

# The Forgetting and Rediscovery of Soviet Machine Translation

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What comes to mind when you think of the word *algorithm*? This is not a rhetorical question: I am asking you to actually picture the word and what comes along with it. Based on the assumptions that populate the mushrooming scholarship about the history and sociology of algorithms, as well as buzzwords in the blogosphere, algorithms seem to have two dominant characteristics. First, they are intimately tied to machines and divorced from people. To be sure, they are coded by people and act on data about people (in many cases), but the domain of the algorithm is in silicon. The second assumption is related: the algorithm lives in Silicon Valley or one of the multiple other hypertechnological hotspots of the Information Age. What the algorithm is *not* is embodied in a person, and to the extent that it circulates around Eurasia it is most definitely not *Soviet*. This essay explores a slice through an alternative history of an algorithmic problem, machine translation (MT), in order to show the multiple recastings of a specific set of algorithms in the Soviet Union. Since what it meant to be Soviet and what it meant to machine translate are rather unstable signifiers, the account here remains unsettled, nonmonolithic.

Consider another pair of words: *Russian* and *computer*. Most Slavic languages (with the exception of Bulgarian and Macedonian) do not use definite or indefinite articles, and the above phrase is one of many instances in which

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their absence generates an ambiguity. If we insert an *a* before both nouns, we pick out a person with an electronic device. The issue of Russians and computers has been somewhat in the news in recent years, although the topic of state-sponsored promotion of hacking, distributed denial-of-service attacks, and cybersurveillance has attracted journalists for some time.<sup>1</sup> If we instead add a definite article to the second noun, we are in a different area altogether: the Russian language. Computation and languages is another touchstone of the narrative of the rise of the algorithms, as Google Translate rolled out its new neural-net-based translation program to a salvo of adulatory coverage.<sup>2</sup> As with most journalism, the sense of history is not very deep—going back typically either to the ascendancy of Vladimir Putin to the Russian presidency in 2000 or to the unveiling of Google Translate in April 2006.

If one rewinds a bit, it turns out that the story of Russian (or in this case, Soviet) computing and that of machine translation were intimately related, both starting in roughly the mid-1950s. This essay begins at that moment, when MT was one of the signal preoccupations of both Soviet applied mathematicians and Soviet linguists and their numerical and to some degree theoretical dominance in the field was recognized globally. Needless to say, the memory of that time has faded into nothingness, and today's enthusiasm for natural language processing, and hysteria about Russian algorithmic malevolence, are seen as possessing very different origins and very different implications.

The narratives recounted here are neither the secret history behind Google Translate nor the hidden origins of computer science in the Russian Federation. I invoke both to cleanse the palate and bracket presentist concerns for a rather opposite goal: to explore how stories of progression and dominance get constructed. What follows is a set of three stories about

1. For example, see Adrian Chen, "The Agency," *New York Times Magazine*, 7 June 2015, [www.nytimes.com/2015/06/07/magazine/the-agency.html](http://www.nytimes.com/2015/06/07/magazine/the-agency.html). I selected this article for its pre-2016-election vintage. More recent articles, both long and short form, about Russian computational mischief are easily at hand.

2. See Gideon Lewis-Kraus, "The Great A.I. Awakening," *New York Times Magazine*, 14 Dec. 2016, [www.nytimes.com/2016/12/14/magazine/the-great-ai-awakening.html](http://www.nytimes.com/2016/12/14/magazine/the-great-ai-awakening.html)

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how Soviet history intersects with the history of technology. Technology is not, as a rule, very well incorporated into mainstream narratives. Part of this neglect stems from general queasiness about technical details, but it also concerns a teleology of innovation, which both obscures complex continuities with the past and discourages the association of present-day marvels with bygone arcana like the Khrushchev era.<sup>3</sup>

The paper revolves around a specific technological incarnation of algorithmic reasoning: the prototype of a translating machine proposed by Petr Petrovich Smirnov-Troianskii in 1933 and posthumously published with great publicity in 1959, in the midst of the Cold War boom in MT. I approach these in reverse order, starting with the Cold War, moving to the pamphlet defense of Smirnov-Troianskii, and ending in the Stalin era with the inventor himself. There is very little direct historical research on either Smirnov-Troianskii or the massive enterprise of Soviet MT in the 1950s and 1960s; although one goal of this essay is to flesh out the story, my broader quarry is the forgetting of it and what that elision might tell us.<sup>4</sup> I adopt an inverted timeline in order to disrupt the common tendency to view technologies as intrinsically progressive and cumulative and also to emphasize how each story was tied to the political regime in which it took place. The goal is to alienate the machine from the center and return the human to the algorithm and to our narratives of Soviet technology.

