The Dominance of English as a Language of Science

Contributions to the Sociology of Language

84

Editor
Joshua A. Fishman

Mouton de Gruyter
Berlin · New York

The Dominance of English as a Language of Science

Effects on Other Languages and Language Communities

edited by
Ulrich Ammon

Mouton de Gruyter
Berlin · New York 2001

Mouton de Gruyter (formerly Mouton, The Hague)
is a Division of Walter de Gruyter & Co. KG, Berlin

∞ Printed on acid-free paper which falls within the guidelines of
the ANSI to ensure permanence and durability.

Library of Congress Cataloging-in-Publication Data

The dominance of English as a language of science / edited by Ulrich Ammon.
p. cm. – (Contributions to the sociology of language ; 84)
Includes bibliographical references and index.
ISBN 3 11 016647 X (cloth : alk. paper)
1. English language – Technical English. 2. Scientific literature – Authorship. 3. Technical writing – Social aspects. 4. Communication, International. 5. Communication in science. 6. Science – Language. I. Ammon, Ulrich. II. Series.
PE1475 .D66 2001
428–dc21
2001030388

Die Deutsche Bibliothek – CIP-Einheitsaufnahme

The dominance of English as a language of science : effects on other languages and language communities / ed. by Ulrich Ammon. – Berlin ; New York : Mouton de Gruyter, 2001
(Contributions to the sociology of language ; 84)
ISBN 3-11-016647-X

Printing: WB-Druck GmbH & Co., Rieden/Allgäu.
Binding: Lüderitz & Bauer-GmbH, Berlin.
Printed in Germany.

Editor's Preface

That English is today's dominant language of science is stating what would be called a *Binsenweisheit* in German, a trivially obvious insight. Science has in fact been pointed out repeatedly as one of the main fields contributing to the spread of English as a global language (Crystal 1997: 80f., 107–109; Graddol 1997: 8f.). Many a triviality, however, reveals less generally agreed-upon, or even hitherto unknown aspects upon closer inspection. Thus in the present case, it may not even be clear what we mean by „dominant language". Do we simply have in mind *prevalence,* i. e. the language being used more frequently than others, or do we imply – in the literal sense of the word – dominance of some persons over others by means of the language in question? It seems that both meanings make sense in the present context and can be explored as to their reality.

The degree of prevalence of English in science communication has been investigated in numerous studies of which Tsunoda's (1983) is one of those frequently quoted (for an overview see Ammon 1998). Other widely recognized studies of the topic have been done by Baldauf and Jernudd (e. g. 1983) who both contributed to the present volume with the former presenting new comprehensive data and the latter, with co-authors Wu and Chan, specific data on Hong Kong. McConnell gives here an overview of the prevalence of English over French for East Asia illustrating the situation by maps. In addition, nearly all the articles in the present volume contain new data on the extensive use of English in science communication, at least for the country under scrutiny, as for example Gunnarson for Sweden or Kryochkova for Russia. Nevertheless we are still far from a comprehensive picture. Though any such picture will of course remain ephemeral, its details may at any point of time be crucial for more refined questioning.

Reasonably comprehensive, even historically comparative, data are available for the share of languages in printed science publications, but they are – due to available bibliographical data bases – less comprehensive for the social than the natural sciences and least for the humanities. De Swaan's article on the social sciences or Siguan's that extends into the humanities, in the present volume, are problem-oriented rather than concerned with representative figures; they touch, among other things, upon linguistic relativity asking, how completely terminology in the social sciences and the humanities can be translated from another language

into English, or whether the wealth of knowledge available in different languages can be stored and expressed in a single one.

For kinds of communication other than printed publications, like oral presentations at conferences, informal encounters, written and oral correspondence, or science teaching, the available data for the share of languages, or for language choice in the case of international contacts, are still rather sporadic. Nevertheless, the contributions to this volume do fill many a gap. Some demonstrate the ascent of English in recent years by comparing data collected at different points of time, as do Medgyes and László for Hungary. Others show the degree of penetration in different countries and language communities like Murray and Dingwall in their comparison of Sweden and Switzerland.

Most studies go beyond mere description in that they attempt to explain, how prevalence, or dominance, of English in science has come about. It seems safe to predict that such attempts at explanation will never be complete but will still always remain rewarding for deepening our insight into the development and history of the world language system. Kaplan takes on the task of comprehensive explanation in a convincing manner, but other articles contribute likewise, though from different angles, as does Martel's by revealing forces that counteract the prevalence of English in science communication which otherwise would be even more overwhelming. This contribution also deals with questions of language politics and language planning within the framework of states and nations, with reference to the case of Quebec.

A question which peaks through in many articles is the evaluation of the prevalence of just one natural, historical language over all the others. De Swaan puts forth an explicitly positive viewpoint by stressing the advantages, especially for scientific communication, of a world lingua franca in comparison to a linguistic Babel, without being unaware of problematical implications at the same time. Other articles show stronger tendencies towards a critical view. An example is Truchot's contribution on the public debate in France on the trend towards Anglification of science communication and on measures of the state to guarantee the maintenance of the country's own language in functions complementary with English.

It seems to me that negative valuations of the present world language situation are often not frankly expressed in publications, in order to avoid conflicts or criticism of being resentful or simply for reasons of politeness. The absense of explicit value statements is therefore, in my opinion, a questionable indicator for real judgment. Fishman in a way

uses such statements in his analysis of the contributions to the volume *Post-Imperial English* by taking authors' expressed „own opinion" on „the absence or presence of English linguistic imperialism" as an indicator for the reality of linguistic imperialism (Fishman 1996: 634–636). This is a useful first approach, but there remains the possibility that such value-loaded views are not readily expressed. Therefore we need more valid, and of course representative, resentment studies with respect to the present prevalence of English.

Many of those who resent the present situation will at the same time admit that the English language community has only achieved what others would have liked to but couldn't. This seems to be a valid assumption in face of practically all the larger language communities' endeavors at spreading their own language or promoting its status and function in the world, at least in recent times. It is mainly after failing themselves that the non-English language communities or countries now start to compare the present situation with conceivably fairer solutions. Prototypical for such a solution would be having Esperanto, or some other generally non-native tongue, as the world language. Though such wishes appear somewhat phony if being put forth after the game has been lost, they may still comprise truthful aspects of the present situation.

A number of contributions to the present volume point out real advantages of the English-speaking world, or its scientists, and disadvantages of the other language communities and their scientists. Here the question of dominance in the literal sense arises, namely dominance of the native speakers of the world lingua franca by means of their language over the non-native speakers, let alone the non-speakers.

It seems almost self-evident that the native speakers of the prevelant scientific language have less difficulty using it passively (in reading, oral understanding) and actively (in writing or speaking) than do non-native or foreign-language speakers and, therefore, have advantages over the latter in communicative situations which require the use of English. It is easier for them to produce utterances and texts in line with the existing, native-speaker norms. Higher investment in language learning and additional costs of producing linguistically adequate texts are additional problems with which the non-native speakers have to struggle. These difficulties extend beyond the individual scientist and scholar to publishing companies or even all firms for which science and scientific communication are economically essential in countries where English is not the native or at least a widely-used official language.

In order to raise awareness of these problems I have postulated, in my contribution to this volume as well as elsewhere (Ammon 2000), the

„non-native speakers' right to linguistic peculiarities." It may appear a rather hopeless postulate considering the well-founded linguistic veneration of the native speaker, but I believe it deserves close examination, also re the possibilities of a political campaign to gather support similar to that for female linguistic rights. The feminist campaign too was far from being taken seriously at the beginning but has certainly had considerable success meanwhile. I am aware that the postulate of equity for non-native speakers of English, to put it another way, faces far more formidable obstacles than did, or does, linguistic gender neutrality. It needs, first of all, adequate specification before it can be taken seriously.

The possibility of disadvantages of scientists who are native speakers of English should not be entirely forgotten. They become noticeable in Baldauf's report on Australia, where scientists typically seem to be less and less inclined to study foreign languages and, as a consequence, are unable to take notice of publications in languages other than English. There is, however, also the tendency from the side of the English-speaking scientists to stress this point in order to calm down complaints about their otherwise enormous privileges.

The English-speaking scientists' advantages extend way beyond what has been mentioned above. They enjoy, for one thing, their prestigious language's halo effect that texts tend to be valued more highly if written in English (cf. Ammon 1998: 194–197; Nylenna/ Riis/ Karlsson 1994). Also, the English-speaking countries, or their scientists and scholars, are credited with inventions and innovations which in reality were made elsewhere but have not become known for language reasons. Willemyns' contribution to this volume demonstrates this with examples from sociolinguistics.

The spread of English, in science and other fields, limits the use of other languages even within their home countries. A domain in question is teaching at tertiary level for which the penetration of English is reported in a number of articles in this volume, like in Spolsky's and Shohamy's on Israel, Smolicz', Nical's and Secombe's on the Philippines, de Cillia's and Schweiger's on Austria, or Dürmüllers on Switzerland. Though perhaps still limited to only a few institutions or certain occasions, like in the case of Israel to the Medical School at Tel Aviv University or to new staff members not yet familiar with Hebrew, respectively, the language is there and often noticably on the advance. Often it makes inroads via graduate and post-graduate studies as in the case of Switzerland. Writing theses in English is widely tolerated, if not the rule, in non-English-speaking countries, especially in the natural but also the social

sciences. Many countries have introduced English-language teaching in order to attract more foreign students, who are not always willing to learn the native language. This is even true of countries with quite large and widely studied languages (cf. Inoue's contribution on Japan or my own on Germany).

