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Mapping Translation Technology Research in Translation Studies. An Introduction to the Thematic Section

1. Introduction

Nowadays translation is all around us, and our globalised world would probably not function without it (Taravella/Villeneuve 2013). In 2016, the annual study of the translation industry by the Common Sense Advisory proclaimed that the demand for language services is constantly growing (DePalma et al. 2016). In order to fulfil this demand, for several decades language service providers (LSPs) have implemented increasingly advanced translation technology to optimise translators' productivity (Taravella/Villeneuve 2013: 62). The adoption of technology in the language industry was initiated when information and communication technology (ICT) was first launched, but it was the internet and its usage as a communication and collaboration tool that accelerated the uptake of translation technology in the 1990s. As emphasised by Alonso/Calvo (2015: 136), the adoption of technology has affected all types of human activities, but perhaps the effect has been most dramatic in the field of translation, whose processes of decoding and coding from one language to another appear to be easily aided or even taken over by computers. In addition, translation technology is no longer used exclusively by professional translators; now it is also used by many non-translators, who take advantage of free online **machine translation (MT)**[1] engines to help them understand and produce texts in foreign languages. Thus, for instance, in 2016, Google Translate machine translated an average of 143 billion words a day in 100 language combinations (Lumeras/Way this issue). Consequently, translation technology is now so much an integrated part of all our lives that it could be described as **everyware**, a term coined by Cronin (2010).

Due to the growing uptake of translation technology in the language industry and its documented impact on the translation profession, translation students and scholars need in-depth and empirically founded knowledge of the nature and influences of translation technology (e.g. Christensen/Schjoldager 2010, 2011; Christensen 2011). Unfortunately, the increasing professional use of translation technology has not been mirrored within translation studies (TS) by a similar increase in research projects on translation technology (Munday 2009: 15; O'Hagan 2013; Doherty 2016: 952). The current thematic section aims to improve this situation by presenting new and innovative research papers that reflect on recent technological advances and their impact on the translation profession and translators from a diversity of perspectives and using a variety of methods.

In Section 2, we present translation technology research as a subdiscipline of TS, and we define and discuss some basic concepts and models of the field that we use in the rest of the paper. Based on a small-scale study of papers published in TS journals between 2006 and 2016, Section 3 attempts to map relevant developments of translation technology research within TS by dividing papers on translation technology research into three thematic categories. Section 4 uses the same categories to introduce and discuss the papers included in the thematic section. Our paper

1 In the current paper, we will boldface terms that we consider central to the field of translation technology research.

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is rounded off in Section 5 by some concluding remarks and a brief discussion of what the future might hold for the translation profession.

2. Introducing translation technology research in TS

Translation scholars generally agree that TS became an independent academic field during the mid-1980s (Snell-Hornby 1995; Munday 2016: 13). From the outset, the discipline was interdisciplinary by nature and characterised by a diversity of research methods borrowed from other research fields. The evolution of TS has often been described by means of "turns" (Brems et al. 2014: 2). In the 1970s, the field witnessed a pragmatic turn, in the 1980s, a cultural turn, and in the 1990s, an empirical and a globalisation turn. Currently TS is witnessing a technological turn (Cronin 2010; O'Hagan 2013). Alonso/Calvo (2015) even argue that TS is experiencing an epistemological transformation of the conceptualisation of translation and that this has been brought on by technological advances. According to Alcina (2008: 90), the discipline of translation technology research deals with "the design and adaptation of strategies, tools and technological resources that make the translator's job easier as well as facilitating the research and teaching of such activities". While Alcina (2008: 79) considers this an interdisciplinary field situated midway between computer science and TS, in our paper translation technology research will be dealt with as a subdiscipline of TS.

In a seminal paper on translation technology, Alcina (2008: 96-98) distinguishes between resources and tools in a classification of translation technology by means of computer applications related to translation. **Resources** refer to all sets of data that translators can look up, such as online corpora or dictionaries, whereas **tools** are computer programs, in which translators can carry out certain functions and actions that can be managed and then stored by the translator, such as terminology in a **terminology management system (TMS)**, word files in a word processor, and translations by means of translation software (for an overview of translation tools, see Folaron 2010). Alcina's (2008) classification helps us grasp the idea of translation technology from an instrumental perspective by means of subcategories, though some of the subcategories appear to overlap (language tools, for instance, may also be seen as documentation tools through which translators obtain knowledge). Below is our interpretation of Alcina's (2008) suggested subcategories of translation technology:

1. **Computer equipment**, which includes elements that are instrumental in the general functioning and maintenance of the computer, such as operating systems, antivirus software, DVD drives and simple image processing programmes.

2. **Communication and documentation tools and resources**, which translators use to interact through the computer and networks, such as e-mails, virtual networks and collaborative work environments, to interact with their actual or potential clients and with other translators or specialists, or to obtain information and data from other computers or servers, such as online encyclopaedias and websites.