### 1. 1966

Looking back at the technological detritus left in the wake of 1966, it seemed apparent that everyone's judgment had been flawed. As Martin Kay observed the MT field through seven years of settling dust, "there has probably been no other scientific enterprise in which so much money has been spent on so many projects that promised so little."<sup>5</sup> Across the Northern

3. For a forceful critique of the innovation-centric focus in popular and scholarly narratives of technology, see Andrew Russell and Lee Vinsel, "Hail the Maintainers," *Aeon*, 7 Apr. 2016, [aeon.co/essays/innovation-is-overvalued-maintenance-often-matters-more](http://aeon.co/essays/innovation-is-overvalued-maintenance-often-matters-more). See also David Edgerton, *The Shock of the Old: Technology and Global History since 1900* (New York, 2007).

4. Aside from the secondary literature about Petr Petrovich Smirnov-Troianskii that I will treat as primary sources in part 2, his story has been told in three pieces; see W. John Hutchins and Evgenii Lovtskii, "Petr Petrovich Troianskii (1894–1950): A Forgotten Pioneer of Mechanical Translation," *Machine Translation* 15 (Sept. 2000): 187–221; Hutchins, "Two Precursors of Machine Translation: Artsrouni and Trojanskij," *International Journal of Translation* 16 (Jan.–June 2004): 11–31; and Sylvie Archaimbault and Jacqueline Léon, "La langue intermédiaire dans la traduction automatique en URSS (1954–1960). Filiations et modèles," *Histoire Épistémologie Langage* 19, no. 2 (1997): 105–32, esp. pp. 113–16 on Smirnov-Troianskii. This last, excellent piece remains the best history of Soviet MT.

5. Martin Kay, "Automatic Translation of Natural Languages," *Daedalus* 102 (Summer 1973): 217.

hemisphere, in both the first and second worlds, it seemed obvious that the Americans were at fault, both for the beginning and the end.

The American who seemed to bear the brunt of the blame for the MT gold rush of 1954–66 was a native-born Frenchman who adopted American citizenship after the fall of France to Adolf Hitler's armies. His name was Léon Dostert, and he directed the Institute of Languages and Linguistics at Georgetown University. His path from Longwy, France, via Pasadena to Georgetown, is a complex and fascinating story of charisma and coincidence, but it would lead us astray from the development of Soviet MT.<sup>6</sup> We pick up Dostert's story in 1952, when he was invited to the first conference in MT at MIT, a gathering organized by an Israeli postdoc, philosopher Yehoshua Bar-Hillel, and financed by the Rockefeller Foundation to jumpstart interest in this nascent area by bringing together linguists and electrical engineers. Dostert, the architect of simultaneous translation at the postwar Nuremberg Trials and the fledgling United Nations, was presumably invited to speak about the difficulties of human translation, and he would later admit that he arrived in Cambridge as a skeptic.<sup>7</sup> The potential of a machine that could translate—obviating the profession that had been his lifeblood before and after the war—took hold of his imagination, and he discarded his prepared presentation and instead stumped for a pilot project, a prototype that would, by its very existence, demonstrate that MT was feasible.

The result was the Georgetown-IBM experiment of 7 January 1954. Through his wartime contacts, Dostert was able to persuade IBM to donate a machine—the IBM 701, then the world's most powerful computer available for civilian purchase—and a programmer, mathematician Peter Sheridan, to team up with Georgetown linguist Paul Garvin. Together, they produced a program working from a limited dictionary (about 250 words) and six grammatical rules that generated almost perfect translations of specially constrained Russian sentences into English every few seconds. A few characteristic examples, in Dostert's idiosyncratic transliteration:

MI PYERYEDAYEM MISLYI POSRYEDSTVOM RYECHYI

We transmit thoughts by means of speech.

VOYENNIY SUD PRYIGOVORYIL SYERZHANTA K  
LYISHYENIYI GRAZHDANSKYIX PRAV

6. For more on Léon Dostert, see Michael D. Gordin, *Scientific Babel: How Science Was Done Before and After Global English* (Chicago, 2015), chaps. 8–9 and “The Dostoevsky Machine in Georgetown: Scientific Translation in the Cold War,” *Annals of Science* 73, no. 2 (2016): 208–23. See also Janet Martin-Nielsen, “‘This War for Men’s Minds’: Birth of a Human Science in Cold War America,” *History of the Human Sciences* 23, no. 5 (2010): 131–55.

