JoSTrans
The Journal of Specialised Translation

Risk management and post-editing competence
Jean Nitzke, Silvia Hansen-Schirra and Carmen Canfora, University of Mainz

ABSTRACT

Post-editing machine translation has become an important part of the translation industry in recent years. Although some aspects of the post-editing (PE) task are similar to translation from scratch, some considerations concerning the task and competences required of the post-editor differ. In this article, we want to focus on three important aspects of PE. First, we want to relate translation risk management considerations to the PE task. Based on this, we want to introduce a decision model for PE jobs that will help to decide whether a translation job should be done with machine translation (MT) systems, which includes factors like text type, the MT system, the required quality of the final text, turnaround time and life span of the translation. Although these decisions often have to be made by customers or project managers, they also indicate various competences required of a post-editor, which differ to some degree from competences that a translator or reviser needs. Hence, after revising existing translation and revision competence models, we will outline our own post-editing competence model.

KEYWORDS

Post-editing, risk management, decision model, competence model.

1. Introduction

Post-editing (PE) has become an integral part of the translation industry. Combining translation memory (TM) technology and machine translation (MT) is considered one of the most time and cost-efficient ways to translate text (Arnhold *et al.* 2017). Depending on the amount of text, the scope of time and the required quality level, PE can be done to different degrees and accordingly needs specific guidelines or a PE brief. Two rough differentiations are commonly used for PE styles (cf. Massardo *et al.* 2016: 16-18). *Light post-editing (LPE)*, on the one hand, should make the final text understandable. It should convey the same meaning as the source text, but style, terminology, grammar, and/or syntax might not be perfect. On the other hand, *full post-editing (FPE)* should produce a comprehensible and accurate text with flawless grammar and syntax. Style usually does not need to be perfect, either. Full post-edited texts are often destined to be published (cf. ibid.). However, product quality and time are not the only factors to be considered. Process quality aspects must also be examined, such as data security and the qualitative and quantitative choice of training data for MT engines. If a post-editor negligently machine translates sensitive data via an open access system, the damage for the customer might be much worse than insufficient target text quality. Further, if not enough high-quality data is available to train the MT system, the quality of the MT output will not be

sufficient, and the post-editor will have to put too much effort into the task, independent of the PE mode (Lacruz *et al.* 2016; Carl *et al.* 2015; Aziz *et al.* 2014).

While most empirical studies on PE focus on temporal and technical efficiency as well as cognitive effort (e.g. O'Brien 2006; Koponen *et al.* 2012; Carl *et al.* 2015), mirroring a differentiation suggested in Krings 2001, we see a need to assess the economic PE process, as well. In this paper, we want to adapt translation-specific risk assessment considerations to PE. Then, we want to specify different criteria which help to decide if and how to post-edit, and represent those in a decision model. Although these decisions often have to be made by customers or project managers, they also indicate various competences required of a post-editor, which differ to some degree from competences that a translator or reviser needs. Hence, we adapt translators' and revisers' competence criteria to outline a PE competence model. With this competence model we want to offer an instrument that helps differentiate between translation and post-editing competences. We would like to contribute to the debate on the need to shape a proper self-perception of post-editors, whose task requires much more than the mere correction of error-prone MT output.

2. Risk assessment for post-editing

Translating texts generates risks for all actors involved in the translation process[1] (cf. Canfora and Ottmann 2015 and 2016). Although translation contains specific creative and cognitive aspects which alone can be the research focus of many scientific studies (cf. Pym and Matsushita 2018), decisions made during the whole translation process are underpinned by the same principles as the decisions on any other business level. Therefore, these decisions should be made in an economic framework (cf. Hofmann 2012). One instrument to develop decision criteria in economics is risk management. Generally, business decision criteria can be differentiated between strategic (long-time), tactical (medium-term), and operative (short-term) decisions (cf. Wöhe *et al.* 2016: 78-81; Hofmann 2012: 173). When considering risk management for a PE situation, the business decisions can be categorised as strategic (e.g. if the organisation wants to use MT at all) and operative (e.g. what PE guidelines – full vs. light - are necessary for the specific text or the respective text type in regard to the organisation's general strategic decisions)[2].

The international standard ISO 31000 (2009) "Risk management – Principles and guidelines" can be used in all contexts for the translation process, because it is a horizontal standard. Risk management is considered an integral part of all processes in an organisation including translation (either

in-house or as part of a supply chain risk management). Next to the risks which emerge from translation in general, the use of MT and PE generates risk factors such as:

- data breach, i.e. confidential information ends up on the web as in the case of Statoil (cf. Common Sense Advisory 2017);
- loss of control of processes, e.g. the customer cannot control whether the translator uses MT or the functionality of the MT system is not transparent to the user of the MT system at all, especially with neural MT (NMT);
- increasing liability for the customer when instructions for use are translated with the help of MT and PE. A court could judge, e.g., in a case of claims for compensation that the use of MT and PE for high risk texts, i.e. danger to life and limb, was negligent, and that the customer is partially to blame for the damage caused by translation mistakes (however, there has not yet been a precedent);
- customers might have difficulties in finding qualified translators and post-editors, because professional translators might still have prejudices against MT and PE (e.g. Cadwell *et al.* 2017; Guerberof Arenas 2013; Läubli and Orrego-Carmona 2017);
- the quality of the post-edited text might not be sufficient for the purposes of the target text.

Basically, the customer should consider if the benefits outnumber the risks before using MT and PE. Or, in other words, if the risks are tolerable in a specific situation. This includes general considerations arising from the customer's own "risk management policy" (cf. IRM 2002). In the context of ISO 31000, the term *risk management policy* describes a "statement of the overall intentions and direction of an organization related to risk management" (ISO 73 2009). The general risk attitude of the organisation is an important factor in creating the risk management policy, which describes the "organization's approach to assess and eventually pursue, retain, take or turn away from risk" (ISO 73 2009, term 3.7.1.1). Accordingly, an organisation can be more or less willing to take risks, and this so called "risk appetite" also influences strategic decisions. An organisation with a higher risk appetite is more willing to take the risks mentioned above than a risk adverse organisation. These decisions are usually made on a long-term basis and therefore usually concern the strategic part of business management (cf. IRM 2002).

