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A BRIEF BUSINESS HISTORY OF AN ON-LINE DISTRIBUTION SYSTEM FOR ACADEMIC RESEARCH CALLED NEP, 1998-2010

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Structured Abstract

Purpose Applications of information technology have been directly responsible for the increase in productivity of business, government and academic activities. Business and management historians have yet to contribute to better understanding such processes. This paper aims to address this shortcoming through the internal and organisational history of a system for speedy, online distribution of recent additions to the broad literatures on economics and related areas called NEP: New Economic Papers.

Design This is a first person account (partly autobiographical) which also includes interviews and the use of archived e-mail correspondence.

Findings The advent of the Internet promised a revolutionary change by democratising the social institutions related to the creation and dissemination of academic knowledge. Instead, this story tells how participants slowly but steadily tended to replicate established institutions.

Research limitations Researching the impact of the Internet on organizations is a promising topic for historians, for which this might be one case study.

Practical implications The development of NEP provides an illustrative example for the kind of new business models that have emerged as the Internet has been used by creative minds to provide existing services in a new way.

Social implications This paper provides a story of the NEP project and shows how one person's drive could generate a broader community of volunteers (constituted by a large number of academics and practitioners who provide critical support for its functioning). We provide details of the social and technological challenges for the construction of the technological platform as well as the evolution of its governance.

Originality There is no historiography in business and management history on how to deal with changes in archived material resulting from the application of information and telecommunication technologies. Given the rate of change for events in the third industrial revolution, this article shows is its possible and indeed relevant to document events in the recent past.

Keywords: digital libraries, on-line communities, New Economic Papers (NEP), RePEc

October 2011 (10,078 words – including tables and references)

[1] Previously circulated as 'On-line distribution of working papers through NEP: A Brief Business History' (http://ideas.repec.org/p/wpa/wuwpeh/0505002.html March 2005). Research assistance from Elena Moran and helpful comments of Damir Jelic, John S. Irons ,Marco Novarese, Antonio Tena, Leandro Prados de la Escosura, Larry Neal, Bill Russell, Fernando Guirau, Jeff Yost, Thomas Haigh and anonymous referees as well as staff presentation at Universidad Carlos III, Universitat Pompeu Fabra and Dundee University are gratefully acknowledged. The usual caveats apply.

Introduction

The so-called WIKILEAKS affair, in which major international newspapers published and commented upon previously secret, classified and private e-mail correspondence distributed by an international, non-profit organisation;[2] has richly demonstrated how information systems themselves are now the *fons et origo* of contemporary and future archives. Indeed, Grier and Campbell (2000, 32) and the ethnographic study in Ketly (2008) note the challenges to historical research of the Internet era include the ephemeral nature of network correspondence (such as that by chat programmes), the lack of archives of early e-mail, rapidly decaying and fast obsolesce of storage media (e.g. floppy disks). Research documented in this article shows that the appearance of e-mail management and distribution list programmes help to address the challenge of new media archives by enabling a systematic storage from where a coherent picture of historical phenomena can emerge (see also Victorsson 2007). But important challenges for future research in business and management history remain even where records do exist because there is no clear historiography to deal with such archives nor how to deal with the new organisational forms of the late twentieth and early twenty-first centuries. Indeed, with the notable exceptions of Locke and Schöne (2004) and studies documenting the automation of banking (see Bátiz-Lazo *et al.* 2011, and references therein), the discussion of business and management historians around the nature of the third industrial revolution has been limited to the impact of information technology applications over the continuity and longevity of the Chandlerenian model of the firm (e.g. Chandler 2005; Galambos 2005; Lamoreaux *et al.* 2003; Langlois 2003). Hence, there is very little on offer to help explain the creation of digital organisations (Brynjolsson and Saunders 2010).

By documenting the creation of a service to the academic community using a combination of first-hand accounts and e-mail correspondence this paper offers not only a case study of a new organisational form but also a way to deal with new archival material emerging from the advent of the Internet. As a result, this paper offers interesting avenues for the use of electronic media and the study of digital organisations for future research in business and management history. The premise for this is study is how applications of information technology provide new ways for organisations and individuals to co-operate

[2] See for instance http://www.guardian.co.uk/media/wikileaks (accessed 07/Oct/11).

with one another (Castelles 1996). Specifically, the way an Internet service was managed through the formative years of information provision to a particular community of people. It reflects the trials that this service had especially as its service providers changed. This effort is in tandem with growing interest to better understand from an historical perspective the means upon which geographically disperse communities use the Internet to interact (e.g. Abbate 2010; Aspray and Ceruzzi 2008; Campbell-Kelly 2003; Elzen and Mackenzie 1994; Russell 2008; Varian and Schonfeld 2003). The emphasis of these contributions, however, is how engineers developed its infrastructure, that is, the software, platforms[3] and protocols that link them. Other studies look at how users built the social networks that made them useful (e.g. Dongarra *et al.* 2008; Grier and Campbell 2000; Hargittai 2007; Kelty 2008; Shumate and Dewitt 2008; Tapscott and Williams 2006). But these studies neglect the managerial and corporate governance challenges around these communities. As has been documented by among others Lerner and Tirole (2002), there are implicit hierarchies in these apparently democratic organisations. Therefore, the emergence and evolution of these practices is of interest to business and management historians.

In particular, this papers looks at the use of hyperlinks as a community-building tool. Defining a community and particularly an Internet community can be elusive. Akera (2008) noted that different types of Internet communities appear under different modes of operation. The higher education community has set up social institutions that help and foster free-flow of ideas, networking, association and interaction while looking to facilitate exchanges and synergy amongst people of similar interests. Examples of the latter to distribute innovations to the academic literature include peer-reviewed outlets, conferences and social networks. In some areas controlling the output of a dozen or so peer reviewed publications was enough to keep up with developments. This partly resulting from a high concentration of the main contributors in specific geographies (namely USA, Western Europe and Japan) but also due to a clearly-defined research agenda. In other areas and subfields, however, the main contributors were highly dispersed across the globe and the research agenda responded to a large, atomistic set of interests. The focus of

[3] A software platform is a general-purpose technology that makes services available to other software programs through application programming interfaces (APIs or in the vernacular, apps) (Evans *et al.* 2008, vii).

this paper is a geographically disperse academic community and the managerial challenges a group of members faced when bringing it together through a collection of hyperlinks stored in the form of a digital library.