7. See Francesca Gaiba, *The Origins of Simultaneous Interpretation: The Nuremberg Trial* (Ottawa, 1998).

A military court sentenced a sergeant to deprivation of civil rights.

DOROGI STROYATSYA YIZ BYETONA

Roads are constructed from concrete.

DYNAMYIT PRYIGOTOVLYAYETSYA XYIMYICHYESKYIM

PROTSYESSOM YIZ NYITROGLYITSYERYINA S PRYIMYESIYU

YINYERTNIX SOYEDYINYENIY

Dynamite is prepared by chemical process from nitroglycerine with admixture of inert compounds.<sup>8</sup>

The experiment was a public-relations smash, triggering an avalanche of sensationalist press coverage, almost all of which highlighted Dostert's prediction that "five, perhaps three years hence . . . interlingual meaning conversation by electronic process in . . . important functional areas of several languages may well be . . . an accomplished fact."<sup>9</sup> Automatic translation of natural languages was the first nonnumerical task that humans had posed to computers, and Dostert was not alone in believing that the problem would be relatively easy to solve. Despite the favorable press and his specific efforts to court the intelligence and defense communities, he was unable to secure funding to expand from the prototype to a full program in MT.

The positive press did, however, attract both attention and funding abroad. Aleksei Liapunov of the Steklov Mathematical Institute at the USSR Academy of Sciences, often hailed as the father of Soviet cybernetics, came across the news coverage of the Georgetown-IBM experiment while perusing a Soviet abstract journal, seeking new areas that would be susceptible to electronic computation. (Cybernetics became an enormous enterprise in the Soviet Union, and that story forms the broader landscape in which this specific story unfolds.)<sup>10</sup> The dream of a translating machine grabbed Liapunov, and he began to turn his focus (and his considerable access to resources)

8. "A Sample of Russian Sentences Translated by the IBM Type-701 Data Processing Machines, Together with the English Translations," Georgetown University Archives, School of Languages and Linguistics collection, Box 1, Folder 1-6/1954, pp. 1-2.

9. Léon Dostert quoted in W. Schweisheimer, "Language Translation by Electronic Computer," *Mechanical World* (Dec. 1955): 534. Characteristic of the bullish reading is Jacob Ornstein, "Mechanical Translation: New Challenge to Communication," *Science* 122 (Oct. 1955): 745-48, which Dostert circulated broadly to attract funding. For a careful historical reconstruction—to the extent allowed by the available evidence—of the experiment and the reaction, see Hutchins, "The First Public Demonstration of Machine Translation: The Georgetown-IBM System, 7 January 1954," Mar. 2006, [hutchinsweb.me.uk/GU-IBM-2005.pdf](http://hutchinsweb.me.uk/GU-IBM-2005.pdf). Engineers and linguists both at the time and throughout the boom appreciated the visibility garnered by the experiment but nonetheless emphasized that the existence proof had proved only a tiny sliver of existence. See, for example, Neil Macdonald, "Language Translation by Machine—A Report of the First Successful Trial," *Computers and Automation* 3 (Jan. 1954): 6-10, and Émile Delavenay, *La machine à traduire* (Paris, 1963), p. 47.

10. On Soviet cybernetics, see Slava Gerovitch, *From Newspeak to Cyberspeak: A History of Soviet Cybernetics* (Cambridge, Mass., 2002).

to the problem. He was not alone. Every major figure in Soviet MT who has left testimony about the origins of his or her interest has consistently pointed to the Dostert venture as making them aware of MT.<sup>11</sup> Looking back from 1962, Bar-Hillel—who had turned from the first full-time researcher in MT to its most persistent and effective critic—saw a watershed in the international balance of research:

Whereas until then [1954] MT had been studied only in the United States and England, immediately thereafter Soviet Russia moved into the field with such a concentrated effort that it became, within a couple of years, the leading country of MT. Other countries quickly followed suit, and today MT research groups exist in most European countries, as well as in the United States, Mexico, Japan, China and Israel. More countries will doubtless join in the future.<sup>12</sup>

1954 had fired up the Soviets but generated little enthusiasm in the US. In 1956, the tables turned as Soviet researchers unveiled their multipronged research program in MT. *Pravda* featured a brief article describing MT, providing the highest possible profile for Dmitrii Panov's group at the Academy of Sciences, and the leading journal of linguistics, *Voprosy iazykoznaniiia* (Questions of Linguistics)—itself a child of the post-Stalin renaissance in structural linguistics—produced a special issue describing the fundamental linguistic questions opened up by algorithmic programming of translation devices.<sup>13</sup>