On the operative level, risk management can provide decision criteria for or against the use of MT and PE for certain text types. Therefore, the approach to risk management for translations according to ISO 31000 can also be used for decision processes in MT and PE (Canfora and Ottmann 2015). This

means that the potential risks must be identified before the actual translation process to foresee problems that might affect different actors involved in the translation process such the translator, the TSP (Translation Service Provider), the client, the end user or any other agent. This initial analysis should consider the negative consequences of failures in the translation, such as impaired communication, loss of reputation, property damage, lawsuits or other legal consequences, injuries, which could even amount to danger to life and limb, etc. Afterwards, the likelihood that these risks could occur in each case and the priorities of the customer regarding the translation risks need to be analysed in compliance with the strategic risk management policy. This means that the customer or the manager has to decide which translation risks must be avoided and which can be tolerated. Therefore, it is sensible to create different categories (e.g. very high-risk, high-risk, and low risk documents) and to categorise the source text documents according to the risk analysis and risk evaluation[3] (ibid.). In line with these categories, different processes can be shaped for the use of MT and PE. Hence, low-risk texts, for example, could be machine translated with subsequent LPE or even without PE. High-risk texts might be suitable for FPE so that a balance is created between risk considerations and the advantages of MT and PE. For very high-risk texts, the customer has to evaluate whether a combination of MT, FPE, and additional measures like revision assure the necessary quality. If this is not the case, MT might have to be completely disregarded for those text types because the risks are too high. Furthermore, it has to be assessed if it is still more efficient to combine MT, FPE and additional quality measures. Maybe a translation workflow with only human translation provides more security and higher productivity, and reduces costs in the end.

3. Decision criteria

Aragonés and Way (2017) describe the benefits and disadvantages of statistical MT systems, and, in particular, what they are and are not capable of compared to human translators. These considerations are especially useful for post-editors so that they know what they will have to deal with when post-editing as well as for customers who might not be aware of typical MT mistakes. In this section, however, we want to take a step back and concentrate on the level before the actual post-editing process, where the customer, project manager, or the translator must decide if MT can be used and to what extent PE is needed. The standard ISO 18587 on PE already includes this preparation step in the PE process "[b]esides the general commercial aspects, there is also the question of whether the source text is actually suitable for MT" (Wallberg 2017: 150). Therefore, we want to present different criteria according to which customers and other decision makers like project managers can decide whether machine translation can be implemented in the translation process.

3.1 Text types and risk considerations

Usually, it is advisable to use MT for text types that are not very creative, contain redundancies, and may have been created using specific guidelines and rules or even using a controlled language. Very creative texts such as any form of literature, marketing texts, or slogans should be translated from scratch, because they also need creative translations that might differ a lot from the source text (Daems *et al.* 2016; Carl and Schaeffer 2017). Machine translated texts are usually very linear to the source text, which is often not desired in creative texts. Accordingly, the post-editing effort might be too high. Further, it could be argued that PE might suppress creative translations. However, O'Brien (2012: 13) claims that "this [editing as a less creative task] is certainly open to debate – can we really argue that improving or correcting what an author has written is 'less creative' than translating another author's words?" Restricted texts, on the other hand, like most domain-specific communication, are, in general, more suitable for MT, because linearity and similarity to the source text is acceptable and often even favoured. Hence, the question to be raised at the beginning of the potential PE job is whether MT can be used at all in the specific situation. Therefore, it must be assessed if the text is suited for MT. As a rule of thumb: when the texts seem suitable for the use of Translation Memory software, they can also be used for MT (cf. Arnhold *et al.* 2017: 221-224).

Next, we have to consider if the risk of using MT is manageable. Unfortunately, risk considerations as introduced in section 2 present a reverse picture. Text types that are very restricted and straightforward are often the ones that are the riskiest. Warning messages, for instance, are typically written in a specific, very restrictive, repetitive way so that they are understandable, clear and explicit. This is done because they are very high-risk texts, which do not allow for creativity. Hence, these text types might not be suitable for MT, either, because the risk of mistakes and misunderstandings is too high. Accordingly, the following prediction cannot entirely be agreed with, when considering risk-management aspects, because some of the most controlled content should not be covered by MT alone:

> Repetitive, controlled content such as user documentation and user interfaces will be increasingly covered by MT as it improves. However, marketing and brand content will remain the preserve of human translation. (Massey and Ehrensberger-Dow 2017: 303-304)

Massey and Ehrensberger-Dow (ibid.: 309) do emphasise this point later in their argumentation:

> Although routine translation work can and will increasingly be done by automated solutions such as NMT, the responsibility still lies with humans to decide in each case whether the risks of mistranslations and other errors are ethically acceptable.

It is clear that both text type and risk aspects have to be considered to decide if MT should be used at all and how much PE is necessary.

3.2 MT quality

The main aspect of an efficient PE process is the quality of the MT output. If the MT system is well-trained, the output becomes better and less effort is needed for PE. To train a data-driven MT system, bi- or multilingual corpora are necessary. These corpora need to contain well-aligned, high quality translations. Moreover, the quality of the MT output improves if the engine is trained on domain-specific text and on the respective text type (Gavrila and Vertan 2011). Therefore, it is advisable for companies and LSPs with a lot of multilingual text to train their own systems, because the closer the training material is to the source texts, the more precise the MT output becomes. Hence, reliable bi- or multilingual data are needed to train the systems. Translation memory and term base data, for example, can be very profitable for this purpose, since they contain former translation solutions and terminology specifications. However, if not much in-house data are available in general, or in cases where a language has only been introduced recently, or if the translation memory and term base data are not of high quality (e.g. the translation memories might contain raw translations, because the revision of these translation was not done in the tool), it might be necessary to rely on external corpora. Still, for some language pairs none or only very little data might be available. Hence, it might be problematic or even impossible to train a system. Furthermore, a decision needs to be made concerning what kind of MT system (statistical, hybrid, neural) can be trained and if the training is done in-house or is outsourced to a supplier. If no in-house MT system can be used or trained because of technical or financial reasons, it might be possible to use an external or free online MT system, although considerations regarding data security (see section 3.4) are vital when making such a decision (Kamocki *et al.* 2015).

