Chapter 6

Online Technology in Knowledge Transfer

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Abstract The transfer of knowledge entails a challenge for any research activity. It drives the promise and results towards implemented and replicable facts. The transfer is frequently crystallised in contracts and patents, but not solely: scientific communication, general publication, property rights, or public R&D + innovation projects generated in the heat of research are also transference products and tools. This article lays out the benefits and weaknesses of these devices, underlining the participation of technology, especially online tech, when appropriate. We found that there are a variety of resources for transference, and that technology is only valid in some of them.

Keywords Transfer · Commodification · Impact · Sustainability · Online technology

6.1 Transference Versus Commodification of Results

Spain is a powerhouse of quality researchers and cutting-edge research; the rest of Europe, too. We have strong teams, individuals, and institutions in health sciences, educational innovation, social policies, IT security, and other fields who interpret and shape daily reality and a promising future. However, tangible contributions, including the contact with civil society, complicity with companies and other agencies, and the actual use of products, services, and results by standing users or entities, are somewhat more elusive. Transference is sometimes not effective.

As researchers, we bear some of the blame. We follow the rules established by each call or accreditation step in order to fulfil the requirements, obtain a favourable review, and connect with a new project or activity that will enable continuing the line of investigation or group within a department. But we fail at the actual commodification of the results in the marketplace through serious dialogue with other stakeholders. Funding and accrediting agencies must facilitate the administrative

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steps that, paradoxically, often consume practically all the energy and most of the budget and time instead of facilitating the object of the call, whether it is research, development, or innovation. But at the same time, researchers must integrate our work in an obligatory and coordinated manner, into agencies, the market, and society, in order to ensure the usable and applicable transfer of results and knowledge.

6.2 Meaning of Knowledge Transfer

It is challenging to speak of transference. It is like speaking about innovation; everyone considers it crucial but there is no uniform definition or a minimally common consensus about it (Cooper, 1998; Goswami & Mathew, 2005; Baregheh, Rowley, & Sambrook, 2009). For some, transfer in academia means contracts between the university and companies. Thus, we find researchers focused on the industrial sector, measuring it by weight, quantity of projects, or the sum of associated contracts. By-products include the creation of industrially applied results—though not necessarily products—such as regulations, guidelines, specifications, or standards, and of course, industrial or intellectual registrations, by way of patents or utility models, and copyright clearance. For others, transfer means an impact on society, measured by, among other possibilities, target audience, end users, or Internet downloads. There are also scientific publishers, who insist on including specialised scientific production under the transfer umbrella, i.e. articles in scientific publications, chapters in books focused on a specific trade, and doctoral theses, or even conference communications. Conversely, we can find communicators who measure transference by hits obtained in unspecialised media and the budget conversion implied by crossover ads. We also have entrepreneurs, who defend the creation of companies in the wake of other initiatives, either as spin-offs, or as start-up incubators (Mowery, Oxley, & Silverman, 1996; Argote & Ingram, 2000; Agrawal & Henderson, 2002; Easterby-Smith, Lyles, & Tsang, 2008; Paulin & Suneson, 2015).

Although it is true that everyone is correct, because there is no singular definition, or a solid framework within which to include or exclude the concept of transfer, the fact is that most of the time the scientist is happy to link a new publicly-funded project in the wake of a prior finished project. And this, too, is considered transfer.

We can therefore group transfers into eight blocks or modalities (Fig. 6.1): (1) industrial, (2) property registration, (3) regulatory, (4) social impact, (5) scientific communication, (6) general publishing, (7) entrepreneurship, and (8) secondary public funding.

Fig. 6.1 Eight blocks of knowledge transfer

6.3 Advantages and Disadvantages of the Modalities

6.3.1 *Industrial*

Each of the blocks exhibits benefits and weaknesses that become more or less evident according to the block's success in matching the type of knowledge to be transferred with the chosen device. For example, the industrial block, focused on business contracts, has the advantage of returning the results of research, development, or innovation to the market and society through productive use (Ivascu, Cirjaliu, & Draghici, 2016). When this development has been funded or financed with regional, national, or international public funds, a tangible and measurable process of commodification that resonates in other subsequent productive processes is usually demanded. A contract with a company is a clear indication of this demand. Conversely, if the result is privately funded, the backers will certainly seek a way to recover that investment through industrial commodification. This block presents weaknesses, however, such as industrial ownership and the beneficiary of the commodification. If a public agency subsidises research that produces applicable results in a university using public funds, let's say state funds, and that commodification is attained by way of a contract between the university and a company, the economic benefit of the commodification will be ceded to the school. Public funds originate a benefit that reverts to the public university, but which does not necessarily return, either in full or partly, to the funding agent. In this context, the funding agency (the State, for example) functions as a driver or breeding ground at a sunk cost.