The preponderance of English in science and other domains does affect the other languages even internally. Jacobson reports on frequent code-switching and code-mixing in scientific communication in Malaysia. In most cases, modernization of terminology occurs mainly by way of loans from the English rather than using indigenous linguistic recources, as Inoue shows for Japan. Will such terminology further distance the lay population from the realm of science? This would hardly be compatible with democratic ideals. In addition, loans from English are – facilitated by the language's prevalence in science – ubiquitous in everyday domains practically all around the globe. Oliveira and Pagano illustrate the situation for Brazil. Contrary to wide-spread opinions, these loans not only affect the receiving languages' lexicon but also their deeper structures. Haarmann and Holman demonstrate this for Finnish. Is there a slow assimilation process of all languages in the direction of English?

The prevalence and dominance of English in science is a global fact, but it varies of course in kind and degree, as well as to its effects, between language communities and countries. Such distinctions are suggested in a rough manner by the way the contributions to this volume have been assembled in chapters. The first group of articles deal with general problems or give overviews of various countries. It is followed by a chapter on countries with a history of English-language dominance. Australia where English is the sole official language has been included since the language has been imported and the population is linguistically diversified even today. The third section comprises articles on countries which have always, or at least in recent times, used languages for science different from, or in addition to, their own indigenous tongue. For these countries adjustment to the recent prevalence of English only means shifting from one foreign language to another if at all. The fourth, final chapter pictures countries and language communities which have until recently had their own international language of science. For them, one would think, it must be hardest to adjust to today's Anglification of scientific communication. This becomes noticeable in some of the articles, especially those on France and Germany. Delimitation between these types of countries and language communities is of course not clear-cut and at times arbitrary.

May the present volume inspire further theoretical and empirical research into language choice for scientific communication and into the consequences of the spread of English as the world lingua franca of science. Insights gained by such studies might help control and alleviate ensuing problems.

I do not want to end without expressing thanks to all contributors to this volume as well as the editor of the series, Joshua Fishman, and the publisher. Finally, I want to thank Gabriele Scheewe, one of the secretaries of Germanistik at the Gerhard-Mercator-Universität Duisburg, for invaluable computer and paper work, and Peter Joy, an Australian Ph.D. student at the same University, for linguistic corrections in line with my suggestion not to eliminate all the non-native-speaker traces.

Ulrich Ammon Duisburg, February 2001

References

Ammon, U.
1998 *Ist Deutsch noch internationale Wissenschaftssprache? Englisch auch für die Lehre an den deutschsprachigen Hochschulen.* Berlin/ New York: de Gruyter.
2000 Towards more Fairness in International English: Linguistic Rights of Non-Native Speakers? In Phillipson, R. (ed.) *Rights to Language: Equity, Power, and Education.* Mahwah, NJ: Lawrence Erlbaum, 111–116.

Baldauf, R./Jernudd, B.
1983 Language of Publication as a Variable in Scientific Communication. *Australian Review of Applied Linguistics* 6 (1): 97–108.

Crystal, D.
1997 *English as a Global Language.* Cambridge: Cambridge University Press.

Fishman, J.
1996 Summary and Interpretation: Post-Imperial English 1940–1990. In Fishman, J. A./Conrad, A. W./Rubal-Lopez, A. (eds.) *Post-Imperial English. Status Change in Former British and Americal Colonies, 1940–1990.* Berlin/ New York: Mouton de Gruyter, 623–641.

Graddol, D.
1997 *The Future of English. A Guide to Forecasting the Popularity of the English Language in the 21st Century.* London: The British Council.

Nylenna, M./Riis, P./Karllson, Y.
1994 Multiple Blinded Reviews of the Same Manuscript. Effects of Referee Characteristics and Publication Language. *The Journal of American Medical Association* 272 (2): 149–151.

Tsunoda, M.
1983 Les langues internationales dans les publications scientifiques et techniques. *Sophia Linguistica:* 144–155.

Table of Contents

I. Overall Perspectives and General Models

English – the Accidental Language of Science?[1]

Robert B. Kaplan

> And who in time knows wither we may vent
> The treasure of our tongue, to what strange shores
> This gain of our best glory shall be sent.
> To enrich unknowing nations without store?
> Which worlds in the yet unformed Occident
> May come refined with the accents that are ours.

1. ELT and the U. S. balance of trade

In 1996, the United States agricultural sector was a key contributor to international trade; it contributed something on the order of US$ 60 billion in exports (Klintberg 1997). In the 1998 budget year, the federal government spent about US$ 1 billion on international education. In the same year, nearly half a million international students studying largely in the tertiary sector in the United States contributed something like US$ 7.5 billion to the U. S. economy and supported something like 100,000 jobs (Levinson and McCarthy 1998). In other words, international students account for about one eleventh the value of agricultural exports. That's a lot of money. When taken together with overseas student numbers in the United Kingdom, Australia, Canada, New Zealand, and other

English-speaking countries, international education and education through English has become a massive business.

However, this trade in English education is only half the story. No calculation has ever been attempted to estimate the additional contribution to the United States balance of trade that derives from teaching English abroad. Such is the demand for English tuition that there are literally thousands of United States citizens -mostly young- teaching English to speakers of most of the world's other languages. Some of these teachers are college-age youngsters, equipped with back packs and a yen for foreign travel, who constitute a cadre of itinerant teachers in virtually every large city around the world. As an untrained teaching force, they really shouldn't be out there – in educational terms – but they have the virtues of being native-speakers of English and of being available on site, thus inexpensive. They serve to answer part of the world-wide demand for English; for example, in such places as Eastern Europe (see, e. g., Medgyes and Miklosy in press) and Asia. Their incompetence is supplemented and modified by the Peace Corps and by a very large number of teachers in programs developed and maintained by the United States Agency for International Development (AID) and the United States Information Agency (USIA, in other countries USIS), by a smaller consort of Fulbright scholars, and by the hundreds of additional teachers in programs mounted overseas by U. S. academic institutions and other organizations.

As with the market in overseas students, the English-language teaching market is not the exclusive preserve of the United States. All the other members of the English-speaking world – Australia, Canada, New Zealand, and the United Kingdom – are out there too. All of these English speaking nations have competed through their agencies for international development[2] by investing to varying degrees in development projects in less developed nations around the world; such development initiatives almost always carry a component in teaching English as a foreign language – much of it targeted at science and technology (see, e. g., Ablin 1991; Crooks and Crewes 1995; Kaplan in Press 1997; Kenny and Savage 1997). Finally, the tertiary academic institutions in the English-speaking nations are also recruiting international students. Not only are academic institutions directly recruiting students to their campuses in the English-speaking world, but they are also mounting programs delivered abroad in conjunction with academic institutions and other agencies in the third world.

This cohort of teachers, of course, requires materials, and the publishing industry produces a plethora of dictionaries, grammars, spellers,

course books, readers, audio tapes, computer assisted language learning programs, and a multitude of other resources to meet these needs.[3] Often, these resources require electronic equipment, such as tape recorders, 35 mm. cameras, slide projectors, copying machines, video cameras, videotape players, overhead projectors, CD-ROM players, entire language laboratories; in some instances, even entire computer laboratories equipped to access e-mail and the world wide web are required. In sum, all of this activity generates money, and the teaching of English around the world has become big business. Except for the obvious fact that all this activity generates a lot of money, it would seem important to ask why it exists.

The quotation with which I began this chapter could be argued to constitute the underlying rationale for the teaching of English worldwide. Although this thought was expressed by Samuel Daniel in his poem, *Musophitis,* in 1599, not much has changed in the thinking of English speakers over the past four hundred years.

2. An historical note

2.1. Long history

Before I undertake to address the question why all this language teaching activity exists, let me first set the scene. Over the past four and a half million or so years, the human species has undergone a long series of biological modifications, among them the modifications that made speech possible. But since the emergence of language, the species has undergone three major post-biological modifications: 1) the invention of writing, 2) the invention of printing, and 3) the invention of electronic word processing and the World-Wide Web.

The distinction between biological and post-biological modifications is critical; biological changes constitute a part of the human genetic baggage, while post-biological changes seem not to include any genetic change. All human offspring within the normative ranges have the capacity to speak and to understand speech. But it is not the case that all human children are born with a biologically conditioned predisposition to acquire the skills of reading and writing; on the contrary, reading and writing must be learned anew in each new generation.[4]

From the emergence of language to the emergence of writing, human populations had access to information primarily as it was held in human

memory. There is evidence that pre-literate people had the capacity to retain huge quantities of information in memory; nevertheless, memory is an unsatisfactory, unstable, and inefficient mechanism for the transmission of information. Retrieval from memory depends at least on the presence of the owner of memory, on the condition of the owner of the memory, on the audience for whom retrieval was undertaken, on the form in which the information was stored, and on the circumstances in which retrieval occurred.

Once it became possible to write things down – the first post-biological modification – the nature of information must have changed, since it became possible to retrieve information across time and space. Whereas memory probably necessitated the use of memory-enhancing stylistic devices, written text has a different stylistic and rhetorical structure essentially free of memory-enhancing structures. It was no longer necessary for the owner of information to be present, and the condition of the owner of memory and of the form of the stored text became essentially irrelevant. Text could be more widely distributed – granted that the process of manual copying was slow and subject to error, and that the production of large numbers of copies was unlikely. Indeed, the small production resulted in texts that were perceived as works of art and that were quite expensive, limiting acquisition to the elite.

The invention of printing constituted the second post-biological change. Printing permitted much more rapid production of texts and, gradually, over the next several hundred years, reduced the cost of owning texts. As early as the mid-17th century, Samuel Pepys regularly reported on his acquisition of published books and on the various structural modifications he made in his library. The structure *library* gradually became a major repository of texts, making material available not only to scholars, but also to ordinary persons.[5] Gradual improvements in print technology increased the speed of production and the number of copies available.