3.3 Turnaround time and life span of translations

Another factor that needs to be considered when deciding for or against MT and PE is how much time and manpower are at hand. If the deadline is very tight and/or only a few translators can or should[4] be involved, MT and PE might be the solution, because translation time can be reduced immensely (Carl *et al.* 2015 or Nitzke and Oster 2016). Furthermore, the lifetime of the translated text might be an impacting factor. If the texts are only needed for a short time, because they will be updated or replaced soon, the effort for

human translation might be too high. The same pertains to the quantity of translations. If huge amounts of texts have to be translated over and over again, because the texts are generated very fast, human translation might be too effortful and expensive or even not possible at all (Way 2013; Hu and Cadwell 2016). Possible scenarios where this might apply might be posts in discussion forums or messages to customer services. For the latter, it might not be possible to have personnel for every language. However, quick help is often essential for the customer. Hence, even raw MT output might be sufficient for customer service to understand the problem and send instructions or information to the customer that have been prepared in the respective language. If the problem cannot be solved that easily or if the MT output is not helpful, the employee of the customer service can still request a translation or a post-edited version of the text.

3.4 Data security

Data security is a very important consideration when making decisions on the use of MT (see also section 2). If in-house MT is used, these considerations are less problematic, because the data that are fed into the system are safely stored on an internal system or server. Still, it might be reasonable to assess who should have access to the MT system and it might be relevant to inform the users of the MT system about confidentiality. However, if an external and/or free online system is chosen, the text that is translated is often saved on the provider's server and hence might become accessible for third parties. This can be unproblematic, e.g. if we are dealing with the translation of a website and this text will be publicly available anyway. However, if the data are sensitive, MT systems that do not provide a safe environment must be avoided (cf. also Kamocki and Stauch 2017).

3.5 Controlled languages

According to Ferlein and Hartge (2008: 39-41), controlled languages restrict natural languages according to pre-defined rules. They claim that the aim of controlled languages is to increase readability, translatability, and the reusability of texts by consistent, clear, and target-oriented writing. Thus, controlled languages are usually constructed for very specialised communication needs, i.e. domain-specific communication.

In statistical MT, it is argued that a text that was written in a controlled language can be translated more easily by an MT system and the final product will contain less errors, because the source text already adheres to strict language rules that can be easier processed by the machine. Accordingly, the post-editing effort decreases (cf. Aikawa *et al.* 2007). However, the picture might be a bit different for NMT as Marzouk and

Hansen-Schirra (manuscript submitted for publication) showed in their study which compares the influence of controlled languages on rule-based, statistical, hybrid, and neural MT. These researchers found that controlled languages improve the MT output in rule-based, statistical, and hybrid MT. However, the use of controlled language has no influence on the quality of the NMT output.

3.6 Decision model

As we have seen in the previous sections, many aspects of the source text and considerations concerning the *skopos* (Vermeer 1983) of the final target text must be taken into account to decide if MT and PE can be used. We combined all the above-mentioned criteria into a decision model with a tree like structure (cf. figure 1). As already mentioned above, this decision model is described from the customer's point of view and/or the person who decides if MT will be used and what degree of PE effort is necessary. Starting with the basic question whether MT can be used at all and ending with a recommendation on the use of MT and to what scope the PE task should be conducted. Of course, this can only be regarded as a tool and individual cases might be resolved by another solution than predicted here.
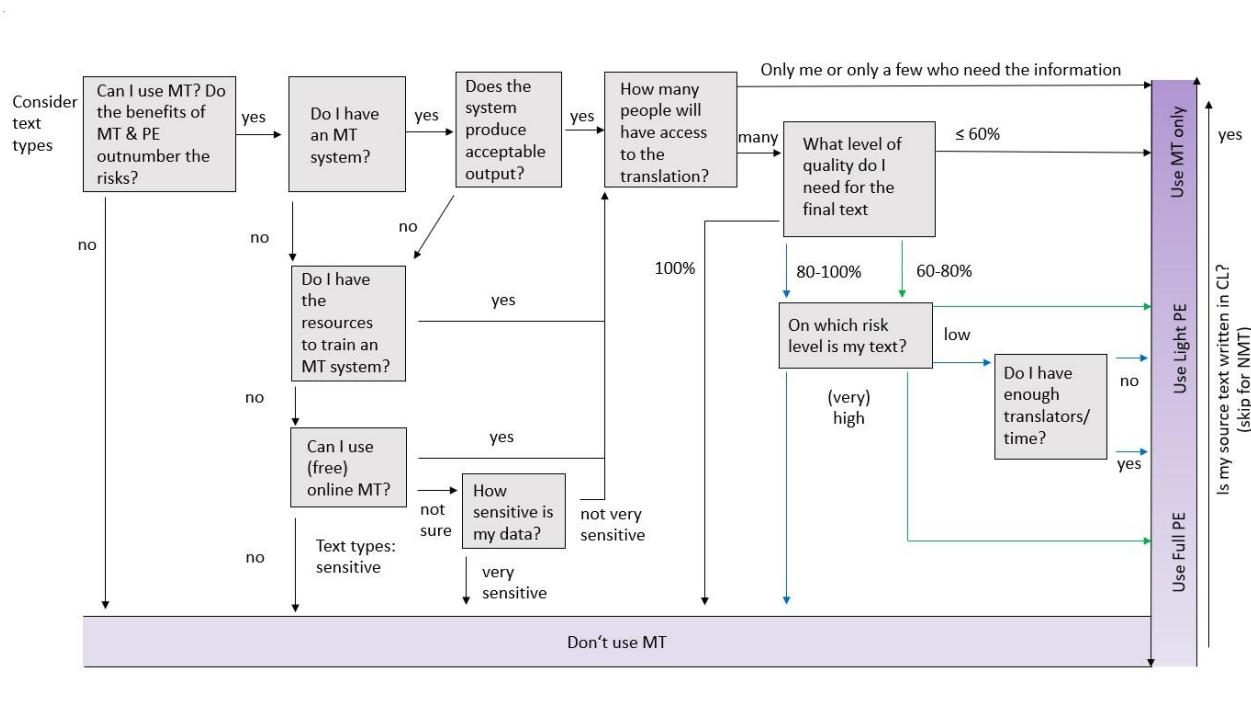

