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# The Transformation of Research in the Knowledge Society

**By**

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## Introduction

Of the holy trinity that has comprised the modern university since von Humboldt in the 19th century, (teaching, research, service), most observers agree that research sits on top of the higher education structure. Whether one is talking about rankings, league tables, faculty strengths, promotion criteria, recruitment of graduate students, fund-raising or general reputation (number of Noble Prize winners), the discussion returns again and again to the research question, the nature, capacity and quality of research, and how it drives the system. This is certainly true for the top tier universities but increasingly true for the other tiers as well as smaller colleges. This has not always been the case. In 1852 John Henry Newman wrote: "a university . . . is a place of teaching universal knowledge. This implies that its object is . . . the diffusion and extension of knowledge rather than the advancement. If its object were scientific and philosophical discovery, I do not see why a university should have students" (Newman 1996 p.22).

Since that time, of course, we have seen the continual global expansion of what has become known as the research university, and even in smaller liberal arts colleges, formerly thought of as "teaching colleges", faculty are expanding their research interests and in some cases being pressured by their leadership to engage in publishable research. The literature on the nature of research in higher education (hereafter HE) has typically focused on one or more of the following issues: research capacity, research productivity, and research relevance or utility among others (Vesuri & Teichler 2008). There are other ways to slice the research in HE pie including more recent concerns such as university-industry linkages, new market conditions as they relate to higher education innovation, the research capacity gap between rich and poor nations and institutions, gender participation, the colonial legacy, political-economic stability or instability, the role of international agencies, and so on. (John: how about universities serving as "research extensions" for the state, especially for defense "things")

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In this paper, I will discuss briefly the historical context in which research has been considered, principally in the United States, what might be considered the "old paradigm", and then look at how higher education (hereafter HE) has been transformed and with it how research and development (R&D) has followed suit. Then the focus will shift to the development of a new R&D paradigm as the notion of the knowledge society has increasingly dominated the discussion. A case study will be presented of how this new paradigm has been implemented, drawn from my own institution, UCLA, followed by some concluding remarks.

**The Old Paradigm: Happy Anarchy**

As has been noted above, when one speaks of research in HE the focus is generally on the so-called "research university" although increasingly, research is finding its way into other segments of HE as well. To take the case of the US as an example, of the over 4,000 HEIs there, only 261 are classified as research institutions and there is enormous diversity within that group (Bienenstock 2008). It is generally agreed that "high quality" research universities share some essential characteristics:

- The existence of high quality faculty committed to research
- The recruitment of high quality graduate students
- A supportive intellectual climate
- High quality facilities to support research
- Sufficient funding to remain competitive and up-to-date
- A research infrastructure
- Supportive leadership with a vision (Bienenstock & Vesuri 2008)

Trow (1974) noted long ago that as HE moved from elite to mass education, its social role changed as well, especially the role of research and the expansion of knowledge. New sub-disciplines emerged, new research agendas were proposed, and everything downstream from an expanded research program changed as well. The classic model of the research university in the immediate post WWII period was summed up by Burton Clark (1983) as a period of "happy anarchy" by which he meant that faculty functioned in an environment of freedom to teach and conduct research on topics of their choice, weaving together teaching and research, and funded generously by both their own sources (either state/public funds or endowments) and the U.S. Federal Government. (John, if you could use U.S. instead of US, that would help since it is part of the Palgrave

style sheet.) In addition, US HEIs practiced an "open door" to international scholars who were recruited as faculty and visiting scholars. There had been an early post-war buy-in to supporting research by the federal government, and that combined with a tradition of individual philanthropy and a broad and deep commitment to public service, created a free and supportive environment for individual and team research in all disciplines, but especially in the sciences (Vest 2007). (Including the social sciences. One can trace this pattern to the vast post-war expansion of SS including the creation of Communications as a discipline out of Columbia, e.g. Manicas)

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**Central to the creation of this research environment, and also to the research infrastructure which we see today, was the report issued in 1944 entitled: *Science—the Endless Frontier*, commissioned by President Roosevelt and authored by Vannever Bush, the head of the Office of Scientific Research and Development. The purpose of the report was to ascertain how the scientific community, especially those in HEIs, could serve US interests in the post-war era. The follow-up to the report came from Roosevelt's policy adviser, William Golden, whose influence was central to the founding of the National Science Foundation (NSF) which served as a model for other national agencies (e.g. National Institute for Health, National Endowment for the Humanities, the Social Science Research Council, and so on). (SSRC is, however, not a governmental agency. From the website: What is the Social Science Research Council?**
The Social Science Research Council (SSRC) is an independent nonprofit organization devoted to the advancement of social science research and scholarship. Founded in New York City in 1923 as the world's first national coordinating body of the social sciences, it is today an international resource for interdisciplinary, innovative public social science.")