Hyperlinks are at the heart of the Internet and these do not appear automatically or at random; the way they intertwine represents individual communities and their intentionality (Thewall 2005). Networking is the operative term here as it allows individuals to meet strangers (or in this case, new additions to a particular area of knowledge) as well as make visible their own contributions to their community (Boyd and Ellison 2007). A purposeful collection of hyperlinks not only offers means for connecting creative work together but it also establishes which people and ideas have the right to be heard and their ranking in matter of importance (Shumate and Dewitt 2008, 407 and references therein). For instance, the apparition of a large number of online journals (that is, digital-only archives of publishable material with the potential to network through hyperlinks) was heralded by some as the advent of a new regime, with the end of private publishing houses appropriating residual income of academic effort as well as promising to increase the potential for a larger number of individuals to influence and have an impact on research agendas. However, the likelihood of this potential impact varied substantially given idiosyncrasies across disciplines and subfields. Many of these online journals soon disappeared, chiefly because their publications were considered of insufficient quality for inclusion in tenure track and job market selection processes. However, some new organisational forms supporting the academic community created in the early years of the Internet were successful as they grew in scale and scope. We tell the story of one of these.

Although designed to be widely accessible, digital communities will typically attract a homogenous population (at least initially) (Hargittai 2007). This is reflected on previous research investigating how academic communities use the Internet (Dongarra *et al.* 2008; Estrin 2000; Grier and Campbell 2000). Here the contributions by Thelwall (2002; 2003) are of particular interest as they established the value of academic enquiry into the formation, structure and meaning of hyperlink networks and the use of the Internet by academics more generally. A theme emerging from these studies relates to how the higher education academic community across the world is a domain supported primarily through public funding and very much geared up to the production of

"public goods". Public goods are said to have two main characteristics, first, consumption of the good by one individual does not reduce availability of the good for consumption by others; and, second, that no-one can be effectively excluded from using the good. Bimber *et al.* (2005) and Fulk *et al.* (1996) extend the definition of public goods to include information and computer-mediated public goods. Shumate and Dewitt (2008, 409) specifically point to collections of hyperlinks as a form of public good as their use by one individual searching the network does not decrease but rather increases its value for participants. They are also characterised by the impossibility of exclusion given their access through the Internet as long as an individual has a computer and Internet connection.

In summary, the case study in this paper details the emergence and key stepping stones in the evolution of the technical infrastructure supporting a hyperlink network in the form of an online digital library of working papers. As a result, it adds to the understanding of how technological solutions mapped to a particular academic community. This technological infrastructure was created to offer a service for speedy, on-line distribution of recent additions to the broad literatures on economics and related areas and was called NEP: New Economics Papers.[4] NEP emerged as part of a wider project called RePEc: Research Papers in Economics, a digital library that facilitated distribution of contributions to the relevant scientific communities through the Internet. Another major digital library was the Social Science Research Network (SSRN), which in the mid-1990s started to charge for accessing its services, including subscription to e-mail distribution of pre-print academic texts. This by storing hyperlinks to actual articles in RePEc and disseminate new additions through NEP. NEP was thus born in 1998 as free-of-charge alternative in the digitalisation of collections of pre-print academic articles.

The creation of NEP required developing social and application programming that interfaced with RePEc. A combination of purpose-made, open-source and free software enabled NEP to achieve its aim of facilitating interaction between decentralised groups of like-minded scholars and users of academic research. Open source and free software applications were adequate (but not essential) to create a scalable model. Having the means was a necessary but insufficient condition for success because building a sophisticated community is largely a

[4] http://nep.repec.org (accessed 22/Oct/10).

social activity. Success was contingent to reaching critical scale in the number of users and items in the digital library, sorting out issues of high fixed costs, attracting talent to develop incremental innovations and differentiation. Challenges also included sorting out the consequences of decisions about the technical infrastructure such as the selection of readymade vs purpose specific applications, negotiating host computers, etc. The narrative also tells how NEP resisted attempts to develop into an online journal as a way to attract new collections and therefore, make the network more valuable to new and prior subscribers (that is, the emergence of network externalities). But as the number of subscribers, collections and editors grew, coordination required evolution and adaptation of responsibilities, progressing from *ad hoc*, fortuitous collaboration to the introduction of processes, procedures and formal governance (selection of content and editors, duties and responsibilities of general editor, role of editorial and technical board, etc.).

Fieldwork in this paper combined multiple source material to document technical and organisational developments of NEP. The research method goes beyond simple observation of a distributed phenomenon as the authors were deeply involved in creating NEP and building the community around it. This experience helped to explain the history of these resources and their continuing impact. However, the research method also introduced interviews and archived documents (primarily in the form of e-mail exchanges).[5] Following established best practice in this area we solicited views and comments on the document from other people involved in the development of NEP and RePEc. They provided their accounts separately and we conducted several rounds of drafting as the narrative grew increasingly detailed. Drafts were crossed-checked by all participants. Alongside this process, archived documents were also gathered. These encompassed protocols, statement of intent, software and contemporary e-mail correspondence (both private and through discussion groups) while aiming to verify details and prompt more accurate recollections. The process of "triangulation" between personal recollection, interviews and archives eventually yielded a stable and robust narrative.

[5] E-mail correspondence is noted below through its URL. Access to these and indeed other NEP and related data can be granted to any *bona fide* researcher by subscribing to and requesting access through NEP-researchers@lists.openlist.org (see http://lists.openlib.org/cgi-bin/mailman/listinfo/nep-researchers accessed 08/Oct/11).

The reminder of this paper proceeds as follows, the next section tells of NEP's origins and growth in scale and scope. It also documents the evolution of its governance. The third and final section reflects on the case study of NEP and offers conclusions.

The Technological Infrastructure of a Current Awareness Service

Origins of NEP

NEP was conceived as an initiative to go beyond the legacy model of digital library services (see Cortada 2008; Krichel and Chu 2003). NEP is a human-mediated current awareness service (CAS), that is, a service that informs users of new documents within a subject of interest. Most CASs are run by publishers or producers of specialised abstracting and indexing (A&I) services . If the CAS is run by a publisher, it is usually limited to books, journals and other products from that publisher. If the CAS is run by an A&I service, the CAS is available to subscribers-only. Most current awareness services are produced by a computer. Usually, it means that a piece of software is looking for some terms in the document or some other criteria such as the membership of a document in a certain collection. If not produced by computer, a CAS can be quite expensive to produce.

Krichel (2007b) identified three types of CAS, namely common classification based, keyword based and usage history based. The first refers to the computer filtering new information into a pre-determined classification (such as "sports", "national politics" or "culture"). This works well as long as vocabularies in documents of different classes is very distinct (e.g. Google News). Academic information, however, tends to be difficult to classify. A second type of CAS is the keyword based, where a user builds up a profile of his/her interests and files it with a service provider. The provider will e-mail documents that contain those keywords (e.g. Nexis contents alert or work opportunities by jobs.ac.uk). This works well if the keywords are right. Unfortunately this is difficult for academic documents[6] as getting the keywords right is often elusive (e.g. searching for jobs in "management" can return both openings at business schools and administrative work in universities). Thirdly, in a usage history based CAS where a system tracks account activity to build up a profile of

[6] Krichel and Zimmerman (2009) define academic texts as "documents that authors do not expect to be paid royalties for, that are targeted towards a very specialised audience and that do not contain advertising." (p. 15).

interest of the user (e.g. suggestions at Amazon.com). It works well as long as user interests remain unchanged. But it is hard to think of a unified system to catalogue usage of academic documents that a computer could watch.