Figure 1. Decision tree model for PE tasks.

First of all, it has to be decided whether using MT and PE is an option at all. Do the benefits compensate the disadvantages? Is the text type suitable for MT or is it too creative or does it contain too many risks that the organisation

is not willing to take? If the realistic answer to the first question is no, MT should not be used, and the text should be translated by a human translator.

Next, it has to be assessed whether an in-house MT system is available and whether it is well-trained and produces high-quality output. If this is not the case, the next question is whether bi- or multilingual resources are available to either train a new system or to improve the existing one. If not, a decision has to be made whether an external and/or a (free) online system can be used for the text without the risk of revealing sensitive information. Again, if the answer is no, MT and PE should not be used for the translation job.

After an assessment has been made on the use of MT and whether there is a suitable MT system available, the focus is on the source text again. If there is only one or a few target text readers, light or no post-editing might be suitable. If the readership is large, further aspects have to be considered, starting with an estimation regarding the quality level of the final text. If quality requirements are low, light PE or even no PE might be sufficient. On the other hand, if very high quality is required, it might be reasonable to abandon MT and PE altogether and employ a human to translate the text from scratch. For mid-range quality, the risk factors need to be revisited to decide how much PE is necessary. The riskier the texts, the higher the quality of the post-edited texts needs to be. Finally, it must be assessed how much time is required and how many translators are available, in order to adjust the PE effort.

As a last step, it should be considered whether the source text was written in a controlled language or using a set of restricted authoring rules. If this is the case, light PE might be more applicable than full PE, because the quality of the MT output when using restrictive ST language is expected to be better. When the decision has been made to use PE and it is clear how much PE effort is necessary to improve the quality of the final text, it is essential to compose a PE brief for the post-editor with specifications concerning the necessary PE effort.

4. Post-editing competence model

As we have seen, many aspects have to be considered when dealing with MT and PE. Not all decisions are necessarily made by the client – some clients might need a lot of guidance when it comes to MT. A post-editor, therefore, must be able make informed decisions concerning risk assessment and MT and PE considerations. Further, post-editing is a complex task. Accordingly, a qualified post-editor needs specific competences to be able to fulfil all the requirements of such a task. The proposed post-editing competence model (figure 2) is based on PACTE's (2003) translation competence model and

Robert *et al.* (2017) revision competence model since they share some of the competences needed for post-editing machine translation output. The differences and commonalities will be explained in the following:

Post-editing is split into core competences and subsidiary sub-competences. The core competences are the following:

- risk assessment competence:
  As explained above, one of the most important competences a post-editor needs is the ability to assess the risk of the text to be translated. The proposed decision tree helps the customer or the post-editor to competently assess and document the risks around a specific source text as well as the corresponding translation workflow.
- strategic competence:
  Based on the risk assessment, the post-editor may decide between full or light post-editing for the translation task or to use machine translation (MT) only. High-risk translations might even demand further quality assurance processes in addition to full post-editing. In addition, the post-editor has to be able to analyse the post-editing brief and develop adequate strategies to comply with it.
- consulting competence:
  Depending on the risk assessment and the strategic decisions, a post-editor has to inform the customer or project manager about potential risks as well as problem-solving strategies, respectively, i.e. the risk assessment should enable the post-editor to give advice on these questions. The potential consequences of the assessed risks must be evident in case a decision maker does not agree with the post-editor's proposed strategy. This kind of argumentation might justify price calculations on the one hand and using MT or not on the other hand.
- service competence:
  In the field of PE, service competence means that the post-editor should be able to calculate prices competently, consciously, and transparently considering the quality of the MT output and the necessary PE effort (cf. translation competence model by EMT Expert Group (2009)), even though measuring and estimating PE effort is challenging (Specia 2011; Moorkens *et al.* 2015; Schaeffer and Carl 2014). Furthermore, this competence includes handling state-of-the-art CAT and revision tools as well as integrated MT systems. In summary, the post-editor should know the translation market, including all aspects of MT and PE, and should be able to negotiate with the customer at eye level. The post-editor should be able to match the needs of the customer with the set-up and conditions of the PE task as well as with the resources available to be able to make an appropriate offer that, for example, calculates a realistic time frame for the job.