All of this contributed to the development of the basic R&D architecture for the US where US private and public HEIs became the national R&D infrastructure paid for in large part by US Federal funding. This Federal-HEIs partnership forever changed US HE and its research mission and capacity through the introduction of such practices as indirect costs, staff differentiation, staff benefits, funding for utilities, staff travel, and a variety of other support activities that came to characterize the impact of research (much

of it financial) on the university. This is often referred to as the *Golden Era* of research in higher education, and lasted up to about 1980 when this laissez-faire attitude was challenged in many ways by Japanese production techniques and concerns over national security and a shift began to occur toward the commercialization of R&D and a redefinition of the role of research (Vest 2007). (John, This is also when the Reagan White House went after behavior science at NIH and NIMH) One policy response to these shifts was the Bayh-Dole Act of 1980 that provided US universities with the right to commercialize employees' inventions made while engaged in government-funded research. While this Act was beneficial to both the HEIs and private industry it has not gone without criticism (Kennedy & Patton 2009).

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During this initial transitional period however, and indeed well before it, the terms *knowledge society* and *knowledge economy* began to be used to describe the context in which HE was now operating. The former, developed by sociologists, and the latter by economists, often confronted each other as scholars sought to make sense out of this new environment. It is likely that both terms date back to Hayek (1937) who noted the importance of knowledge for economic growth with the market as the guiding mechanism, and market logic as the point of departure for political and educational policy. Various waves of this intellectual trend included the relationship between information theory and economic development, what became known as the Chicago School of economics, the rise of neo-liberalism, all of which focused on the market as the guiding principle (Valimaa 2008). This development, in the broader political economy, began to have a transformational impact on traditional research paradigm.

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The conventional research HE paradigm then was a fairly clear model of large endowment support for the private universities, large investments by state governments for the public universities, increasing federal support for both sectors so that a convergence of both public and private sectors toward increasing reliance on the federal sector of research support became the norm (Vest 2007). Federal support for research in higher education grew substantially in the post-WWII era and still remains the dominant source for funding basic research although this is rapidly changing as the private sector increasingly becomes a partner in more applied research. Since the earl 1970's the federal share of research support has been in decline while industry's share has grown rapidly ("Science" 2007). Indeed, some institutions, such as the University of California have launched specific programs (Industry-University Cooperative Research Program; now renamed UC Discovery Grants—Atkinson 1997; ucdiscoverygrant.org/about/introduction.htm) designed to pro-actively attract the private sector to form partnerships with the university. In the 1960's about 66% of research support for private universities came from the federal sector. By 2004 private universities were receiving 36% of their research support from sponsored research, of which, about 60% came from the federal government. In the public sector, the inverse was true; with the fraction of federal research support in the operating budget growing dramatically as state supported universities sought to replace declining state support with federal, endowment and other sources of support. Overall, the public and private academic sectors began to look more alike although in scale the differences remain quite substantial (e.g. in 2007 the University of California endowment was about $7 billion compared to $22 billion at Harvard; both funds have lost heavily in the current downturn)

(Vest 2007). (John, Want to mention universities running government labs, such as Livermore and Los Alamos?)

The end of the well-funded Happy Anarchy period began to be seen in the mid-1970's as a more utilitarian view of research was adopted by both the state and federal governments, policies of privatization began to take hold (such as the Bahy-Dole Act), increased accountability imposed, suggestions of turning public research universities into private independent corporations were proposed all of which was met with both resistance and suspicion by academics in both public and private universities (Garland 2006; Vest 2007).