The case is sharper if the public body subsidises research in a private university, meaning that the contract between the private university and an outside company may generate a benefit reverting to that university. That is, public funds subsidise at sunk cost a result that generates a benefit to the private sector; in this case, the State invests, but private individuals benefit. Although it is true that the pillars of both public and private universities are portrayed as research and integration to society, leveraging contracts between the school and companies, as in Art. 83 of the Organic Law for Universities 6/2001 (dated 21 December) or any other type, fosters this integration but

generates doubts regarding commodification; this is also true of rights, as described in the following section.

For example, the European Commission requires that all results from a subsidised project (e.g. Horizon 2020 or Erasmus+) should be open access (European Parliament, 2017), and curiously, this requirement is not only for citizens of Europe but for any individual in any country. That means Europe invests €77 billion (theoretically) in the Horizon 2020 program, split between subsidies for research, scholarships, support for SMEs, synergy between universities, etc. (CDTI, 2014). The results of this investment during the seven years of the programme (2014–2020) are accessible from any country, on any continent. Therefore, Europe provides free access to all its subsidised knowledge, born of its residents' taxes. This knowledge, those results, and those products are European, but they can be accessed by anyone in an instant. Intellectual property remains in Europe, but free access does not. Quite the opposite occurs in other continents or countries; Canada, Japan, the United Arab Emirates, the United States, or Colombia do not systematically yield their research for free, and therefore there is no reciprocity of access to information or to its possibilities for transfer.

Conversely, the right of commodification in Europe is regulated within agreements made by a consortium of European partners. If any spin-off commodification is decided or a contract is obtained with an administration, the beneficiary of that profit will be stipulated in the contract but will not reach the European Commission. That is to say, once again, Europe finances or subsidises a product, a result that generates a contract or a commodification of any kind but does not receive any payment in the case of positive production.

These two examples present a system that favours research in exchange for an expected return (productivity, publication, impact on society, etc.) but not at an economic level. The positive aspect is that a contract with a company generates wealth and, with luck, boosts that research and a productive layer. The not-so-positive aspect shows an unbalanced design where private business can happen at the expense of public funding, with no return to that source of funding.

6.3.2 *Property Registration*

Intellectual property proves to be a useful and effective mechanism to register certain aspects related to technology, such as content. Software proves to be somewhat more elusive, as it is also registered as text and is subject to the same norms of similarity ratios when faced with a copy (Joyce, Ochoa, Carroll, Leaffer, & Jaszi, 2016; Bettig, 2018; Stokes, 2019); this is undoubtedly a pending issue in support of developers. Industrial property follows a long procedure with multiple stages that means registration of technology or processes that lead to software development is obtained too late, with too-large budgets, and generally in an ineffective manner. Both Moore's Law (Waldrop, 2016) and the biannual logic of updating and modifying software and hardware mean that the 2-to-3-year process of patent registration exhausts any

possibility of real commodification before the stamp is obtained (Mancini, 2019). A more agile, affordable, and equally robust mechanism is required in the face of possible plagiarism or misappropriation.

But not everything must be registered by copyright or patent. The open movement, mentioned earlier, has been extending its influence since 1975: software, content, education, access, etc. (Nyberg, 1975; D'Antoni, 2009; Downes, 2007; McAndrew, 2010). Code registered as Open Source, as in GitHub, GitLab, or SourceForge warehouses (Coelho & Valente, 2017), or in the Software Heritage project (Di Cosmo & Zacchiroli, 2017), provides immediate recognition of authorship, under the premises of fair and balanced use. The same is true of content and Creative Commons, pre-prints of scientific publications, or open education (Wong, 2017). The latter also cements its activity in technology together with other pillars (9 in all) such as access, research results, research data, content, educational policies, use licenses, accreditation, and inter-operability (Burgos, 2017). Society, in the shape of some users, has decided that there are alternative means of registration, warehousing, product use and recognition, and development and services which differ from the officially stipulated ones; this is an agreement between parties, with full operational effectiveness, which enables and more, stimulates, according to context, goal, and target audience, the exchange of information, knowledge, and resources among end users, whether they individual or institutional.