Electronic word-processing constitutes the third post-biological change. Electronic document production and distribution increased speed of production, served to change the role of the middle man in text distribution (the library), and increased exponentially the amount of material available not merely to the scholar but to anyone with the technical facilities to access the World-Wide Web.

Each of these post-biological changes decreased the effort and cost required to produce, store, and distribute information, and each has, in its turn, caused an information explosion. At the same time, increased

availability of printed information is reciprocal with increased desire for literacy; when there is little or nothing to read, literacy is a superfluous skill. Each leap in the availability of information complicates the verification of information, making the veracity of information harder and harder to determine. Each leap in the availability of information seems to be associated with the dawn of a fundamentally new form of human society; it appears that the invention of language and its accompanying genetic changes mark the beginning of what we designate as 'human.' But the post-biological changes are, respectively, associated with the dawn of civilization, with the beginning of modern civilization, and with a new orientation not yet possible to describe or define (or perhaps even imagine). Each has been accompanied by an invention that caused an information explosion. In sum, a limit on the production of information impeded progress in the time preceding each information explosion. As Robertson (1998: 9) suggests, civilization *is* information, and civilizations are perhaps limited more by lack of information than by lack of physical resources. Information limitations are probably quantitative as well as qualitative; limitations on information restrict the number of things a society knows how to do. Unfortunately these phenomena have not been well studied, in part at least because the notion of information as quantifiable is very new – first articulated by Claude Shannon in the 1940s. The French historian Henri Berr, in 1934, writing well ahead of his time and before the invention of the computer, suggested that these post-biological inventions had epochal significance.

Following the invention of the printing press, books became suddenly available in quantities beyond the conception of earlier societies.[6] This proliferation of books carried ideas to a wider audience than ever before. This explosive spread of information (some of it misinformation) offers an explanation for the stunning achievements of the Renaissance.[7] The development of 'scientific method' in the 16th and 17th centuries is really a response to the need to verify information reported elsewhere and to the need to find patterns in large quantities of information.[8] The existence and distribution of the *Philosophical Transactions* of the Royal Society of London helps to explain the explosion in scientific activity in the 18th century. It is important to note that the *Transactions* were published and distributed largely (but certainly not exclusively) *in English*.[9]

The Royal Society was formed in November 1660 as a 'society of gentlemen' committed to the exchange of experimental knowledge under a Baconian[10] plan articulated by Robert Hooke in a letter also written in 1660. The reporting format of experimentation was essentially defined by

Robert Boyle; the venture was to a significant extent a reaction against scholasticism and marked the birth of empirical research. Boyle set the tone for scholarly writing; he may be credited with the introduction of hedging in science writing. In his *Proemial Essay,* he wrote:

> [I]n almost every one of the following [experimental] essays I (...) speak so doubtingly, and use so often, *perhaps, it seems, it is not improbable,* and such other expressions as argue a diffidence of the truth of the opinions I incline to, and that I should be so shy of laying down principles, and sometimes of so much as venturing explications (cited in Atkinson 1999: 103).

But it is not only for the invention of the research article that Boyle is remembered; he and his colleagues in the Royal Society created the overriding code of the gentleman in science – a code which has persisted into the 20th century. Thus, in part, the Royal Society was a 'gentleman's club,' a place where one met and socialized with one's 'own kind.' But quite beyond that, being a British gentleman meant being a financially independent individual

> (...) who cultivated various socially approved pastimes as ways of occupying and improving himself, and sometimes his society, as well, in the eyes of his fellow men and [the] Creator. The study of nature and technology was one such approved pastime (...) In sum, the Royal Society was a society of gentlemen in the fullest sense – run by gentlemen, for genteel purposes, via genteel standards of conduct and communication, as part and parcel of a genteel form of life (Atkinson 1999:17).

It was this orientation which was spread around Europe through the publication of the *Transactions*, made possible by the royal charter of the society, which privileged the group to the patronage of the king, granted permission to publish without government censorship, and assured the right to correspond freely with the citizens of other countries. After all, this was the first "(...) *public institution for the pursuit of scientific research* (...)" (Atkinson 1999:16; italics in the original). As much as facilitating the spread of English, these events facilitated the diffusion of empirical research and the rhetoric in which such research would be reported (see also Prelly 1989).

The electronic storage and retrieval simply increases exponentially not only the availability of information but the mode of its expression. More importantly, it vastly increases the capability to *use* this information. The amounts of information necessary to maintain communication networks, multinational corporations, and international transportation systems exceed the information production and distribution capacities of earlier societies. In short, societies are basically limited by the amount of information they can produce, store, and distribute. This is not an argument

for technological determinism based on an assumption that certain levels of information produce certain kinds of societies; on the contrary, the argument is that the *lack of information inhibits the development of certain kinds of societies.*

Science and technology lie at the heart of this discussion, as increased information accessibility encouraged the development of science and technology, and the resulting science and technology reciprocally increased the amount of information.

2.2. The shorter history

Foreign languages have, of course, been taught for as long as there are any records of human societies; Jean Auel, in her yet to be completed four-part series collectively called *Earth's Children*, provides a fanciful notion of multilingualism among the earliest humans. The Greeks taught Greek to the people they conquered, and the Romans taught Latin. During the great expansion of Islam, Arabic was carried to the furthest corners of the known world. In more recent times, Europeans taught French, German, Spanish, Portuguese, and Russian throughout the European world and even further afield in their spheres of colonial activity in Africa, Asia, and South and Central America (see, e. g., Paulston 1998: 2–3). English has now been taught to populations of speakers of other languages for quite a long time-probably since the British Empire was at its greatest expansion. While English (and other languages) have been taught in many places, they have not always been taught from the best possible motivation. It was necessary for the British to teach English throughout their wide-spread empire because they needed people in distant places to speak English so that soldiers could understand their British officers and so that a civil service could be developed to maintain civil order under the leadership of British administrators. Indeed, "[i]t was considered self-evident that the civilizing influence of Britain was a desirable goal, anywhere in the world, and that the English language was an essential means of achieving this end (...)" (Crystal 1997 b: 70).

An interesting point is that, as the British Empire contracted, the teaching of English did not. A set of curious accidents that began with the end of WW I[11] (Ammon 1992) and that were significantly augmented in the middle of this century caused English to thrive. When WW II ended, the United States, generally claimed to be an English-speaking country, was the only major Western power whose educational and scientific infrastructure remained completely intact. The United States participated,

with its allies, in dictating the conditions under which the post-war world would be organized. The United Nations, created in the aftermath of the war, chose only five official languages – Chinese, English, French, Russian, and Spanish – basically, the languages of the first four members of the Security Council – the WW II allies.[12] Indeed, the phenomenon had begun to a lesser extent after WW I, but the critical difference in mid-century was the important technological change; i. e., the availability of the computer.

The creation of the United Nations accidentally coincided with the birth of the computer age. The first computer programs were written in English-like languages (e. g., Basic, FORTRAN) and their output was also English, or English-like. Gradually, because so much scientific material had been written in German, the German language had been added to the list as a documentary language. At the same time, the earliest computers could not deal with Chinese characters, and consequently very little was stored in standard written Chinese. By the mid-1970s, the languages of the United Nations were Arabic, Chinese, English, French, Russian, Spanish – and German was also widely used. But the advent of the cold war resulted in heavy political restrictions on the use of Russian – imposed by both sides; i. e., the reluctance of the Soviet Union to share scientific information and the equal reluctance (and inability) of the western states to access material written in Russian.[13]

Because the scientific, technical, and educational structure of the United States remained in tact in the years immediately following WW II, students from the third-world flocked to academic institutions in the United States (see the opening paragraphs of this chapter). United States science and technology flowered in the post war years. It is a 'law' of science that those doing the greatest amount of research both require the greatest quantities of information from the information banks and contribute the greatest quantities of new information to those information banks. Vast numbers of scientists were trained in English, and vast quantities of information were written, abstracted, stored, and disseminated in English.

3. The special status of English

3.1. The special status of English in Europe

More recently, when Britain and Ireland were admitted (1973) into the European Union (EU),[14] English became one of the nine official lan-

guages[15] of the EU (Danish, Dutch, English, French, German, Greek, Italian, Portuguese, and Spanish). Against this complex linguistic, cultural, and political background, English has developed a special status within the EU; i. e., English and French are the sole "official" languages of the European Council, while the other languages are designated "working" languages. According to Ammon (1996):

- English has constantly made gains as a language of science over the past fifty years;
- English is the sole working language of the European Science Foundation (which coordinates research projects in EU countries and elsewhere);
- The leading European scientific journals now tend to prefer English as their language of publication; and, in addition,
- English is the most widely taught language in the member countries of the EU;
- There has been a clear shift toward using more English in business-oriented communication among the political bodies of the EU and in the economic domain within EU countries.