**Higher Education Change and Transformation: the Rise of the Entrepreneurial University**

By the mid 1970's, HE in the US (and elsewhere) was beginning to show the effects of the combined contradictory forces of globalization, internationalization, and national security. HEIs in general began to undergo a transformation characterized by a movement from public to private, from academic to entrepreneurial, from laissez-faire to market driven, and from research focused on discovery and innovation to research focused on applied and utilitarian goals (Mok & Hawkins 2008). Public HEIs became more dependant on state support as US federal dollars leveled off and research became more dependent on state funds allocated to enhance state economies. Though there was a long history of this kind of support in the area of agriculture in the land-grant institutions in the US, now the emphasis shifted to S&T, developing engineering experimental stations, and other STEM (science, technology, engineering, mathematics) areas resulting in the kind of strong linkages one could see in Silicon Valley in California and the Route

128 corridor around Boston. Though these research efforts were driven by private capital the presence of research universities, federal laboratories, high-level defense companies, and cutting edge R&D all were essential to this phenomenon.

By 1995 every state had one of these linkages resulting in about $3 billion in partnerships. While these efforts supported the research transformation from the days of happy anarchy to those of more utilitarian partnerships, the problems associated with these linkages began to emerge. These were strategic rather than tactical moves and thus resulted in tension between the kinds of basic research HEIs are best at, rather than the pressure to solve immediate problems. Furthermore, not every state was competitive and states had to be careful about leveraging their investments with federal dollars, resulting in pork-barrel earmark support rather than support based on merit. Finally, there was a danger of romanticizing the potential of these entrepreneurial efforts to leverage technology transfer from HEIs to the private sector with profit sharing. More cautious HEIs such as MIT, UC Berkeley, and UCLA, among others avoided the temptation to build these kinds of funds into their operating budgets and become dependent on them, thus distorting the mission of the HEIs focus on basic research (Vest 2007).

A final important feature of the rise of the entrepreneurial university in the 1980's was the commercialization of university laboratories. Kleinman's (1998) classic, historical ethnographic study of the "independence of research and laboratories" in the US university found that although one cannot say that labs were forced into commercial alliances, once they began to engage in them, they gradually became subjected to the rules that govern the commercial world, thus moving them outside the traditional culture of the university and in that of the business. This study and others noted that such

alliances and extension of outside rules into the university disrupted the notion of independence of science and society, of research and freedom of inquiry.

Another area where the transformation of HE and the rise of the entrepreneurial university have affected research is with respect to what might be called "openness". One of the key features of the US research model was the degree of openness that characterized faculty recruitment, retention and reward. Since the 1960's, US HE became increasingly internationalized and this was especially true of research. In the UC system alone, of the many Nobel Laureates that have been awarded in the post WWII era, winners have been born in Taiwan, Poland, France, Hungary, Germany, Austria, and Norway among others. The same is true in other large research universities such as MIT where they have come from Japan, India, Mexico and Italy. It was accepted that scientific knowledge, research and technology should have unfettered freedom to cross borders. After 9/11 much of that changed and it is only now some of the problems created by the US response to 9/11 are being rethought and readdressed (Vest 2007).

The USA Patriot act in 2001 and a variety of executive orders that followed, focused among other things on imposing limited access to what were called "sensitive areas of study". There was precedent for this going aback to 1982 with Executive Order 12356 which increased the authority of the government to classify defense relevant information. But even under the administration of President Reagan, the interpretation of this order and others that followed was fairly flexible and leaned toward openness when considering issues of national security. After 9/11 research restrictions increased with the addition of such measures as Technology Alert Lists (TAL) that limited access and importation of "sensitive" knowledge and technology.

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On the student and scholarly exchange side, the new (date?) computerized Student and Exchange Visitor Information System (SEVIS), created a tracking system and screens that proved to be barriers to the previous focus on openness. This was followed by national-security based restrictive clauses in federal research and contracts with universities. All of these actions have damaged the openness of research and the dissemination of knowledge between and among HEIs in a global setting and illustrate the contradictions of HE in an era of globalization, internationalization, and national security (Vest 2007). Clearly a redefinition of what constitutes research and development had begun.

