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Fostering MT Literacy and Reasserting the Value of Human Translators

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In a rapidly evolving language services landscape where the boundaries between translation, revision, and post-editing are becoming increasingly blurred, this article provides a state-of-the-art review on the intricate relationship between human translators and Neural Machine Translation (NMT). While acknowledging the significant advancements made in the field of Artificial Intelligence (AI) applied to automatic language processing, we want to emphasize the pressing need to reassert the value of human translators over unconscious algorithms that automatically generate translations. This paper also highlights the synergy between human skills and technology, positioning NMT as a key additional tool in a translator's toolkit that enhances both speed and efficiency to meet the exponentially growing demand for translation services and to cope with the ever-tightening deadlines. Nevertheless, considering the ambivalent effects of NMT on the quality of the final product, we advocate for the informed and responsible use of machine translation (MT) tools by both professionals and translation students. Furthermore, we believe that beyond fostering MT literacy, translation trainers may play a crucial role in nurturing adaptability in future translators, equipping them with the necessary skills and tools to confidently navigate the latest and emerging technologies—such as interactive and adaptive MT tools or chatbots—in order to secure them a competitive advantage in the translation industry.
Keywords: machine translation; MT literacy; human translators; MT tools; translation students

1. Introduction

For the past few years, the translation industry has been shaped by a technological boom, largely driven by the advent of new translation technologies, such as neural machine translation (NMT). Hence, professional practices are changing, and adapting translation training programs has become a critical challenge both for translation training and for the future of the profession.

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Given this rapidly changing language services landscape, this paper proposes to explore the intricate relationship between human translators and machine translation (MT). The following sections of this paper will delve deeper into the diverse aspects of MT literacy, which involve acquiring comprehensive knowledge of the benefits and limitations of MT tools as well as promoting their responsible and effective use. It will also examine the evolving role of human translators, reaffirming their central position in the translation process and emphasizing their human-specific qualities. This paper will discuss innovative approaches aimed at optimizing the integration of MT into the translation workflow, thereby supporting 'machine-assisted human translation' rather than 'human-assisted MT.' We conclude this article by stressing the crucial role of translation trainers in cultivating flexibility and adaptability among translation trainees in order to successfully navigate the blurring boundaries between human translation and MT.

2. Promoting MT Literacy

Given the increasing role of MT tools in the language services industry and their ambivalent effects on target-text quality (Schumacher, forthcoming), we consider it crucial to promote their informed and responsible use, both among professionals and students, referring to the concept of "MT Literacy" (Bowker and Ciro 2019; Loock 2019, 2020d; Loock and Léchauguette 2021; O'Brien and Ehrensberger-Dow 2020; Rossi 2019). The term "MT Literacy" was introduced by Lynne Bowker and Jairo Buitrago Ciro (2019) and initially limited to activities related to scientific research and publication by non-professionals. However, De Clercq et al. (2021) called for a broader definition, asserting that "[translators] should develop their MT literacy . . . that is the need to know what the machine can(not) do, what the difference is between human translations and MT output, and what to focus on during the post-editing (PE) process" (22).

Similarly, Sharon O'Brien and Maureen Ehrensberger-Dow (2020) emphasize the importance of understanding how MT works and reflecting on its contextual application: "MT literacy means knowing how MT works, how it can be useful in a particular context, and what the implications are of using MT for specific communicative needs" (146).

Regarding the inner workings of MT systems, Rudy Loock (2019, 56) notes that an in-depth understanding is not necessary. He does, however, stress the need for students to know that the

performance of these tools is directly related to the quality of training data. Loock (2020a) agrees with the pragmatic approach advocated by Bowker and Ciro (2019) and encourages this approach in the training of future translators. According to Loock (2020a, 271), as these tools are here to stay and are already being used extensively by different user groups, it is therefore important to foster MT literacy.

