

# From Translation Machine Theory to Machine Translation Theory – some initial considerations

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## Summary

*Early, rule-based machine translation worked on the basis of contrastive linguistic and translational considerations. The advent of corpus-based machine translation techniques from the 1980s on shifted this paradigm towards a more computationally oriented one. Lately, through the use of techniques like domain adaption or factored models, linguistic and translational considerations have made a comeback. Still, the exchange between the two disciplines of machine translation and translation studies is rare, though they have already benefitted from each other at least in one way: Translators nowadays regularly use tools like translation memories. Present-day machine translation can benefit from translation theory, too, as this paper attempts to argue, by incorporating theoretical and experimental insights into areas like factors that guide translation shifts. For this, it is necessary for both to share at least some common terminological code and theoretical perspective. This paper will attempt to lay a basis for that by locating relevant concepts from machine translation within translation theory and vice versa, and investigating how the two fields could further benefit from each other.*

**Key words:** translation studies, machine translation, translation theory, translation shifts, translation factors, post-editing

## Introduction

Early, rule-based Machine Translation (henceforth MT) worked on the basis of contrastive linguistic and translational considerations. Dictionaries were hand-built and rules were manually created in order to transfer syntactic structures from one language into the other. The basis for transfer often was some kind of valency information or dependency structure, allowing syntactic complements to be shifted around and adapted for differences e.g. in word order or morphology between languages. Examples of this are for instance EUROTRA (Johnson, King, and des Tombe 1985; Copeland et al. 1991) or the METAL system (Gebruers 1988); Hutchins and Somers present an overview of early MT systems (Hutchins and Somers 1992). Present-day MT, however, is mainly based

on a computationally oriented, statistical model of translation (Brown et al. 1993), with techniques like sentence alignment (Gale and Church 1993), word alignment (Och and Ney 2003) or phrase alignment (Koehn, Och, and Marcu 2003) – where phrases are not phrases in the strictly linguistic sense, but continuous stretches of words – as key techniques that research is performed on. However, as the following sections will show, MT has lately begun to re-integrate linguistic as well as translational knowledge. Also, a new field is emerging in which human translators and machine translators meet: post-editing. Given these recent developments, this paper argues for an intensified exchange between the two fields of translations studies (TS) and MT. In the following, I present some initial considerations how MT could benefit from TS research done on text typology and post editing. However, before such an attempt is made, it is necessary to locate MT within the field of translation research, both to understand what the relation of MT to other TS fields is, as well as to create a basis for a common vocabulary for the two disciplines, which should facilitate exchange.

### **What kind of translation is MT?**

Functional translation theory, in terms of (Nord 1997; Nord 2006), distinguishes two types of translations: documentary and instrumental translations.<sup>1</sup> The documentary translation aims to reflect key features of the original, e.g. choice of words, syntactic structure, by mimicking them in the target language, leaving them more or less unchanged. This could, for instance, be a gloss as it is often given in linguistic literature for non-English examples. The instrumental translation, on the other hand, aims to function as a text that could have been produced as such in the target language as an original, too. This would e.g. be a translated manual or a newspaper report. Instrumental translation involves cases in which the original function of a text is kept (i.e. *functionally equivalent* translations) as well as those cases in which it is changed (*functionally divergent*). Translations can be functionally divergent on purpose or simply because they cannot function in the same way in the target language. For instance, a report on gay rights, which may serve a simple information purpose in the source language and culture, may have a very different effect in a target culture.

We can assume that the main goal of MT is to produce a functionally equivalent translation, while we cannot rule out that functionally divergent translations may be produced using MT, as the product may receive a different functional interpretation in the target language. As for the status in terms of documentary vs. instrumental, high quality MT would certainly be aimed at creating fully instrumental translations. But the current performance of MT systems only allows for the product as being defined as documentary translations. This is, however,

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<sup>1</sup> There are, of course, competing distinctions like House's distinction of overt and covert translation (House 1997), but they are comparable in their key characteristics (Nord 2006).

only valid at the textual level. While we can hope to at least get the gist of a machine-translated text, there may still be enough instances, single words, phrases or sentences, in there that are completely incomprehensible.

This being a tentative initial analysis of the status of MT from the viewpoint of TS, it still is a first step to entrench aspects of MT in translation studies such that a common vocabulary and a common point of view is established – two important factors for intensified exchange. That this is not an easy task and will need further work in order to overcome philosophical problems as well as resistance from within the TS community, has been argued e.g. by Rozmyslowicz (in press). The author argues that the fact that MT has not yet been identified as a TS problem, “is not accidental but a symptom of certain theoretical and methodological predispositions” (ibid.). On the other hand, as has been said before, MT of the past decades has been more concerned with solving computational problems and, in my view, needs to become more open towards newer developments in TS. The following sections will briefly assess from what kinds of TS concepts and research MT could benefit.