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**Research Begins to be Redefined: the Knowledge Society**

As these changes in HE began to be realized, the role of research in the university also began to be redefined. It was within the context of the concepts of "knowledge/learning/society/economy" that scholars began to analyze these changes. The concepts dated back to the 1960's and to their respective disciplines when there was great optimism that advances in science would somehow solve the looming development problems facing much of the world and that HEIs and research would be at the forefront of these changes (Hawkins 2007; Lane 1966; Valimaa 2008). This notion that the knowledge society would advance the world modernization process was more of the kind of linear thinking that continued into the 1990's promoted by UNESCO and other agencies, or to quote Stehr (1994), "modernization essentially involves multiple and necessary unilinear processes of 'extension and enlargement'" (p. 29).

What Clark (1998) referred to as the entrepreneurial university quickly became redefined as the "enterprise university": "it has a strategically centralized leadership

highly responsive to the external setting, the wide use of corporate and business forms, the 'emptying out' of academic governance and the weakening of disciplinary identity" (Marginson & Considine 2000, p. 34). The implications for research and knowledge innovation have been several. It has been argued that the transformation of the relationship between knowledge production through the research and innovation system of HE has been a shift from one mode ("knowledge production within autonomous disciplinary, contexts governed mainly by academic interests of a specific community") to a second mode ("knowledge produced within a context of its application which is trans-disciplinary, heterogeneous, more socially accountable and reflexive") (Valimaa & Hoffman 2008, p. 268). Another way of looking at this is that the mode of knowledge production, i.e. research, moves away from the disciplinary, cognitive context, toward what has been called the "knowledge value alliance" (KVA) which is a loosely coupled collective of knowledge producers and users (e.g. scientists, manufacturers, lab technicians, students) pursuing a unifying knowledge goal. The ends of this pursuit may, however, be diverse including but not limited to simple curiosity, practical application, product development, skills development and so on (Rogers 2001). This is clearly what has happened in my own institution as will be detailed later.

It is in this context of the transformation of research that the term "triple helix" began to be used to describe the new research, knowledge production paradigm (Valimaa & Hoffman 2008). It is loosely defined at this time as a state in which the university becomes a node between industry and government in the knowledge production and innovation system. I will refer to it in this paper as the "triple linkage". Research universities particularly become hybrid organizations, losing some of their traditional

autonomy as they began to be further shaped and formed by this three-way relationship. It was also at this time that the current world financial crisis became a factor in the reformulation of research in HE. The crisis set in motion several research and knowledge related changes in HEIs especially in the US. Prior to that, private HEIs with large endowments (the Ivy League HEIs mostly situated on the east coast of the US) were able to fund a diverse set of research interests during the rapid growth stage of their investments. The same was true for the public research HEIs as state governments allocated increasing sums for their university systems. This infusion of resources supported world-class research facilities and a climate in the academy characterized by salary inflation, research largesse in areas that had been typically ignored, unfettered innovation, and the hiring of "super stars" in the sciences, social sciences and humanities. It also allowed the support of methodological approaches, especially in the social sciences, with little pressure to justify the relevance of such work (one thinks of rational choice theory).

As the financial crisis unfolded followed by budget cuts, the results have been transformative. Income from all sources, both public and private has been falling, and more practical, applied disciplines are now favored. It has been suggested for example, that in the social sciences, area studies are once again in vogue as support for the so-called mathematical social sciences, the emphasis on modeling over case study research, is being withdrawn. As over-size salaries are being cut, there is some evidence that Asia will gain as US scholars seek positions in that region of the world (Oxresearch 2009).

Another transformation that is taking place during this transition period for research in HE has to do with the divide that has typically characterized "teaching"

institutions and "research" institutions. It is increasingly the case now that all faculty are expected to do some research. The new divide is between faculty who involve students in their research and those who do not. Another way of looking at this aspect is that in the previous model faculty engaged in independent research, usually not involving students at all, and the new model is more collaborative where the students are increasingly involved gaining both research and publication experience. There is increasingly a cultural divide between these two models. The more collaborative model prevails in the sciences and has been promoted by the National Science Foundation in the US. Collaboration is less common in the social sciences and humanities but this may be changing as well (Malachowski 2006). My colleague Sandy Astin (1993) discovered more than ten years ago in his freshman surveys that the degree to which students are involved in faculty research in some way, is the degree to which student-learning outcomes are positively affected. (On another front, research across the curriculum is on the move at the undergraduate level, with some universities adopting it as a requirement.)