3. **Text editing and desktop publishing**, including tools used for writing, editing and revising texts, especially word processors.

4. **Language tools and resources**, which are designed for the collection and organisation of linguistic data, such as TMS (tools) and corpora, databases and online dictionaries (resources).

5. **Translation tools**, which play a part in the translation process and are specifically designed to work with at least one source text and one target text at the same time and establish relationships between both texts on a segment or a text level. These tools might be combined with another type of software, such as word processors or terminology databases, which belong to the above categories. This subcategory embraces assisted translation programs, which in-

clude **translation memory (TM)** management software, terminology databases, word processors and MT engines.

Hutchins/Somers' (1992) well-known model is often used to distinguish between modes of translation in accordance with the degree of human involvement and automation in the translation process. In the human translation mode, there is, by definition, only human involvement and no automation – that is, no translation technology is involved. Translation technology is involved in all other modes: **fully automated high-quality translation (FAHQT), machine-aided human translation (MAHT)** and **human-aided machine translation (HAMT)**. In FAHQT, the machine carries out translation without human intervention. In MAHT, the translator is in charge of the translation process, but is provided with different kinds of linguistic support by the tool, including TM suites, and in HAMT, the tool essentially carries out the translation, but humans aid the process by pre- or post-editing texts (e.g. Christensen/Schjoldager 2016: 90), for instance. The latter two categories cover tools that are generally referred to as **computer-assisted translation (CAT)**, which are those tools that are primarily used in the language industry of today. Alcina's (2008) conception of translation technology may be said to be present in all modes of Hutchins/Somers' (1992) model except for the category of human translation.

The aim of MT is to automate the translation process and to produce FAHQT, but, so far, this aim has not been achieved, and perhaps it never will be (Lumeras/Way this issue). For quite some time, the language industry has therefore focused on developing CAT tools that aid the translation process rather than automate it. Commercially viable CAT tools first became widely available in the early 1990s (e.g. Maylath 2013: 41). Initially, the tools were mainly used for technical translation and computer-software localisation, which benefitted from an extensive use of TM tools combined with a TMS, but currently almost all professional translation seems to be carried out as some form of CAT (e.g. Garcia 2007, 2012; O'Hagan 2009; Pym 2011). A TM is a database that contains previous translations (paired source and target segments) that can be reused. The latest trend in the language industry is to add MT to TM suites (Koby 2013), which we will refer to as **MT-assisted TM**, or to use an MT engine (typically built in-house) to pre-translate a source text, which is then post-edited (e.g. Flanagan/Christensen 2014; Christensen/Schjoldager 2016). **Post-editing (PE)** is defined as the task of editing, modifying and/or correcting pre-translated texts that have been processed by an MT system from a source language into a target language (for an overview, see Flanagan/Christensen 2014: 257). Since MT engines in professional settings are typically trained using in-house TM databases and termbases, and since translators edit the MT output to be included in these TM databases and termbases, the concept of MT-assisted TM blurs the traditional distinction between MT, PE and TM translation (FAHQT, HAMT and MAHT, respectively), which is also emphasised by Bundgaard (2017: 15 and this issue).

We know for sure that tools such as CAT and MT are used on a regular basis in the language industry and that this is changing the industry, the translators' role and translation processes (e.g. Christensen/Schjoldager 2016; Gaspari et al. 2015). While translators previously concentrated on carrying out linguistic transfers from one text to another and producing a target text that could live up to the expectations of their clients, modern-day translators spend most of their time interacting with translation technology that provides them with translation proposals (so-called matches), or they spend much time post-editing machine-generated translations. Indeed, because they hardly translate from scratch anymore, professional translators might now be regarded as **de-facto post-editors** (e.g. Pym 2011, 2012; Garcia 2012; Bundgaard et al. 2016, Bundgaard 2017). Similarly, inspired by the research field of human-computer interaction (HCI)[2], O'Brien (2012) suggests that professional translation should now be conceptualised as **translator-computer interaction (TCI)**. Further, according to Risku's (2010) paradigm of situated, embodied cognition, translation tools are not to be understood as isolated auxiliary artefacts, but should be seen as part

2 For an overview of HCI research, see Wobbrock/Kientz (2016).

of a complex network in which computers function as extensions of humans' memory and knowledge.

The use of CAT tools is an illustrative example of the TCI approach to professional translation: consider, for instance, how terminology databases and TM systems assist the translators' personal capacities by allowing them to retrieve stored knowledge electronically in the form of translation proposals. As a consequence of this and also because translators tend to connect with each other via computers and the internet (like most other professionals nowadays), Alonso/Calvo (2015) propose that the activity of translation should now be regarded as **trans-human translation**, which they define as "an extended cognitive, anthropological and social system or network which integrates human translators and technologies, whether specific to translation or not, and acknowledges the collective dimension of many translation workflows today" (Alonso/Calvo 2015: 148).