Furthermore, the objectives and challenges of such training are manifold:

> A core focus of this training is ensuring that translation students understand the most recent approaches to MT, its strengths and its limitations, how to evaluate it and how to post-edit. Importantly, understanding when and how MT ought to be used has become central to training, both for translation students and for those who are not trained in translation. (O'Brien 2022, 118–119)

Additionally, Caroline Rossi (2019) advocates collective reflection to promote an informed and responsible use of MT in translation education programs. She recommends that students be taught adaptation strategies to help them overcome their fears, encouraging them to critically assess current technological developments and consider their role in an AI-driven environment.

Building on the insights of the researchers we have cited, we firmly believe that translation trainers have the responsibility to foster MT literacy among translation trainees with the aim of developing informed and autonomous users for responsible MT use.

3. Reasserting the Value of Human Translators

For Loock (2020b),[1] in order to master MT tools effectively and use them adequately, it is crucial not to completely reject them nor overly idealize them. Instead, the focus should be on highlighting the added value that human translators bring. Clearly, we share this imperative to revalue the role of the human translator, especially in the context of future generations of translation professionals. In a case study focusing on a series of linguistic features, Loock (2018) identified deviations from the linguistic norms/usage in French machine-translated texts compared to original French language, despite significant advances in NMT. This deviation phenomenon, he argues, is problematic because it reveals the translated nature of the text to the reader, which contrasts with

[1] All translations into English are provided by the author of the paper.

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the translation industry's expectations of translator invisibility. Hence, the need arises to emphasize the added value of the human translator over the machine:

> In an educational setting, by focusing on specific linguistic features, translators-to-be can be sensitised to the benefits and limits of MT systems and therefore define their added value over the machine, since MT output, in spite of indisputable progress, does not seem to take into account language norms such as frequencies of use. Students can then become aware of the gap that exists between original and machine-translated language, while in order to reach the invisibility required by the industry this gap should be at least reduced. (Loock 2020c, 165)

Acknowledging the fundamental importance of humans is thus vital since many professionals seem to have lost the pleasure of translating. They frequently feel undervalued in a task that is perceived as lacking creativity, replacing the gratifying process of transferring meaning with the more challenging task of reconstructing meaning and cohesion (Grass 2022). They feel relegated to the status of mere "fixers" of MT errors while receiving less compensation for doing such work:

> In the context of MT, not only can translators feel replaced by the machine, but the machine generates fundamental linguistic errors that a trained human translator would rarely generate. The professional translator is then demoted to the status of a fixer (Krings 2001) of seemingly unintelligent errors. That they are paid lower rates to fix such errors than to create their own translation adds to the feelings of negativity. (O'Brien 2012, 108–109)

Similarly, Hanna Martikainen (2022) denounces the dehumanizing nature of MT tools, which impose a workflow that reduces the role of the human translator to merely correcting MT errors in a one-sided process with no real interaction.

Donald A. DePalma and Arle Lommel (2017) also acknowledge that many translators have lost their enthusiasm for the profession, as it is losing some of its attractiveness:

> Until now, language technology developers have focused their work on speeding up the process and lowering costs. Those drivers have left many translators feeling alienated from the very aspects of their work that attracted them to the job in the first place – the creativity of language, the challenge of solving difficult problems, and the ability to work on stimulating texts and topics. Translators often find that they spend as much time managing the technology as they do translating, and that their rates are always under pressure. (n.p.)

However, as O'Brien (2022, 105) rightly points out, MT is an imperfect technology, and users are often unaware of its limitations, shortcomings, and inconsistencies, which require human

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intervention at all stages of its use (Kadiu 2016, 218). As of today, no technological tools are capable of fully replacing a human translator to produce a text of publishable quality (Deneufbourg 2020; Loock and Léchauguette 2021; Vieira, Alonso, and Bywood 2019).

We share Dorothy Kenny's view (2022)[2] that NMT should be considered as one of the many auxiliary tools available to translators, enabling them to work faster and more efficiently to cope with the ever-increasing translation volumes and ever-tightening deadlines: "[T]he productivity gains brought about by machine translation (MT) can help translators meet ever-tighter deadlines and respond to pressing demands for publishing content simultaneously in different languages" (Martikainen 2022, n.p.)