A related difference between faculty and student research collaboration is between the large research universities where there is less of this and the predominantly undergraduate institutions (PUIs) where this has been more the norm. As the PUIs move more in the direction of requiring faculty to engage in research there is the danger that the teaching mission will suffer as well as the diversity that has so long characterized HE in the US (Malachowski 2006).

This redefinition of the role of research in the knowledge innovation and production system involving new alliances between the academy and other agencies, the emergence of the triple linkage (to be discussed in more detail below), the unfolding of

the global financial crisis, and the restructuring of faculty-student relations has not been limited to the US. It is emerging or already well engaged in Europe, Asia and increasingly in Latin America and Africa (Carvalho 2008). These features and others are forming the basis for a new paradigm for research in HE and it is to this that we now turn.

John: Somewhere in the above, as part of the old paradigm, you may wish to mention the emergence of "multi-national" big since, especially in astronomy and sub-particle physics as the costs of building and operating the equipment became larger than any one university or country could manage: e.g., Mauna Kea or Berne. This has been going on at least since the early 1980s.

**The Emergence and Domination of Research-Knowledge Strategic Alliances**

What does this emerging research model look like more specifically? We have noted that the mode of the individual researcher, well-funded, working in his/her lab in the sciences, or on a social science or humanities research project, with little or no connection to the outside world, has been giving way to a mode of specific sorts of alliances and funding dependency with outside agencies. Over twenty years ago, Korten (1989) recognized this shift as being one away from: "a research tradition [that] has been independent of outside interests" (p. 1) to one driven increasingly by industry and corporate interests.

This shift coincided with the period when funding, at least for public universities, began to decline as did state and federal research funds, or at the very least, the acquisition of those funds became much more competitive. One can also see that this occurred in a climate characterized by Neoliberalism both globally (IMF and World Bank) and domestically (Reagan and Thatcher—and later GW). A third area of

confluence had to do with the issue of alignment of students with the so-called "real world". This began to dominate the discussion of reform of the accreditation and accountability system. Industry applauded these changes and this shift because of the benefits that accrued as a result of putting together cost-effective teams of industry-university specialists (Korten 1989).

In addition to these partnerships, some HEIs created their own industries by developing new technologies and marketing them with companies established "off-site" or outside the typical campus. Royalties were fed back into the university for future research. A major shift in the structure of knowledge occurred around 1980 as well, as faculty involved in these partnerships and start-ups found that the challenges and problems they faced in this new model involved a multi-disciplinary approach, and this moved the curriculum away from the traditional disciplines and toward the inter-disciplinary center. On most campuses a plethora of interdisciplinary "centers" arose to encompass these new sub-fields often supported with start-up funds from the core university budget (Korten 1989). If we fast-forward twenty years, we see that this aspect of the reformulation of research and knowledge, in light of the current economic crisis, is in danger of being dismantled as the "core" disciplines have fought back to deny funding to these relatively new endeavors. At UCLA, for example, because of the current fiscal crisis, the Chancellor's office has announced that it will be increasingly difficult to justify supporting IDPs with state funds; the "core", or in other words, the traditional disciplines, will receive priority status for state funds. (True at UH as well.) What is likely to remain of the multi-disciplinary center approach will be those that are able to raise funds for themselves independent of the university and become somewhat autonomous entities on

or off campus; in other words those for which a market exists (one could imagine, for example, that a Center for Chinese Literature would disappear while a Center for US-China Economic Relations would prosper).

While one might debate the positive and negative implications of this shift and emergence of a new research mode, the case has been made that the value of research in higher education must be seen in its capacity to create wealth and this capacity is increased to the degree that HEIs are able to apply knowledge to knowledge itself. What is often now referred to as an "innovation web" is seen by some as essential to yield the kind of benefits that will result in national development, economic growth and social change. In this up-dated quest for "development", higher education research is seen as a key element to the renewal of knowledge but closely aligned with innovative firms and networks (Enders 2005).