3. Mapping translation technology research in TS

The first attempt to define and map the academic discipline of TS was published by Holmes (1988/2000) in a paper entitled "The Name and Nature of Translation Studies". In this seminal paper, Holmes made a basic distinction between pure and applied research. Pure research covers two subdisciplines: theoretical research, which theorises about translation, and descriptive research, which comprises empirical studies that can be either product-oriented, process-oriented or function-oriented. Applied research investigates applications of TS that deal with aspects beyond the limits of the academic discipline, such as translator training, translation tools and resources, translation policy and translation criticism.

In view of the technological turn in TS (Section 2), Holmes' traditional map probably needs to be expanded with some new research areas that are particular to translation technology research (both pure and applied areas). Hoping to contribute to this process of expanding the traditional TS map, we decided to provide an overview of the field of translation technology research by means of a small-scale study of TS papers published from 2006 to 2016. The aim of this study was twofold: (1) to assess to which extent the professional uptake of translation technology has been reflected by research papers within TS and (2) to identify the areas of interest and orientation of the authors in question. In the following, we will present our methods of data collection (3.1) and data analysis (3.2), and we will report on and discuss our findings (3.3).

3.1. Data collection

We started our study by looking at the list of TS journals provided by the European Society for Translation Studies (EST), which included a total of 129 journals at the time of our data collection (November 2016). We soon discovered that it would be too time-consuming and unmanageable for us to study all the listed journals and then decided to disregard journals that were not accessible online and those that mainly publish in languages that none of us master (Chinese or Japanese, for instance). Unfortunately, the resulting list was still rather extensive and unmanageable for our purposes. To narrow the list even further, we simply selected those journals in which members of our own research group[3] at Aarhus University had published papers in the period 2006-2016. Further, we chose to include only those journals that had published at least two papers by at least one member of the research group. While this selective collection of journals might not render results that can be regarded as representative of TS as a whole, we feel confident that our results may give an interesting indication of some important trends within TS and translation technology research.

During the investigated period, we found that at least one member of the research group had published at least two papers in the following nine journals (in descending order): 1) *JosTrans – Journal of Specialised Translation*, 2) *Hermes*, 3) *Perspectives – Studies in Translatology*, 4)

3 At the time of data collection, our research group was the Translation and Interpreting Research Group, and it comprised 11 TS scholars.

Meta: Translators' Journal, 5) *Linguistica Antverpiensia – New Series – Themes in Translation Studies*, 6) *Target*, 7) *The Translator*, 8) *Fachsprache*, and 9) *Trans-kom*. As can be seen from this list, no member had published papers in journals that deal exclusively with CAT or MT, such as the journal of *Machine Translation*. All nine journals state online that they place themselves within the field of TS and/or that they cover translation research, but very few explicitly refer to translation technology in their descriptions of scope, aims or themes. Exceptions are *Meta*, which mentions CAT and MT, and *JosTrans*, which mentions PE. We assume, however, that all nine journals welcome papers on translation technology research.

3.2. Data analysis

Inspired by Alcina's (2008) categorisation (Section 2), we decided to define translation technology research as research that deals with

- Communication and documentation tools and resources (Alcina's category 2)
- Language tools and resources (Alcina's category 4)
- Translation tools (Alcina's category 5)

For our purposes, translation technology research also includes interpreting technology research (e.g. Hamidi/Pöchhacker 2007; and Connell 2006).

To find the papers that would be relevant for our study, we conducted an inductive, accumulative analysis of terms referring to translation technology research (as defined above) in paper titles, abstracts and, if available, keywords (hereafter referred to as titles etc.). This resulted in a list of terms that were thought to reflect translation technology research content. Papers were then included in our study if the paper titles etc. comprise any of the listed terms, unless the terms are used to describe what the authors do not deal with (e.g. Chaume 2007). If papers make no mention of translation technology in their titles etc., they were not included in our study though they may deal with translation technology in other parts. In addition, we did not include papers that have no abstracts (e.g. editors' prefaces and introductions, features, interviews, reviews, review articles and lecture articles), and we did not include papers with dead links in the journal's table of contents. Though we assume that this approach allowed us to find papers that deal primarily with translation technology research, we are aware that it might also have led us to include some that deal only minimally with this – such as Domínguez's (2010) overview of Spanish university scholars' reflections on translation theory in which it is mentioned that some see translation "as technology".