3.2. The special status of English in science and technology

Another development which occurred in this same time period was the vast increase in scientific and technical research. While modern science was a child of the first industrial revolution,[16] the heavy dependence on science and technology during the war years resulted in a great growth in scientific activity. The United States, by virtue of the fact that its scientific infrastructure was undamaged by the war, assumed leadership in science and technology. It is an established fact that progress in science depends on the accumulation of a written record of all previous science; that is, science requires great information storage and retrieval systems. The invention of the computer made those information storage and retrieval systems geometrically larger and more accessible. As already noted, it is also a fact that those who do the greatest amount of research *require* the greatest amount of information from those information networks, and they naturally also *contribute* the greatest amount of new information to those networks. Since much of the science and technology research in the 1950s and 1960s was conducted in English, most of the information in the great information storage networks was written in English. The International Federation on Documentation (FID), a world body which

keeps track of information distribution, reports that nearly 85% of all the scientific and technological information in the world today is written and/or abstracted in English. (Indeed, FID urges that an article written in another language be accompanied by an abstract in English, German, or Russian.) Scientific and technological journals in countries like Sweden and Hungary publish more material in English than they do in their national languages (Baldauf 1986; Baldauf and Jernudd 1983 a, b, 1986, 1987; Medgyes and Kaplan 1992). Not only is English the undisputed language of science, but because of the importance of the computer in the internationalization of English, the English-speaking nations may hold a virtual cartel on scientific information because the international information systems are organized according to an English-based sociology of knowledge. Even research and development (R&D) functions in non-English states are impacted, since it is necessary to be able to search scientific literature in English and according to its sociology of knowledge. The emergence of a whole new cadre of information managers seems inevitable – both in terms of science – trained balanced bilingual translators at the input end and in terms of comparably trained skilled science readers at the output end. It would seem that R&D functions in third world nations (largely along the North-South axis) cannot survive without such a development. But the emergence of such a new function places another level of intervention between the scientist and the information. The social construction of science information has been extensively researched by discipline and by function, and the implication for language policy and language-in-education policy have been explored (Bazerman 1985 – Physics; Gilbert and Mulkay 1984 – science discourse; Grabe and Kaplan 1986 – language-in-education; Latour and Woolgar 1979 – laboratory science; Maher 1987 – Medicine; Myers 1990 – Biology; Windsor 1990 – Engineering).

Thus the WW II settlements and the birth of the United Nations, the invention of the computer, and the geometric growth of science and technology, all occurring coincidentally at the same time, created the conditions which made English not just an important language but the predominant language of science and technology. At the moment, more people in the world speak English as a first or second language than spoke any other single language in the history of the world (Crystal 1997 a, b) (except written Chinese – which, as I have noted previously, is not [yet] easily computer storable; spoken Chinese is made up of nine mutually unintelligible spoken regional dialects – see Harrell 1993). As a result of all these factors, the teaching of English to speakers of other languages

has become a huge industry. However, because of the broad, global distribution of English, and because it has been, and is being, taught in so many places, English is no longer the property of English speakers. Many new varieties of English have developed – for example, Indian English, Nigerian English, Philippine English (ESL varieties), Japanese English, Hong Kong English (EFL varieties). These Englishes are not exactly like British or American English; each one is unique, drawing on the local substrate languages. The growth of other Englishes is assured because in many countries English is frequently taught to children by individuals who are not themselves native speakers of English and who may not have had extensive exposure to native English speakers. In polities like India, Nigeria, Samoa, and Singapore, there are many native speakers of their national varieties – i. e., the local variety of English is their first language. These individuals may also be able to speak an international variety of English (e. g., American or British English) as well.

4. The notion of a standard

This dispersion and diversity makes a mockery of the notion that there is a standard variety (or a number of standard varieties) of English – or of any other language for that matter. A 'standard' language results, generally, from a complex set of historical processes intended precisely to produce standardization; indeed, a 'standard' language may be defined as a set of discursive, cultural, and historical practices – a set of widely accepted communal solutions to discourse problems. Additionally, a 'standard' language is a potent symbol of national unity. If this definition of a 'standard' language may be assumed to be viable, then the 'standard' language is really no one's 'first' language. On the contrary, the 'standard' language must be acquired through individual participation in the norms of usage, and these norms are commonly inculcated through the education sector (with the powerful assistance of canonical literatures and the media – conventional and electronic). But the reality of most linguistic communities is marked by the normative use of a wide range of varieties in day to day communication – i. e., the use of slang, of jargon, of non-standard forms, of special codes, even of different languages (as in code-switching). Consequently, a 'standard' language constitutes a purely ideological construct. The existence of such a construct creates an impression that linguistic unity exists, when reality reflects linguistic diversity. The notion of the existence and dispersion of a 'standard' variety through a

community suggests that linguistic unity is the societal norm; it also suggests a level of socioeconomic and sociopolitical unity which may be contrary to the reality of linguistic diversity. The legal obligation to use a codified standard is likely to cause frustration among minority-language speakers, since the standardized language is for them a non-dominant variety (see the case of Slovakia – Kaplan and Baldauf in press); minority-language speakers probably use a contact variety, likely to be at considerable variance from the 'standard' variety. If this is true within a linguistic community, the variation must be much greater across linguistic communities.[17]

Science is an important candidate for promoting the growth of a standard language because it uses a common set of methods and measurement-standards and is cumulative and self-referential. New research constantly becomes available, but it builds on prior research; thus, there is a need to access both the new and the previous research efficiently if one is to participate in the research activity. Increasingly, as 'special-purposes' language (i. e., in science and technology) has been studied, it has become apparent that the special registers of science and technology are more important than was initially conceived. Translation and the use of technical dictionaries are not sufficient to access science research; in addition, an understanding of discourse styles and rhetorical structures is essential (Burrough-Boenisch 1998; Ventola and Mauranen 1991). A recognition of this issue has led to increasing internationalization and standardization in science writing (Baldauf 1998). Authority and 'gate-keeping' in science lies in the hands of journal editors, referees of papers, and a cadre of self-appointed guardians of 'appropriate' writing. As a consequence, those researchers whose written English-language skills are inadequate find that publication is difficult and indeed may be effectively excluded from participation in the exchange of science information.

As Mühlhäusler suggests (1996: 207–208), language planning efforts, including the world-wide dissemination of English, reflect the cultural view of the West. This view, known as the 'plumbing' or 'conduit' or 'telegraphic' conception of communication, is defined as the translation of messages which exist in the sender's mind into speech signals (coded in linguistic form) which are converted back into the original message by the receiver. Thus, there is a need to identify a single, 'standard' code to assure that this single code is optimally regular, simple, and modern, and to assure that there are optimal channels (postal services, road networks, telegraphs, newspapers, journals, television, etc.) along which the signal

can flow. The problem is that this metaphor is not a reliable description of how human beings communicate (see also Wurm, Mühlhäusler and Tryon 1997).

5. On the extinction of languages

While there is no question that a number of new varieties of English have come into existence, a very large number of other – usually smaller – languages are threatened with extinction.[18] Mühlhäusler writes: "Of more than 6,000 languages currently spoken more than 95% are on the endangered list, and the overall rate of language extinction is far greater than that of any biological species" (1996: 206–207; see also Robins and Uhlenbeck 1991). And Crystal (1997 b: 17) reiterates the point:

> No one knows how many languages have died since humans became able to speak, but it must be thousands. In many of these cases, the death has been caused by an ethnic group coming to be assimilated within a more dominant society, and adopting its language. The situation continues today, though the matter is being discussed with increasing urgency because of the unprecedented rate at which indigenous languages are being lost, especially in North America, Brazil, Australia, Indonesia, and parts of Africa. Some estimates suggest that perhaps 80 per cent of the world's 6,000 or so living languages will die out within the next century.

Languages become extinct sometimes because of the decimation of the population of speakers (e. g., the instances of many Native American languages, Australian Aboriginal languages, etc.), sometimes as the result of a period of bilingualism during which a second language is adopted for an increasing number of purposes by a growing number of people (as in the case of Welsh, Irish, and Scottish). (For further discussion, see, e. g., Dorian 1989; Dorian in Bright et al. 1992/3: 135–136; Ingram in Bright et al. 1992/2: 303; Romaine in Bright et al. 1992/4: 21.) Kaplan and Baldauf (1997: 272–273) suggest that languages die for a number of complex reasons:

1. The introduction of a non-indigenous language that, for whatever reasons, takes over some – or all – social functions;
2. The disappearance, for whatever reasons, of the population speaking some particular language;
3. The forceful introduction of a non-indigenous language so that certain functions *must* be conducted in the imposed language.

In sum, other than in the case of the total destruction of a language community, languages die because:

1. Parents are reluctant or unable to pass on a language intergenerationally to their children;
2. The language ceases to serve key communicative functions in the community;
3. The community of speakers is not stable and/or expanding, but rather is unstable and/or contracting.

Where English has been introduced, either as a colonial language or as a commercial language, some or all of these conditions are often met (see, e. g., Phillipson 1992). In science and technology, English has captured the key registers.

It would be unreasonable to assert that the introduction of English is exclusively responsible for wide-spread language death. A great many factors are involved, among them:

1. Population dislocation and redistribution as a result at least of war, revolution, religious persecution, economic development, or urbanization;
2. The spread of world languages other than English – e. g., Arabic, Chinese, French, Japanese, Portuguese, Russian, Spanish (Ammon 1994);
3. The development of supralinguistic functions – e. g., world-wide aviation, tourism, banking, science and technology, etc.[19]

At the same time, it would be equally unreasonable to claim that the huge English-language teaching activities of the English-speaking nations have played no role in language death. The role they have played is, however, not well understood.[20]

6. What global English does

As English is introduced into communities where it has previously had no role (or only a very limited one), and as people perceive English-language ability to provide access to a better standard of living, English is replacing some registers normally reserved to indigenous languages – even some indigenous languages in total. While the register of sports is, perhaps, not particularly significant (though that point is arguable), sports register can serve as an apt illustration. Such phenomena as the introduction of baseball in Japan, of soccer and cricket in much of the former British Commonwealth, or – most recently – of American foot-

ball in Europe have led to significant language and social change; other phenomena such as CNN news have pervaded the world wherever television is available and have brought with them language and social change. (See Kaplan and Baldauf 1997: 233–235, for a discussion of the penetration of English technical lexicon into Russian.) (Political leaders who want to make a point to a world-wide CNN audience know that it must be done in English.) Still other phenomena such as the multinational corporations (and their accompanying R&D functions – see, e. g., Paradis, Dobrin and Miller 1985), offering good jobs and high wages, have brought language with them and have resulted in significant language and culture change. As noted above, an additional factor in language loss is urbanization (which requires more frequent and more effective communication across a wider range of domains); thus, urbanization is frequently marked by the expanded use of English.