This view is also supported by Loock (2020c): "MT output can be very good and serve as inspiration for students, meaning MT should be considered a translation tool to help them in the same way translation memories and specialized electronic corpora do" (164), as well as by Elisa Alonso and Lucas Nunes Vieira (2020):

> [D]espite its potentially negative consequences, technology can also have a positive impact on translation as a practice and profession. . . . While MT can be perceived to threaten translators' standing and professional status, it is in a relationship of complementarity with translators and not in one of exclusion. (400)

Despite technological advances and unfounded claims that human parity has been achieved in MT (Grass 2022; Loock and Léchauguette 2021;[3] Poibeau 2022[4]), human translators should undeniably remain at the core of the translation process. It is crucial not only to recognize it, but also to raise awareness about it. Like Joss Moorkens (2018), we are convinced that teachers and trainers have a key role to play in reasserting the value of human translators: "[I]t is incumbent on translation trainers to ensure that students are made aware of their usefulness in order to maximize their agency as translators, and to fulfil industry employment needs" (375).

[2] "NMT is just the latest in a line of technologies designed to automate translation, albeit one that has risen to prominence remarkably quickly" (Kenny 2022, 46).
[3] "Contrary to popular (and student) belief, most of the time MT output is never ready-for-use and often requires post-editing (PE), with both accuracy and fluency errors . . . MT output is rarely perfect and systematically requires checking" (Loock and Léchauguette 2021, 205–207).
[4] "[I]t is clear that performance varies a lot from one domain to the other, or from one type of text to the other. MT is not a solved task and has not reached human parity between any language pair (although some results obtained in evaluation conferences on specific data from specific domains may suggest the opposite). . . . A quick look at current systems clearly shows that we are still far from any 'human parity'" (Poibeau 2022, 6018–6019).

4. Are We Cutting off the Branch We are Sitting on?

This question, albeit in a different form, was posed by O'Brien in 2012: "By repairing MT segments and letting the machine learn about those repairs, are we progressively making ourselves redundant? Or, again, are we freeing ourselves up for those harder, subtler, more complex problems?" (117). And this question inevitably gives rise to a series of other questions: What is the place of human translators? "Do they become liberated or alienated by the machine (which cannot function without human-produced data)? […] Does the machine make the bio-translator an augmented or a diminished translator?"[5] Are MT tools a real threat to the profession? How can we reconsider the translator's role? What is the added value of human translators over machines? What does the future hold for humans in this context? As Thierry Poibeau (2022) recommends, "[t]he minimum is at least to consider these questions seriously and not just put forward the replacement of humans as an unquestionable desirable advantage of technology" (6022).

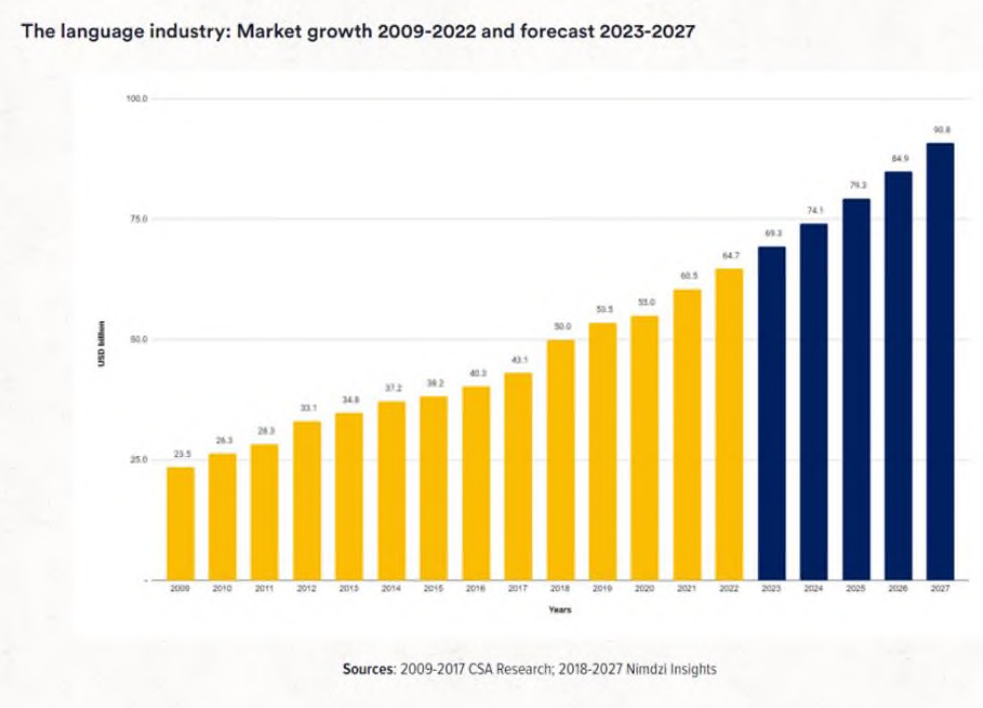
5. Is Machine Translation a Real Threat to the Profession?