The Knowledge Valued Added ? (KVA) mode, as noted by Rogers and Bozeman (2001) presented a model whereby the researcher is in a position that allows for fundamental research while being intimately related to commercial ventures. These webs of relationships are held together by a "knowledge covenant" that allows heterogeneity in order to attain a stable research environment for both fundamental, or discovery research (principally but not necessarily in the sciences) and application and profit driven ventures as well as student learning (Rogers & Bozeman 2001).

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While this mode of research and knowledge innovation appears in a modulated form in the US there are instances, for example in the UK, where it has been institutionalized at the highest levels. The new central government Department of Business, Innovation and Skills was recently established and Britain's HEIs will be

placed under its purview (Mandelson 2009). This represents a clear statement that HE and continuing education are in the service of business and government and that alignment with the private sector is of critical importance. Recognizing the probability that basic science would suffer under such an arrangement, special fiscal measures have been taken to "ring" in the science budget to assure that applied science does not dominate basic science. Nevertheless, this move has drawn much criticism among both science and non-science faculty and researchers (Mandelson 2009).

In the US, as this model becomes more accepted, fields of study and their curricular content are being revised in order to better prepare and socialize students to this triple linkage mode (government/university/ industry). These reforms are being rationalized with the alignment argument. In order for students to be competitive in the job market, they need to be involved early on in the three way teaching/research model, especially the links to industry (Adderly-Kelly 2003). Meanwhile, internationally, a recent OECD report cautioned HEIs to be careful about promoting an over-enthusiastic commercialization of research with industry and government at the expense of knowledge diffusion ("Tertiary education" 2008).

As has been noted above, the expansion of this three-way linkage has serious implications for the role of students in research, extending that role from the familiar graduate student researcher to now include increasing numbers of undergraduates. At the University of California, Berkeley over 50% of all undergraduates (divided about equally between STEM and non-STEM fields) now are engaged in some form of externally funded research (Berkes 2008). The numbers are similar at UCLA. When asked what motivated them to apply for such projects the majority of students indicated it was

because of increased competitiveness for career options and links with industry and the jobs that may result form such links (Berkes 2008).

This aspect of the transformation of research in the new knowledge triple linkage matrix and the role of both undergraduate and graduate students in it, dramatically changes the pedagogical experience for these students as well as the curriculum. While the trend of involving increasing numbers and levels of students in funded research is generally applauded in most HEIs including my own, the inequality that has always characterized these relations becomes even more pronounced. Because of the nature of the triple linkage, the pedagogical environment and student learning that results from it, is shaped by an exchange system with industry. In one study, faculty members basically exchanged students with their industrial partners (large entities such as Chevron, Intel, Exxon, Eastman Kodak, IBM, Texas Instruments, etc.) as one form of institutional linkage (Slaughter 2002). And although government funding contributions to the research far exceeded that of industry, the study found that ". . . .Federal funds tend to push industry toward greater collaboration" (p. 307). This in turn contributes to the transformation of HEIs so that fields close to the market do well while those unaligned with global markets (humanities, social sciences, education, social work) are marginalized. As Slaughter (2002) further notes: "in other words, national policy has shifted from a welfare-warfare state that insulated the university from market demands to a neoliberal state that promotes universities' interactions with the market" (p. 308). And, the student researcher is the university's gift (supported by government funds) to industry. The lesson that the student learns is that the university is fused with industry

and the state and if you are in the right field you stand to gain great benefits, including job options, but if you are in the wrong field you are at a distinct disadvantage.

**The Triple Linkage In Practice: UCLA's Clean Tech Los Angeles**

As my own institution goes through the most severe economic crisis since it was founded, the contradictions outlined above illustrate the triple linkage employed in a recent project on the environment. Entitled "Clean Tech Los Angeles, this project began prior to the current budget cuts brought about by the state, national and global economic crisis. In promoting this project the chancellor and other supporters referred to it in the context of "an opportunity in the midst of a crisis" but the crisis they were referring to was a global economic and environmental crisis; not something as close to home as the financial melt down of the state of California. The focus here was clearly on the issue of sustainability and how a major research university can address this challenge. In envisioning this project it was correctly noted that in order for the RU to be able to address the complexity of today's global economy, RUs would have to find ways to marshal expertise across a wide-ranging scope of disciplines and inter-disciplinary programs within the university and establish linkages with a variety of partners outside.

