types of legal texts and the translation challenges associated with them. Her book boasts an extensive bibliography and, by incorporating examples from English–Chinese legal translation, provides a refreshing departure from the almost exclusive emphasis on European languages elsewhere in the literature. Another recommended resource is *New Approach to Legal Translation* (1997) by Susan Šarčević, one of the more prolific and thoughtful writers on legal translation theory and practice. As this chapter notes, however, Sarcevic's approach is not without its pitfalls. Finally, Malcolm Harvey's 2002 essay 'What's So Special about Legal Translation?' is a powerful—and entertaining—retort to the puffed-up claim that legal translation occupies a privileged (and separate) place in translation theory.

CHAPTER 17

SCIENTIFIC, TECHNICAL, AND MEDICAL TRANSLATION

SUE ELLEN WRIGHT

17.1 INTRODUCTION

The misnomer 'scientific, technical, and medical translation' is ubiquitous in translator training curricula, but the apples-and-oranges title actually represents different levels of abstraction. Scientific and technical documents and spoken discourse together constitute a continuum of subject fields and text classes. Although conflating science and technology is inappropriate, it is nonetheless difficult to draw clear boundaries between the concepts. This chapter refers to the continuum as 'Sci-Tech' where appropriate, and differentiates its constituents when necessary. In this sense, Sci-Tech comprises a high-level domain-oriented typology coordinate with, for example, legal-commercial or literary texts.

Medical texts, although important, occupy one of many sub-domains, such as chemistry, bioscience, genetic engineering, or automotive engineering, each with its own set of sub-topics and text classes distributed across the Sci-Tech spectrum. For instance, one medical text might be a scientific report on current lab research and another might provide technological instructions to an end user of a medical device. This distinction does not, however, undermine medical translation as 'the most universal and the oldest form of scientific translation' (Fischbach 1998: 1).

Science involves human inquiry and the observation of the natural world, based on rational effort to discover regularities that can be codified into laws of nature (Shermer 2008: 38). The scientific method implies an empirical and often experimental approach to this act of observation and the postulation of rules.

Technology is older than science. It applies observed knowledge to manipulate the environment for the improvement of the human (or primate, for that matter) condition. An ape poking a simple stick into an ant hill to retrieve a tasty snack engages in a technological act, and so does an astronaut heating, opening, and consuming a more complex package of 'space food'. The ape is unlikely to expound on the design of the stick, but the astronaut can probably describe the dietary merits of her food and the efficiency of the packaging, for the technology behind her lunch is informed by science.

Applied science and engineering facilitate the transitional phase whereby scientific knowledge and processes are exploited for technological ends. Universities, research organizations, and sponsored programmes actively support technology transfer—the so-called 'translation' of research-related knowledge, skills, and methods into patents, commercial designs, etc., that benefit public, private, and industrial users.[1] Improving the human condition provides ethical satisfaction, but converting innovation for commercial gain serendipitously supports further research funding. 'Technology transfer' also refers to the North–South transfer of Sci-Tech know-how from highly developed language communities to developing societies, often requiring language and terminology planning in order to facilitate language translation (see 17.5.3 below).

This chapter focuses primarily on Sci-Tech texts (documents), along with their categorization and translation, but also views them in the context of spoken discourse. Texts for translation must be evaluated based on:

- the language of the source text (SL of the ST);
- the potential language(s) of the target text(s) (TL of the TT);
- the subject field(s) of the ST, which is/are embodied in:
  - special language terminology;
  - SL constraints and conventions anticipated by the TL audience for the subject field;
- the ST register and the appropriate TT register (not necessarily identical);
- the SL text class factors (type and variety) and desired TT class factors (not necessarily identical);
- presentation issues (layout, medium, etc.);
- the specification of translation job parameters.

[1] Wikipedia, 'Technology transfer'.

Current trends in Sci-Tech translation are grounded in historical practice, but are contextualized with respect to the commodification of translation and its evolution as a global industry. Furthermore, translation flows from SLs offering a rich store of Sci-Tech knowledge in the direction of TLs where gaps exist, at least in certain domains. This flow is conditioned by the dynamics of technology transfer, but particularly by the hegemony of English as the language of science.

17.2 Sci-Tech subject fields and sub-domains

Identification of the SL is usually unproblematic, and specification of the TL(s) depends on the potentially complex needs and intention of the requester. The latter can often state the ST subject field as well, but this is not always true for third-party texts, which may require examination by a competent linguist. Science proper can be classified at a high abstract level into broad subject fields such as: mathematics, astronomy, statistics, computer science, bioscience (zoology, botany, and medicine), chemistry, and earth sciences (geology and geography).

Traditionally, high-frequency categories include medicine, along with manufacturing and construction engineering, and agriculture (Sager and Nkwenti-Azeh 1989), with the huge addition today of electronic communications, software, and Internet content. These classes can be further broken down pragmatically, sometimes with variations reflecting different cultural traditions. Library subject classifications are usually inadequate for detailed enterprise applications, but digital taxonomies and ontologies are increasingly created as knowledge-management solutions.