In these circumstances, it is not purely language which penetrates other cultures. Let us consider the case of baseball; it is not merely the game that has penetrated Japan. Rather, the whole panoply of activities connected with the game has also been adopted. The big game, the big star (and the accompanying "star" salary), the live broadcast, even the ubiquitous "beeru" and "hotu dogu," have become part of the Japanese environment. By a similar process, the introduction of any new technology carries with it the language in which the technology was developed; thus, the spread of the technology itself facilitates the spread of English if (as is often the case) the technology arose in an English-speaking polity.

It is unlikely that there is some grand conspiracy among English-speakers to disseminate English world-wide;[21] on the contrary, the spread of English is largely accidental, based in part on the quest for an allegedly better standard of living on the part of receiving populations, and in part on the unconscious press of English on other populations. People talk about the "dominance" of English in certain registers or in certain geographic zones, but the language does not have a will of its own to become dominant, and there is nothing in the natural characteristics of English or of English speakers which would make it inevitable that English should become *the* world language. On the contrary, it is the actions of English-speakers – including journal editors, reviewers and other gate keepers in science and technology – which underlie the spread of English. English-speaking scientists have also contributed to this phenomenon. Again, there is nothing insidious about the actions of English speakers; it is simply a matter of more-or-less benevolent self-interest. After all, English speakers have a distinct advantage in a world that has

adopted English as its universal language. At the same time, good scientists who cannot write English to meet the standards of journal editors are deprived of the opportunity to have their views and contributions disseminated through the global information networks; as a consequence, their contributions are not only lost to the scientists themselves, but more seriously are lost to science.[22]

One of the reasons for this advantage is that English is a pluricentric language, and its speakers have never (until very recently[23]) tried to enforce a rigid single standard. Thus, there are American English, British English, Canadian English, Irish English, South African English, and West Indian English – just to name a few varieties. Each creates its own identity and ways of speaking. These are all accepted as English – unlike French, for example, whose speakers try to maintain a single world-wide standard. The fact that English varieties flourish, without being reduced to 'substandard' dialect status, with the only condition on them being that they maintain some level of mutual intelligibility, is one of the underlying keys to the continued success of English as an international language (Baldauf 1998). For example, Iraqi Foreign Minister, Tarak Aziz, may not want to be perceived to be speaking either American or British English, but he does speak English and identifies with a number of other varieties or even with something increasingly recognized as 'international English.'

However, the developments with respect to English are not unidirectional. While the English speaking nations not only push the dissemination of English but also perhaps actively push English in the direction of a uniform 'standard' language for universal communication, the Council of Europe is quietly moving toward multilingualism. As Baetens Beardsmore (1994: 94) suggests:

> A general policy goal [of the 1992 Treaty of Maastricht] is to place the highest priority on educational mobility; the objective is to enhance the level of familiarity of as many European students as possible with other European cultures and languages as an element of quality in education. Language learning remains a top priority, and to this end, member states are encouraged to promote trilingualism; they are advised to make language qualifications desirable for entry into, and compulsory for exit from, higher education; and they are requested to give particular attention to the learning of minority languages.

7. Conclusion

Here one can see the playing out of two conflicting ideologies – on the one hand the acceptance of the fundamental value of multilingualism as

an amazing world resource which allows different perspectives and insights and thus encourages reaching a more profound understanding of the nature of the human mind; on the other hand, the perceived fundamental value of a common language as an equally amazing world resource which allows unprecedented possibilities for international co-operation, especially in the solution of scientific and technological problems. Global use of English serves the latter position. But to the extent that global use of English contributes to the death of small languages, the price may be too high; the extinction of small languages is even more catastrophic than the extinction of biological species, precisely because the extinction of languages is an extinction of the means to understand the world and to interact with it. Such extinction narrows the human condition. Some balance between these two views must be struck.

As Koch (1992: 42, cited in Norberg 1994: 156) has said about the destruction of Sorbian:

> I can only imagine the world with my ethnicity in place. Its disappearance signifies loss. Slowly but surely the impoverishment would be perceptible across the country's breadth. Perhaps even continentally and planetarily. One color less. Increase of grayness. One sound less, one language less. Increase of silence.

This is, of course, an emotional rather than a rational view of the problem. While rational approaches involving analysis and description of actual language-loss environments are necessary – indeed, indispensable to an understanding of the problem and of the means of redress – one must not ignore the emotional reactions of the human populations who are being deprived of the right to their language, along with other inalienable rights.

Thus, the spread of English in the registers of science and technology is essentially a coincidence of the confluence of a number of political and economic forces during the last half of the 20th century. But that spread threatens not only the survival of small languages; it also stills the voice of science in languages other than English. While the spread of English – and to a significant extent the widespread use of English in science and technology[24] – has the gravest consequences for the practice of science and technology in other languages – assuring the dependence of less developed nations on the scientific and technological development of a few states (Kaplan 1983), and largely in a single language – in the end, 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.

8. Notes

1. I am grateful to Professor Richard B. Baldauf, Jr. for his helpful comments and suggestions. I am also grateful to my graduate students at Meikai University, Japan, for their interesting insights on the issues discussed.
2. Britain's Overseas Development Administration [ODA], the British Council, the Australian Overseas Service Bureau [OSB], the Australian Agency for International Development [AusAID], the Canadian International Development [CIDA] and even some agencies of nations where English is not the first language (e. g., the Swedish International Development Cooperation Agency [SIDA]).
3. It is important to note that much of this activity is directed toward science and technology and that the number and diversity of the material results, at least in part, from the absence of a standard variety of English.
4. While reading and writing must be acquired *de novo*, speech must also be acquired, but the acquisition of the capacity to speak is genetically conditioned; it is socialization to the community norms of spoken language that must be taught.
5. The great library at Alexandria about the third or fourth century A. D. probably contained something on the order of 532,800 scrolls. But that library was unique and had a function quite different from later libraries. The state of libraries in China (where printing was invented) has not been well researched, but libraries in China are still difficult to use because classification systems are based on the stroke order in characters.
6. Johann Gutenberg (1398−1468), usually credited with the invention of movable type, worked in Germany (starting printing in 1454 and producing the Vulgate Bible in 1456). William Caxton (1422?−1491) usually recognized as the first English printer, working between 1477 and 1491, issued some eighty separate books from his press at Westminster; a stunning revolution in technology in a period of about 25 years.
7. Renaissance is perhaps a misnomer, since the society emerging from the second post-biological evolutionary change bears little or no resemblance to any preceding classical society.
8. Tycho Brahe, for example, might have been the first person to hold two separate sets of computations based on two different theories; his crucial observations may constitute a reaction to the possession of an unprecedented amount of information.
9. The German-born Henry Oldenburg, whose patron was Robert Boyle, and who was appointed Secretary of the Royal Society in 1662, invented the scientific journal. He had earlier developed a large network of correspondents among those working in the new science; from 1663 on, as scholars throughout Europe became aware of the Royal Society, it was bombarded with letters seeking or offering scientific information. As Secretary of the Society it was Oldenberg's charge to respond, and respond he did; the correspondence, arriving largely in French, German, Italian, and Latin was 'English'd' by Oldenberg and published in the *Transaction*.
10. Francis Bacon was the main conceptual founder of empirical science.
11. Because the delegates of the United States did not speak French, English was introduced into international diplomacy at the Treaty of Versailles (1919).

Furthermore, the English language played a significant role in the League of Nations, whose first Secretary-General was an Englishman.

12. Arabic was added to the list in 1974.
13. It was the Reagan administration in the United States that invented the term 'technology hermorrhage' and that for the first time in recent history began to impose serious restrictions on the free flow of scientific information, not merely in terms of 'national security', but in the context of protecting patents and copyrights.
14. So called since 1993, formerly the European Community [EC – 1967–1993], and before that the European Economic Community [EEC – 1957–1967].
15. The number was increased to 11 in 1995.
16. "Big science" had begun to develop early in the 19th century. The 1875 volume of the *Philosophical Transactions* reports on "a series of experiments carried on by a Committee appointed by the Secretary of State for War ..." (Noble and Abel: 49–50).
17. In a social gathering in Tokyo in 1998, I met a professional economist who had for many years worked for the Japanese Ministry of Economics and who had, in the course of his duties, negotiated on behalf of Japan in a wide variety of other countries. He reported that such negotiation was commonly carried on in English, even though English was not the native language of either side in the negotiations. He complained that the teaching of 'standard' English to Japanese was ineffective and urged that 'broken' English be taught since that was the variety most commonly used in the spheres of activity in which he had been engaged.
18. Of course, when one speaks of the extinction of languages, it is implicit that the speakers of those languages also disappear. The actual human beings may not be gone, but their ability to communicate in the particular language is gone. A discussion of the extinction of languages should not evoke sympathy for the language but rather for its speakers.
19. Because of the need for standardization in scientific and technology information and because, increasingly, problems are recognized as global in nature rather that national or regional, the use of English as a world-wide vehicle has increased.
20. Mühlhäusler (1998) has suggested that perhaps this phenomenon is related to the fact that previous inter-communication languages (i. e., pidgins, etc.) were designed for limited purposes and thus did not infringe on the domains of the contact languages. English, on the other hand, can serve both inter- and intra-communication purposes.
21. This is not to overlook or underestimate the efforts of the British Council or the United States Information Agency to spread English. These efforts appear to be a 'natural' tendency of development agencies to spread the languages in which they operate, sometimes as a matter of official foreign policy, sometimes for economic and cultural reasons. Organizations like the *Alliance Française*, the Goethe Institute, the *Instituto Cervantes*, the Japan Foundation, the Korea Foundation, to name just a few, are engaged with equal enthusiasm in the spread of their respective languages. None of this activity can be construed as a 'conspiracy'; rather, it is a natural outgrowth of economic and political competition (see, e. g., Kaplan and Baldauf 1997: 4–14). It must be noted that, in a historical context, the efforts of language agencies are very recent – almost entirely within the past fifty years – and essentially superfluous.