Our inductively accumulated list of terms concerning translation technology research included the following terms:

> translation technology, translation tool, translation resources, translation aids, bi-text, (post)-editing, computer-assisted translation, technology-assisted translation/interpreting, translation automation, interactive translation, translation memory, translator-computer interaction, machine translation, collage translation, terminology management (systems), speech recognition, speech synthesis software, speech to text/text-to-speech, remote interpreting, translation in cyberspace, virtual translation communities/translation networks, translation blog, crowd-translation, cloud-translation, translation blogs and localisation[4], including derivatives and subordinate terms hereof (e.g. fansubbing as an example of crowd-translation and game-localisation as subordinate to localisation) and their descriptive equivalents or translations.

If titles etc. comprise terms like:

4 The term localisation is polysemantic. In our analysis, we only included papers that deal with localisation as defined by Alonso/Calvo (2015: 138): "the adaptation of technological products (and the discourse around them) to each local market and to local uses, customs and linguistic variety (locale)" (Alonso/Calvo's emphasis).

> information and/or communication technology, electronic, mobile and printed dictionaries, databases, automated tools, corpora, termbases/-banks, terminology-extraction systems or software (e.g. concordances), template files, the internet/web and networks,

then the papers were also included in our analysis, but only if they were deemed to deal with tools or resources used for computer-mediated translation. This means that we included papers that deal with tools and resources as applications that make the translator's job easier and as part of a process in which computers are applied to translation, whereas we did not include papers that do not deal with the tools and resources in this way. Thus, for instance, Prassl's (2011) paper on translator dictionary consultation processes was included because we assumed that the dictionaries in question could be computer-mediated, though Prassl does not mention this explicitly in the paper title etc. In contrast, Fuertes-Olivera's (2014) paper on designing online dictionaries was not included because we assumed that the paper does not deal with translation. Similarly, if a term like 'web' is mentioned in a paper title etc., the paper was included if we assumed that the paper deals with (web-based) translation, whereas the paper was not included if we assumed that it does not deal with translation. Papers that deal with the use of tools and resources for translation teaching were also included (e.g. Zhu/Yip 2010, who report on the prospects of using a corpus-based, machine-aided program for translation teaching termed ClinkNotes). In contrast, papers that deal with tools and resources exclusively from a language-(e-)learning perspective were not included.

Finally, papers that deal with all kinds of multimedia translation – such as screen translation, subtitling, audiovisual translation, audio description, surtitling, dubbing, web translation, digital translation and the like – were included in our study if at least one of the listed terms concerning translation technology research is mentioned in the title etc. In contrast, papers that focus on genre aspects of multimedia translation – such as the translation of metaphors or humour in subtitled movies – were not included.

Building on the research classification suggested by Christensen/Schjoldager (2010: 99), who focus on authors' interests and orientation[5], our next step was to divide the journal papers into three thematic categories:

1. **Technology-oriented research** focuses on technical aspects of translation tools and resources, including the evaluation of tools in the broadest sense. This research concentrates on studying the technology itself and its functionalities.
2. **Workflow-oriented and industrial research** is mainly interested in workflow or process issues. This type of research considers the technology in action, focusing typically on social, cognitive and other relevant aspects of the process, including industrial issues.
3. **Translation-theoretical research** focuses on translation from the translator's or translation student's perspective or on textual aspects of translation. This category also includes research dealing with the impact of technology on the profession, translator training, translation research or translation theory. Translation-theoretical papers were only included in this category if the research could be situated within translation technology research – dealing with (aspects of) translation tools, computer-aided translation or machine translation, for instance.

If we thought a paper was eligible for more than one category, we used the category that we thought would reflect the main interests and orientation of the author(s).

3.3. Results

We now proceed to present the results of our analysis of the papers published from 2006-2016 in the nine journals. It is important to emphasise that the results are based on our interpretation of

5 Whereas Christensen/Schjoldager (2010) deal with empirical research on TM translation, the analysis for the current paper took a broader view and included papers on all kinds of translation technology and on all kinds of research (in Holmes' 1988/2000 sense).

the content and aims of the selected articles (dividing them into the three thematic categories, as explained in 3.2) and must therefore be regarded as rather subjective. In other words, there is no guarantee that other scholars using our analytical framework would reach the same conclusions as we did.

Table 1 shows the number of issues published during the period for each journal, the total number of papers that we could access and analyse, the number of papers that deal specifically with translation technology, and the percentage of papers dealing with translation technology out of the total number of papers analysed.