The highlight of this work—the Soviet equivalent to the Georgetown-IBM splash—was a set of algorithms devised at the Steklov Institute to translate from French into Russian. These algorithms were developed by February

11. See D. Iu. Panov, *Avtomaticeskii perevod* (Moscow, 1958), pp. 7–8. See also the reminiscences in Olga S. Kulagina, “Pioneering MT in the Soviet Union,” in *Early Years in Machine Translation: Memoirs and Biographies of Pioneers*, ed. Hutchins (Amsterdam, 2000), p. 197. For contemporary publications by luminaries of Soviet applied mathematics attempting to explain how the Georgetown-IBM algorithm must have worked, see V. P. Berkov and B. A. Ershov, “O popytakh mashinnogo perevoda,” *Voprosy iazykoznaniiia* 6 (Nov.–Dec. 1955): 145–48, and A. A. Liapunov and Kulagina, “Ispol'zovanie vychislitel'nykh mashin dlia perevoda s odnogo iazyka na drugoi,” *Priroda* 8 (1955): 83–85.

12. Yehoshua Bar-Hillel, “The Future of Machine Translation,” in *Language and Information: Selected Essays on Their Theory and Application* (Reading, Mass., 1964), p. 181. On Japanese MT, to take just one of these examples, see Makoto Nagao, “Machine Translation: The Japanese Experience,” in *Progress in Machine Translation*, ed. Sergei Nirenburg (Amsterdam, 1993), pp. 203–09.

13. See Panov, I. Mukhin, and Izabella K. Bel'skaia, “Mashina perevodit s odnogo iazyka na drugoi,” *Pravda*, 22 Jan. 1956, p. 4. See also Kulagina and I. A. Mel'čuk, “Mashinnyi perevod s frantsuzskogo iazyka na russkii,” *Voprosy iazykoznaniiia* 5 (Sept.–Oct. 1956): 111–21, and G. P. Zelenkevich, L. N. Korolev, and S. P. Razumovskii, “Opyty avtomaticheskogo perevoda na elektronnoi vychislitel'noi mashine BESM,” *Priroda*, 8 (1956): 81–85.

1956, the fruit of eleven full-time coders and programmers who assembled the seventeen subprograms and modules, consisting of over seven thousand commands. By June 1956 the program was able to produce its first translations, with each sentence taking 1.5 to two minutes a piece.<sup>14</sup> Here are some of the examples, all drawn from French mathematical texts:

1. Ensembles et éléments sont désignés dans les raisonnements par les symboles, qui sont en général les lettres ou les combinaisons de lettres.  
Множества и элементы обозначаются в рассуждениях через символы, которые, вообще говоря, буквы или сочетания (комбинации) букв.
2. Les solutions précédentes tendent vers zéro quand t augmente indéfiniment.  
Предыдущие решения стремятся к нулю, когда t возрастает неограниченно.
3. Les relations que nous avons trouvées entre les racines et les coefficients d'une équation conduisent assez naturellement à l'étude des formes symétriques.  
Соотношения, которые мы нашли между корнями и коэффициентами уравнения, приводят достаточно естественно к изучению симметрических форм.
4. Le théorème [sic] qui vient d'être établi subsiste dans ces nouvelles conditions.  
Теорема которая только что была установлена, существует в этих новых условиях.
5. Nous supposons que le cercle ait l'origine pour centre et l'unité pour rayon et de plus que le centre du cercle correspond au point Z0 de l'aire A.  
Мы предполагаем, что (чтобы) круг (окружность) имеет начало в качестве центра и единицу в качестве радиуса и сверх того, что (чтобы) центр круга (окружности) соответствует точке Z0 площади (области) A.<sup>15</sup>

Unlike the Georgetown sentences, where one saw only successes, Kulagina, Mel'čuk, and their colleagues also detailed instances where the translations had been botched and explained the patches to the algorithm implemented in response.

14. See Kulagina, "Mashinnyi perevod s frantsuzskogo iazyka," *Izvestiia vysshikh uchebnykh zavedenii* 5 (1958): 47.

15. Kulagina, "Mashinnyi perevod s frantsuzskogo iazyka," pp. 48–49. If you do not read Russian and/or French, rest assured that these are really quite good. A contemporary Western researcher, in comparing the reports of the Georgetown-IBM experiment with the Steklov Institute translations—although he found both problematic—considered the latter more fruitful in method and more accurate in description; see L. Brandwood, "Previous Experiments in Mechanical Translation," *Babel* 2 (Jan. 1956): 125–27. Without elaborating his reasoning, A. D. Booth, the leading British researcher in MT (to whom we will return in the next section), alleged that "internal evidence" indicated that these sentences were not generated by computer at all (Andrew D. Booth, "Mechanical Translation and Its Implications in Data Processing," *Automatic Data Processing* 1 [July 1959]: 19).