22. The academic reward structure is heavily imbued with the notion 'publish or perish'. In brief, the reward structure in the academy presses scientists to publish, and in general they must publish in English. Scientists who cannot place their work in English journals are doubly penalized; not only is their voice stilled, but they are denied the conventional rewards available through the academy.
23. The English-Only movement in the United States is an illustrative case. See Gonzales and Melis 1999 for discussion.
24. It is not only science and technology that is influenced by English. Cohen has the following to say:

> In ethically charged areas of international life touching on issues such as conflict resolution, human rights, religion, ethnic identity, security, and so on, English by itself proves an inadequate and biased guide. Thick knowledge of the local language and culture of one's interlocutors is essential if one is to make sense of their needs and concerns. Only unmediated access to the knowledge encapsulated in native discourse can enable negotiators and analysts to identify the congruencies and dissonances between their own assumptions and those of others. If negotiation is an attempt to create shared meanings and understandings where contradictory readings existed before, then there is really no alternative to the attempt to break out of the habits of thought conditioned by the English Language . . .[W]ithin the international relations field on the whole the blatant fact of linguistic and therefore semantic diversity receives little attention and the dominance of English is presupposed. International negotiation is a prime case of neglect, since it is preeminently an activity which brings together individuals who speak different native languages and depict and evaluate reality in different ways (In preparation).

9. References

Ablin, D.
1991 *Foreign Language Policy in Cambodian Government: Questions of Sovereignty, Manpower Training and Development Assistance.* Paris: UNICEF.

Ammon, U.
1992 The Federal Republic of Germany's Policy of Spreading German. *International Journal of the Sociology of Language* 95: 33–50.
1994 International Languages. In Asher, R. E./Simpson, J. M. (eds.) *The Encyclopedia of Language and Linguistics.* 4 vols. Oxford: Pergamon, 1725–1730.
1996 The European Union (EU – formerly European Community): Status Change of English During the Last Fifty Years. In Fishman, J. A:/Conrad, A. W./Rubal-Lopez, A. (eds.) *Post-Imperial English: Status Change in Former British and American Colonies, 1940–1990.* Berlin/New York: de Gruyter, 241–267.

Atkinson, D.
1999 *Scientific Discourse in Sociohistorical Context: The Philosophical Transactions of the Royal Society of London, 1675–1975.* Mahwah, NJ: Lawrence Erlbaum.

Baetens Beardsmore, H.
1994 Language Policy and Planning in Western European Countries. In Grabe, W. et al. (eds.) *Annual Review of Applied Linguistics, 14.* New York: Cambridge University Press, 93–110.

Baldauf, R. B., Jr.
1986 Linguistic Constraints on Participation in Psychology. *American Psychologist* 41 (2): 220–224.
1998 Standardization, Variation and Authority in English: The Impact on Language Diversity. *TESOL in context* 8 (2): 4–10.

Jernudd, B. H.
1983 a Language Use Patterns in the Fisheries Periodical Literatur *Scientometrics* 6: 245–255.
1983 b Language of Publication as a Variable in Scientific Communications. *Australian Review of Applied Linguistics* 6 (1): 97–108.
1986 Aspects of Language Use in Cross-Cultural Psychology. *Australian Journal of Psychology* 32: 381–392.
1987 Academic Communication in a Foreign Language: The Example of Scandinavian Psychology. *International Review of Applied Linguistics* 10 (1): 98–117.

Bazerman, C.
1985 Physicists Writing Physics: Schema-Laden Purposes and Purpose-Laden Schema. *Written Communication* 2: 3–23.

Berr, H.
1934 Preface to G. Weill *Le Journal.* In the series *L'Evolution de l'Humanitè*, ed. H. Berr.

Bright, W., et al. (eds.)
1992 *International Encyclopedia of Linguistics.* 4 vols. New York: Oxford University Press.

Burrough-Boenisch, J.
1998 Writing Science Like an English Nativespeaker: How Far Can and Should Non-Native Speakers of English Go? *Il Jornades Catalanes sobre Llengües per a Finalitats Espec'fiques.* Canet de Mar: Universitat de Barcelona.

Cohen. R.
In Preparation International Negotiation: A Semantic Analysis. Paper Presented to the Annual Convention of the International Studies Association. Washington, DC, February 16–20, 1999.

Crooks, T./Crewes, G. (eds.)
1995 *Language and Development.* Jakarta: Indonesian Australian Language Foundation.

Crystal, D.
1997 a *The Cambridge Encyclopedia of the English Language.* Cambridge: Cambridge University Press.

Crystal, D.
1997 b *English as a Global Language.* Cambridge: Cambridge University Press.

Daniel, S.
[1599] 1956 *Musophilus.* In Lamson, R./Smith, H. (eds.) *Renaissance England: Poetry and Prose From the Reformation to the Restoration.* New York: W. W. Norton. 632–641; (see esp. p. 640., lines 337–342).

Dorian, N. C.
1989 *Investigating Obsolescence: Studies in Language Contraction and Death.* Cambridge: Cambridge University Press.
Gilbert, G./Mulkay, M.
1984 *Opening Pandora's Box: A Sociological Analysis of Scientists' Discourse.* Cambridge: Cambridge University Press.
Gonzales, R. D./Melis, I. (eds.)
2000 *Language Ideologies: Critical Perspectives on the Official English Movement.* Urbana, IL: National Council of Teachers of English.
Grabe, W./Kaplan, R. B.
1986 Science, Technology, Language and Information: Implications for Language and Language-in-Education Planning. *International Journal of the Sociology of Language* 59: 47–71.
Graddol, D.
1997 *The Future of English.* London: British Council.
Harrel, S.
1993 Linguistics and Hegemony in China. *International Journal of the Sociology of Language* 103: 97–117.
Kaplan, R. B.
1983 Language and Science Policies in New Nations. *Science* 221: 4614.
1993 The Hegemony of English in Science and Technology. *Journal of Multilingual and Multicultural Development* 14 (1/2): 151–172.
1997 Review of: *Language Development: Teachers in a changing world.* Kenny, B./Savage, W. (eds.) 1997. London: Longman. *Asian Journal of English Language Teaching* 7: 121–126.
1998 Review of *Language and development.* Crooks, T./Crewes, G. (eds.) 1995. Jakarta: Indonesian Australian Language Foundation. *English for Special Purposes* 17 (3): 317–320.
Baldauf, R. B., Jr.
1997 *Language Planning From Practice to Theory.* Clevedon, Avon, UK: Multilingual Matters.
2000 Not Only English: "English Only" and the World. In Gonzales, R. A./ Melis, I. (eds.) *Language Ideologies: Critical Perspectives on the Official English Movement.* Urbana, IL: NCTE.
Kenny, B./Savage, W. (eds.)
1997 *Language Development: Teachers in a Changing World.* London: Longman.
Klintberg, P. P.
1997 Farm and Farming. *The World Book 1997 Year Book*, 207.
Latour, B./Woolgar, S.
1979 *Laboratory Life: The Social Construction of Scientific Fact.* Beverly Hills, CA: Sage.
Levinson, E./McCarthy, J.
1998 Ferment in Overseas Advising Circles, as Concerns Mount About Weaknesses in the Front Lines of Student Mobility. *International Educator* 8 (1): 18–19.
Lynch, M.
1985 *Art and Artifact in Laboratory Science: A Study of Shop Work and Shop Talk at a Research Laboratory.* London: Routledge and Kegan Paul.

Maher, J.
1987 The Role of English as the International Language of Medicine. *Applied Linguistics* 7: 206–218.
Medgyes, P./Kaplan, R. B.
1992 Discourse in a Foreign Language: The Example of Hungarian Scholars. *International Journal of the Sociology of Language* 98: 67–100.
Miklósy, K.
In press The Language Situation in Hungary. In Kaplan, R. B./Baldauf, R. B., Jr. (eds.) Special Issue. *The Journal of Multilingual and Multicultural Development* 20 (5/6).
Mühlhäusler, P.
1996 Ecological and Non-Ecological Approaches to Language Planning. In Hellinger, M./Ammon, U. (eds.) *Contrastive Sociolinguistics*. Berlin: de Gruyter, 205–212.
1998 Layer Upon Layer of Languages. *Journal of Pidgin and Creole Languages* 13 (1): 151–158.
Myers, G.
1990 *Writing Biology: Texts in the Social Construction of Knowledge*. Madison, WI: University of Wisconsin Press.
Noble, R. A./Abel, F. A.
1875 Researches on Explosives – Fired Gunpowder. In *Philosophical Transactions* 165.
Norberg, M.
1994 The Sorbs between Support and Suppression. *International Journal of the Sociology of Language* 107: 149–158.
Paradis, J./Dobrin, D./Miller, R.
1985 Writing at Exxon ITD: Notes on the Writing Environment of an R&D Organization. In Odell, L./Goswami, D. (eds.) *Writing in Nonacademic Settings*. New York: Guilford, 281–307.
Paulston, C. B.
1998 Linguistic Minorities in Central and Eastern Europe: An Introduction. In Paulston, C. B./Peckham, D. (eds.) *Linguistic Minorities in Central and Eastern Europe*. Clevedon, Avon, UK: Multilingual Matters, 1–17.
Phillipson, R.
1992 *Linguistic Imperialism*. Oxford: Oxford University Press.
Prelly, L. et al.
1989 The Rhetorical Construction of Scientific Ethos. In Simons, H. (ed.) *Rhetoric in the Human Sciences*. Newbury Park, CA: Sage, 48–68.
Robertson, D. S.
1998 *The New Renaissance: Computers and the Next Level of Civilization*. Oxford: Oxford University Press.
Robins, R. H./Uhlenbeck, E. M. (eds.)
1991 *Endangered Languages*. Oxford: Berg.
Ventola, E./Mauranen, A.
1991 Non-Native and Native Revising of Scientific Articles. In Ventola, E. (ed.) *Functional and Systemic Linguistics: Approaches and Uses*. Berlin: de Gruyter, 457–492.