	Number of issues from 2006-2016	Total number of papers analysed	Number of papers dealing with translation technology	Percentage of papers dealing with translation technology
JosTrans	22	230	67	29.1
Hermes	20	168	6	3.6
Perspectives	43	284	24	8.5
Meta	40	490	37	7.6
Linguistica Antverpiensia	11	146	27	18.5
Target	26	172	11	6.4
The Translator	25	152	6	3.9
Fachsprache	22	85	1	1.2
Trans-kom	17	113	13	11.5

Table 1. Papers analysed

As shown in Table 1, two TS journals publish papers on translation technology research quite often, namely *JosTrans* (29.1 %) and *Linguistica Antverpiensia* (18.5 %). Six other journals publish such papers less frequently, namely *Trans-kom* (11.5 %), *Perspectives* (8.5 %), *Meta* (7.6 %), *Target* (6.4 %), *Hermes* (3.6 %) and *The Translator* (3.9 %). The journal *Fachsprache* (1.2%) rarely publishes papers on this topic. While these percentages do not say much by themselves, they show that all nine journals published at least some papers on translation technology in the chosen period. This indicates that translation technology research is now an integrated and viable subdiscipline of TS, though, as mentioned in 3.1, only two journals, *Meta* and *JosTrans*, refer to translation technology in their descriptions of scope, aims and themes, and then only by means of some rather specific terms (MT/CAT and PE, respectively).

Table 2 shows the frequency of translation technology research papers in each journal and in all journals together. We conducted this analysis with a focus on the diachronic changes in the journals in order to investigate if frequencies changed at different points in time.

Journal/year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	In total
JosTrans	3/18	3/15	7/15	7/22	0/20	6/24	14/22	8/20	1/20	9/27	9/27	67/230
Hermes	0/14	0/9	1/19	1/20	1/22	0/16	0/13	2/16	1/17	0/10	0/12	6/168
Perspectives	0/16	7/26	1/12	0/17	0/19	2/21	2/31	3/34	3/35	4/34	2/39	24/284
Meta	5/54	7/51	4/55	4/50	6/50	3/53	0/55	3/32	1/31	1/27	3/32	37/490
Linguistica Antverpiensia	2/19	1/21	2/13	10/10	0/10	8/9	1/12	2/10	0/18	1/10	0/14	27/146
Target	0/13	1/18	1/14	0/13	1/12	2/13	1/14	2/20	2/17	0/17	1/21	11/172
The Translator	1/14	0/12	0/15	0/17	0/13	1/17	3/14	0/10	0/13	0/10	1/17	6/152
Fachsprache	0/8	0/6	0/7	0/8	1/9	0/10	0/6	0/6	0/8	0/9	0/8	1/85
Trans-kom[6]	-	-	0/12	2/10	0/9	2/9	2/13	0/15	1/14	4/23	2/8	13/113
Papers on translation technology in total in all journals	11	19	16	24	9	24	23	20	9	19	18	192/1840

Table 2. Technology research papers and the total number of papers published each year from 2006-2016

6 *Trans-kom* was first published in 2008.

Some 192 out of 1840 papers published in the nine journals (corresponding to 10.4 %) deal with translation technology. The total output of papers on translation technology research is rather constant over the period, fluctuating between 9 as the lowest output (in 2010 and 2014) and 24 as the highest (in 2009 and 2011). Our study therefore seems to indicate that the technological turn (Section 2) had already started in 2006. To establish with any certainty when the technological turn actually started within TS, we would have to expand our study to papers published before 2006. We would also have to analyse journals with narrower scopes than those of the nine journals that were analysed for the present paper. Notably, it could be interesting to analyse papers published by, for instance, *Machine Translation*, which approaches translation from a computer science angle. Perhaps we would then find that some of the nine journals demonstrate a delayed response to the technological turn in TS, though to a varying degree.

As was explained in 3.2, we carried out a thematic analysis of the 192 papers that deal with translation technology research, dividing them into three thematic categories. Table 3 shows that the main trend in the nine journals seems to be papers on translation-theoretical issues (our category 3), as 92 papers take this perspective, while 66 papers focus on the technical side of the tools (our category 1) and only 34 focus on workflow-oriented and industrial aspects (our category 2). This mirrors quite closely what Christensen/Schjoldager (2010) found in empirical TM technology research.

Journal/Total numbers	1) Technology-oriented research papers	2) Workflow-oriented and industrial research papers	3) Translation-theoretical research papers
JosTrans	19	15	33
Hermes	5	0	1
Perspectives	7	7	10
Meta	14	6	17
Linguistica Antverpiensia	17	3	7
Target	2	2	7
The Translator	2	0	4
Fachsprache	1	0	0
Trans-kom	9	1	3
Total numbers	66	34	92

Table 3. Thematic analysis of papers on translation technology research

Analysing the themes of the 192 papers, we found that most translation-theoretical papers seem to focus on the translator and the impact of technology on the translators and the profession in general or on translator training. As for the papers focusing on technical aspects, these primarily highlighted tool functions and conducted quality assessment and evaluation. The workflow-oriented and industrial research seems to focus more on the implementation of technology in the language industry than on the impact of this on translation processes. Even though process research is one of the most rapidly developing areas in TS studies (Munday 2009: 104), so far this trend does not seem to prevail in translation technology research. Furthermore, our study reveals that relatively few scholars have investigated translation technology in the workplace, and also that research on translators' interaction with translation tools and how this affects their minds and work processes is rather scarce.