It is true that the open movement, on all levels, presents great grey areas. The definitions of open, unrestricted, free-of-charge, and universal tend to be commonly confused. Oftentimes, through a mere out-of-context translation of the English word “free” which can mean either “at no cost” or “unrestricted”, or both, the multiple meanings are sometimes harmful to the appropriate use of the listed resource. The main objection lies in the approach of an over-inclined sector advocating for the unrestricted, free-of-charge, and unregistered use and enjoyment of external resources, without any type of compensation or financing from the user (Schimmer, Geschuhn, & Vogler, 2015). Content generation is the clearest example but this objection can be applied to any of the other nine pillars mentioned in the preceding paragraph. If a university official generates a course during their workday, the resource must be cost-free (Jahn & Tullney, 2016). The official is already paid for this effort from public funds and should not overburden the budget for private interest or use. If the university, as an institution, wishes to manage additional services (accreditation, tutoring, extra activities, etc.) or wishes to commercialise the course under certain parameters, there is certainly a viable and sustainable framework of commodification, but an institutional one, not for the official personally. If an individual generates a course in their free time, they have the right to offer it at no cost or for a fee, and they own their content and the means of distribution. Lastly, if an employee of a private institution (e.g. a university, research facility, or foundation) generates a course during their work time the institution will decide the commodification of the product, and whatever compensation it considers for the employee. In other words, if a product derives from public funding it cannot be doubly appraised. If it derives from private funds, the owner of those funds decides on access and costs. However, a wide sector of the open movement holds that everything must be open in education

and academia, regardless of whether it is the result of personal, public, or private funds. Everything must be available for the free and unbound enjoyment of any user, regardless of which other user or institution has put up the funds.

Something similar occurs with registration. If an institution offers a free course, they cannot request registration information, depending on the sector, not even for academic tracking, licenses (any user can use, reuse, modify, and interpret what is published freely and without restrictions), or technology, including software; and so on, for many more resources (Fecher, Friesike, & Hebing, 2015; Ardi & Heidemann, 2019).

6.3.3 Regulatory

The creation of regulations, norms, standards, or technological specifications, among other productions, implies a form of transfer applied to the medium and long terms (Lerner & Tirole, 2015; Verhoeven, Bakker, & Veugelers, 2016). The possibility of regulating by defining the patterns of definition, use of, behaviour toward, and relation to a determined technology or technological process, enables *replicability* according to calibrated metrics, which should guarantee minimal levels of quality and control. The problem lies in the timing. Setting up any of these instruments requires years of preparation, and above all, approval, making streamlined transfer impossible and suggesting an almost impossible return within a prudent timeframe. The designer or group of designers must be willing to keep to the average years-long processing time before expecting to see any type of return.

6.3.4 Social Impact, Scientific Communication, and General Publication

Regarding user communication and interaction, transfer is centred on moving results and knowledge to different sections and groups of target audiences (Beck, S., Mahdad, Beukel, & Poetz, 2019; Cosgrove, Cristea, Shaughnessy, Mintzes, & Naudet, 2019). From a schoolteacher to a corporate lawyer, to a newspaper vendor; from a researcher in the same field to a critic of our theories, to a legislator; they are all valid, if rather limited, audiences, and all become possible interlocutors. This term, interlocutor, is wilfully chosen because those potential users do not act merely as receivers, but are emitters and replicators of communication in turn, at least potentially. Thus, a user becomes the focus, objective, initiator, medium, and even message, disrupting the usual chain in the communication process (Evans, 2010). They shift from merely passively observing to being a defining force (Hummel et al., 2005).

In this context, technology, especially online technology, represents a major trump card. Ever since a more popular Internet was launched through web service in 1996,

and learning management systems like Moodle, Sakai, LAMS, and Claroline, and content managers like Drupal or PHPNuke, user communities such as the ubiquitous Facebook, instant messaging services like Messenger, file exchange services like eMule, and many other services flourished after 2000—since everything that has happened in these last fifteen years, the beast's evolution has been relentless. Any online service becomes a *de facto* social network: Ali Express, Telegram, WhatsApp, TripAdvisor, Booking, etc. (Karapanos, Teixeira, & Gouveia, 2016). From travel agencies to supermarkets to forums about automobiles or in journals, all services, or most of them, require user traffic and visits, and transform their original objective in order to embrace volume which will enable higher invoicing, obtain more publicity, or increase their value in a sale or a place on the stock exchange. In all of them it is common to use forums, downloads, ratings (the poorly named gamification which trivializes a useful yet complicated process for improvement and advancement, merely by attributing little stars born of a fleeting feeling and a simplified system) (de Sousa Borges, Durelli, Reis, & Isotani, 2014), assessment, file exchange, access to privileged information according to different metrics, and other tools. The entire ecosystem of interaction becomes crucial to knowledge transfer when designed with the appropriate approach. In the case of publication, the argument seems obvious: generating a community of users (or sharing the results of research, development, or innovation by way of an already-established community of users) implies an immediate and broad scope of possible impact. The trend is confirmed by universities' increasingly common use of networks or services with communities, such as LinkedIn, YouTube, Twitter, or Yammer.