The following subsidiary sub-competences support the core competences[5]:

- bilingual competence:
  Similar to translation and revision competence, a post-editor has to have proficient knowledge of the source and target language, as monolingual PE[6] always bears the risk that content mistakes are not recognised (cf. Čulo *et al.* 2014).
- extralinguistic competence:
  Again, similar to specialised translation and revision competences, a post-editor also needs to have general world knowledge as well as the relevant domain knowledge in order to properly understand the thematic subject of the source text. Knowledge concerning cultural domain differences helps the post-editor to interpret the meanings in the source text correctly.
- instrumental competence:
  A post-editor needs to know how to use the CAT tools, in which MT is integrated. These include, for instance, state-of-the-art translation memories or authoring tools (e.g. controlled language checkers). Moreover, they also need to know how to use simple text processing functions like the "Track changes" mode in the respective tools if the customer demands it.
- research competence:
  A post-editor needs to know where and how to find information he or she does not know. Depending on the thematic field of the translation, specialised (online) dictionaries might be the first choice, whereas, for others, parallel corpora or thesauri might be a better option. Efficient research strategies positively influence the workflow time of a post-editing task. Further, the post-editor needs to learn to what extent he or she can trust the MT output and when the MT translation decisions have to be challenged[7].
- revision competence:
  Similar to revision, a post-editor has to develop strategies for consciously reading a text, not written by him or herself. He or she has to apply very similar problem-solving strategies and know how to correct texts written by other authors. Furthermore, the post-editor has to handle the trade-off between necessary changes and over-editing, i.e. to "spot significant mistakes" (cf. Mossop 2014).
- translation competence:
  It is not only important for post-editors to have meta-knowledge about the revision process but also about the translation process (e.g. O'Brien 2002). This includes knowledge about text type conventions, style guides, controlled languages, contrastive differences, cultural specificities etc. These features have to be assessed and, if necessary, improved.
- machine translation competence:

A post-editor needs to know how an MT system works and which possible pitfalls it may generate. MT systems often generate different problems than human translators produce (Carl *et al.* 2015; Nitzke forthcoming). Most of them are related to the architecture of the MT system. Knowing how MT is implemented helps to spot potential problems or difficulties. Ideally, in our view, a post-editor should be able to assess the quality of the MT training materials and even to improve the training process if necessary.

- post-editing competence:
  Statistical MT systems, which have so far been state-of-the-art in post-editing practice, generate errors which are typically very easy to identify. An example from English into German would be incorrect word order when translating subordinate clauses, with German demanding an SOV structure. (Navratil *et al.* 2012). Neural MT is able to correctly translate these obvious problems (Zhang *et al.* 2017). As a consequence, errors triggered by neural MT are harder to identify since the MT output is more fluent and correct, which leads to the problem of overlooking mistakes which are not obvious (Toral *et al.* 2018 show that pauses become fewer but longer in PE NMT output). Therefore, the post-editor has to be trained in spotting exactly these more fine-grained problems.

Figure 2. Post-editing competence model.

As stated by PACTE's (2003) and Robert *et al.* (2017) models, a PE task is also influenced by its surrounding factors such as:

- psycho-physiological components,
- the post-editor's self-perception,
- the PE brief including guidelines for the PE task,
- an affinity towards technology and computer.

Some of the psycho-physiological components are especially important for post-editors, such as a well-developed ability to concentrate and sustain attention (especially with repeated mistakes in the MT output), stress-resistance, logical reasoning, analytical thinking, and quick-wittedness. An affinity to working with technology and computers is an essential requirement to work as a post-editor, because PE tasks always go hand in hand with MT and CAT tools.

A PE job can only be accomplished successfully if the post-editor knows the target audience, the *skopos* of the target text, the effort that needs to go into the PE task (light vs. full PE, etc.), and which responsibilities are the post-editor's (e.g. maintenance of translation memory and terminology management systems, reporting or even correcting flaws of the MT system). Ideally, the customer or project manager should collect the necessary information in a PE brief so that the post-editor can be successful.

The broader perspective of the role and responsibilities of the post-editor that we have outlined in this paper should be accompanied by a new self-perception and appropriate professional ethics. Our post-editor's model would require that post-editors perceived themselves not only as mere proof-readers of machine output, but as competent language consultants and experts in creating PE processes. As such, they should take responsibility for the successful creation of the target text. It would also require new professional ethics that still need to be conceptualised. The new ethos would incorporate elements such as the willingness of post-editors to accept that sometimes the quality of the target text does not have to be 100% to still meet the purpose of the target text (Gueberof Arenas 2013). In addition, post-editors (as well as revision experts) should be able to resist the urge to correct text units that do not need corrections just to prove that they are competent professionals who are indispensable to the market (cf. also Mossop 2014).

Our model presents many similarities to translation and revision models. However, some extra competences such as MT and PE competences are necessary, and some competences need to be expanded. In view of the

models, it could be argued that translation and post-editing should not be trained separately, but PE could be an addition to translation curricula.

5. Conclusions and outlook

Post-editing should be a cooperative task, in which customers, post-editors, project managers, and everyone who is involved should work towards the same goal. We have shown in this paper that different aspects have to be considered in the PE process than might be necessary in from-scratch translation scenarios – although many parallels can be drawn, of course.
More specifically, we have presented how risk considerations apply to the PE process and that they are an essential part of said process. Similar risks to those affecting human translation can occur in the PE process, e.g. text type specific risks. On the other hand, PE generates different risks such as data breach, loss of control in processes, increasing liability, and achieving the required target text quality. Therefore, the PE process should be subject to risk management right from the beginning.

Additionally, we focused on the decision criteria that are necessary to decide whether MT can be used with the source text and how much PE effort is necessary. Influential criteria include the balance between text type and risk considerations, the existence and quality of an MT system, the turnaround time and life span of the translation, data security considerations, and the potential use of controlled languages during the source text production. We combined these criteria into a decision tree model to outline which decisions have to be made, in which order and what the outcome might be. Of course, this can only be theoretical assistance as every PE job is unique.

Finally, we presented a PE competence model, which unifies four core competences (risk assessment, strategic, consulting, and service competence) and eight sub-competences (bilingual, extralinguistic, instrumental, research, revision, translation, MT, and PE competence). Our PE model shows that there are similarities between translation and revision, which suggests that translators with revision competences have the perfect basis to become post-editors, but that they need additional competences. In view of our PE model, we would argue that there is no need for translators and post-editors to be trained separately, because too many of their competences overlap. Instead, an integration of PE in translation education would be enough to provide translators with the extra competences they need to become skilled post-editors. Additionally, the full implementation of our PE model would require not only a set of specific skills, but a new self-perception for post-editors and the assumption of new responsibilities in order to better contribute to a fine-tuned PE process.