Among the various stakeholders in the translation industry, some are relatively optimistic about the future of human translation. They believe that the prospects for translators are not as bleak as they may seem, especially as advances in deep learning MT systems are enabling professional translators to address the market's needs by increasing productivity and meeting the growing demand for translation services.

Moreover, the number of people working in the translation industry has never been higher (Moorkens 2022, 24). The language services market is thriving and continues to expand internationally, and the forecasts for 2023-2027 are equally positive, as shown in figure 1. According to the Nimdzi 2023 report, the global market was estimated at 64.7 billion dollars in 2022 and is expected to reach 69.3 billion dollars in 2023 (Hickey 2023).

[5] "Literary Translation and AI: Assessing Changes in Translation Theory, Practice and Creativity." Call for papers (Tract Conference and/or Palimpsestes no. 38). Accessed December 20, 2023, https://lit-trans-ai.sciencesconf.org/.

Figure 1. Nimdzi report 2023 (Hickey 2023)



O'Brien (2012), for instance, already predicted that increased human-machine interactions (using statistical MT at the time) would have positive consequences: "By interacting more with computer-supported translation tools, translators will enable more translation to occur, into more languages and, hopefully, in language directions that do not normally gain attention through lack of resources" (119).

And this remains true after the MT paradigm shift: "Evidence suggests that only a small portion of content produced globally is translated (Language Industry Survey 2019) but as MT becomes more successful, translation volumes are increasing globally" (O'Brien and Ehrensberger-Dow 2020, 160).

Enrico Antonio Mion (2020) asserts that new technologies have not replaced human jobs; in most cases, they have modified them. This is a position shared by Moorkens (2022, 24), who recognizes that online translation systems, which are now highly efficient and accessible to all, have not killed the profession but rather transformed it.

In line with this, Baptiste Dirand and Caroline Rossi (2019, 76) believe that advances in MT do not condemn the human translator but rather allow for more numerous and smoother human-

machine interactions (MT outputs integrated into a CAT tool, interactive MT adapting as the translator is typing).

6. Human Efforts Behind-the-Scenes

Originally inspired by the workings of the biological brain (Poibeau 2019), NMT paradoxically relies on human brain activity at various levels. To illustrate this, one need only examine the huge training datasets that enable these systems to work, which, as Dirand and Rossi (2019, 72) aptly point out, are nothing but the work of human translators. Alonso and Vieira (2020) rightly emphasize that "an important bottleneck to neural MT is the availability and quality of multilingual data [and] it should be noted that high-quality data require human effort and expertise" (395). Kenny (2022, 46) further adds that neural MT is based on human translations, or at least translations validated by humans, which serve as training data. Consequently, it is a fact that MT engines cannot function without human-produced data.