Winsor, D.
1990 Engineering Writing/Writing Engineering. *College Composition and Communication* 34: 313–341.
Wurm, S. A./Mühlhäusler, P./Tryon, D. T.
1996 Atlas of Languages of Intercultural Communication in the Pacific, Asia, and the Americas. 2 vols. Berlin: de Gruyter.

When Does Knowledge Have a National Language? Language Policy-Making for Science and Technology

Angéline Martel[1]

1. Introduction

The spreading of English as *lingua franca* of science and technology on the one hand, and of business and finance on the other hand, is increasingly documented[2]. The phenomenon does not seem to leave individuals indifferent; nor does it leave collective organisations, particularly states, inattentive to what some call the invasion of English. Different attitudes prevail: some may accept this fact as a contemporary imperative, others may seek alternatives.

In this context, collective organisations are increasingly drafting language policies, each according to their own socio-economico-political context, according to their linguistic ideology or to their positioning intentions. In effect, science and technology[3], just like business and finance,

just like languages, are contemporary objects of regional, national and international positioning in the pecking order of recognised powers. In this information age, the adage that "Knowledge is power" has never been taken so seriously; by individuals (scientists, citizens, bureaucrats, professors, students, entrepreneurs, managers, etc.) as well as by collective structures: states, business firms, industries[4], research laboratories, language communities, etc.

Within the very words "Knowledge is power" lies, however, a paradigm shift for science: from a pursuit of knowledge for itself (science for science) to a pursuit of politics through sciences (politics with science). And so "Knowledge is power" has evolved into another axiom: "Knowledge is the most powerful engine of production" (Schutz 1980). Although this belief is open to debate and has not proven itself in all contexts (Salomon 1990; Limoges 1990), the presumed causal link between knowledge, productivity (wealth) and power has particularly enticed states to institutionalise scientific and technological development[5]. In addition to the traditional physical powers of states (i. e. territory, military forces, demographic weight), sciences and technologies take states into a new grey matter power edge that is couched today into an ideology of innovation, consumerism and competition.

The research presented in this paper is situated at the crossroad of state policy discourses with a vertical axis on science and technology and a horizon on languages. This focus on states is justified in two ways: states are today the most active structural bodies drafting language policies, world wide; and they still remain the major type of human collective governance structure although clear trends towards global integration and regional collaboration are developing. Similar analyses could, and should, however, be drawn with supranational bodies (United Nations, UNESCO, European Union, etc.) as well as with multinationals businesses and with linguistic communities, in a minority situation, for example.

In this paper, I focus on the conditions of emergence, and on the particular configurations, of state language policies for science and technology. Of interest is an understanding of the conditions when the language of science and technology becomes problematic for a state: for what purposes? in whose interests? A study of the nationalisation of science, technology and language reveals important issues about the spreading or diminishing of cultural/linguistic powers, and about its dialectic with economic powers in our modern world (Montgomery 1996: 45). Such a study could also help gain an understanding of the extent to which states value the interconnection between scientific and technological activities and the importance that they give to the cultures/languages that make them possible.

"When does knowledge have a national language?" was chosen as a title to contrast with a more predictive intent: "When *should* knowledge have a national language". In order to begin answering the first question, I provide a descriptive framework and a case study. In order to answer the second question, one could place himself or herself from a particular language *planning* perspective. In the latter case, he or she could utilise one of the language planning typologies reviewed by Kaplan and Baldauf (1998) or by Cooper (1989). But there is yet no framework to guide the interpretation of the former question in the context of science and technology.

In the first part of this paper, I briefly review the paradigm shift that has occurred in the representations of science and technology as they are outlined in public policies in the Organisation for Co-operation and Economic Development (OCED) countries. In the second part, I present a heuristic framework for understanding the dynamics of language policies by repertoiring the sectors that we need to investigate. In the third part, this framework is used to understand the importance, or its lack thereof, of language policies pertaining to science and technology in a case study: Québec. The following aspects are of interest: the sociopolitical context, the linguistic ideology, the scientific/technological paradigm invoked. The fourth part summarises today's studies on the status of French language in science and technology. Finally, I propose some hypotheses on the dynamics of language planning in science and technology by states.

2. Science and technology: increasingly handmaidens of state and economy

Only a quarter of a century ago, most countries did not envisage that scientific and technological policies could be important while today, policies on this subject have been institutionalised in most Western states (Salomon 1990). Technology is now a particularly important dimension of official state discourse.

But, policies on science and technology are not a recent invention. In the IXth century, the calife Abbâssides intended to give Islam means to transcend its state of militarily conquered civilisation with a scientific culture that would position it with the Greek, Syrian and Indian sciences (Leclec 1990: 7). Another example of the merging of scientific and political interest is the famous Manhattan Project, a U. S. government research effort which involved numerous researchers in different countries and

which culminated in the production of the first atomic bomb during the Second World War.

In effect, states have become increasingly involved in scientific and technological development since the Industrial Revolution[6], mainly through the allocation of research funding (Salomon 1990; Kaplan and Baldauf, 1988: 243). But what has primarily changed over the last decades is the emphasis placed on the *utilitarian* function that science and technology are to play in the economic, social and political context from which they emerge. This change of emphasis is evidenced by the key words chosen to name policies: from science, to technology, to innovation, each having its own constellation of meanings, actors and financial resources in the relationship between knowledge and utilitarianism.

2.1. The age of "science policies"

One of the first official and foundational policies on science was Vannevar Bush's *Science: the Endless Frontier* (1945). As scientific councillor to the American president, Theodore Roosevelt, Bush proposed the creation of a national agency to support scientific research, thus bringing to public awareness the implication of the state in science. Scientific research (particularly fundamental research) was then seen as contributing to culture and national well-being, as well as being part of education for scientists and for the general population. Such a policy gave priority to supporting research in universities and research centres and to the training of researchers. The quality and value of scientific results was to continue to be judged by peers. Encouragement was also given for the application of research by industry.

This model of science is linear: from fundamental research to applied research to technological development, production and commercialisation. At that time, science policy came down to "research policy". Key words in this paradigm are *free* and *fundamental*, in a context of economic prosperity, demographic growth and tertiarisation of the economy in the Western world. In this model, scientific activities are mostly conducted in universities. The researcher's most prominent need is to communicate freely with peers at national and international levels.

In this paradigm, investigations on the languages used in science focus on understanding the trends with indicators like:

- number, and percentage of total, of articles published in a particular language in national and international scientific journals, according to disciplines;

- number, and percentage of total, of articles published in a particular language in dissemination journals, be they national or international;
- number, and percentage of the total, of citations for a particular country (as indicator of the recognition of its science);
- number of scientific journals;
- official languages, and the languages of presentations at national and international conferences;
- sources and amounts of research funding;
- language of training in institutions;
- number, an percentage of total, of thesis in a particular language;
- number, and percentage of total, of textbooks.

2.2. The age of science and technology policies

The 1960's see the emergence of a discourse on scientific and technological development in most of the OCED countries (Gingras and Godin 1998; Davis and Duchesne 1986: 129). In a context of increased state involvement, of a realisation that there is no pure science, of economic crises and of a revolution in production and consumer systems introduced by the new technologies, science policies were reoriented toward an inclusion of technologies.

Conscious of the trend towards increasing pressures for a merging between science and technology and their increasing subservience to economic imperatives, the OCED published in 1971 a report entitled *Perspectives on Scientific and Technological Policies.* This report called for a more global approach to science and technology deeming that innovation should not be exclusively economic but also social. It asked states to consider "a new approach to research and development, no longer aimed exclusively at improving existing technologies and producing new ones, but also at perfecting conceptual instruments for the better understanding of man and his society and at delineating the requirements of harmony in social and economic development" (Brooks 1971: 62). This call was not heard: the focus by scientific and technological development on production of consumer products and processes deepened.

2.3. The age of innovation policies

Today, the new breed of scientific and technological policies definitely gives emphasis to innovation. As evidence, Table 1 shows the title of recent policies from seven OCED countries. We can note that:

- innovation plays a large role as the subject of policies;
- science and technology are used towards political ends;
- well-being and competitivity increasingly become covert or overt issues in which science and technology play a role through increased production.

Table 1: Scientific and technological policies: Samples from seven OCED countries (1993–1996)

United States	1993	*Technology for America's Economic Growth: A New Direction to Build Economic Strength*
	1994	*Science in the National Interest*
	1996	*Technology in the National Interest*
Great Britain	1993	*Realising our Potential. A Strategy for Science, Engineering and Technology*
	1995	*Competitiveness. Forging Ahead*
European Union	1996	*Green Book on Innovation*
OCED	1996	*Technology, Productivity and the Creation of Jobs*
Japan	1996	*Science and Technology Basic Plan*
France	1996	*La recherche: une ambition pour la France [Research: an ambition for France]*
Ireland	1996	*White Paper on Science, Technology and Innovation*
Canada	1996	*Sciences and Technologies at the dawn of the 21st Century. Federal Strategy in Science and Technology*

Innovation is defined by OCED as the development/commercialisation of an efficient product as a method of production/distribution with the objective of providing new or better services to consumers. In effect, innovation conveys a dramatic paradigm shift, –at the same time as a continuous development–. First, innovation takes science and technology out of the traditional breeding ground of universities and research centres and places it in businesses and industries because of the emphasis on the production of consumer goods and processes. Secondly, it displaces fundamental research from the initial point in the chain of production to a collective process where all stages of creation and production are intermingled.

