR, payroll, student services, library, and research administration systems. We build on top of Kuali open source, ERP software, adding key capabilities, cloud delivery, consulting services, and support to maximise the benefits of open source software and minimise the risks. http://www.rsmart.com/
Symplectic Elements	Elements is a powerful, complete and integrated research information management system that helps research institutions to collect, contextualise and report on all their research outputs. It is used by thousands of researchers, research managers, repository heads and librarians in some of the worlds leading institutions. http://www.symplectic.co.uk/
Über Research	ÜberResearch is a software solutions company focused on helping funding organisations, non-profits, and governmental institutions make more informed decisions about science funding. They manage a consortia of shared awarded grants data from participating funders with the goal to improve decision making, reduce duplication, and advance research. http://www.uberresearch.com/
Wellspring Sophia	Specifically, Sophia is enterprise software that manages your organisation's knowledge assets and network of innovation partnerships. Leading innovators actively develop and manage their knowledge assets: from test data to patents to publications to expertise. http://www.wellspringworldwide.com/sophia