The inadequacies of computer generated CAS for academic work led to the development of human-mediated CAS. The earliest known CAS in economics dates to the efforts of Mr Fethy Mili at the University of Montreal.[7] Around 1993, Mili created the first electronic announcement service of working papers. Collections of research articles deemed suitable for publication had grown in popularity as the queue for publication in peer-reviewed outlets grew ever larger. Academics found in these collections a way to make available to a wider audience research which had been accepted for publication (or deemed to be of publication quality by their department). Access to these collections, however, was limited and restricted to libraries where hard copies were deposited by authoring institutions. Mili found a way to give a wider audience access to working paper collections by managing a CAS through an e-mail distribution list, in other words, he would inform of recent additions by e-mail to subscribers of his list. These additions sourced in hard copies of working papers deposited at the Library of the University of Montreal. Subscription to Mili's list was free but subscribers had to post or e-mail a request directly to the authors and not to Mili (who did not have the staff nor copyright clearance to deal with individual requests).

Also in 1993, Thomas Krichel[8] (then at the University of Surrey) established NetEc[9], a consortium of Internet projects for academic economists.[10] One important part of the NetEc consortium was WoPEc, a service for electronic working papers in economics. Between 1996 and 1999, the NetEc group received support for its WoPEc project by the Joint Information Systems Committee (JISC) of the UK Higher Education Funding Councils, as part of its

[7] The bibliographic information of these holdings was incorporated into NetEc in 1997 (http://www.economicsnetwork.ac.uk/cheer/ch11_1/ch11_1p19.htm Accessed 20/Nov/2010).
[8] http://openlib.org/home/krichel/ (accessed 01/Nov/2010).
[9] http://netec.mcc.ac.uk/ (accessed 25/Mar/2005).
[10] Dongarra *et al.* (2008) Tells of the evolution of a similar effort to form a digital collection of mathematical software, papers and databases in the 1980s. By the 1990s such collections seem to have become popular in other fields. For instance, Joseph Halpern (then at the Centrum Wiskunde & Informatica) wrote to Francisco Moraiz (then at the University of St Andrews and editor of nep-gth) how through his work at the Computing Research Repository or CoRR (http://arxiv.org/corr/home accessed 20/Nov/2010) left him with the impression that: "Right now [2002) there seems to be too many game theory repositories; the orginal one at Washington University (which seems somewhat moribund), the WoPEc/RePEc repository, the ERN repository, and others. I wonder if there's a way of hooking them all together, so that there is one, rather than just many." (e-mail 22/Jul/2002).

Electronic Libraries Programme (eLib). In 1997, Krichel further developed WoPEc into a decentralised database of hyperlinks to working papers (i.e. recent research reports prior to formal publication), journal articles (i.e. peer reviewed writings) and software components called Research Papers in Economics or RePEc. By March 1999 RePEc had grown into an interconnected network of over 60 archives holding over 13,000 downloadable papers and over 50,000 descriptions of offline papers from close to 1,000 series, as well as data about over 4,000 academic Economics department and research institutes (Karlsson and Krichel 1999). RePEc grew to be one of the two main recipients of specialised information for academics through the Internet (surpassing the likes of Google[11]). See Table 1 below.

Table 1: Number of Items in RePEc, 1998-2010

Year end	**Working Papers**	*% of total*	*Annual Growth*	**Journal Articles**	*% of total*	*Annual Growth*	**Total***	*Annual Growth*	**Downloadable**	*% of total*
1998	54,954	86%		8,414	13%		63,629		11,651	18%
1999	61,972	81%	13%	14,484	19%	72%	76,930	21%	20,870	27%
2000	79,650	69%	29%	34,741	30%	140%	115,040	50%	35,337	31%
2001	94,562	64%	19%	52,166	35%	50%	147,497	28%	59,225	40%
2002	106,257	61%	12%	67,154	39%	29%	174,272	18%	84,289	48%
2003	120,058	57%	13%	88,461	42%	32%	210,321	21%	117,640	56%
2004	143,530	48%	20%	152,338	51%	72%	298,293	42%	201,525	68%
2005	169,727	47%	18%	184,993	52%	21%	357,666	20%	257,397	72%
2006	199,152	44%	17%	247,840	55%	34%	451,079	26%	343,775	76%
2007	224,744	40%	13%	327,430	59%	32%	556,654	23%	448,151	81%
2008	277,737	41%	24%	399,289	58%	22%	683,838	23%	570,868	83%
2009	317,488	38%	14%	488,410	59%	22%	825,358	21%	703,033	85%
2010	382,365	39%	20%	586,492	59%	20%	992,459	20%	864,356	87%
Avg		55%	18%		44%	46%		26%		59%

Source: Own estimates based on data from http://logec.repec.org/details.htm (accessed 29 October 2010)
Note (*) - including books, chapters in books and software items.

[11] Peter Jasco at "Peter's Digital Reference Shelf"(http://www.galegroup.com/free_resources/reference/peter/dec.htm#googlescholar Accessed 28/Dec/04).

Data in Table 1 shows the breadth of material at RePEc. Originating from publishers, an increasing number of items became available to the public at no charge (from 18% of all items in the digital library in 1998 to 87% in 2010). This trend witnessed the increasing interaction between commercial companies (i.e. journal publishing houses) and the on-line community around RePEc. Table 1 also shows items deposited at RePEc doubling to almost one million between 2005 and 2010. An average of 55% of these were hyperlinks to working papers and the other half made up by hyperlinks to journal articles (with an average of 1% being made up by books, chapters in books and software items).[12] Working papers therefore constituted a key part of the RePEc digital library. However, between 1998 and 2010 items in RePEc were growing at an average 26% p.a., with journal articles growing at a higher rate (45% p.a.) than working papers (17%).

As part of the WoPEc project and influenced by Mili's work, Krichel managed a CAS through an e-mail distribution list that carried announcements for new papers deposited at WoPEc. By 1998 the list had a membership of 700 unique e-mail addresses. Based on the growing success of RePEc, Krichel identified a need to move further the concept of an associated list to inform of new contributions. The reason being the legacy distribution list from WoPEc considered papers from all parts of the economics discipline. There was thus an opportunity to create subject-specific reports, each distributed through its own list. Moreover, a system that would not only inform subscribers but also provide the opportunity to download papers upon request and free of charge.

On February 4, 1998, he wrote to the young economists discussion list, a now defunct electronic discussion forum, detailing his vision and hoping for some enthusiasts to act as editors of subject-specific reports:

> There is a large-scale development going on to unify the provision of electronic working papers through the internet [*sic*], called the RePEc project, see http://netec.mcc.ac.uk/RePEc. The NBER, the US Federal Reserve Banks and WoPEc are working together in that project, and so are a few others. Currently new additions to that database are circulated through the WoPEc-announce mailing list, see http://www.mailbase.ac.uk/lists/wopec-announce/. This carries

[12] Note that only a subset of journal items are the published version of working paper items.

announcements for new papers. However the interest of the list is limited by the fact that it carries papers from all parts of the discipline. Despite that fact there are over 700 people on the list.