4. The thematic section on translation technology research

The current *Hermes* issue comprises eight papers that deal with a variety of topics within translation technology research based on a wide selection of theories and methods. Following the thematic categorisation explained and used in Section 3, we would say that most papers (four) may be categorised as workflow-oriented and industrial research. This seems to break with the trend in the nine journals that were analysed for our study, and it appears to break with a trend in *Hermes*,

in which most papers (five out of six) published in the period were categorised as technology-oriented (Table 3). In addition, while the field seems to lack translation process research (Section 3.3), all papers in the current issue discuss or at least touch on process aspects of CAT and/or MT.

As already explained (Section 3), *technology-oriented research* focuses on technical aspects of translation tools and resources (in Alcina's 2008 sense). Two papers fall within this category. **Maite Aragonés Lumeras and Andy Way's** research is categorised as technology-oriented because they study the strengths and weaknesses of **statistical machine translation (SMT)** in comparison with human translation. The paper has reassuring news for professional translators who fear that their jobs will be taken over by computers any day soon. According to the authors, humans constantly outperform translation tools when semantic disambiguation, contextual knowledge and genre expertise are required, though computers are faster at translating and pre-processing texts and can assist the translator with spellchecking and terminology. Lumeras and Way therefore conclude that human skills are not likely to be replicated by automatic processes and will remain the most valued component of the translation process now and in the future, suggesting that developers, computational linguists and professional translators ought to acknowledge this more and work closely together to optimise translation processes.

Michael Carl and Moritz Jonas Schaeffer's paper is categorised as technology-oriented because they discuss and evaluate the usefulness of MT. In a corpus-based study involving several language pairs, the authors investigate systematic difficulties in connection with the **post-editing of MT (PEMT)** focusing on some consequences of syntactic and semantic dissimilarities between source and target languages, which they refer to as non-literality in translation. In particular, the authors study correlations between the complexity in the post-edited output and in the search graph of the SMT system (the shortest path to a possible translation). A main result is that post-editors struggle more with non-literal translations generated by an MT engine than translators do translating the same texts from scratch.

Workflow-oriented and industrial research concentrates on the tools or resources in action, dealing with social and other process issues in professional translation (Section 3). Four papers fall within this category. **Ignacio Garcia** examines a new, revolutionising translation tool – cloud computing – and its influence on the labour environment of the industry, including power relations in the online translation marketplace. Based on critical analyses of recent and relevant literature as well as important industry sources, Garcia documents that the emerging cloud paradigm is reshaping the translation industry in the sense that managers and clients increasingly control and monitor the entire translation process by recruiting translators from a "massive pool of casual, inexpensive labour that can be tapped on demand". From the management perspective, cloud computing is highly profitable due to the competitiveness and flexibility of the online marketplace, but for professional translators it is alarmingly disempowering as they lose bargaining powers and control over their working lives.

As pointed out by **Kristian Tangsgaard Hvelplund**, although digital resources appear to be used extensively by most professional translators, we still lack empirical knowledge of these resources and how they impact translation processes. The author sets out to help fill this gap. Digital resources are defined as aids that translators can access from the computer and use to solve translation problems – such as online dictionaries and the Google search engine. In an empirical translation process study, Hvelplund examines professional translators' use of digital resources in a series of translation recording sessions, in which the translators translated English-language fictional and specialised texts into Danish. A main result is that digital resources are consulted for almost 20 % of the time used for the entire translation task, which is quite considerable. Hvelplund ends his paper by arguing that the use of digital resources should be explored more in translation process research.

Nora Aranberri's paper investigates the nature of edits made in MT and reports on an investigation into the post-editing of SMT-generated translations from Spanish into Basque carried out by experienced translators, who faced the task without prior training, as many professional trans-

lators have to nowadays. The quality of the MT output was assessed as moderate, which tends to be the case with MT from or into lesser-known languages such as Basque. Whereas post-editors of high-quality MT output can generally concentrate on fixing the MT matches that need changing, Aranberri's participants had to spend a considerable time assessing the moderate-quality matches to know whether to accept, reject or revise (fix) them. Aranberri refers to this as "patchwork" PE and recommends that prospective post-editors are made aware of this kind of PE in guidelines and training workshops.

Joss Moorkens and Ryoko Sasamoto study productivity in connection with various segments in MT-assisted TM translation. Within a relevance-theoretic framework and taking a grounded theory approach, they report on an exploratory, empirical study of professional English-Japanese TM-assisted MT translation. They aim to establish whether there is a relationship between elements of inferential communication (procedural/conceptual encoding) in the target text, temporal effort and the type of translation segment (TM translation, MT or translation from scratch). Their study shows that translation productivity increases when translators work from TM matches, which is in line with previous studies, but it lowers when translators edit MT matches and increases when they translate from scratch, which is contrary to what was expected.