17.2.1 Special language and terminology

The subject field of the text is coordinate with its special language. ('Language for special purposes' (LSP) can be confusing, especially in American English, where it is commonly associated with foreign-language pedagogy.) A special language is 'a language used in a subject field and characterized by the use of specific linguistic means of expression, [which] always include(s) subject-specific terminology and phraseology and also may cover stylistic or syntactic features' (ISO 1087-1: 2000).

The vocabulary of special languages is documented in specialized lexicography and terminological dictionaries and is supported today by electronic terminology-management systems, but special languages are not limited to vocabulary (Sager, McDonald, and Dungworth 1980, Byrne 2006, Felber and Budin 1989). Special-language terminology is embedded in general language, and linguistic communities have their own expectations regarding conventions and constraints associated with specific text varieties. These include preferences for certain syntactic forms and idiomatic and collocational usage, as well as varying degrees of formality. As one instance among many, where British English favours passive voice and nominalized verbs (Sager et al. 1980, Ahmad and Rogers 2001), American English, particularly in technical writing, prefers semantically expressive verbs (e.g. *manipulate, fabricate*) as opposed to sequestering verbal action in nominalized forms (*manipulation, fabrication*) (Byrne 2006, Delisle et al. 1999). Although passives are commonly used in pure science writing to report reproducible results, they give way to a prescriptive demand for active voice in popular science and technical writing. The translation process is informed by the tensions that exist between SL and TL conventions, and by recasting strategies adopted to satisfy end-user expectations.

17.2.2 Usage register

The term 'register' is polysemic. On the one hand, it is sometimes equated with the special language per se as 'an open-ended set of varieties (or styles) of language typical of occupational fields, such as [. . .] medical language, technical language, etc.' (Trosborg 1997: 5). More commonly, however, text or term register is associated with field of discourse (Quirk 1985) or levels of formality: 'very formal, formal, neutral, informal, very informal'.[2] ISO 12620: 1999 defined the data category /register/ as a 'classification indicating the relative level of language individually assigned to a lexeme or term or to a text type', with the permissible values: *neutral, technical, in-house, bench-level, slang, vulgar,* sometimes expanded to include *formal, colloquial,* etc.

'Situational diversity' (Sager and Nkwenti-Azeh 1989: 19) can also dictate division into sub-categories to meet end-user expectations depending on the roles of participants in a given speech act (including acts of text production and reception):

- peer-to-peer scientific communication (professional journals, books, scholarly papers, etc.);
- scientist to skilled practitioner (oral and written communications, frequently in instructive mode);
- skilled practitioners addressing technicians (e.g. engineers to specialized technical personnel; medical doctors to medical technicians);
- specialists to lay people (oral and written explanations, evaluations, sometimes in instructive or persuasive mode, e.g. medical brochures on how to lose weight);

- science writers addressing the educated, interested lay public (popular science articles, web pages with high levels of information content);
- specialists addressing educated laity (health care providers treating educated patients)
- specialists addressing laity who have issues involving education, dialect, ethnicity, personal life experience (healthcare providers treating less educated, unsophisticated patients who may harbour suspicions about modern medical practice);
- laity and end users discussing Sci-Tech topics (medical issues, technological products, software, etc.) among themselves, possibly reflecting traditional prejudices.

Differences in usage register can trigger variations in terminology and style, as well as in the general language matrix surrounding special language. Depending on situational factors and the projected target audience, a given concept may be designated by variant terms reflecting different registers within the same special language. For instance, *tummy, stomach, gut, belly,* and even a few others might occur appropriately in different situational contexts. These factors affect target-term choice—English *appendix* might be translated in a specialized text in German as *Appendix,* but as *Blinddarm* for lay readers. Thus the myth of mononymy and monosemy (univocality), which would banish synonymy from special languages, only applies in narrow contexts, such as standards and patents, for consistency within a given document, or when using rigidly defined controlled language (Controlled English 2007, NAMAHN 2001).

Furthermore, written Sci-Tech texts and documents exist in the environment of spoken discourse within a discipline. For pure science, there may be very little difference in usage between the two modes. Along the continuum towards technology, however, spoken discourse may reflect lower registers, and in cases involving manufacturing, processing, and end-user application, regional dialects and sociolects are often introduced.

17.3 Text classification (type and variety)

Usage register is at least partly determined by issues of text type and text variety (genre), a distinction based on the German concepts of *Texttyp* (categorization of the intention or function of a text or text segment) and *Textsorte* (class of texts based on common regularities in style, vocabulary, presentation, and intention, i.e. communication practices; see Nord 1997: 53). The relationship between text type and variety is intersecting rather than hierarchic. Sci-Tech translators need pragmatic guidance in this regard rather than conflicting theory, for identifying type and variety is crucial for the final translation product. Neubert and Shreve conflate the two aspects of classification as the manipulation and combination of 'textual features necessary to make the text an instance of the [chosen] text type in the target language community' (1992: 126).

17.3.1 Text types

As noted, text types reflect the *intention* of the author as a sender of a speech act (Sager et al. 1980: 24) or the *function* of the text itself (Bühler 1965, Reiss and Vermeer 1984/1991, Nord 1997). Rough consensus categories include:

- informative: factual texts focused on content; dubbed 'referential' by Nord because they refer to real-world objects;
- expressive: often literary texts, but also associated by Sager with evaluative texts, thus linking them to Sci-Tech;
- appellative, persuasive: including advertising, as well as directive, instructional texts;
- phatic: usually embedded fragmentary elements that employ metacommunicative rapport between the author or voice of the text and the receiver.