In the case of this project, that meant bringing together expertise from business and entrepreneurship, biology, physics, law, public policy, engineering and others. The central partners were UCLA, University of Southern California, California Institute of Technology, Office of the Mayor of Los Angeles, the Community Redevelopment Agency of LA; LA Business Council, LA Department of Water and Power. The stated goal was to establish LA as the global leader in research, commercialization, and

deployment of clean technologies. This model of research and innovation clearly reflects the triple linkage mode discussed above.

More specific goals are job creation, retention of clean technology firms, to stimulate growth of a marketplace for clean technology goods and services, and the deployment of new technologies to help clean up the environment. UCLA research centers, faculty and staff were mobilized to address these issues from several different disciplinary perspectives: natural sciences, urban planning, engineering, business, nanotechnology, public health and law. Several of UCLA's research centers, established in recent years as part of the inter-disciplinary restructuring of knowledge were brought into play: the Center for Energy Science and Technology Advanced Research, the Center for Embedded Networked Sensing, the Emmett Center on Climate Change and the Environment, the Institute of Environment's Center for Climate Change Solutions, and the Center for Corporate Environmental Performance. With respect to students, a new IDP was established entitled: Leaders in Sustainability, to "provide graduate students with knowledge and skills to address sustainability issues in their fields through multidisciplinary collaboration" (p. 2) and to align them with emerging job opportunities.

Shortly after this was established, a new program and fellowship was established with support from NSF under its, integrative graduate education research traineeship (IGERT) award. (Two uses of "established" in previous sentence) The Clean Energy for Green Industry Fellowship was designed to support students in environmental energy but will require that they take courses in sciences, business and the policies of clean technology. So while students remain in their disciplines for degree purposes, they alter their program of study to satisfy the IDP requirements targeted toward this particular area

of knowledge. There is a clear career path aspect to it which makes it somewhat novel, and NSF support indicates that the federal government is interested in this kind of IDP approach even if UCLA due to the current economic crisis, may cut back on such interdisciplinary programs. This suggests a hypothesis that IDPs and the research they produce are reduced or cut back selectively based on sources of funding and the power of pressure groups. That is to say, during times of economic crisis, IDPs associated with the humanities and social sciences are likely to see a reduction in their support in contrast to those in STEM fields where agencies such as NSF put pressure on the institution and job alignment appears more closely linked. The macro goal of this sort of project is to utilize the region as a "real world laboratory" rather than address these issues in an on-campus lab.

So we see here in this one project the coming together of the basic ingredients of the shift in research and knowledge, the emergence and dominance of the triple linkage, and globalization. In this instance, on the one hand, we see a global and national economic crisis, and a related state-level economic crisis, resulting in severe financial cutbacks to the university system--all of which forces the university to reassess its existing financial commitments to what had been the novel restructuring of knowledge and research taking place since the 1980's: IDPs and the centers associated with them. On the other hand, we see the employment of the triple linkage, much more suited to the sciences than other fields of study (though not entirely), to address global research issues, of great practical utility, and closely aligned to the job market but which must still marshal IDPs, centers, and expertise from a variety of fields to address these issues. Real world labs challenge on-campus labs, and application challenges basic research;

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partnerships are perforce forged with business and both local and national government. As this model becomes more dominant, it raises serious questions about the future of research and knowledge innovation in the university at large. (John, one of the things that this listing begs is the issue of who does what in these research endeavors? For example, how are consultants brought into the mix to conduct work previously done by university "staff".)

**Concluding Comments**

The reformulation of research toward the triple linkage model is occurring in tandem and possibly supported by the worldwide focus on rankings or league tables. It is not easy to achieve a triple linkage model of research for many universities and this is especially true in light of the current economic crisis. The complexity of these linkages and the cost involved in putting them together are considerable, yielding well documented cases where it has been tried and failed (New Zealand 2009). Yet, the OECD, among others, views this model of research and the economic crisis as an important opportunity which may result in the birth of new industries aided and launched by HEIs that are successful in pulling together the three critical components. What Osborne (2009) refers to as "creative destruction" may come to characterize a whole new set of industries similar to those that emerged out of a previous period of crisis (Microsoft, Nokia, etc.).