Translation-theoretical research focuses on the translator's or translation student's perspective or on textual aspects (Section 3). Two papers fall within this category. Both deal with professional translators' attitudes towards the technology and its functionalities and focus on negative aspects of the tools. In a workplace study of MT-assisted TM translation in a Danish translation company, **Kristine Bundgaard** uses Pickering's (2005) framework of perceived resistances to conceptualise translators' irritation with the technology. A main conclusion is that the translators were more critical of MT than TM translation as they generally felt less in control of the translation process in connection with MT matches (having to accommodate more resistance from these), which impacts severely on their job satisfaction.

Sharon O'Brien, Maureen Ehrensberger-Dow, Marcel Hasler and Megan Connolly report on the findings of an international online survey, which was part of the *Ergo Trans* project, an impressively large and multi-disciplinary project. In the paper, the authors use Cooper's (2004) concept of cognitive friction to conceptualise the translators' irritation with the tools. While they believe that some cognitive friction experienced by many translators in connection with CAT may be due to a lack of "technological maturity", they suggest that software developers should work closely with translators to develop tools that cause less cognitive friction for the users – a recommendation that is also voiced by Lumeras/Way (this issue).

5. Concluding remarks and discussion

The current lack of translation technology research in TS inspired us to invite papers for a thematic section of *Hermes*, and we are pleased to present such innovative and interesting papers, which will help fill an unfortunate gap in TS. The aim of our introductory paper was to present the eight contributions against the backdrop of the history and current trends within translation technology research. We started with a brief discussion of translation technology research as a subdiscipline of TS, and we provided an interpretation of Alcina's (2008) categorisation of translation technology, which we then used as a basis for a mapping study of translation technology research papers published by nine TS journals in the period 2006-2016.

The aim of the mapping study was twofold: (1) to assess to which extent the professional uptake of translation technology has been reflected by research papers within TS and (2) to identify the areas of interest and orientation of the authors in question. The analytical method was inductive and accumulative as we identified translation technology related terms in paper titles, abstracts and keywords published by the nine journals, dividing them into three thematic categories. The analyses resulted in a map of translation technology research as it was represented in the nine journals during the chosen period. Like all maps, the map that we present is a simplified reflection

of reality, but we believe our results may help to demonstrate some interesting trends that are indicative of the technological turn in TS; and we think the three categories of translation technology research that we found may possibly be used to supplement Holmes' (1988/2000) traditional map of TS.

A main result of our analysis is that translation technology research is now an integral part of TS, though not to the extent that one would expect from the overwhelming uptake of technology in the translation profession. The main trend in the nine journals seems to be translation-theoretical, with 92 translation-theoretical papers out of a total 192 papers on translation technology research (Table 2, Section 3.3). We also find that the nine journals deal with translation technology in varying degrees, ranging individually from 1.2 to 29.1 % of the total number of papers (Table 1, Section 3.3). In other words, while translation technology research has left an indelible footprint on some TS journals, it is almost invisible in others. The analysis also shows that most papers that deal with translation-theoretical aspects of translation technology take the translator's perspective or focus on translator training and the translation product. Thus, for instance, many translation-theoretical papers in our study discuss and assess the ability of the tools to meet professional quality standards, while translation-theoretical papers that deal with process aspects of translation technology are relatively scarce.

Though projects on translation technology within TS are still relatively few, the evidence that we have before us clearly shows that the advent of translation technology has had a tremendous impact on the translation profession. The papers of the current *Hermes* issue certainly suggest that translation technology has changed most aspects of professional translation – including translation processes, workflows and products, translators' working conditions and status as well as the management and infrastructure of the language industry; and more essential changes are still to come with the emerging MT tools. A sure sign that we are entering an era of increasing automation is that most contributors to this issue seem to work on a premise that the norm in professional translation is now PEMT or MT-assisted TM, as opposed to traditional TM translation (without MT functions), which was the norm till relatively recently.

Essential changes in the practice of translation are bound to alter professional translators' perception of what they are doing, and this should also alter the way we think about translation theoretically. Now is definitely the time to reconsider and discuss what we mean by translation and translators. In particular, professional translation nowadays might more aptly be described as TCI (O'Brien 2012) and as a trans-human activity (Alonso/Calvo 2015), since technology, translators and the industry must now be seen as one coherent system, a point that all contributors to the thematic issue also seem to take for granted.