Prevalence of these types varies across the Sci-Tech continuum, with informative texts predominant for pure science and evaluative texts common in review articles. Persuasive elements play a role in defending controversial positions or when exhorting the public to accept scientific findings, for example to adopt healthy life styles, protect the environment, or combat global warming. Some popular writers of scientific texts (e.g. Rachel Carson, Steven Pinker) interleave pure science with persuasive or even phatic elements.

Although phatic elements are rare in pure science texts, they sometimes slip in subtly: a factual report on the findings of obesity studies in Germany reports that 'a higher percentage of Germans are overweight or obese than Americans (!).' The inserted exclamation mark in an otherwise non-phatic, non-persuasive text (along with later repetition of this finding) addresses an anticipated reader preconception that obesity is a more prevalent problem in America than anywhere else. The use of phatic reference increases in instructions and science-related advertising (pharmaceutical commercials, etc.), and may vary according to language-specific expectations. Interestingly, it is more common in German popular-science writing, which can be more entertainment-oriented than much Anglophone science writing, although variations abound. *Scientific American* or the *New York Times* science section maintain a more detached scientific register than do technology blurbs and reports in *Wired*, for instance. Translators working along this sliding scale must study TL parallel texts carefully to adapt the TT effectively, and corpus studies can be instructive in documenting usage.

17.3.2 Text varieties

Text varieties have been related to special-language levels: theoretical, experimental, applied sciences → technology, manufacturing, consumption → advertising, etc. (Hoffmann 1974, Bucholz 1978, Sager et al. 1980). Trosborg (1997) and her contributors provide a broad spectrum of considerations, as does Byrne, who focuses most of her book on heterofunctional strategies for into-English translation of technical brochures, informed by insights from technical communications and cognitive science (Byrne 2006). Velasco (2008) develops a comprehensive view from an Iberian perspective. Göpferich's matrix of 'Written Text Varieties for Science and Technology' provides the most useful pragmatic framework for working translators (Göpferich 1995). Figure 17.1 presents an instrumental translation of her chart, updated by electronic publication aspects and with the addition of a new row representing translation-specific varieties.

The matrix embodies criteria discussed above, including subject field, register, text type and text variety, but also delves deeper into subtypes while avoiding any futile attempt to produce exhaustive lists. Göpferich includes modes and styles of production (e.g. simply printed text vs. publications with high print values). Viewed from the upper left to the lower right, the chart traverses the Sci-Tech continuum, starting from formal scholarly research intended for peer-to-peer communication and progressing in the direction of plain text instructions for end users of technological products.

Five column headings divide the continuum into primary communicative functions. The boundary setting off 'legal texts and standards' demonstrates their dual legal/scientific text typology. Standards and government regulations presume discourse directed from authoritative bodies, primarily to practitioners, manufacturers, and service providers. Patents are declarative and descriptive, and also comply with rigid formal constraints designed to prevent ambiguity. Standards and patents alike tend to use different vocabulary from other text varieties pertaining to the same subject. User-friendliness and common usage are sacrificed in favour of close intertextual reference to existing standards and patents (prior art). Likewise, laws and legal regulations frequently create new terms, which over time gain legally binding currency.

Texts classified as 'leading-edge' scholarship of discovery report the development of novel material based on what is already known by domain experts. Translation of these texts supports dissemination of new science to a broad international audience, but also poses challenges for non-expert translators because their knowledge base rarely corresponds to that of subject specialists and requires in-depth research in order to produce effective equifunctional TTs (Wright and Wright 1999). Translation direction for science texts is discussed in section 17.5 below.

Figure 17.1 differentiates scientific texts according to presentation values, separating content-oriented texts with minimal print values from published works where layout and display features play a stronger role. It should perhaps be noted that given the current sophistication of word-processing, web design, and desktop publishing applications, the gap between 'simple' reports and theses on the one hand and 'print-quality' articles and web pages on the other is rapidly narrowing. In some areas of science, 'pure content' documents produced without the benefit of high-quality colour photography and graphics have become rare (e.g. in highly visual fields like botany or crystallography).

'Didactic-instructive' texts, on the other hand, do not assume significant prior knowledge, except as a function of curricular articulation. Pedagogic materials provide fundamental knowledge of the subject covered, along with detailed terminology, definitions, and common synonyms. They usually start with basics and expand in logical, linear fashion to more complex, state-of-the-art treatment of the topic at hand.

Texts with a pedagogical orientation are classified by Göpferich as 'mnemotechnically organized'—a non-transparent term that has been adapted here for the targeted audience of practising translators. The original term focuses on presentational features such as summary paragraphs, study guides, and review questions, all common to textbook style. The emphasis here is on full, logical presentation of subject-area knowledge, whereby the text itself supports knowledge acquisition by the translator.