I am now thinking of opening a series of lists that would operate peer-reviewed announcement [*sic*]. That is each list would be headed by an editor, correspond to a subject that the editor has specified and would only receive annoucements [*sic*] of papers that the editor thinks fit into the subject [*sic*] of the list. Each editor would receive a list of new additions to RePEc each week, and would pass on the edited information to the list as (s)he sees fit. All lists put together would be called FERN (like Free Economics Research Network). They would concentrate on delivering contents, rather than administrative information or the names of the big cheeses on the editorial board. Each individual list would be called "FERN reports on XXX", where XXX is the subject stated by the editors. There is no limit to the subjects that could be covered.

This is a call for editors to come forward. As an editor, you would receive a list of additions to the RePEc dataset each week for you to filter, and pass on a selected few to your list. That would not take much of your time, and if you do not feel like sending anything, well then there would be no FERN report on your topic for that week. You will receive absolute power to manage your list as you see fit. You will need to remove dead addresses from time to time, that is all. The reason being the legacy distribution list from WoPEc considered papers from all parts of the economics discipline. There was thus an opportunity to create subject specific reports, each distributed through its own list. Moreover, a system that would not only inform subscribers but also give them the opportunity to download articles upon request and free of charge.

There are a number of good reasons why the position of editor could be attractive esp. for young economists. First you have to stay on top of the literature anyway, and that is a good way of doing so. Second, being the editor of a well edited FERN report series will raise your profile in the profession. Third, you will have the opportunity of work with other editors in faraway places and join the wider community working on the free dissemination of research material on the internet [*sic*].

> This is just an initial call, if you would be interested in an editing position please get in touch with me privately, stating what subject area you would like to cover. If you would like to help with organising the list infrastructure (as kind of a super editor) I would also like to read from you.

The initial name of the project was "FERN", the Free Economics Research Network. The label FERN was invented by Bob Parks[13] (Washington University) for a large scale mailing to many economists to advertise services like EconWPA, WoPEc, etc. This mailing was a one-off campaign in June 1996, long before junk mail became pervasive. The name FERN then lay dormant until Krichel's e-mail reference above. After discussions with respondents to this e-mail, the name NEP: New Economic Papers, suggested by Sune Karlsson[14] (then at the Stockholm School of Economics), was adopted. At the time, NEP was mainly used as an abbreviation for a brief experiment of economic policy in Russia in the mid-1920s.

There were a number of good reasons why a name too close to the existing Economics Research Network (ERN) was not thought to be the best solution. One was a potential threat of legal action by Social Science Electronic Publishing (SSEP[15]), who traded under the name of ERN. Second the inclusion of the word "free" was considered bad marketing. It was felt that academic economists, as target audience, would look with some suspicion something that was "freely available" and make the project look like a lower quality ERN. This couldn't have been furthest from the objective. The aim was to be better than ERN and become the best service for rapid dissemination of recent additions to academic literature. The ethos of remaining a free service should only be perceived as an additional advantage.

Another problematic point of the initial e-mail is that it confused e-mail lists with reports. Mailing lists are technical devices. What was at stake in the creating of NEP was a new type of serial that would have issues that contained descriptive data on new additions to the RePEc working paper stock. Thus, this required attracting people from the academic community to create a

[13] http://economics.wustl.edu/parks (accessed 01/Nov/10)
[14] http://ideas.repec.org/e/pka1.html or http://blog.repec.org/category/repec-volunteers/page/2/ (accessed 01/Nov/10)
[15] SSEP's lists were established in 1994. They were re-bundled as the Social Science Research Network or SSRN (http://www.ssrn.com/, accessed 28/Dec/04). Charges for accessing their collections and subscribing to their distribution lists were introduced 'circa' 1996.

decentralised organisation where contributors, working as editor, were to be responsible for at least one report – as editing multiple reports was allowed and actually encouraged. The mailing list was just a means to circulate report issues.

A third problem with the initial e-mail was the promise that editing a report "would not take much of your time". This was true at the time when the e-mail was written, when one editor could typically expect 30 new papers to look at. But that soon ceased to be the case. By 2002 an editor could expect to review 300 papers per issue of nep-all. Bumper crops of over 600 papers were not unheard of. The success in attracting new collections to the digital library started to disrupt the functioning of the NEP editorial base (more below).

Neither did the initial e-mail nor did subsequent discussion state the motivation for the creation of NEP, thus we have to speculate. Reading between the lines, it appears that the main motivation was a reaction to the announcement services that were run by SSEP. The name FERN points to that, but also the reference to "big cheeses on the editorial board" as SSEP services were established and promoted by well-known academics such as Michael Jensen (Harvard Business School)[16]. SSEP also boasted editors of established hard-copy, peer-reviewed outlets and other famous economists on "advisory boards". There is no evidence of what has been the added value or actual role of these advisory boards, but the lack of a similar structure for RePEc seems to have been a concern for those setting up NEP as well.

There were two respondents of note to the initial e-mail by Kritchel. First, John S. Irons[17] (then at the Massachusetts Institute of Technology) was interested in becoming the "super editor", later called General Editor. Secondly, Vania Sena (then at the University of York) who helped Krichel to work on a general document that was to serve as a "constitution" for the service, as well as a general guide to the project. Its first version was discussed at a meeting in York on 14 February 1998. The document was thus called the York protocol.[18] The first nep-all report had 32 papers and was posted by Irons on May 4, 1998.[19]

[16] See further "SSRN Celebrates its 10th Anniversary". Available at http://ssrn.com/update/general/mjensen.html (accessed 01/Nov/2010)
[17] http://www.americanprogress.org/events/2008/05/inf/IronsJohn.html (accessed 01/Nov/2010)

Implementation

The software to scan the RePEc contents and extract a list of new additions was written by José Manuel Barrueco Cruz (Universitat de Valencia)[20]. He also wrote software to distribute the list of new additions to all the editors – as detailed in a central register which also acted as the NEP's web page.[21] He was thus chiefly in charge of the technical infrastructure until 2005 (for reasons that will be explained below).

The software written by Barrueco Cruz would compile a report of new working paper additions to RePEc and this file was then edited by the General Editor to remove undesired content. This was distributed as a text-based e-mail report (called nep-all) to individual editors. It also formed a report in its own right, because it was---and is---deemed suitable for general consumption. Individual editors manually removed references to papers considered inappropriate to the subject area of the individual NEP report and then forward this message to subscribers with the aid of the e-mail distribution manager.