As mentioned at the beginning, many studies deal with the technical and cognitive processes of PE. However, empirical studies on the economy of the PE process would be necessary to underpin the assumptions discussed in this paper. Therefore, the next steps in our further research may involve post-editing norms and strategies so that these insights can be passed on to students and trainers.

References

- **Aikawa, Takako, Schwartz, Lee, King, Ronit, Corston-Oliver, Mo and Carmen Lozano** (2007). "Impact of controlled language on translation quality and post-editing in a statistical machine translation environment." Bente Maegaard (ed.) (2007). *Proceedings of the MT Summit* XI *Copenhagen. Denmark, 10-14 September*, 1-7. http://www.mt-archive.info/MTS-2007-Aikawa.pdf (consulted 15.10.18).

- **Aragonés Lumeras, Maite and Andy Way** (2017). "On the complementarity between human translators and machine translation." *Hermes* 56, 21-42.

- **Arnhold, Philip, Grizzo, Sara, Hansen-Schirra, Silvia, Nitzke, Jean, Porsil, Jörg, Schaeffer, Moritz and Michael Schneider** (2017). "Maschinelle Übersetzung Und Post-Editing." Angelika Ottmann (ed.) (2017). *Best Practices - Übersetzen Und Dolmetschen*. Berlin: BDÜ Fachverlag.

- **Aziz, Wilker, Maarit Koponen and Lucia Specia** (2014). "Sub-sentence Level Analysis of Machine Translation Post-editing Effort." Sharon O'Brien, Laura Winther Balling, Michael Carl, Michel Simard and Lucia Specia (eds) (2014). *Post-editing of Machine Translation: Processes and Applications*. Newcastle: Cambridge Scholars Publishing.

- **Cadwell, Patrick, O'Brien, Sharon and Carlos Teixeira** (2017). "Resistance and accommodation: factors for the (non-)adoption of machine translation among professional translators." *Perspectives* 26(3), 301-321. https://doi.org/10.1080/0907676X.2017.1337210 (consulted 01.12.2017).

- **Canfora, Carmen and Angelika Ottmann** (2015). "Risikomanagement für Übersetzungen." *trans-kom* 8(2), 316-346. http://www.trans-kom.eu/bd08nr02/trans-kom_08_02_02_Canfora_Ottmann_Risiko.20151211.pdf (consulted 1.12.2017).

- **—** (2016). "Who's afraid of translation risks?" Presentation held at the *8th EST Congress* (Aarhus, 15-17 September 2016) (consulted 17.09.2016).

- **—** (forthcoming). "Who's afraid of translation risks?" Heike Jüngst, Lisa Link, Klaus Schubert, Christiane Zehrer (Hg.) *Challenging boundaries of translation studies*. Berlin: Frank & Timme.

- **Carl, Michael, Gutermuth, Silke and Silvia Hansen-Schirra** (2015). "Post-editing Machine Translation: Efficiency, strategies and revision processes in professional translation settings". Aline Ferreira and John Schwieter (eds) (2015). *Psycholinguistic and Cognitive Inquiries into Translation and Interpreting*. Amsterdam/Philadelphia: John Benjamins Publishing Company, 145-174.

- **Carl, Michael and Moritz Schaeffer** (2017). "Why Translation Is Difficult: A Corpus-based Study of Non-literality in Post-editing and From-scratch Translation." *Hermes* 56, 43-57.

- **Common Sense Advisory** (2017). "Data breached in translation." https://www.csoonline.com/article/3236348/data-breach/data-breached-in-translation.html (consulted 01.12.2017).

- **Čulo, Oliver, Gutermuth, Silke, Hansen-Schirra, Silvia and Jean Nitzke** (2014). "The influence of post-editing on translation strategies." Sharon O'Brien, Laura Winther Balling, Michael Carl, Michel Simard and Lucia Specia (eds) (2014). *Post-editing of machine translation: Processes and applications.* Newcastle upon Tyne: Cambridge Scholars Publishing, 200-218.

- **Daems, Joke, Carl, Michael, Vandepitte, Sonia, Hartsuiker, Robert and Lieve Macken** (2016). "The Effectiveness of Consulting External Resources During Translation and Post-editing of General Text Types Pages." Michael Carl, Srinivas Bangalore and Moritz Schaeffer (eds) (2016). *New Directions in Empirical Translation Process Research.* Heidelberg: Springer, 111-133.

- **EMT Expert Group** (2009). "Competences for professional translators, experts in multilingual and multimedia communication." European Master's in Translation (EMT). https://ec.europa.eu/info/sites/info/files/emt_competences_translators_en.pdf (consulted 16.01.2018).

- **Ferlein, Jörg and Nicole Hartge** (2008). *Technische Dokumentation für internationale Märkte: haftungsrechtliche Grundlagen, Sprache, Gestaltung, Redaktion und Übersetzung*. Vol. 679. Renningen: expert verlag.

- **Gavrila, Monica and Cristina Vertan** (2011). "Training Data in Statistical Machine Translation — the More, the Better? — " Galia Angelova, Kalina Bontcheva, Ruslan Mitkov (eds) (2011). *Proceedings of the International Conference Recent Advances in Natural Language Processing. Hissar, Bulgaria, 12-14 September 2011*, 551-556. http://www.aclweb.org/anthology/R11-1077 (consulted 15.10.2018).

- **Guerberof Arenas, Ana** (2013). "What do professional translators think about post-editing?" *The Journal of Specialised Translation* 19, 75-95. http://jostrans.org/issue19/art_guerberof.pdf (consulted 01.12.2017).

- **Hofmann, Sascha** (2012). *Prozessgestütztes Übersetzen. Vom funktionsorientierten Übersetzungsprozess zum GP-Modell für die Dienstleistung Übersetzen*. Lichtenberg: Harland Media.

- **Hvelplund, Kristian Tangsgaard** (2017). "Translators' use of digital resources during translation." *Hermes* 56, 71-87.