Public interest in innovative science and technology is high. Consequently, scientific writing is 'translated' into popular-science writing by technical communicators and 'science writers' who, although they are frequently well trained in the scientific method and style, are not themselves involved in scholarship of discovery. The distinction mirrors the difference between the German terms *Forschung* and *Recherche*, which does not exist in English and French, where a single term (*research*/*recherche*) suffices for both concepts. *Forschung* implies original, often experimental or empirical, investigation to create new knowledge, whereas *Recherche* accesses, evaluates, and reflects upon existing resources. In this light, popular-science writing incorporates the findings of original research and 'dumbs them down' to present them to a defined lay audience. As will become evident in 17.5.2, language direction and language politics play a significant role in this process.

'Human technology interaction' accounts for the delivery to end users of information generated by applied science, engineering, and technology. Examples include tech-oriented instructions, usually with a narrow, clearly defined focus, involving a concrete object (how to operate a device) or procedure (how to perform a task). Stylistic principles laid down by the originally Anglophone formal discipline of technical communication strongly influence both terminology and presentational features. The clarity of the ST can severely affect the quality of the TT. Some government regulations stringently dictate 'plain text' style and legally binding information content designed to guarantee safe and effective use of

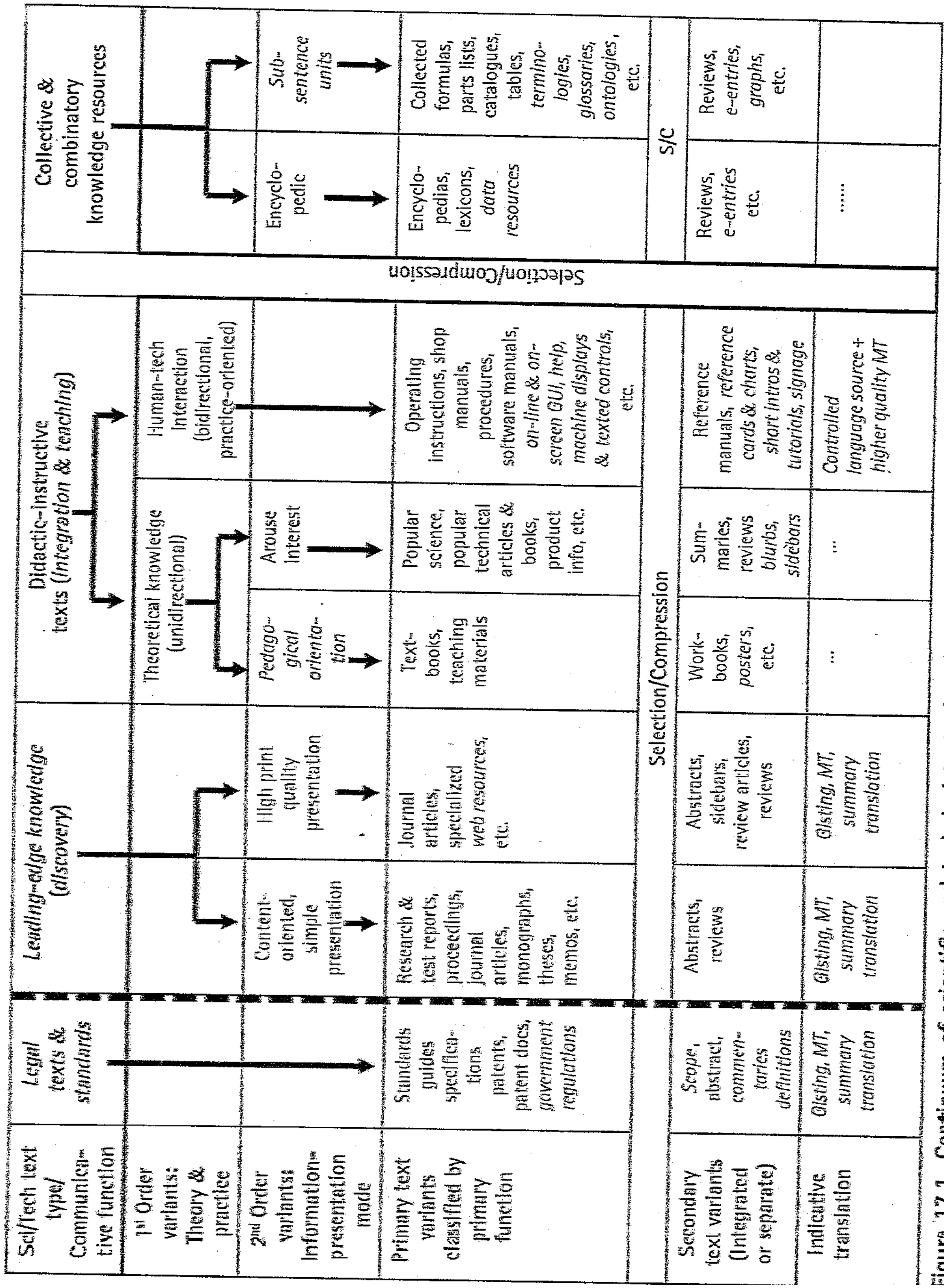

Figure 17.1. Continuum of scientific and technical texts; based on chart from Göpferich (1995). Italics indicate instrumental modifications in the chart.

products. In this regard, translators must be aware of both SL and TL constraints in order to fulfil such regulations.