Then in late 2001 and at the initiative of Irons and Christian Zimmerman[22] (then at the Université du Québec à Montréal) there was a first move to streamline the work of editors as it was getting quite burdensome to generate the reports on a purely manual system due to the growing number of online working paper series being incorporated into RePEc. Irons programmed and introduced a first version of a web interface on January 2000.[23] Karlsson then greatly improved it and produced a fully functional web-based interface to create reports.[24] This "tool" had an immediate impact in reducing the time for individual editors to generate a report.

But in spite of the new tool, reports were still limited to text-based messages as editors had to "cut and paste" content into individual e-mail accounts for distribution. Between 1998 and 2010, NEP made use of three e-mail

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[18] Although the York protocol document went through several revisions by Krichel, Irons and Bátiz-Lazo, it was never made public. See http://openlib.org/home/krichel/papers/search .doc (accessed 01/Nov/2010). Its last known edit was dated January 24, 2001 by Bátiz-Lazo. This version is available upon request.
[19] http://lists.repec.org/cgi-bin/mailman/private/nep-all/1998-May/000000.html (accessed 06/Nov/2010).
[20] http://www.uv.es/~barrueco/ (accessed 01/Nov/2010).
[21] http://nep.repec.org (accessed 01/Nov/2010).
[22] http://ideas.repec.org/e/pzi1.html (accessed 01/Nov/2010).
[23] http://lists.openlib.org/mailman/private/nep-editors/2000-February/000144.html (accessed 06/Nov/2010).
[24] http://lists.openlib.org/mailman/private/nep-editors/2000-February/000362.html (accessed 06/Nov/2010).

distribution managers. NEP reports were originally posted to subscribers through e-mail distribution lists administered by Mailbase[25] at the University of Newcastle. Mailbase was a funded by JISC. Mailbase' remit was to explore and develop electronic exchanges between British academics. This project included the development of the software infrastructure to manage and support e-mail distribution lists. In November 2000 the service moved to a more cost-effective provider at the Rutherford Appleton Laboratory in Oxfordshire while the rights to the "Mailbase" name remained with Newcastle University. Services for academic mailing in the United Kingdom were then to be managed by the National Academic Mailing List Service or JISCmail.[26] Another important change was that e-mail lists and e-announcement service were to be hosted with the aid of an "off the shelf" package called "Listserv"[27] rather than under purpose built software as was Mailbase.

Like its predecessor at Mailbase, e-mail lists, e-discussion forums and announcements at JISCmail were really meant for the benefit of the UK academic community. Initially this posed no threat to NEP because WoPEc was also a project of JISC. The only requirement for NEP was that at least one list owner had to be a UK academic. This person was originally called the "mailbase person". Krichel took on that responsibility until October 2000 when Bernardo Bátiz-Lazo[28] (then at the Open University) took the position. As NEP grew he effectively became the single biggest owner of JISCmail lists.

A review of services provided by JISCmail in May 2002, however, threatened the continuity of NEP. Although the review was satisfactory and positive for the future of NEP within JISCmail,[29] Krichel and Bátiz-Lazo decided there was a real risk of JISCmail ending NEP with very little notice. They decided to migrate NEP to the same machines based at Washington University of St. Louis that hosted the US mirror of NetEc. Reports were then to be distributed using Mailman[30], a freely available mailing list manager software.

[25] http://www.mailbase.ac.uk/ (accessed 25/Mar/2005). The mailbase software was retired in April 2007. See http://www.ncl.ac.uk/iss/software/e-mail/lists/MB_info/ (accessed 01/Nov/2010).
[26] http://www.jiscmail.ac.uk/ (accessed 01/Nov/2010).
[27] http://www.listserve.com (accessed 01/Nov/2010).
[28] http://ideas.repec.org/e/pba14.html (accessed 01/Nov/2010).
[29] http://lists.openlib.org/mailman/private/nep-editors/2002-November/000938.html (accessed 06/Nov/2010). At the time, NEP had 25,710 subscriptions from 9,209 unique addresses. Of these, 1,618 (18%) were identified as British academics (as ending with "ac.uk").
[30] http://www.gnu.org/software/mailman (accessed 01/Nov/2010)

Quality and Coverage

Work on the migration of the e-mail distribution manager started in September 2002 and stretched itself well into 2003. Jeremiah Cochise Trinidad Christensen (then a student at Long Island University) helped Krichel. Setting up the lists on Mailman was not a problem, but getting the historic information from the old system definitely was. Three basic problems ruined the historical record. The first was that both JISCmail and Mailbase removed parts of the headers in the archived files. In particular, the "From:" headers of intermediary machines did not appear. Many times the only date data available seems to have been the date on the mail client of the editors sending the report issue. Since time on personal computers is not well kept, dates could be well out of line. Dates of a report could be read from the contents of the report but some editors took the habit to change the ISO formatted date into something they felt looked more welcoming. As a consequence, there was a suspicion that many editors did not to a timely job on report delivery.

A second problem was that most of the time, editors would cut-and-paste from the web tool into their mail client. Character set on the clipboard would be highly dependent on the editor's locale. As a result, many of the characters in the reports were badly affected. In particular, the "handle" (i.e. the unique identifier) of individual papers was often garbled. Some editors used HTML mail clients which further compounded the problem.

A third issue was that the mechanisms for filtering of handles that had already been passed on to individual editors was deficient. As a consequence some papers were presented to subject editors several times, and some editors included them twice or more times. Under these circumstances, estimating the timeliness of a report issue became almost impossible.

A fourth issue at the time was deciding on scope of individual reports. It had two elements, namely subject coverage and quality. Regarding the latter, the appropriate role of the editors was (and is) to make announcements about new on-line papers in their field with the relevant abstracts, but not to "review" the papers for quality. However, some editors had been posting calls for papers and other information through their e-mail distribution list. In discussing the content of the e-mail distribution and the need to stick solely to NEP reports, Krichel initially floated the idea of NEP developing into a peer reviewed

electronic outlet. He suggested NEP having "hundreds of editors … and each would list the papers they are most interested. If they would rank them, we would have a real community peer-review system. We could build overall recommendation strategies out of the recommendations of a lot of people, somewhat alike to what google [sic] does for web pages."[31] A heated exchange followed through which editors rejected the idea of changing the nature of the reports.[32] This discussion amongst editors confirmed that they had a uniform view that NEP could not be regarded as a vehicle for a preliminary peer review. Moreover, this discussion made clear that editors' only concern to disseminate new working papers was based on the subject matter. NEP announcements, therefore, were (and have been) selective as they rely on the editors' judgment for simple filtering (see further Bakkalbasi and Krichel 2005).