- **Hu, Ke and Cadwelll, Patrick** (2016). "A Comparative study of post-editing guidelines." *Baltic Journal of Modern Computing* 4(2), 346-353.

- **IRM** (2002). *A Risk Management Standard*. London: The Institute of Risk Management. https://www.theirm.org/knowledge-and-resources/risk-management-standards/irms-risk-management-standard/ (consulted 01.12.2017).

- **ISO 18587** (2017). *Translation services – Post-editing of machine translation output – Requirements.* Geneva: International Organization for Standardization.

- **ISO 31000** (2009). *Risk management – Principles and guidelines*. Geneva: International Organization for Standardization.

- **ISO 73** (2009). *Risk management – Vocabulary*. Geneva: International Organization for Standardization.

- **Kamocki, Paweł, O'Regan, Jim and Marc Stauch** (2015). "All Your Data Are Belong to us. European Perspectives on Privacy Issues in 'Free' Online Machine Translation Services." David Aspinall, Jan Camenisch, Marit Hansen, Simone Fischer-Hübner and Charles Raab (eds) (2015). *Privacy and Identity 2015: Privacy and Identity Management. Time for a Revolution?* Springer: Cham.

- **Kamocki, Pawel and Marc Stauch** (2017). "Data Protection in Machine Translation under the GDPR." Jörg Porsil (ed.) *Machine Translation*, 148–55. Berlin: BDÜ Fachverlag.

- **Koponen, Maarit, Aziz, Wilker, Ramos, Luciana and Lucia Specia** (2012). "Post-editing time as a measure of cognitive effort." Sharon O'Brien, Michel Simard and Lucia Specia (eds) (2012). *AMTA 2012 Workshop on Post-editing Technology and Practice (WPTP), San Diego, United States, 28 October*. http://157.56.13.76/AMTA2012Files/html/13/13_paper.pdf (consulted 15.10.2018).

- **Krings, Hans P.** (2001). *Repairing Texts: Empirical Investigations of Machine Translation Post-editing Processes* (Geoffrey Koby, ed.). Kent: Kent State University Press.

- **Lacruz, Isabel, Carl, Michael, Yamada, Masaru and Akiko Aizawa** (2016). "Pause Metrics and Machine Translation." Utility Paper presented at *The 22nd Annual Meeting of the Association for Natural Language Processing. NLP 2016, Sendai, Japan*. http://www.anlp.jp/proceedings/annual_meeting/2016/pdf_dir/E7-4.pdf (consulted 15.10.2018).

- **Läubli, Samuel and David Orrego-Carmona** (2017). "When Google Translate is better than Some Human Colleagues, those People are no longer Colleagues." João Esteves-Ferreira, Juliet Macan, Ruslan Mitkov and Olaf-Michael Stefanov (2017). *Proceedings of the 39th Conference on Translating and Computer, London, November 16-17*. Geneva: Tradulex. 59-69. https://www.asling.org/tc39/wp-content/uploads/TC39-proceedings-final-1Nov-4.20pm.pdf (consulted 01.12.2018).

- **Marzouk, Shaimaa and Silvia Hansen-Schirra** (Manuscript submitted for publication). "Evaluation of the Impact of Controlled Language on Neural Machine Translation Compared to Other MT Architectures."

- **Massardo, Isabella, van der Meer, Jaap, O'Brien, Sharon, Hollowood, Fred, Aranberri, Nora and Katrin Drescher** (2016). *TAUS MT Post-Editing Guidelines*. Amsterdam: TAUS Signature Editions. https://www.google.de/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=2ahUKEwiQjpr-q-_cAhUS-qQKHcqpCxEQFjABegQICRAC&url=https%3A%2F%2Fwww.taus.net%2Ffile-downloads%2Fdownload-file%3Fpath%3DBooks%25252FTAUS%252BPost-Editing%252BGuidelines.pdf&usg=AOvVaw3nYRG1A0vvBGGg_4vvx7sT (consulted 15.08.2018).

- **Massey, Gary and Maureen Ehrensberger-Dow** (2017). "Machine learning: Implications for translator education." *Lebende Sprachen* 62(2), 300-312.

- **Moorkens, Joss, O'Brien, Sharon, da Silva, Igor A.L., de Lima Fonseca, Norma B. and Fabio Alves** (2015). "Correlations of perceived post-editing effort with measurements of actual effort*." Machine Translation* 29(3-4), 267–284.

- **Mossop, Brian** (2014). *Revising and Editing for Translators*. 3rd ed. New York: Routledge.

- **Nitzke, Jean** (2016). "Monolingual post-editing: An exploratory study on research behaviour and target text quality." Silvia Hansen-Schirra and Sambor Grucza (eds) (2016). *Eye-tracking and Applied Linguistics*. Berlin: Language Science Press, 83-109.

- **—** (forthcoming). Problem solving activities in post-editing and translation from scratch: A multi-method study. Berlin: Language Science Press.

- **Navratil, Jiri, Visweswariah, Karthik and Ananthakrishnan Ramanathan** (2012). "A comparison of syntactic reordering methods for English-German machine translation." *Proceedings of COLING 2012, Mumbay, December 2012*, 2043–2058. http://www.aclweb.org/anthology/C12-1125.

- **Nitzke, Jean, and Katharina Oster** (2016). "Comparing translation and post-editing: An annotation schema for activity units." Michael Carl, Shrinivas Bangalore and Moritz Schaeffer (eds) (2016). *New Directions in Empirical Translation Process Research*. Cham: Springer, 293-308.

- **O'Brien, Sharon** (2002). "Teaching post-editing: a proposal for course content." *6th EAMT Workshop Teaching Machine Translation, Manchester, 14-15 November 2002*, 99-106. https://www.researchgate.net/publication/228787033_Teaching_Post-Editing_A_Proposal_for_Course_Content' (consulted 05.12.2018).

- **O'Brien, Sharon** (2006). "Pauses as indicators of cognitive effort in post-editing machine translation output." Across Languages and Cultures 7(1), 1-21.