These communities may be general or categorised by a thousand filters, ranging from language or gender to geography or experience, to personal interest or income range; those obtained through means both legitimate and subtly or directly illegal, as in the case of Cambridge Analytica (Cadwalladr & Graham-Harrison, 2018); through Alessia or Siri, or through thousands of unnecessary cookies. They may also be thematic communities focused on research, such as Research Gate or Academia; on dataset repositories, like Mendeley; or on publication indexing, like Scopus ID or Orcid. In any case, they all group and connect users according to the system's or user's own criteria, often with recommendations based on behaviour and profile, in the same spirit as Newton Learning, Netflix, or Amazon. Thus, they become powerful tools not only for knowledge transfer, but also for cultivating ideas, maintaining relationships, screening profiles, and enabling the creation of partnerships for new projects. On the other hand, exposing personal data or individual or collective behaviours allows the recovery or cataloguing of information for multiple uses. Characterisation of the user or the group favours a more direct and precise identification according to search criteria, which can be used towards noble ends (educational supervision, psychological support, sports training, etc.) or for other—not necessarily or expressly authorised—services, such as consumer profiling, political campaigning, triage of current or future patients, identity theft, and many other purposes (Tene & Polonetsky, 2012).

6.3.5 *Entrepreneurship*

The creation of spin-off companies from universities, as well as the use of incubators and accelerators to support start-ups and other entrepreneur initiatives, imply a determined step towards linking that fantastic university-business duo which is so idolised (Aceytuno & Báñez, 2008; Shapero & Sokol, 1982). Part of any university's function is to create knowledge and professionals that may be satisfactorily integrated into the business world, or better yet, help to form it. Without dramatising it, because not all universities should be dedicated to this singular goal (for example, certain Humanitarian or Arts careers) (Pilegaard & Neergaard, 2010), and because not all graduates should seek the same thing (for example, adult studies due to intellectual concerns or double degrees as a complement), the enterprising and integrating function in the market constitutes an important pillar of the modern university spirit. And in that context, technology and health play a key role. Fifty percent of the 949 companies created from universities in Spain between 2008 and 2016 are technology-based (REDOTRI, 2017; IUNE, 2019); 18% of them are engaged in ICT. The remaining 50% pursue diverse non-technical activities (Gómez-Miranda & Román-Martínez, 2016). Given these percentages, it is imperative to support technology as the driver, object, and result of transfer. If we focus on online technology, we find Internet products or services: communications (voice, text, and images), storage, anti-theft, security, secure transference (e.g. Blockchain), mobile networks, etc. With this spectrum of possibilities so completely enmeshed in daily life, a university's achievement in these fields is powerfully represented by the influence and success of its technological transfer in the form of the businesses which are established.

6.3.6 *Secondary Public Funding*

Considering publicly funded research projects as the only way to support lines of work is quite a common problem. The possibility of applying to so many open programs at the European Commission, Mineco, CDTI, regional invitations, and other institutions makes it possible, somewhat accidentally, somewhat purposefully, to maintain tasks and perspectives without the pressing need to diversify the origin of said funds.

Let's use the 7th Framework Programme, from 2007 to 2013, and the Horizon 2020 programme, from 2014 to 2020, as examples. Both have generated projects financed with €130 billion. Europe has invested over €191 billion in framework programmes (Fig. 6.2) (Feldman & Lichtenberg, 2000; Hoekman, Scherngell, Frenken, & Tijssen, 2013) altogether, beginning with the 1st Framework Programme which only lasted four years (1984–1987) and which contributed €3.75 billion.

A detailed analysis of Framework Programme VII (FP7), which allows us to focus on a closed and extensively studied cycle, presents spectacular numbers: 29,000 partners in 170 different countries financed by Europe, 136,000 applications reviewed,

Years	Framework Programme	Euros	M Euros
1984-1987	I	3.750.000.000	3.750
1987-1991	II	5.400.000.000	5.400
1991-1994	III	6.600.000.000	6.600
1994-1998	IV	13.100.000.000	13.100
1998-2002	V	14.960.000.000	14.960
2002-2006	VI	17.500.000.000	17.500
2007-2013	VII	50.000.000.000	50.000
2014-2020	VIII	80.000.000.000	80.000
TOTAL		191.310.000.000	191.310