As Bowker (2020) rightly pointed out,

> the success of some forms of translation technology, such as statistical MT and neural MT, is in fact heavily dependent on their having access to large volumes of training data made up of high-quality human translations. So, far from replacing translators, current state-of-the-art technologies are dependent on them. (465)

Rather than obscuring human efforts behind AI algorithms, the discourse surrounding MT should benefit from greater attention to the numerous human-machine interactions (Dirand and Rossi 2019), which play a key role in developing and improving MT systems. While MT advances are often the focus of attention, it is important to recognize that humans are, for instance, responsible for selecting the datasets used to train MT systems, as well as the linguistic and terminological resources that are integrated into them.

Although MT tools may create the illusion that the translation process is fully automated and requires no human intervention, it is essential to acknowledge that human interventions remain an integral part of the process:

> [N]ot only does free online machine translation imply that translation is "an agentless, automatic function that can be realized in no time at all" (Cronin 2012, 47) thus obscuring the human labor that produces the translated and other data on which SMT is based; systems

> like Google Translate also obscure the labor of the computer scientists who build SMT systems, and can give the impression that there is nothing to SMT. (Kenny and Doherty 2014, 288)

7. Augmented or Diminished Translator?

In an effort to optimize the work of translators, the boundaries between human translation and MT are becoming increasingly blurred. NMT is being more closely integrated into Computer-Assisted Translation (CAT) tools (Castilho et al. 2018),[6] suggesting a different approach to MT, one closer to Machine-Assisted Human Translation (MAHT) than mere MT post-editing (Hansen et al. 2022, 22). Lucas Nunes Vieira (2019) even discusses a paradigm shift that would put the human translator at the center of the translation process, moving from human-assisted MT to MAHT:

> [M]uch has been done lately to improve the use of MT in professional translation. MT is now available in most computer-assisted translation (CAT) tools. As implied by their name, these tools changed the focus from human-assisted MT to machine- (or computer-) assisted human translation. Unlike the paradigm from early MT research, machine-assisted human translation puts humans at the centre of translation production. The incorporation of MT into CAT tools and, more recently, a higher degree of integration of these tools' different features – such as translation memories, terminological resources and MT itself – all contribute to an understanding of MT as a resource that helps human translators improve their productivity. (319–320)

According to Martikainen (2022), integrating MT into CAT tools now constitutes the most comfortable solution for translators: "The ideal scenario for translator well-being would seem to be the integration of MT into the usual translation workflow, wherein MT is just another potentially useful tool available for the professional translator through the CAT interface" (n.p.). She emphasizes the importance of training students in machine-assisted human translation tasks: "Students are . . . trained to put in practice a workflow inspired by best practice, i.e., integrating

[6] "We contend that the boundaries between HT and MT (and, to some extent, also those between translation as understood in academia versus in the industry) are increasingly blurring; this is apparent, in particular, in software and web localisation as well as in a wide range of technical and specialised domains, where MT (often supported by PE) is becoming widely used alongside the now commonplace computer-assisted translation (CAT) software such as translation memories, especially for projects involving major languages as source or target, or for language pairs with substantial commercial interest" (Castilho et al. 2018, 11).

different MT engines into the CAT environment of their choice so as to maintain the benefits offered by CAT tools, particularly for ensuring coherence, and limit MT interference" (ibid., n.p.).