'Encyclopedic' and 'sub-sentence' resources were once the province of hard-copy texts. In current authoring and translation production venues, these resources are frequently embedded in the computerized document production environment, both locally and on the web, and are dynamically updated using software solutions to keep pace with workflow.

17.4 Specifying the Translation Work Order

The previous discussion deals in a translation-neutral way with language, text, and content features that must be identified for both the SL and the TL, but does not indicate who makes these decisions. First it must be understood that most Sci-Tech translation occurs in the context of the translation industry. Byrne attributes 90 per cent of all translation to Sci-Tech, a rough but credible guess, which probably includes localization (Byrne 2006: 2; Chapter 18 below). In this marketplace, translation is not just an intellectual activity—it is a commercial one as well. With rare exceptions, Sci-Tech translations are prepared as works made for hire, based on a commercial transaction between a translation requester and a translation service provider (TSP; LSP in the case of localization service provider). Translations are frequently billed by the word or standard line, which triggers a view of translation as a kind of commodity that can be offered for bid like bushels of corn.

The semi-automation of the translation process entails terminology management and translation memory, localization and project-management tools (Chapter 30 below). Translation is often closely integrated as an industry partner in the overall content-management and delivery environment, which has inspired the adoption of industry standards and metrics and fostered the notion of the 'translation factory' (Schäler 2004). However, reflecting professional consensus, American and European standards for translation focus on services, with emphasis on process more than product per se (ASTM F 2575–06, 2006; CEN's EN-15038:2006). Quality assurance (QA) emphasizes clearly defined, secure, and capable processes, taking precedence over quality control (QC), although QC practices such as editing and review remain in place.

Commercial translation is not just the act of a single individual, the translator. Defined roles ('stakeholders') include:

- (author/originator): not cited; frequently uninvolved;
- requester: commissioner of the translation (*Auftraggeber*); individual or entity requesting the translation;

- project manager (PM): individual or possibly group of individuals responsible for coordinating the translation project; PMs are usually members of a TSP team, but savvy requesters sometimes perform the PM function themselves;
- translation service provider (TSP): entity or individual (e.g. translation company or individual translator) supplying the translation;
- editor ('reviser' in EN-15038), proof reader, and (third-party) reviewer: roles responsible for checking the translation for linguistic accuracy and TL adequacy;
- end user: consumer, the target audience for the translation.

Although these roles are spelled out individually, the service functions can be conflated in a single individual, with the caveat that the CEN standard requires that the reviser be a second person. When initiating a Sci-Tech translation, some one or more of these stakeholders classifies the text according to the criteria discussed above and specifies technical issues such as format and tool use. In the best-case scenario, authors internationalize the ST for translation (stripping out problematic culture- and language-specific elements) and coordinate with the TSP via the PM. Authors are, however, seldom aware their texts will be translated, and even if they know, they are ignorant of translation issues. Assuming that the requester knows the target audience, s/he might state the relevant specifications in a work order (the translation 'brief' or 'commission', *Auftrag*), which may be a simple purchase order or a formal contract. Alas, requesters are sometimes clueless about the ST language or text variety, and are even more likely to be unfamiliar with TL requirements. As a consequence, PMs and TSPs usually determine requirement criteria in consultation with the requester and set down specifications for TT quality assessment. The primary purpose of the ASTM Guide is to outline procedures for this process, although it often takes place in a fairly informal way. The requester–TSP relationship is not unlike a client/patient approaching an attorney or physician: it is the professional who identifies the problem and negotiates the required service with the client's collaboration.

Figure 17.1 describes the text variety, but does not provide guidance on transfer issues between ST and TT. It would be naïve to assume that Sci-Tech texts are devoid of cultural content or that their translation involves straightforward transfer. Differences in stylistic constraints aside, there is also the possibility that requesters may want to shift the function between ST and TT based on their intentions vis-à-vis the target audience. Despite classic discussions of fidelity to the ST, best practices provide a foundation for this kind of choice.

The pragmatic work-order process is nonetheless grounded in modern translation theory. The first translation theorist to single out scientific translation is perhaps Schleiermacher (1813/2002). He cites *Geschäftsleben*, *Wissenschaft*, and *Kunst*—commercial life (including trade and probably much of what we would classify as manufacturing and technology), science, and the verbal arts—and adds diplomatic relations and more complex legal texts as a kind of afterthought.

Commercial and diplomatic texts he relegates to *Dolmetschen* (interpreting), which he acknowledges to be oral mediation and equates with simple transfer (*Übertragung*). Differences in language at this level are 'insignificant' and the use of individual words (terminology) is clearly fixed by rules and custom. In his view, any competent bilingual can do this. Works of art and science, on the other hand, demand *andere Kräfte* und *Geschicklichkeiten* (other powers and skills), and are the venue of the true translator (*der eigentliche Übersetzer*). When translating science, the translator employs paraphrase instead of adaptation (both problematic suggestions for the modern translator); but be that as it may, the implication is that such translations involve moving the text in the direction of the reader to create a fluent TT. In House's terms (1977/1981), this creates a 'covert translation' in keeping with the contention that pragmatic texts, if 'well translated [. . .] will not be recognized as translations' (Neubert and Shreve 1992: 125).