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One major critique of this reformulation is that it is somewhat exclusive and likely to be achieved primarily by those institutions in the more developed nations, located near government funding sources and corporate entities. Will the triple linkage model exacerbate the research divide between rich and poor nations, states, communities,

and universities? Not necessarily says at least one scholar who offers a new vision of how high-level research can be shared and participated in globally (Vest 2007). Heavily influenced by his experience as the CEO of MIT, he calls this the "global meta university" and suggests that new media and technology can make possible widespread dissemination and participation in research without each institution having to achieve a high level of the triple linkage.

He suggests that the innovative use of technology can help to democratize research for HEIs of different sizes and locations. Antecedents for this kind of meta approach to research were such developments as JSTOR (short for Journal Storage), funded by Mellon in 1990 to build an on-line trusted archive of over 1,000 academic journals thus allowing smaller HEIs to collaborate and mount research projects that their own meager library resources would not allow. Then, of course, came the MIT open courseware, funded by Hewlett and Mellon, and "pledged to make available on the web, free of charge to teachers and learners everywhere, all of the approximately two thousand subjects we teach on our campus" (Vest 2007, p. 96). Included in this effort were all syllabuses, course calendars, well formatted and detailed lecture notes, examinations, problem sets and solutions, and lab and project plans as well as video lectures. So far access has continued to grow with 43% from North America, 20% from Asia, and 16% from Western Europe. This experiment also spawned additional open course efforts in the US, China, Japan, France, Spain, Portugal and Brazil. The China Open Resources for Education (CORE) program is noteworthy for translating the MIT materials into Chinese and making them available across China.

This has been followed by other "open" initiatives, such as open archiving, indexing, and publishing (the Million Book Project, DSpace, Google Library Project, etc.). Vest predicts that the next stage of such a movement is likely to be web-based laboratories (i.e. iLab which is functioning in Singapore and Taiwan). All of these efforts bring into question the previous elite status and exclusivity of high-end research and the complicated triple linkages that have been necessary to make it work. As this movement grows it could mean that research with a big R and innovation may be made more available to HEIs previously left out of such efforts, thus expanding the notion of the knowledge society on a global scale. The meta global research university idea proposed by Vest and others while appealing in leveling the playing field does not address the triple linkage issue or question its assumptions.

Internationally the funding support gaps are even wider. In the Asian-Pacific region the average percent of GDP devoted to R&D is about 2.5%. In 2008 in India it was about 1.2%, in China, .69 %and most Asian nations devote less than .5% to R&D (Zakri 2008, p. 41). However, as in the US, overall statistics are misleading, as within these nations there are various centers of excellence in research areas where there is a comparative advantage. In the Philippines this has typically been in international rice research, in Malaysia, in oil palm research, in China, in world-class research in seismology and in India in mathematics. Nevertheless, research prowess is differentially distributed for a variety of historical, economic, and technological reasons.

We are left with a number of questions about what all of this means for HE in the US and perhaps elsewhere, the knowledge society, and the relationship between research and the academy. Some tentative conclusions can be reached while in other areas we

must wait to see how current events (principally the economic crisis) turn out. There has clearly been an expansion of research across all HE sectors with the possible exception of community colleges. The old paradigm, dominated by a dual linkage system between HE and the Federal government has given way to a more entrepreneurial/enterprise HE triple linkage system involving the private industrial sector. This has occurred in a climate of marketization and commercialization and has had implications for the shift from disciplinary to multi-disciplinary studies and the rise of research focused centers. The Discovery Grant program in the University of California system is one institutional expression of this shift as is the new department linking higher education with industry in the UK. The tentativeness comes about as we seek to understand how this new research model and the knowledge society will fare in the current economic crisis. Questions are certainly raised about the tilt toward applied and utilitarian research and what this would mean for science as well as social science and humanities. The new university that emerges from this will certainly look different from its predecessor. A positive view sees a new meta university, utilizing technology and media to allow much broader access and capacity on a global scale for joint research efforts. A negative view would be concerned about increasing gaps in research productivity between those institutions able to afford the triple linkage and those that will slip further behind. What is certain is that HE and the research that drives it is undergoing a period of critical change and merits close scrutiny from within and without.

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