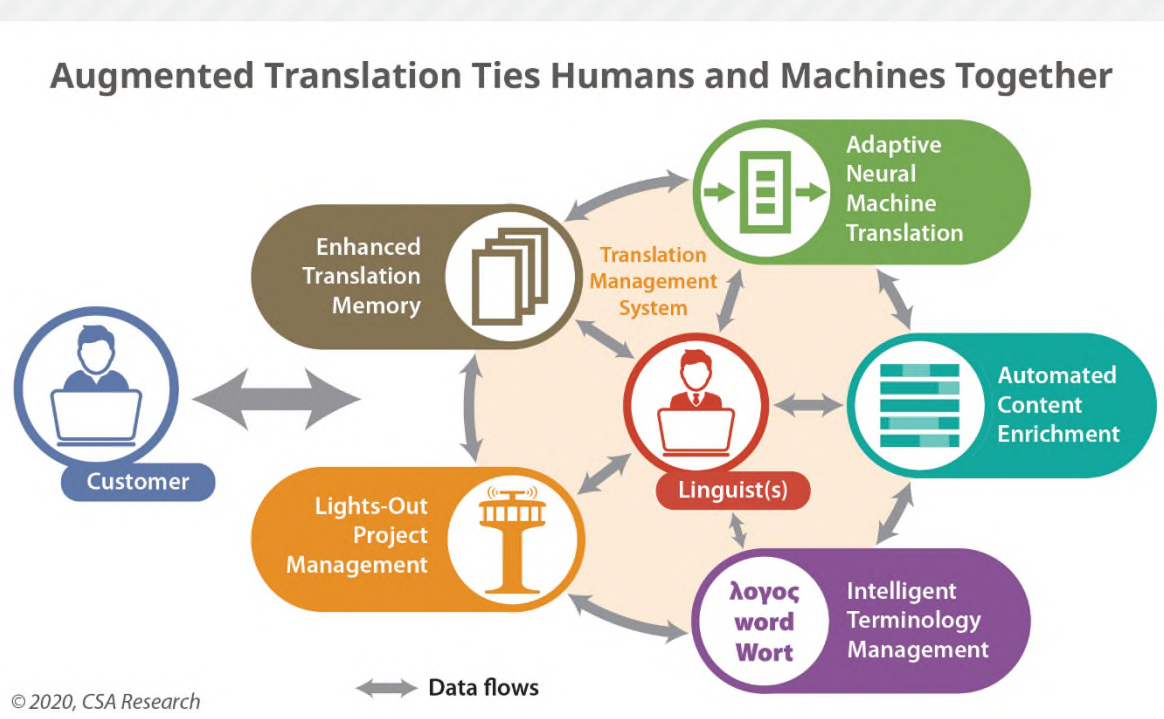
Nowadays, thanks to a range of innovative solutions, including MT and CAT tools, translators can work in a groundbreaking working environment (Mion 2020), allowing them to engage in a new form of translation known as "augmented translation" (see DePalma and Lommel 2017):

> In such environment, professionals have access to tools that enhance their efficiency, productivity, and skills. Using digital dictionaries, the internet, terminological resources, corpora, voice recognition, voice dictation software, translation memories, automatic correction tools, and many other tools and functions, language service professionals are guided to perform a new kind of translation: augmented translation (Mion 2020, n.p).

With the concept of augmented translation, human translators are given a central role (see figure 2) and are allowed to rediscover the joy of translating, as they are freed from some of the repetitive and draining tasks. As DePalma and Lommel (2017) had already foreseen, such a highly technological environment enables translators to focus on other aspects of their work, particularly their creative potential:

> They work in a technology-rich environment that automatically processes many of the low value tasks that consume an inordinate amount of their time and energy. It brings relevant information to their attention when needed. This computing power will help language professionals be more consistent, more responsive, and more productive, all the while allowing them to focus on the interesting parts of their jobs rather than on "translating like machines". (n.p.)

Figure 2. Augmented translation (Lommel 2020)



8. Human-Centered Tasks

In this new environment, among the latest innovations available to translators are tools that combine interactive MT (Peris et al. 2017; quoted in Forcada 2017, 296)[7] and adaptive MT, such as the Lilt software.[8] These two concepts are sometimes used interchangeably, but it is essential to make a clear distinction:

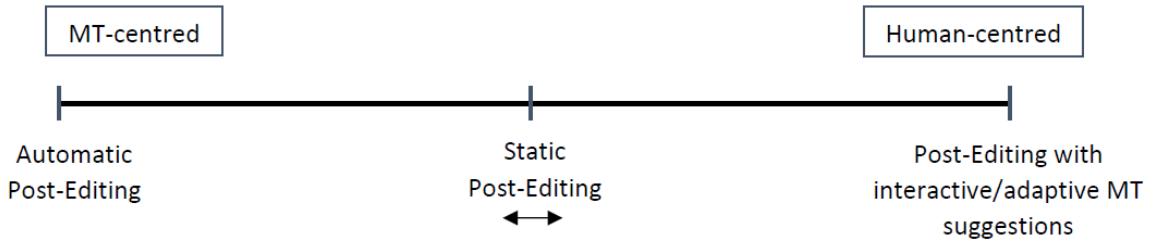
> An interactive system tries to autocomplete the text the user is going to type; it either predicts the text the user is going to type or changes the MT suggestion on the basis of what

[7] "Peris et al. (2017) have proposed what they call interactive neural machine translation, a special kind of interactive machine translation or interactive translation prediction, which had customarily been performed so far using SMT instead of NMT. In these prediction–completion translation workflows, the system suggests possible continuations which may be accepted … or ignored by the professional translators as they type the target text" (Forcada 2017, 296).
[8] https://lilt.com. "This technology – currently found in Lilt and SDL BeGlobal – learns from translators on the fly. It adapts to the content they work on, automatically learning terminology and style. It remembers what linguists have previously translated at the sub-segment level, and goes beyond translation memory to help translate text it has never seen before in a way that is consistent with how the individual professional works. Rather than post-editing MT output of dubious quality, linguists see the results as suggestions they can choose to use or not. The more they use the system, the better these suggestions will become" (DePalma and Lommel 2017, n.p.).

> is typed, whereas an adaptive system is an MT system that learns from corrections on the fly and is continuously trained. (Daems and Macken 2019, 118)

On the spectrum of human agency in the post-editing process proposed by Vieira (2019) (figure 3), post-editing with interactive MT and adaptive MT logically stands at the opposite end of mere MT post-editing.

Figure 3. Spectrum of human agency in the post-editing process (Vieira 2019, 328)



To gain a better understanding of how these tools function, let's refer to the detailed explanation provided by Martikainen (2022, n.p.) regarding the Lilt tool: this software adapts at two different stages. Like most MT engines, Lilt adapts to the user and provides more accurate predictions over time. However, unlike static MT engines, interactive MT systems (or "real-time adaptive translation") also adjust during the translation process. The AI solution immediately takes into account each translated word to adapt the suggested output and generate predictions. If the machine's first suggestion is not validated, a new one is provided while typing.

Considered as an alternative to "static MT," adaptive MT can overcome some of the challenges associated with this static approach. These challenges include the limited agency of the translator, as highlighted by Martikainen (2022): "Adaptive MT has been advertised as 'Machine Translation for Human Translators' [Denkowski et al., 2015], a way to recenter the translation process on the human and foster more genuine interaction with the machine" (n.p.). In addition, interactive and adaptive MT is seen as an opportunity to leverage MT outputs more effectively, while also avoiding or speeding up repetitive tasks (Alonso and Vieira 2020, 400).

By enhancing human agency in the translation process, we believe this new approach can reignite the joy of translating. This is partly due to the decreased "priming effect" of MT, as reported by Caroline Rossi and Jean-Pierre Chevrot (2019) in their study conducted at the DGT: "Within this intricate interweaving of technology and human intervention, machine translation, which appears only in the form of easily dismissed segments, may well be of minor importance and its impact limited" (180).

Indeed, translators are no longer presented with an MT output:

> Contrarily to most existing systems, MT output is not presented to the user in the space devoted to the target text. Instead, for each segment, the system shows the source text, followed by a blank space where the user inserts or types the translation, and only under this blank space, the suggested MT output that adapts to the target text being produced. The user interface is simple and intuitive, and allows for easy insertion of translation memory matches, MT suggestions, and glossary terms. (Martikainen 2022, n.p.)

Moreover, the experiment conducted by Martikainen (ibid.) indicates that master's students in translation clearly prefer interactive and adaptive MT over static MT: "The experiment conducted with master's students suggests that interactive/adaptive machine translation indeed has the potential to offer a better user experience than post-editing static machine translation" (n.p.).