Fig. 6.2 Budget per European framework programme, I–VII (Horizon 2020). *Source* <http://www.jeupiste.eu/horizon-2020-and-around/historical-timeline-framework-programme>, 2016

25,000 projects financed, with 70% support to universities and 30% to businesses, with the ICT sector as the greatest beneficiary, in addition to how ICT also appears in ancillary form in other spheres such as Health, Energy, or Transportation. Analysing more deeply, the numbers express a finer reading about knowledge transfer (European Commission, 2015, 2016). This programme produced 197,951 publications, including the mandatory scientific reports per project (deliverables), and evidencing a significant variation: anywhere between 1 and 1,412 reports from one project to another. There were also 1,700 requests made for patents, with companies owning 50% of them. Sadly, there is no tracking of filing registration or resolution to determine their progress. Similarly, 7,400 commodification designs were made, which are never monitored by the financing agent. From a scientific point of view, 50,000 researchers were registered in a system that identifies research (RTD type) as everything that is not management (MGT). Included in the non-MGT categories are software development, product maintenance, publication, etc., without it all necessarily being scientific. Lastly, 10,000 doctoral students were registered and 1,480 theses (14.8%) were presented for review.

These data show a wide capacity for generating interest in universities, generous funding of projects and partners, and concordant scientific production. However, the conversion does not support this. Neither the number of theses, nor the number of patents registered, nor the number of commodification plans, etc., permits accurate

follow-up or analytical tracking, leading to a blurry conclusion regarding its relevance. With the data in hand, the conclusion centres on the imbalance between the resources invested and the benefits reported, allowing us to infer that real knowledge transfer has a relative effect.

What is certain is the linking of research projects. For instance, in research on Technology-Enhanced Learning (TEL, online learning or eLearning), Derntl & Klamma (2012), and later de la Fuente Valentín, Carrasco, Konya, & Solans, (2013) showed the concentration of public funding recipients in this sphere of research: an analysis of 77 and 93 projects in these two studies, respectively, from the FP6, FP7, and eContentplus (ECP) programmes, led to the conclusion that a half-dozen partners pooled most of the projects and financing, forming 27 common work pairs among them: Open Universiteit Nederland (Netherlands), The Open University (United Kingdom), the Catholic University of Leuven (Belgium), IMC AG (Germany), the University of Hannover (Germany), and the University of Jyväskylä (Finland). Curiously, the data sources of these analyses are no longer accessible except for a few analytical reports, so it is impossible to compare the information. Another case in the area of innovation (Competitiveness and Innovation Framework Programme—CIP-) is Intrasoftware, a Luxembourg-based company that linked projects about the same subject during FP7 (education in science, technology, engineering, and mathematics, or STEM), for more than €25 million (CORDIS, 2019). There are similar cases organised by category, country, programmes, and professional areas (Health, Aeronautics, Security, etc.). This effective linking implies an inbred pseudo-transference of knowledge, like a cycle where one project's results feed the next, but have no effective impact outside the circuit. It is undoubtedly a case of circular economy, currently much in fashion, but with a creative interpretation.

We find a clear cause in the lack of post-project follow-up. At best, a project is approved and final funding is collected (after partial disbursements) after review by external experts with no need of subsequent reports. On the other hand, the absence of an effective mechanism for collecting subsidies for provable results obtained during the project and after its completion implies that the project's limit should be its own timeframe for implementation, without considering the commodification of the results. At most, a theoretical plan for transferring the knowledge is required, but will never be proven, as stated earlier. The solution lies in a series of measures, which are not necessarily popular ones: (1) implement these mechanisms and reserve a part of the subsidy, as per accomplishment metrics, for effective commodification once the implementation period has ended; (2) pay by objectives reached and verified, together with—for at least part of the total- an *ex-post* follow-up and impact verification; (3) reward successful commodification with future R&D+i funding; (4) establish a ranking of partners that weighs the participants according to metrics, including results and applied products and services, as well as effectively verified transfer; (5) separate the assessment and review of projects from the financing agency; (6) ensure no connection between reviewers and evaluators with funded partners exists, with sufficient margins for the absence of a relationship (revolving doors); and (7) demand a calibrated scientific and commodification review beyond the minimal viable product, not only an administrative one.

6.4 Conclusions

There are many possibilities for knowledge transfer in academia. Technology can be the object of this transfer but it can also become an instrument, especially in the case of online technology; one example of the former is patents and contracts, and one example of the latter is scientific communication and general publication. Special mention should be given to public financing. In this article we break down the circle of linked funding in a specific regional context, as a sample, and with a concrete object focused on online technology for education. We conclude that a proper selection of the instrument according to the final objective, product, and available medium is a determining component of transfer success.

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