As far as subject coverage was concerned, there was a discussion as to whether NEP should aim for complete subject coverage for broad categories.[33] The exchange touched on the emergence of anecdotal evidence suggesting that an increasing number of working papers in nep-all were not being distributed. In light of this discussion, the first empirical assessment of NEP's performance took place (Barrueco Cruz *et al.* 2003). Its focus was estimating the coverage ratio. That is the ratio between the number of papers out of a nep-all issue that received at least one announcement, and the papers in that some nep-all issue. As shown in Table 2 the number of subject reports had been growing (from 27 in 1998 to 56 at the end of 2003) while the number of nep-all report issues per year remained at circa 30 p.a. or below the desired target of one weekly issue (or some 50 reports p.a.).

[31] Krichel initially floated the idea of a peer reviewed electronic outlet to editors on November 14, 2001 (http://lists.openlib.org/mailman/private/nep-editors/2002-November/000943.html accessed 08/Nov/2010).
[32] Krichel rekindled the discussion of NEP becoming an electronic journal with the same result of it being turned down in March 2005 (http://lists.openlib.org/mailman/private/nep-editors/2005-March/001973.html accessed 01/Nov/2010).
[33] Between September 2003 and July 2004, Bátiz-Lazo and Novarese looked at the possibility of opening reports to match JEL (Journal of Economic Literature) classsification. This initiative was called "Citta d'Alba paper" (http://lists.openlib.org/mailman/private/nep-editors/2004-July/001552.html acessed 08/Nov/2010). The aim was not for JEL codes to dictate NEP structure but for "gaps" to be a guide ".. to open those lists and recruit editors (and probably also be more active in attracting some collections to fill content …" (idem). Although informative, the initiative was abandoned as there were 866 possibilities for level one and two JEL codes and the 68 reports didn't map systematically to either one.

Table 2: Growth and Frequency of NEP Subject Reports, 1998-2010

Year	Number of reports at year end	Growth	Num. of issues	Average days between issues	St. dev.	Mode
1998	27		28	8.96	6.47	7
1999	37	37%	33	10.85	7.13	7
2000	39	5%	42	8.67	3.97	7
2001	49	26%	31	12.00	7.46	7
2002	55	12%	32	11.13	6.52	10
2003	56	2%	43	8.42	4.19	7
2004	57	2%	47	7.91	3.58	7
2005	68	19%	50	7.30	2.14	7
2006	75	10%	50	7.34	2.72	7
2007	78	4%	53	6.83	1.64	7
2008	81	4%	50	7.36	1.90	7
2009	84	4%	50	7.26	1.84	7
2010*	85	1%	41	7.34	2.41	7

Source: Own estimates based on data from http://econpapers.repec.org/scripts/nep.pf? (accessed 01/Nov/2010).

The expectation was that as the number of subject reports grew there would be an improvement in the coverage ratio over time. But instead the coverage ratio remained static at around 70%, which highlighted a "serious problem of coverage" (Barrueco Cruz *et al.* 2003). Using a graph for data available between July 1998 and August 2002, this illustrated that the coverage ratio seemed to be negatively related to the size of nep-all. Bakkalbasi and Krichel (2005) confirmed this trend using formal inferential statistics.

The appearance of the analyses reported in these papers added to concerns within NEP management over how to improve the coverage ratio. Another important concern around this time related to the way editors engaged with their tasks. Generating a report had remained largely unchanged from the early days of the project. The introduction of the "web tool" helped. But reports were still limited to text-based messages as editors had to "cut and paste" content into individual e-mail accounts for distribution. There was also a clear need to support editors as the size of nep-all was growing. An initiative launched back in November 2001 for Sergei I. Parinov (then at the Siberian Branch of the

Russian Academy of Sciences)[34] to coordinate the creation of a new technical infrastructure had proven over ambitious and collapsed.[35] Then in June 2004 and thanks to some UK Government funding still remaining from the WoPEc project, Krichel hired Roman D. Shapiro to start the development of a new system to edit NEP reports.[36]

Krichel wrote a paper describing a generic infrastructure called ernad (*e*diting *r*eports on *n*ew *a*cademic *d*ocuments).[37] It was written in Perl (using LibXSLT and mod_perl) to run on Debian GNU/Linux machine (Apache 2 web server), while not being geared to a specific mailing system (Krichel 2007b). The report data and issue data were encoded in AMF (format for description of academic documents).[38] The advantages of ernad were considered to be

- the centralisation of editor control in one system
- the separation of contents from presentation through the use of XML
- a better integration between report creation and distribution
- enabling HTML-based reports, that is, sending reports in both standardised text and HTML format (bound together by MIME multipart/alternative).
- enabling editors to sort the report result by bringing the papers they like best to the top of the issue
- reduce or even eliminate the use of distribution lists by NEP editors for anything other than NEP reports (i.e. purge of unrelated postings such as calls for papers)
- improve coverage[39]

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[34] http://ideas.repec.org/e/ppa6.html (accessed 06/Nov/2010).
[35] The map for the collaboration was called "Aeroflot proposal". See http://openlib.org/home/krichel/work/aeroflot.html (accessed 06/Nov/2010).
[36] On 19/Jan/2004 Kritchel announced the launching of the so called "Altair project" (http://lists.openlib.org/mailman/private/nep-technicians/2004-January/000252.html accessed 01/Nov/10). This initiative envisioned replacing the "back-office" infrastructure of NEP with an AMF-based set of scripts, and a web interface that would better log the generation of report issues. (http://wotan.liu.edu/home/krichel/work/altai_job.html accessed 01/Nov/10). Later the "Seabro projected", launched on January 2009 by Krichel and John Q. Sillari, aimed to rationalise and make easier to update the software behind ernad (see http://lists.openlib.org/mailman/private/nep-editors/2009-January/003257.html accessed 06/Nov/2010).
[37] See also "Gentilly paper" (http://openlib.org/home/krichel/work/gentilly.html accessed 06/Nov/2010).
[38] Ernad documentation (http://openlib.org/home/krichel/work/ernad.html accessed 06/Nov/2010).
[39] There were 296 nep-all reports issued between January 2005 and October 2010 (http://nep.repec.org/lossage/ accessed 06/Nov2010). Each averaged 360 individual papers, of which

The introduction of ernad had a major effect in the way NEP was run and managed. On the one hand, it provided a simple-to-use interface for the composition of reports (e.g. an easy to scroll input, allowed for easy sorting of a report's content, did a better job at pretty-printing) as well as laying the ground for the introduction of pre-sorting.[40] On the other hand, it restricted editorial freedom: editors no longer sent e-mails to lists but after making their selection on a web interface only one e-mail address (ernad@nep.repec.org) posted to subscribers through individual distribution lists.[41] Editors could not add unsolicited material (e.g. announcements, calls for papers) at the end of the report. Neither could they change dates of issue.

The discussion now turns to explore how ernad changed NEP's management structure in greater depth.