We suspect that Hutchin/Somers' (1992) traditional model of translation modes (Section 2) does not hold for modern-day business and specialised translation (though it may hold for other, more creative kinds of translation, such as poetry or literary translation). Firstly, since all professional translation now tends to be performed by means of some form of computer assistance, Hutchin/Somers' mode of human translation must be considered, if not non-existent then at least, negligible in the translation profession today. We would therefore suggest that the mode of human translation could to be abandoned all together. Secondly, since much professional translation now seems to involve some form of automation, the distinction between MAHT and HAMT is becoming blurred (Section 2), and the model should therefore be supplemented with a mode that comprises both MAHT and HAMT. MT-assisted TM translation (Section 2) is an example of a professional application that comprises both MAHT (TM translation) and HAMT (post-editing MT) – as opposed to traditional TM translation, which does not involve HAMT (because it has no MT functions). Thirdly, we think that the model could be supplemented with some new modes that reflect the significant and diversified technological developments within fully automatic high-quality translation (FAHQT). Examples of such recent tools are SMT, rule-based hybrid MT systems and the recently developed **neural MT (NMT)** systems, whose ability to 'learn' renders impressive quality and speed features (e.g. Kenny 2016; O'Brien 2016; Bundgaard 2017).

There can be no doubt that translators are becoming less and less central to translation processes, which are increasingly dominated by a variety of advanced translation tools and resources (Hvelplund this issue, for instance), some of which have only just become available – NMT, for instance. It is also more than likely that translators are becoming less and less central to professional translation, as the entire translation market might soon be revolutionised by online collaborative solutions, such as cloud computing (Garcia this issue), and no doubt also by ongoing advances in artificial intelligence, which are bound to speed up automation processes even further. As pointed out by Garcia (this issue), such market developments may have a devastating impact on the working conditions and status of professional translators, who risk becoming marginalised as freelancers in an on-call, competitive marketplace, of which they have no control.

However, the future of the translation profession may not be so bleak after all. Firstly, machines are not likely to take over all translation processes, at least not in the foreseeable future, and, secondly, more automated translation processes do not necessarily mean that there will be *no* need for human translators. According to Lumeras and Way's paper (this issue), for instance, there can be no doubt that human translators and SMT systems will still need to complement each other, as humans currently outperform computers in tasks that involve contextual and textual interpretation, but the degree of human involvement will depend on the translation scenario, including "the purpose, value and shelf-life of the content" (Lumeras/Way this issue). The results of several other contributors to this issue also indicate that even high-quality MT still presupposes at least some degree of human involvement, especially in the form of PE in connection with lesser-used languages (Aranberri this issue; Moorkens/Sasamoto this issue). Similarly, the papers by Bundgaard and O'Brien, Ehrensberger-Dow, Hasler and Connolly find that high-quality outputs are more easily achieved from TM than from MT matches and that working with MT matches tends to irritate the translators more than working with TM matches. The latter point is supported by Carl and Schaeffer's finding that non-literality is more problematic (more time-consuming) in the post-editing of MT than in from-scratch translation. To all this, we might add that many translators find it pleasing that they no longer have to perform tasks that they used to regard as rather tedious and time-consuming: looking up words and researching precise terminology in traditional dictionaries, encyclopaedias etc. and carefully coding/re-coding (and typing) these words and terms into the translations. In fact, many current translators probably welcome that they are free to concentrate on other aspects of translation, which to them may be more fulfilling, such as translation project management and quality assurance.

It is probably well known that machines (or robots) can now carry out functions that were previously performed by humans in many professions. Thus, for instance, it is now possible for computers to drive cars, diagnose diseases, carry out complicated surgery and answer (simple) legal and administrative enquiries. However, it is probably also well known that computers can fail fatally, and when they do, it is absolutely necessary that humans are qualified to take over. As an example of this, Højholt (2016) mentions the fatal crash of Air France flight 447 in 2009, when the automatic pilot disconnected due to technical problems. The failure of the automatic pilot was not the reason why the plane crashed; the plane crashed because the crew did not have sufficient practical experience in flying the plane manually. Luckily, the failure of translation technology rarely causes fatal accidents, but the lesson for professional translators is quite similar to that of pilots: even though high-powered technology is now able to take over translation processes that were previously carried out by human translators, and even if these processes appear to run flawlessly, humans will still need theoretical and practical training in translation, and they definitely need to be able to monitor the work carried out by the computers.

Whether the human translators of the future will continue to see themselves as translators or perhaps as something rather different remains to be seen, but we are certain that they will need to develop and expand skills and competences that are beyond what many professional translators master today. The translators of the future will need more training in IT, they will need training in new forms of translation, such as PEMT (Aranberri this issue), and they will need to develop

their competences as efficient communicators and text producers. They will need a thorough understanding of how to interact well with other professionals and with computers in an extensive collaborative network. We therefore end our paper by proposing that language and translation programmes in universities and other institutions turn students into text and translation technology experts. Graduates from such programmes will know how to produce highly functional texts in several languages, what it takes to deliver high-quality translations and how to do all this well by means of advanced technology and in close collaboration with other experts.

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