This paradigm shift radically alters the dynamics of language use in scientific/technological development. First, researchers can no longer

claim allegiance to none other than science; states, suprastates organisations, businesses and industries fund the vast majority of research, world-wide. This has as an effect to add linguistic imperatives from the source of funding, be these imperatives overt, covert, intentional or unintentional. The language of science and technology thus becomes increasingly tied to the language of business/finance and, it is too early to tell, but could well then be that of English as a *lingua franca.*

Secondly, the physical sites of research are increasingly moving, from universities to industries, hospitals, public research centres, small businesses, communities and associations, although this transfer is not occurring as quickly as policies may lead to believe (Godin and Trépanier 1995). At first look, one could hypothesise that moving research into society could militate for the use of a national language. But transfer of knowledge between researchers is increasingly cross-national so that a national language may seem as inadequate in knowledge transfer and, in a context where time is money, short cuts with a *lingua franca* are welcomed. In this context, the location of a business or research centre is less important than its ability to communicate world-wide, increasingly through distance communication technologies.

Thirdly, communications between researchers are no longer horizontal among peers but subjected to the vertical judgement of other spheres in society, particularly from businesses and industries. Evaluation of the quality of research is increasingly couched in terms of its usability on the global market. Thus, the notion of scientific community is moving: from a restricted group to a large diffuse body including entrepreneurs, managers, industrials, bureaucrats, etc. and the jargon of science, where incomprehensibility and non-communicability with the general public was a source of power and a weapon of difference and identity (Montgomery 1996) is increasingly denigrated. These factors could also militate for the use of national languages but again, the generalisation of international transfer of knowledge can be favourable to the use of a *lingua franca.*

Thus, the ivory tower is broken. Large portions of research have been industrialised and domesticated. Science, technology, state positioning and economy are intermingled. A new term, *technoscience*[7] has come to represent the a-social and a-ethical development of knowledge as handmaidens of industrialisation and economy. The products of scientific research are increasingly objects with words (software and technologies). Consequently, investigations on the languages used in science, technology and innovation should now use new indicators, complementary to those used to analyse the paradigm of science, indicator like:

- language of work in laboratories, be they situated in industry or in universities, hospitals, etc.;
- language of software used in industry, business, education;
- language of networking, particularly e-mail;
- the number of patents from a particular country as indicator of creative vitality.

At a policy level, we can ask how attention can be focussed on the language of science and technology? How can the increasing spread of English in science and technology, hand in hand with that of economy and finance, be understood and planned? How can the allegiance of scientists to a particular national language or to a scientific/economic community (or both) be analysed? How can the publication dynamics, which remains as the sediment of scientific and technological activities, be understood? – We now turn to a tool designed to help apprehend this complex and moving field.

3. A heuristic framework for understanding language policy dynamics

Language policy-making is a complex process of situation-assessing, discourse-making, consensus-building, forward-planning. With language planning emerging as an area of applied sociolinguistics, there is an attempt to understand both macro and micro factors affecting overt and covert changes favoured by policies. This section of the paper constitutes an effort to conceptualise the foundations of the dynamics of language planning in science and technology[8].

In this section, I propose a heuristic framework (Figure 1) which helps to draw a picture of the type of elements that enter into the configuration of policies for the language of science and technology. As a framework, it does not have a predictive function. Rather, its aim is similar to that of a geographic map: it could guide the study of particular practices (in time and space). Its intent is also sociocritical to the extent that it encourages the uprooting of the ideologies that ground language planning and implementation. Furthermore, it provides spaces for describing policies within changing notions/functions of science and technology towards innovation; as they were and as they are becoming under increased conditions of globalisation, industrialisation and consumerism.

Language planning takes place on two planes: the subjects and the objects. On the first axis of the heuristic framework, the subjects axis is built on a continuum between collectives and individuals. It shows both

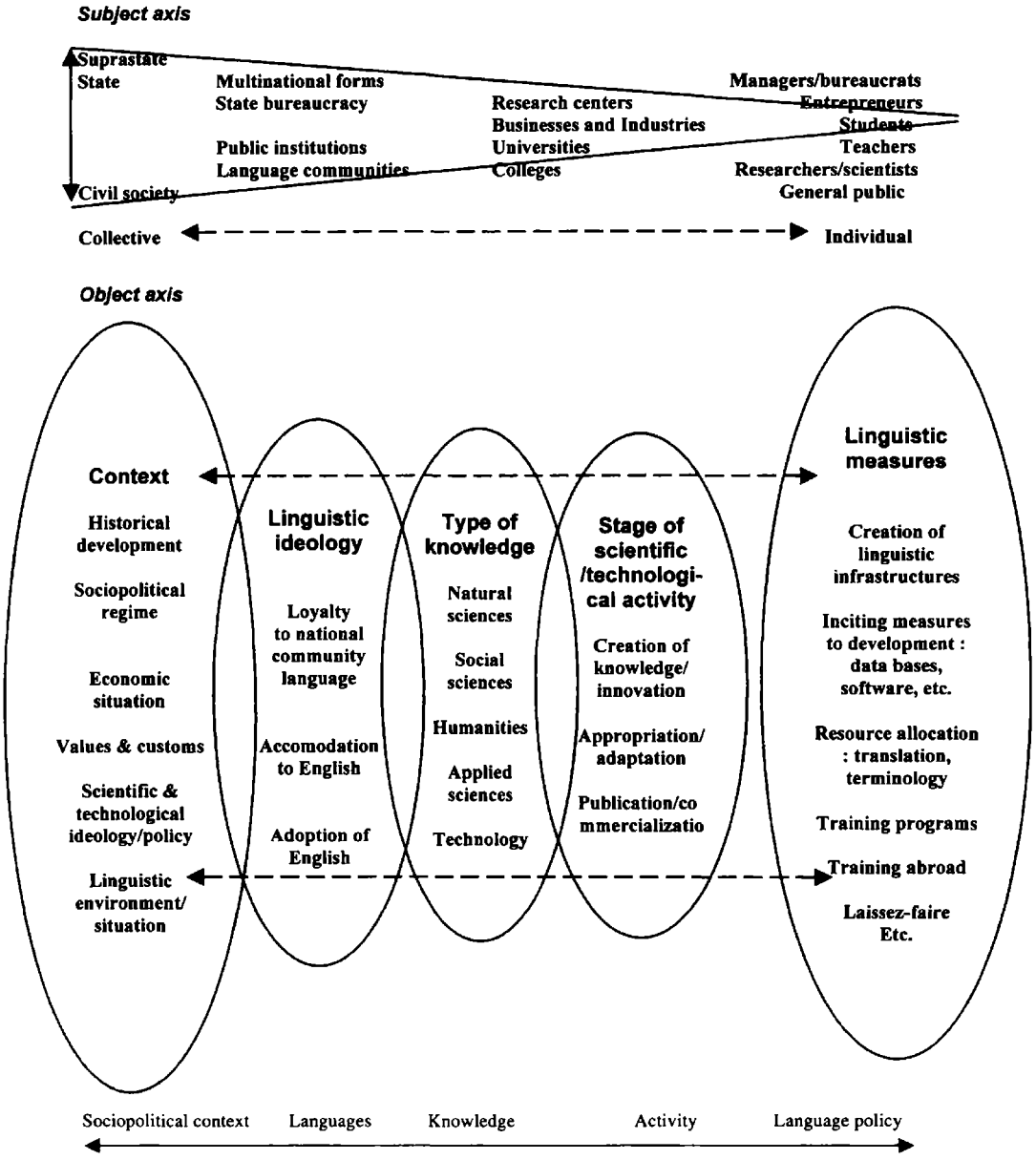

Figure 1: Heuristic framework for understanding the dynamics of language policies in sciences and technologies

the actors (be they bureaucrats, researchers, public institutions, states, etc) and the recipients of language policies, including the general public in a age of increasing discourses on democratisation of knowledge[9] and links science/technology to society[10].

On the object axis are situated four intertwining and inter-influencing spheres, from macro (context) to *meso*, or intermediary, levels of considerations (linguistic ideology, types of knowledge, stages of scientific activ-

ity). They all feed into the type of language planning measures, or its lack thereof, that are likely to be announced, published and/or adopted.

The first sphere, the context, provides a broad overview of the environment: the historical development (developed or developing country, industrialised, urbanised, rural, imperialist, colony or ancient colony, etc.), the sociopolitical regime (democracy, dictatorship, etc.), the economic situation, the values and customs, the scientific and technological ideology, the linguistic environment (including its assessment and statistical description).

The two last components of this sphere are of utmost importance. First, the nature of the scientific and technological policies are crucial since the importance accorded to languages will depend largely on the type of scientific and technological culture a state adopts. The most current ideologies for Western states have been described in the previous section: science for science, science and technology, innovation. The link between development and the adopted notion of science/technology is also important. In industrialised states, approximately 10% of the research funds is allocated to fundamental research and it is never larger than 20%. In many developing states, this proportion is between 18% and 32%. In other words, the more spent on fundamental research, the less the research system is integrated in the production system. The states that spend the most on fundamental research are also those whose industrial structures are the least adapted to technological innovation (Salomon 1990: 52).

Likewise, the linguistic environment, in reference to English, will matter in the type of linguistic ideology dominating. Some types of considerations pertaining to the linguistic environment, in reference to English, are presented in Table 1[11].

Table 2: Typology of linguistic environments in reference to English

Highly developed nation/ community/agency	Developing nation/community/ agency
a) Native of English	a) Native of English
b) Non-native with English as official language	b) Non-native with English as official language
c) Non-native without English as official language	c) Non-native without English as official language
i. who had an international language of science	
ii. who did not have an international language of science	