Governance

Results from Barrueco Cruz *et al.* (2003) suggested that editors' performance needed to be better policed. One way to do that was to look at the time an editor took to create an issue, that is, the time elapsed between the moment nep-all was issued and an individual report posted. Data in Table 2 show the time between nep-all issues increasing between 1998 and 2002 (reaching its maximum at 12 days, 7.46 st. dev. in 2001). Anecdotal evidence suggested the increase amongst individual reports was even higher. However, collecting such data systematically was impossible because of poor archive keeping. Other suggestion from the work documented at Barrueco Cruz *et al.* (2003) was sharing of the editor job between editors, or the creation of a formal hierarchy.

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54 were "lost" (not included in any individual report). That represented a coverage of 87% as opposed to the 70 to 80% identified in Barrueco Cruz *et al.* (2003).

[40] Between 2004 and 2005, Krichel and Nisa Bakkalbasi (Yale University - http://www.library.yale.edu/about/departments/ecollections/staff_responsibilities.html#nb accessed 06/Nov/2010) developed a system that would use statistical learning techniques to learn the preference of individual editors. This routine was incorporated into the ernad web editing interface on August 2005. As a result the nep-all report ranked individual papers based on editor's 13 month usage history (through a combination of individual words out of the contents from titles, author names, abstracts, classification data and the id of the RePEc series or handle). Editors were then free to add, ignore or re-rank these suggestions. The idea behind presorting was not to replace editors (or make them lazy) but to invite them to examine some papers more closely than others. See further Krichel (2007a).

[41] The editor's own e-mail was used in the "reply to" field. On October 2008, e-mail distribution was complemented with the introduction of RSS feeds. (http://lists.openlib.org/mailman/private/nep-editors/2008-October/003188.html accessed 06/Nov/2010).

On July 2003 Krichel launched "nep-technicians".[42] This was the first step in the overall direction pointed by Barrueco Cruz *et al.* (2003) as this list created a dedicated space for the discussions between the most active NEP editors and the technicians managing its infrastructure. Introducing a formal hierarchy took a bit longer. For much of its lifetime, NEP was formally led by a single person known as the General Editor. This post was occupied by Irons between June 1998 and October 2000, and by Bátiz-Lazo between October 2000 and December 2004.

Initially the General Editor would ensure that content added to RePEc was suitable for NEP reports. For instance, that content was clear of unwanted material (either machine- or man-generated). Another common occurrence were papers that had been previously submitted re-appearing, say as a result of two authors from different institutions each submitting the same paper to RePEc through their local working-paper series. These were situations where it was either impossible for the computer to determine if a paper was really new or the computational power to deal with them was too costly. Whatever the case there was a need for human intervention, ideally by the General Editor, to act before individual editors were confronted with such a situation.

Alongside the issue of preparing nep-all, in the early days of the project, a fairly major task of the General Editor was recruiting volunteers to oversee new subject-specific reports. At the beginning, expanding the number of reports and finding good people to act as editor was an uphill battle. In the midst of the so-called "dot-com" bubble, institutions had to be persuaded about the benefits of lending their collections while individuals had to allocate scarce research time for a project of unproven reputation. Not surprisingly and but for a couple of exceptions, the first editors were either doctoral students in economics or young faculty members.

Other tasks of the General Editor included overseeing the performance of individual editors, liaising with the technical support team at RePEc, Mailbase and JISC as well as representing NEP and its editors within the RePEc community. NEP grew from strength to strength but so did the tasks and demands on the time of the General Editor. Part of the ethos of RePEc was and

[42] The original recruits were Bátiz-Lazo, Karslon, Barrueco-Cruz, Kritchel and Trinidad Christensen (http://lists.openlib.org/mailman/private/nep-technicians/2003-July/000001.html Accessed 01/Nov/2010).

has been to avoid a single point of rupture and as a result, the appointment of Marco Novarese[43] (Universitá degli Studi del Piemonte Orientale) as Deputy General Editor in June 2003 had been long in the making.

The introduction of ernad in January 2005 was accompanied by the first major change in NEP's governance structure.[44] NEP would then be led by group of people who would be formally assigned specific responsibilities, namely:

- Managing Director - The person who oversees the expansion of NEP. S/he was given the power to appoint new editors and create new reports. This person often acts as point of contact with editors (for matters other than performance), subscribers and the wider RePEc community. Bátiz-Lazo became the Managing Director from its inception in January 2005 until he retired in April 2007.[45] Novarese then assumed this role.

- General Editor - The person who every week ascertains that content available to individual editors is free of unwanted material (either machine- or man generated). Novarese became the first General Editor in January 2005. Since no other editor wanted to take this post when Bátiz-Lazo retired as Managing Director in 2007, then Novarese continued with this function.[46]

- Performance Controller - The person who oversees the performance of NEP. S/he has the power to retire subject editors who don't issue reports in a timely manner. The first person to act as controller was Christian Calmès[47] (Université du Québec en Outaouais).[48]

- Wizard – The person that provides technical support for NEP and its infrastructure. Barrueco Cruz chiefly took on this task from 1998 until the introduction of ernad in January 2005; afterwards Krichel took over the role.

[43] http://econpapers.repec.org/RAS/pno2.htm (accessed 06/Nov/2010).
[44] http://nep.repec.org/etc/governance.html (accessed 01/Nov/2010).
[45] http://lists.openlib.org/mailman/private/nep-editors/2007-April/002725.html (accessed 06/Nov/2010).
[46] Although there were requests from volunteers to act as General Editor and edit nep-all, Novarese chose to keep this duty to himself (personal e-mail Maco Novarese, 13/Feb/2011).
[47] http://econpapers.repec.org/RAS/pca19.htm (accessed 06/Nov/2010).
[48] To support this function a "delay report" was introduced by Krichel on 27 November 2006 (http://lists.openlib.org/mailman/private/nep-technicians/2006-November/002411.html accessed 01/Nov/2010). This report quantified the gap between the moment nep-all was issued and an individual report posted (http://nep.repec.org/delay/ accessed 01/Nov/2010).

As mentioned, all NEP editors are volunteers. Most of them dedicating part of their research time to furnish the wider community with specialised reports in a topic area. Over time there was a need to attract new editors as a result of new reports being opened by the General Editor (and subsequently by the Managing Editor), because an existing editor retired or because an editor was disciplined and suspended of his/her responsibilities by the Controller. In case of an opening, it was advertised through the subscriber base of the particular report as it was deemed that this was a group of people appreciative of the services provided by NEP. Alternatively, new editors could be recruited by individuals freely approaching the Managing Director with proposals of new NEP reports.

Whichever the case, the introduction of ernad saw the formalisation of appointments. A new system replaced the *ad hoc* approach followed until then. The new procedure envisioned the formation of a Selection Committee made up of a group of standing editors, chaired by the Managing Director, who would meet (electronically) to select between candidates for an opening as editor of NEP. Selection was based on evidence of commitment to the subject area as demonstrated by the candidate's curricula – where sometimes relevant industry experience has been preferred over academic credentials.