From Schleiermacher, there is a great leap forward across at least a century and a half of theoretical disregard for Sci-Tech translation to twentieth-century Skopos theory and functionalism (Reiss and Vermeer 1984/1991, Reiss 2000, Vermeer 2000, Nord 1997). Nord introduces the notion of the 'instrumental translation', which creates a target language instrument for a new communicative interaction between the source-culture sender (the author) and a target-culture audience (the end users) based on the perceived needs of that audience, which may differ from those of the SL audience. As a consequence, translations may be 'equifunctional' (ST and TT needs and intentions are equal) or 'heterofunctional' (needs and intentions differ). It is precisely at this juncture that requesters and TSPs must take hard decisions when specifying a translation work order. Of course, many jobs do require equifunctional strategies, but heterofunctional approaches are not uncommon. Examples include:

- 'for information' translation of a patent retaining SL conventions without adaptation to TL practice vs. patent translation that introduces variations in form and convention necessary to file the patent in another locale;
- adaptation of pure science ST materials to popular science TT articles;
- 'gisting' ('indicative translation'—possibly inelegant, summary translation, sometimes produced via machine translation) for information purposes or as a triage tool for determining which of many texts require more detailed translation.

Work orders may specify that either the individual translator(s) or the TSP shall be certified in order to assure high quality performance and process values. The CEN standard creates a framework for formal TSP certification, patterned on industry practice for other services (e.g. LICS 2009, Jonas 2008). Assessment theory postulates that a set of translator competences will provide further prognosis for TT quality. Orozco and Albir (2002) provide a list of prominent theoretical sources. ASTM F2575-06 (2006) enumerates competences, among others: SL–TL proficiency; relevant experience; references and sample translations; university degree or certificate in translation; certification from a recognized professional body; task-related, subject field, and text-type competences; and translation technology skills. Stejskal (2004) provides exhaustive information on individual certification worldwide. Despite stress on quality, the market teeters in a precarious position, balancing high costs for quality against disproportionate demand with respect to available resources, efforts to provide moderately acceptable machine translation, and fierce global competition to curtail costs while increasing output.

17.5 The Flow of Power: Language Demographics and Translation Direction

> It is axiomatic that dominance in knowledge, customs or technology has major repercussions upon language relationships. What is seen as superior tends to flow into what is seen as inferior; one may view the process in terms of either push (imposition) or pull (borrowing). Whoever leads the field gets to create the words that capture the emerging concepts and products. (McMorrow 1998: 69)

Pym (2000: 79) coins 'intranslation' and 'extranslation' for this forceful give-and-take.

17.5.1 Historical perspectives

Fischbach calls translators who drag or shove powerful bits of knowledge across linguistic and cultural boundaries the 'pollinators of science' and the 'handmaidens of science' (1993: 89, 91). Schleiermacher (1813) also uses vegetative metaphors: transplantation (*Verpflanzung*), propagation (*Fortpflanzung*), and transformation (*Verwandlung*): transplantation of foreign texts improves the fertility and climate of the TL soil, both in terms of ideas and the generation of vocabulary. In line with McMorrow's metaphor, however, translators act as knowledge engineers, manipulating (sometimes arbitrarily) the sluice gates to control the flood of content from areas of high concentration to fill the voids where lower knowledge pressure exists.

Historically, the ebb and flow of Sci-Tech translation across linguistic boundaries has rarely been equal, at times producing a tidal surge in one direction or another. In some cases, one linguistic community rushes to devour knowledge from another (e.g. Roman expropriation of Greek wisdom), and in other colonial scenarios, content is imposed on other cultures, sometimes in the form of translation, but more insidiously via the suppression of target language and culture.

To cite one historical migration of ideas, European tradition recounts the tale of the great Greek philosopher polymath Aristotle, who is said to have penned the array of texts that now constitute the core of European civilization. Lost to the West in late antiquity, they were translated eventually into Arabic and preserved intact, only to be retranslated during the Renaissance into Latin and the then burgeoning vernaculars, thus achieving an almost miraculous lossless/gainless roundtrip whereby Western wisdom was at last returned intact to its rightful heirs.

While Christian apologists in particular suppressed any indication that non-European, non-Greek content was entrained in the process, modern Islamic scholars present a sharply contrasting picture, where virtually all aspects of scientific and technical progress derive solely from Arabic contributions: 'agriculture; the domestication of animals [...] food, clothing and transportation; spinning and weaving; building; drainage and irrigation; road-making and the wheel; metal-working, and standard tools and weapons of all kinds; sailing ships; coinage; abstract thought and mathematics'—all are attributed to knowledge translated from Arabic sources (Zaimeche 2004: 4).

The truth probably lies somewhere in between, along the circuitous route from one hegemonic language to the next, from Greek to imperial Latin to Syriac to Arabic, and then back to medieval ecclesiastical Latin and the European vernaculars. Thanks to teams of translators and oral interpreters, along with subject specialists, the 'Greek' legacy was enriched along the way by nativization, 'redaction', and emendations on the part of untold translators, copyists, and commentators—Nestorians, Jews, Persians, Mozarabs, and Christian Europeans as well as Arabs—drawing on sources as far away as India and China (Montgomery 2000, Pym 2000).