### **Linguistic and translational knowledge in MT**

Recently, statistical MT has in many ways re-integrated linguistic knowledge, e.g. by using dependency treelets for transfer (Ding and Palmer 2005; Quirk, Menezes, and Cherry 2005), using factored translation models incorporating morphology, part-of-speech, etc. (Koehn and Hoang 2007), adding semantic roles (Wu and Fung 2009; Haugereid and Bond 2012), or creating hybrid systems using both rule-based and statistical knowledge (Žabokrtský, Ptáček, and Pajas 2008). In all these fields, not only linguistic, but also translation research can contribute to relevant knowledge of the field, for instance in the research on domains and their textual properties, as will be demonstrated later on.

While these systems are using additional linguistic knowledge, few attempts have been made at including truly translational knowledge. Though training models based on domains of discourse (Koehn and Schroeder 2007; Bertoldi and Federico 2009) is not explicitly translational, it does match the affinity of many translation scholars to have a functional look at the text and what context it is embedded in. Domain here is not the only, but a very important factor, where text type is another (Reiß 1976). The notion of *register* from systemic functional linguistics (Halliday and Hasan 1989) can be seen as a crossing between domain and text type and has been made fruitful for translation analysis (Teich 2003; Neumann 2008; Hansen-Schirra, Neumann, and Steiner 2012). The definition of a register takes into account both the field of discourse (i.e. the topic or domain) as well as the mode (e.g. written, spoken); a third variable is the tenor, the relation between those involved in discourse. The type of register a text belongs to has a strong influence on its linguistic characteristics (Biber 1995; Neumann 2008). In combination with translation direction, it is a decisive factor in guiding translation shifts. Figure 1 shows the proportions of shifts be-

tween the grammatical functions subject and adverb of any kind per combination of translation direction (E2G = English to German, G2E = German to English) and register (ESSAY = political essay, INSTR = computer manuals). The bars read as follows: When, for G2E\_INSTR, a subject is shifted, in more than 4% of the cases it is shifted to some sort of adverb. We can see from this graph that this proportion is about three times higher in the opposite translation direction which in many cases is due to a typological contrast between English and German. English can fill the subject with inanimate entities which German cannot do easily, often resulting in translation pairs such as the following:

*Tray 1 [...] holds up to 125 sheets [...]*

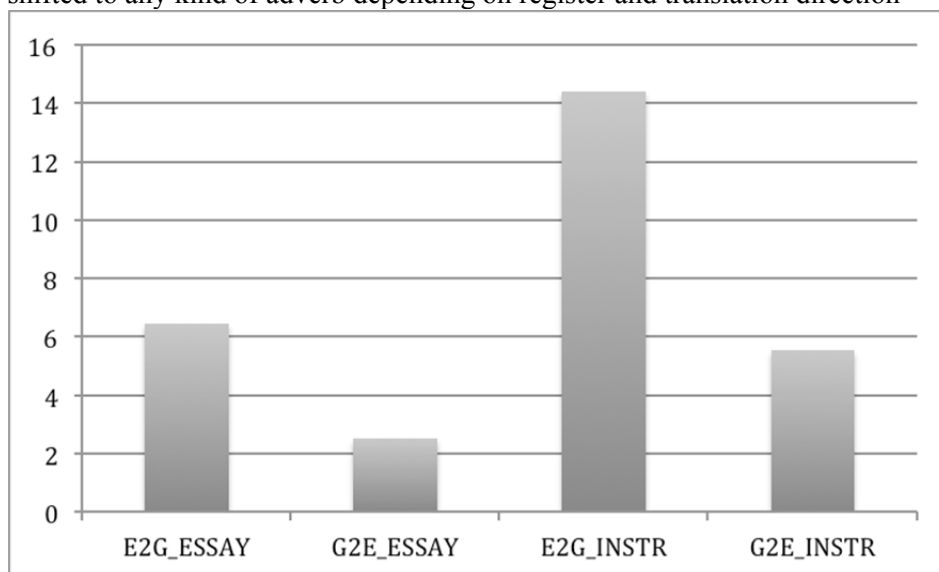
*In Fach 1 [...] können bis zu 125 Blatt Papier eingelegt werden [...]*

*`into tray 1 [...] can up to 125 sheets paper inserted be [...]*

*(E2G\_INSTR\_001)*

The English inanimate subject *Tray 1* is rendered as locative adverb *In Fach 1* `into tray 1` in German. Such shifts are quite common and, as figure 1 shows, are more typical for the register INSTR in the translation direction English to German, which, from heuristic examination, can partially be attributed to the use of inanimate subjects as in the above example.