9. What Role for Humans in the Future?

According to Élisabeth Lavault-Olléon (2018), the future of the translation profession will significantly depend on how translators embrace NMT. To assert their value, translators must emphasize their unique human-specific qualities, e.g., intercultural mediation, linguistic sensitivity, project management skills, etc. Additionally, emerging services such as hyper-localization and transcreation offer exciting opportunities.

Vieira (2019) highlights the potential positive contribution that translation studies can make in this regard:

> Given commercial MT developers' decades-old tendency to oversell the results of their systems . . . translation studies have an important role to play in ensuring a sound understanding of MT's place in professional translation. This is likely to become even more critical as MT technology continues to evolve and gain wider public visibility. (326)

To avoid succumbing to panic, Vieira (2020) proposes that all stakeholders in the translation industry should work together and rethink the role of translators in this context:

> Open dialogue among translation industry stakeholders and the exploration of business models that integrate rather than fragment the role of translators across domains are considered here to be more productive responses to advances in technology than giving in to automation anxiety. (17)

Silvia Bernardini et al. (2020, 302) argue that translators should play a broader role than merely post-editing or evaluating translations. By drawing on their linguistic sensitivity, translators should engage in interdisciplinary collaboration with developers and service providers to improve AI systems:

> New roles involve the appreciation, understanding and critical assessment of AI technologies and the ability to post-edit, approve and vouchsafe the correctness of translations, all firmly rooted in human expertise in languages, cultures and the science of translation. (ibid.)

Christine Breyel and Thierry Grass (2021) are convinced that the unconcealed goal of AI developers is to replace conscious human beings with unconscious algorithms. They believe that in order to continue practicing, translators must be able to anticipate, foster creativity, ensure communication quality, and excel in teamwork, adding that translator training programs should also diversify to include skills such as technical writing and editing.

Finally, we fully agree with Kenny and Doherty (2014) and with Rossi (2019), who believe that translation trainers have a moral duty to ensure the sustainability of the profession: “It is up to future translators to negotiate and build their role in this evolving landscape, and it is up to the trainers to encourage them to do so” (Rossi 2019, 103). And one of the keys to achieve this, in our opinion, is strengthening the translation trainees’ flexibility and adaptability, regardless of the technology or tool (DeepL, Google Translate, ChatGPT, DeepL Write, etc.) that is needed to compete in a highly competitive market.

> Understanding translation technologies and the appropriate evaluation techniques is critical to the successful integration of these technologies in the language services industry of today, where the lines between human and machine have become increasingly blurred and adaptability to change has become a key asset that can ultimately mean success or failure in a competitive landscape. (Moorkens et al. 2018, 1)

10. Conclusion

Drawing on the available translation studies literature on human-machine interactions, we have argued that fostering MT literacy is crucial due to the expanding use of MT tools in the language services industry. The emphasis should be on using MT responsibly with a comprehensive knowledge of its benefits and limitations, with attention to contextual applications and ethical considerations. Within this context, we have highlighted the significant role that translation trainers may play in this regard.

We have also sought to reaffirm that, although there have been noteworthy improvements in NMT, human translators continue to play a central and critical role in the translation process. Furthermore, we have discussed new innovative ways of integrating MT into CAT tools (interactive MT, adaptive MT, etc.) in order to optimize translation workflows and to promote a "shift towards human-centered tasks where MT is regarded as a tool" (Vieira 2019, 325).

Finally, we have conveyed our belief that the future of the profession will depend on translators' ability to adopt new translation technologies and to effectively showcase their distinct human qualities. In this regard, we firmly believe that translation trainers have a crucial role to play by cultivating students' flexibility and adaptability, regardless of the technological solutions at hand—MT tools, chatbots, or AI writing tools. Trainers may thus serve a vital function in highlighting the added value of human translators in a "civilization of digital signals and algorithms" (Rouvroy 2018).

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