Each transitional link in this extended chain of knowledge transfer requires exponential expansion in order to accommodate the richer range of information. This is true of each language in turn as the tide of ideas is forced into an initially inadequate vessel. Hence translation does indeed play midwife to special languages, assisting in the birth of vocabularies across the spectrum of subject fields. Pym (2000: 79) implies that the translation into Castilian of critical texts in science and philosophy results in the creation not only of the language itself but of the nation state as well. Identifying Aristotle as more more likely to have been a great librarian and teacher than the author of all the texts associated with him, Montgomery asserts that 'the tale of Aristotle [...] and the great library, past and present, suggests that in the history of knowledge, the power of translation is commensurate with the power of the word' (2000: 13).

17.5.2 English as the hegemonic language of science

A critical factor affecting translation directionality is the fact that English today is the predominant language for leading-edge science. Not only are most scholarly

articles originally published in English, but a relative low percentage of these articles is translated into other languages because worldwide, scientists have adopted English as their working language, both in written and spoken form.

The ramifications of this situation are manifold. This chapter has cited differences in SL and TL stylistic constraints. For instance, English Sci-Tech texts present known information first and carefully and coherently move on to the novel, creating a strong cohesive, linear focus throughout the text. German texts may commence by stating the novel, and then substantiate assertions by introducing the known on which they depend, proceeding inductively and not without digression, finally to reach the crux of the discussion at the end of a paper. The progression is still approximately linear, but the path is not the same. Japanese texts, in contrast, toss elements together in a stir-fry of ideas, often leaving the reader to deduce the main point from the circular presentation of ideas (Rudlin 2008).

Be all that as it may, peer-reviewed scientific articles adhere today to English conventions. Not only does everyone write in English; Anglophone editors (UK, US, Australia, India, etc.) typically occupy gatekeeper roles in the review process, imposing English criteria for scientific writing. Regarding technology, Anglophone standards for technical communication have become the norm and are even taught in university writing programmes, even in non-Anglophone countries. These factors affect not only how texts are translated, but also what gets translated.

The hegemonic role of English affects different languages in a number of ways. In some smaller languages (Dutch, Scandinavian languages, etc.), English is increasingly the language of university science instruction or even at advanced secondary levels, both in order to prepare students for English-speaking professional environments but also because it is often uneconomical to publish state-of-the-art textbooks for a relatively limited readership. Languages that do not offer a full spectrum of text varieties may lack the highest scientific registers of technical terminology. This means that new knowledge in these languages first becomes available at the level of popular science, skipping both the language of scientific discovery and the in-depth pedagogical approach of instructional texts. These issues also affect spoken discourse as well as written texts, as scientists in some countries even tend even just among themselves to discuss Sci-Tech topics in English.

Popular-science writers working in languages other than English act as translators of a sort, in that they base their work on English texts but write in a TL. Thus knowledge transfer from pure to popular science involves heterofunctional translation to a lower level of special-language communication (from the expert to the educated lay level). Here the onus for generating pertinent TL vocabulary may lie with science writers rather than with subject specialists. English borrowings and loan translations in many cases supplant native forms, and synonymy and unmotivated terms may proliferate.

The prevalence of translated texts as the norm for science writing only reinforces the influence of English constraints in Sci-Tech writing in the TL, and efforts to use comparative corpus linguistics for collocational analysis or other applications suffer from the dearth of texts at the pure-science level and tainted stylistics at the popular level. Even prospects for improvements in machine translation (MT) are affected by this imbalance because the most promising trends in MT involve the aggregation of extensive, high-quality comparative corpora.

Another facet of English dominance involves the use of English as a so-called pivot language in multilingual translation and technical writing environments. Even when texts do originate in other languages, it is also common to generate an initial English translation, which then serves as the SL for translation into other languages, further enforcing the influence of English as the norm.

English dominance and the resulting advantage to first- and second-language Anglophones has not gone without complaint from the international community (e.g. Ammon 2001), but proposals to adopt some minor language (e.g. Albanian or the like, in order to equalize the challenge of working in a foreign language), to adopt Esperanto, or to impose a tax on Anglophones to compensate for the cost that others bear for language training, editing, and similar efforts, are unlikely to overcome the 'hegemonic critical mass' enjoyed by English (Sue Wright 2004). As a consequence, it has become a language of 'transnational use' and a 'utilitarian language of contact', even where no English speakers are involved in communication. Anglicization of the language of science broadens the gap between the scientific community and the lay public by adding linguistic distance on top of the natural knowledge-related distance between the two poles. From a pragmatic standpoint, however, it is probable that despite the investment required to acquire and adapt to the lingua franca, a multilingual approach, although potentially more equitable, would entail costs and delays for translation and interpreting that would likely outweigh any advantages gained. Ammon suggests that the ultimate solution is to evolve a new standard for 'bad English'—which some would argue exists already in European English. Despite the fact that this hegemony 'stills the voice of science in languages other than English [. . .] it cannot be said that the ascendancy of English is the outcome of a conspiracy; it is merely the outcome of the coincidence of accidental forces' (Ammon 2001: 19).