Figure 1: Proportions for subject shifts, indicating how often a subject was shifted to any kind of adverb depending on register and translation direction



The conclusions one might draw for MT are straightforward: Training language models according to translation direction *and* register should be beneficial for the performance of the systems, as shift types are heavily dependent on these two factors. A study in this direction was performed by Kurokawa et al. (2009).

Based on the English-French Hansard corpus, Kurokawa et al. compiled a training corpus in which originals and translations were clearly marked. Models were trained according to the translation direction. The authors report that they were able to reproduce equivalent BLEU scores using only a fifth of the training data when these were sorted according to translation direction, as opposed to training on models in which translation direction is being disregarded of. If we take a closer look, these training data are also from a single register, as the corpus used only contains parliament speeches (written-to-be-spoken text type, political domain). In order to determine the combined effect of translation direction and in-register training of MT models, a broader study setup comparing various registers and translation directions would be necessary.

### **Post-editing: Where humans and machines meet**

In addition to studying the products of translation, both MT scholars and translation scholars are becoming more and more interested in the process of post-editing (O'Brien 2002; Tatsumi 2009; Groves and Schmidtke 2009; O'Brien 2010; Carl et al. 2011), i.e. the process of humans correcting MT output. Post-editing (PE) is a field in which the human translator and the machine meet – as well as the two disciplines MT and TS. It is the task of editing erroneous MT output with the goal of getting it either into a just about usable shape (often referred to as *light* or *fast* PE) or making it indistinguishable from proper translations (*full* PE). This task poses specific problems as compared to purely human translations, as the post editors have to deal with output that can be erroneous on multiple levels: morphology, syntax, semantics and last but not least pragmatics. Also, the cognitive load is heightened with respect to focus: When post-editing, translators have to focus on both the source text as well as the MT output.

These challenges are an opportunity at the same time: As many have noted, a monitored PE process can reveal much about the errors an MT system makes and can thus help improve the system. Also, contrasting PE and the “usual”, purely human translation helps in understanding more about either kind of process.

Research on post-editing can surely be said to be still in its infancy. So far, research on post-editing focuses on such questions as the different post-editing strategies (Carl et al. 2011), on studying efficiency both with respect to time as well as quality (e.g. Groves and Schmidtke 2009; Specia 2011), on differences between post-edited and from-scratch translated texts (Čulo et al. in print), or on the question which additional skills are needed for post-editing (O'Brien 2002). PE is subject to a number of factors, e.g. to the familiarity of the translator with the mechanisms of MT, to their technical skills, and to their attitude towards MT. Besides these, the task description of PE is crucial: When do I discard a sentence and start from scratch, when do I use parts of it and correct it, and when is it good enough for my task description? One of the biggest problems is

the question what exactly light PE is: How do I decide whether a sentence is good enough to be understood, which errors can I disregard of etc. A major question, again, is: Which concepts from TS can be re-used and how can PE-relevant concepts be entrenched in TS and in translator teaching? For instance, the pilot study by (Čulo et al. in print) reveals that certain PE strategies like non-backtracking behaviour (Carl et al. 2011) can lead to errors in consistency. In the example discussed by Čulo et al., the English word *nurse*, which is ambiguous with regard to gender, appeared both in its German female as well as male form (*Krankenschwester* vs. *Krankenpfleger*) in the post-edited texts, where the correct interpretation would have been the male form; this mistake did not happen in from-scratch translations by humans. More careful task descriptions with regard to which strategies a translator is familiar with should be pursued might help avoid such mistakes. This, again, being a tentative point of view given here, needs further study. Various ongoing post-editing research projects like one at the Faculty for Translation Studies, Linguistics and Cultural Studies at Mainz University are looking at such factors impacting on PE.

### **Conclusion: The time is right!**

This paper has presented some, admittedly, quite preliminary considerations on where MT and TS can meet, both with respect to theoretical and practical issues, and how both could profit from an intensified exchange.

On a theoretical level, MT can be described in terms of functional theories on translation, and thus formalised as a type of translation which is very typical for a number of settings in which translators work – the goal of a functionally equivalent translation in mind. Given such a theoretical entrenchment of MT in TS, acceptance for MT could be raised within the translation community, also opening various collaboration opportunities in terms of research. On a practical level, MT could benefit from various studies performed in empirical TS on how factors like register or translation direction impact on linguistic properties and translation shifts. Using this knowledge, MT can optimise its strategies in training MT models, reducing the necessary size of data and in consequence the prerequisites for processing power. In terms of the emerging field of PE, the definition of the PE task based on translational concepts can help optimise the task setting, leading to even larger efficiency and quality gains than those already reported.

Future work for this line of research on how MT and TS can further converge will consist of a broader overview and better formalised model on what kind of benefits can be expected and what the preconditions are for each case. Given the current developments in which exchange has already picked up (see references cited in this paper), the time for this has probably not been better for this endeavour than in quite a while.

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