- **—** (2012). "Translation as human–computer interaction." *Translation* Spaces 1(1), 121-122.

- **PACTE** (2003). "Building a Translation Competence Model." Fabio Alves (ed.) (2003). *Triangulating Translation: Perspectives in Process Oriented Research*. Amsterdam: Benjamins. 43–66.

- **Pym, Anthony and Kayo Matsushita** (2018). "Risk mitigation in translator decisions." *Across Languages and Cultures* 19(1), 1-18.

- **Robert, Isabelle S., Remael, Aline and Jim J.J. Ureel** (2017). "Towards a model of translation revision competence." *The Interpreter and Translator Trainer* 11(1), 1-19.

- **Schaeffer, Moritz and Michael Carl** (2014). "Measuring the Cognitive Effort of Literal Translation Processes." *EACL 2014, Gothenburg, Sweden, 16 April*, 29–37. http://www.aclweb.org/anthology/W14-0306 (consulted 15.10.2018).

- **Specia, Lucia** (2011). "Exploiting objective annotations for measuring translation post-editing effort." Mikel L. Forcada, Heidi Depraetere and Vincent Vandeghinste (eds) (2011) *Proceedings of the 15th Conference of the European Association for Machine Translation, Leuven, Belgium May 2011*, 73–80. http://www.mt-archive.info/EAMT-2011-Specia.pdf (consulted 15.10.2018).

- **Toral, Antonio, Wieling, Martijn and Andy Way** (2018). "Post-editing Effort of a Novel with Statistical and Neural Machine Translation." *Frontiers in Digital Humanities* 5(9), 1-11. https://www.frontiersin.org/articles/10.3389/fdigh.2018.00009/pdf (consulted 15.10.2018).

- **Wallberg, Ilona** (2017). "ISO 18587-A Standard for the Post-Editing Process." Jörg Porsiel (ed.) *Machine Translation. What Language Professionals Need to Know*, 148–155. Berlin: BDÜ Fachverlag.

- **Way, Andy** (2013). "Traditional and emerging use-cases for machine translation." *Proceedings of Translating and the Computer 35, London, 28-29 November*. https://www.computing.dcu.ie/~away/PUBS/2013/Way_ASLIB_2013.pdf (consulted 15.10.2018).

- **Wöhe, Günther, Döring, Ulrich and Gerrit Brösel** (2016). *Einführung in die Allgemeine Betriebswirtschaftslehre*. 26. Auflage. München: Vahlen.

- **Vermeer, Hans** (1983). *Aufsätze zur Translationstheorie.* Heidelberg: Groos.

- **Zhang, Jinchao, Wang, Mingxuan, Liu, Qun and Jie Zhou** (2017). "Incorporating word reordering knowledge into attention-based neural machine translation." Regina Barzilay and Min-Yen Kan (eds) (2017). *Proceedings of the 55th Annual Meeting of the Association for Computational Linguistics, Vancouver, July 30-August 4*, 1524-1534. http://www.aclweb.org/anthology/P17-1140 (consulted 15.10.2018).

Biographies

Jean Nitzke graduated her M.A. studies at the Faculty of Translation Studies, Linguistics, and Cultural Studies at the Johannes Gutenberg University of Mainz in 2011. She has been a teacher and researcher at the same faculty since April 2012. Her main research interests are translation process research, cognitive processes during translation, translation technologies, post-editing, and non-native English. Her PhD thesis dealt with problem solving in translation, contrasting translation from scratch and post-editing.

E-mail: nitzke@uni-mainz.de

Silvia Hansen-Schirra, Dipl.-Übers., Dr. phil., PD, is a full professor of English linguistics and translation studies at Johannes Gutenberg University Mainz in Germersheim, Germany. Her main research interests include specialized communication, text comprehensibility, post-editing, translation process and competence research. As fellow of the Gutenberg Research College she is the director of the Translation & Cognition (TRACO) Center in Germersheim and co-editor of the online book series "Translation and Multilingual Natural Language Processing ".

E-mail: hansenss@uni-mainz.de

Carmen Canfora holds a degree in Translation Studies (Dipl.-Übers.) and has been a freelance translator for over 20 years. She has been teaching and doing research on translator education at the Faculty of Translation Studies, Linguistics, and Cultural Studies of the University of Mainz since 2008. In her PhD thesis, she has focused on active learning methods in translator

education. Her research interests are risk management, translation process research, translator education, and educational neuroscience.

E-mail: canfora@uni-mainz.de

Notes

[1] In this paper, the term *translation process* refers to the economic process from the source text to the final target text, including preparations for the translation, the translation itself, revision and quality assurance phases, etc. and not the cognitive process of the translator during the translation task (cf. Hofmann 2012).

[2] Our decision tree does not include a tactical layer, because it would deal with the way MT would be operationalised. We, however, only want to focus on the decisions concerning whether to use MT (strategical decision) and what kind of MT/PE is suitable (operative decision).

[3] After identifying potential risks, the individual risks are investigated during risk analysis with regard to their inherent consequences and their likelihood of occurrence. The purpose of risk evaluation is to calculate the overall risk and to prioritise individual risks, i.e. to determine the order in which risks are addressed. Risk identification, risk analysis and risk evaluation are all part of the overall risk assessment (Canfora and Ottmann forthcoming).

[4] If too many people get involved in one project, usually the quality suffers at some point. If many translators are involved in one project, it is harder to achieve consistency and with it high quality.

[5] These competencies are not necessarily independent, but they can overlap, e. g. instrumental, MT, consulting and post-editing competence overlap to a certain degree.

[6] In monolingual post-editing, the post-editor corrects the MT output without the help of the source text, because the source text is either not available or written in a language the post-editor does not understand (for more information on monolingual PE see e.g. Nitzke (2016))

[7] See Hvelplund (2017) or Nitzke (forthcoming) for more information on the types of (digital) resources translators using during the translation and post-editing process.