17.5.3 Language and terminology planning

Even if scientists use English, mother-tongue terminology is critical for the dissemination of scientific information and for stimulating interaction between science and technology, thus rendering technical expertise accessible to all sectors of the population. Furthermore, the importance of teaching at elementary and intermediate levels in the native language of children has been repeatedly demonstrated: 'longitudinal studies show that not only do students [who start out in mother-tongue or, in some cases, bilingual education programs] catch up, but they also often surpass their peers both academically and linguistically' (Zelasko 2010).

In order to translate effectively, either at the science-to-science level or across any of the technology levels, mediating between a language with rich special languages and those that are inadequately developed requires the consistent creation of new terminology. This necessity parallels the historical precedence cited above, and it will be haphazard unless it is planned. Sue Wright cites Halliday as contrasting 'language planning' with natural 'language development': 'language planning means introducing design processes and design features into a system (namely language) which is naturally evolving' (Halliday 2001: 177; Wright 2004: 1). ISO CD 29383-1 (2008) defines language planning as 'all conscious efforts to affect the structure or function of language varieties'.

Sometimes language and terminology planning focuses on the purity of language, but in many cases there is a clear necessity to create whole sets of terminology in order to communicate basic science at even the most rudimentary levels. South Africa, for instance, states a variety of reasons for providing equal terminological coverage in its eleven official languages (with current efforts to add Sign to the mix): equitable use of official languages, accommodation of linguistic diversity, as well as capacity for teaching, for information retrieval, and for manipulation in native tongues (Alberts 2008). Mother-tongue early child education is a recurring theme, accompanied by translation of school texts in the sciences and mathematics into native tongues (Antia 2000), underscoring two sides of the language- and terminology-planning coin: the creation of vocabulary enables translation for educational purposes, and the use of planned terminology in the schools disseminates new terminology ('acquisition planning': Wright 2004: 1).

English is not, however, solely responsible for language death. English has indeed been involved in the suppression or destruction of languages in its immediate sphere of influence (e.g. aboriginal languages in colonial settings, Celtic languages in Britain and Ireland), yet other majority languages play or have played a similar role (Spanish and French, also in colonial settings, Chinese in non-Han-speaking areas, Russian throughout the former Soviet Union, etc.). Language planning has worked well in tandem with the translation community in places like Quebec and Catalonia, but the high costs involved are daunting for poor countries struggling to preserve dozens of languages. The challenge of translating science into endangered languages is compounded by the digital divide, but by the same token, web capability may provide a medium for less expensive dissemination of knowledge. Unicode coverage for more and more scripts, expansion of language codes to nearly 7,000 languages, and the introduction of standard operating systems in indigenous languages are all steps designed to facilitate the dissemination of digital information in a broader range of languages (Unicode 2008, ISO 639-3:2007, NRSI 2008, UCB/SEI 2008). Even the best intentions, however, must be balanced by efforts to spread literacy in the vernacular. For instance, Microsoft's introduction of an operating system in Wolof was balanced by the fact that literate speakers of Wolof are more likely fully literate in French than in their mother tongue (Voice of America 2007). Wolof, however, is a sturdy language with more than three million first- or second-language speakers. Very small, isolated languages pose more complex problems, even raising the ethical issue that technological solutions may actually undermine some primitive cultures they are designed to save, and some well-meaning programmes, such as 'One Laptop per Child', can easily become mired in controversy (OLPC 2008).

Further Reading and Relevant Resources

Sager et al. (1980) remains the most comprehensive introduction to special languages, although it focuses almost exclusively on English. Terminology and terminology management are well covered in Wright and Budin (1997, 2000), although the second volume, with its emphasis on electronic solutions for terminology management, gradually grows outdated with time.

One area that this chapter does not attempt to cover is language-pair-specific works designed as textbooks and handbooks for neophyte Sci-Tech translators. These resources are not difficult to find for major languages, but given their diversity, it is critical that they be individually evaluated by experts in the languages in question. Hence they are not listed here.

Nord (1997) offers a succinct introduction to text type and variety, as well as, most importantly, functionalism.

Delisle and Woodsworth (1995) provide a generic overview of translation history with limited emphasis on science and technology. Montgomery (2000) compiles a fascinating account of a narrow slice of the Aristotelian tradition, viewing in great detail the development of treatises on astronomy and astrology, augmented by traditions in China and Japan. Pym's account of translation in the so-called Toledo School of translators includes, but is not limited to, issues involving Sci-Tech translation.

CEN EN 15038:2006 is available from the various national bodies that have adopted it, for example http://www.cen.eu/esearch/CatWeb.aspx?id=127582. ASTM F2575–2006 is available online from ASTM International at http://www.astm.org/Standards/F2575.htm. National and regional bodies offering individual certification programmes usually provide detailed information on their websites, e.g. ATA and ATIO (both 2008). The Canadian General Standards Board (CGSB) has also published CAN/CGSB-131.10-2008, *Translation Services*, which specifies the procedural requirements for delivering translation services to the Canadian federal government.

Sue Wright (University of Portsmouth, not to be confused with Sue Ellen Wright, Kent State University) and Antia provide in-depth views of language policy and language planning (Wright 2004, Antia 2000), with Wright outlining the evolution of English as the language of science.

Ammon (2001) offers an excellent orientation to issues involving English as the language of science, but interested readers should explore evolving new trends as well.