Another ongoing issue addressed by the change in governance was how to deal with contributions in languages other than English. Dealing with these represented an important element to improve the coverage ratio. For some reports (such as those focusing in Latin America or the Confederation of Independent States) it was considered a strength to carry relevant research of non-English sources (e.g. Spanish or Russian). But including non-English sources added to the pre-ernad work of all editors. Arguments for and against were varied. Some editors wanted to focus on freely accessible research to the widest possible audience. English being the *lingua franca* of academia, they argued, non-English contributions should be discouraged and, for some, even banned. In light of the paradox a decision was taken by Bátiz-Lazo and Novarese that non-English contributions should not be encouraged but that submissions would be accepted and the final decision to include them in a report taken by individual editors.[49]

[49] Note there is at least one non-English speaking report focused solely on contributions in German. The decision to create this report was closely related to the idea of serving specific communities and

Discussion and Conclusions

Research in this article documents the use of a hyperlink network to create one digital organisation and how different practices were combined and interconnected to allow it to grow in scale and scope. The NEP project works as a simple refereed electronic announcement service for each specific subject list. It is truly international in membership, subscription and content. Moreover, it is an outlet that combines research from top academics such as those based at the University of Pennsylvania, University of Cambridge, University Paris I (Panthéon-Sorbonne), "blue chip" institutions such as the World Bank, International Monetary Fund, Bank of Italy and Bank of England with other of the less-known research active centres and individuals. The success of NEP to achieve its aim has been startling, as shown by its growth in scale and scope: as of December 2004, NEP had 57 subject area reports and had distributed over 104,662 items listed in RePEc. As of March 2005, NEP encompassed 61 reports (an increase of 22% since April 2002) and a membership of 13,649 unique addresses (an increase of 148% since July 2001). These figures doubled in the following five years as in November 2010, NEP had 87 reports and a membership of 62,866 subscriptions from 28,988 unique addresses. NEP thus acts as a forum for academics, academic institutions and researchers in industry to share ideas and their research with peers elsewhere in the world.

Strictly speaking, NEP is a current awareness service (CAS). NEP is different to other CAS in two fundamental aspects.[50] First, NEP is based on a digital library (called RePEc). A second differentiating aspect of NEP is being a human-mediated CAS; that is, NEP is generated from an interaction of computer applications and human decision-making throughout. All people involved in NEP work as volunteers using source data which is also freely available. But the fact that NEP is freely available is an added feature of its service rather than a differentiating characteristic.

NEP has a simple, two stage workflow. In the first stage, a computer program generates a list of new additions to RePEc. A human then examines that list to filter out papers that are new to RePEc but are not new. This list (called nep-all) is circulated electronically to editors who scan it for papers that pertain to a

democratization of research. Personal e-mail Marco Novarese, 13/Feb/11 and also http://econpapers.repec.org/paper/uctuconnp/2008-17.htm (accessed 13/Feb/2011).

[50] Note that NEP also carries blogs and RSS feeds but these were excluded from the discussion for simplicity.

certain subject. With the assistance of a computer application editors distribute electronically their selection in the form of an issue of a subject specific NEP report.

NEP's technical infrastructure actively makes use of open source and free software to create a hyperlink network that facilitates interaction between geographically dispersed users of the academic community. In this sense, NEP helps to democratise access to new additions to knowledge. It is strongly focused on economics, but as this field also feeds into business and management, some related areas have been added (such as accounting, finance, business history and marketing) while attempts to draw others epistemologically distinct failed (e.g. critical management). Hence gains from NEP accrue to usage from within a community that has means of identifying its boundaries. So although membership is open to all, not everyone will be likely to make use of NEP or indeed be attracted to it. Yet both membership and content are important.

NEP's use of free software is not a pre-condition for its operation as there are commercial e-mail management alternatives. But it had to develop purposely-designed software to meet its objectives. Building NEP has largely benefited from public funding but most of it has come indirectly through research time allocated by contributors rather than directly through grants. In this sense, its construction mirrors the academic community's inclination to create public goods.

NEP distributes hyperlinks collected within RePEc to build a Internet community. But is more than that as it required the building of a hierarchy to assure its functioning. Some features of this hierarchy resemble those in recently documented cases of electronic communities set up around open source software (as suggested by Lerner and Tirole 2002). Identifying these is interesting as they help characterise features of digital organisations. Common features include:

- NEP is the result of the vision and continued enthusiasm of one individual, in this case Thomas Krichel. The extent to which the plans envisioned in his original e-mail have crystallised is remarkable.

However, his authority has not gone unchallenged. Most notably when editors were reluctant for NEP to evolve into an online journal.

- NEP's 30,000 strong unique e-mail subscriber base is most likely made out of "passive" users.
- At another level, there are the most "sophisticated" users. These are a combination of academics and practitioners active in making contributions in the form of papers, suggesting new reports and editing these reports.
- At yet another lever there is a small élite or 'core cadre' of users composed of less than ten editors who actively make or have made important contributions to day-to-day running and managing its evolution.
- Its technical infrastructure is modular so contributions can be clearly traced to individuals making direct (i.e. programmers and editors) or indirect (i.e. mailman) contributions.
- Reports (rather than code) collecting recent additions to the academic literature are freely available. Contributors (whether institutions or individuals) are not charged for uploading and disseminating their work.
- Incentives for individuals to participate as editors are clearly rooted in the visibility of an individual's performance. "Ego gratification incentive" is big as a large subscriber base results in direct peer recognition.

But features that are unique to NEP and do no appear in other documents cases of online communities include:

- Different variants have not emerged. NEP is the only announcement service for RePEc and the only human mediated current awareness service for economics and related areas on the Internet.
- Contributing to NEP (and particularly the coding of its platform) is highly idiosyncratic. NEP has been unsuccessful in attracting large number of programmers. Indeed, only Krichel and Barrueco Cruz have consistently supported the programming of dedicated software.
- The community around NEP increasingly behaved like around conventional peer-reviewed outlets, carefully choosing their reports and

the contents they would publish. It evolved from a largely non-hierarchical community to develop a similar structure to that of an editorial board. But as mentioned, in this process the community rejected challenging established outlets (as for many editors printed journals were linked to promotion).

In short, NEP's success is based in bringing together different parts of the community it serves in a mutually reinforcing way. This success results from encouraging innovation in academic research while allowing as many people as possible to benefit from these innovations for free. NEP has not replaced but complemented the pre-existing institutional framework for the dissemination of academic research. Yet no price is paid for NEP services. But sustained growth in the number of subscribers attests that they clearly generate significant value to contributors, users, editors (and the economy). However, they are not cost-less. These services are financed as through the funding of academic endeavour (i.e. research time and in some cases, the provision of hardware), typically from the public purse. This case study thus shows how there is a promising research agenda for historians in looking at how applications of information technology resulted in the introduction of entirely new goods or created value through greater variety in the offering, quality and timeliness of existing goods and services. These features are at the essence of the third industrial revolution and we need to make a better job at contributing to its understanding.

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