Now it was the Americans' turn to react to developments across the Iron Curtain. In 1956, just after the news of the Soviet French-Russian translation hit Washington newspapers, Dostert finally succeeded in netting a very large grant from the recently established National Science Foundation (NSF) to ramp up his MT operation at the Institute for Languages and Linguistics. As would later become clear, most of this money was supplied by the Central Intelligence Agency (CIA), whose director Allen Dulles had been a colleague of Dostert's in the Office of Strategic Services during the war. The NSF at first served as a cutout for CIA funds, but within a few years CIA support for Georgetown MT was no longer just an open secret but was publicly trumpeted in the media.<sup>16</sup> A canny promoter, Dostert was under no illusions about what had brought about the sudden generosity. As he put it in 1957, referring to another Soviet experiment translating English to Russian at the Institute of Precision Mechanics and Computer Technology at the Academy of Sciences: "This announcement was not unrelated to a renewal of interest and support for work in MT in the United States. In June of 1956 Georgetown University received a substantial grant from the National Science Foundation to undertake intensive research for the translation of Russian scientific materials into English."<sup>17</sup> Money began pouring into programs across the United States and its allies, but to Georgetown more than any other American institution: "There exists no other group in the United States, or in England for that matter, which has been working on such a broad front."<sup>18</sup> Although some of the collaborations included work on German, French, Chinese, and Japanese, the bulk of the research, unsurprisingly, concentrated on Russian.<sup>19</sup> This was a race and a competition between two superpowers, their languages, and their computers.

Soviet researchers had a more ecumenical approach to MT research, working in a greater number and diversity of institutions, with more varied approaches, and on an astonishing number of language pairs. Within four

16. See James Clayton, "Device to Translate Foreign Science Data," *Washington Post and Times Herald*, 30 July 1956, p. 19 and "Machine Translation Tests are Sponsored by CIA," *Georgetown Record* 11 (Jan. 1962): 1.

17. Dostert, "Brief History of Machine Translation Research," speech delivered at the Eighth Annual Round Table Meeting on Linguistics and Language Studies, Washington, D.C., Georgetown University, 1957, [mt-archive.info/GURT-1957-Dostert-1.pdf](http://mt-archive.info/GURT-1957-Dostert-1.pdf)

18. Bar-Hillel, "The Present Status of Automatic Translation of Languages," *Advances in Computing* 1 (1960): [11], [www.mt-archive.info/Bar-Hillel-1960.pdf](http://www.mt-archive.info/Bar-Hillel-1960.pdf); hereafter abbreviated "P."

19. See Hutchins, "The First Decades of Machine Translation: Overview, Chronology, Sources," in *Early Years in Machine Translation*, p. 4. Erwin Reifler of the University of Washington had proposed back in 1954 that attention should focus on Chinese for linguistic reasons, but even he understood that this was not practicable in the current research environment; see Erwin Reifler, "The First Conference on Mechanical Translation," *Mechanical Translation* 1 (Aug. 1954): 31.



years after the first program from 1954, there were programs at the Institute of Precision Mechanics and Computer Technology of the Academy of Sciences, the Steklov Mathematical Institute of the Academy, the Institute of Linguistics of the USSR, the Laboratory of Electrical Modeling of the All-Union Institute of Scientific and Technical Information (VINITI) of the State Scientific-Technical Committee, the Experimental Laboratory of Machine Translation at Leningrad State University, the Computation Center of the Academy of Sciences of the Armenian SSR, the First Moscow State Institute of Foreign Languages, and many others.<sup>20</sup> In May 1958 the (newly founded) Machine Translation Society convened the First All-Union Conference on Machine Translation, which saw participation from representatives of seventy-nine different institutions, twenty-one of which were institutes within the cavernous USSR Academy of Sciences, eight were from the Academies of various Union republics, eleven from universities, and nineteen from other institutions of higher learning. A more restrictive Conference on Mechanical Linguistics in Leningrad the following year saw sixty-two papers among seventy-eight participants.<sup>21</sup>

Soviet MT research quickly assumed distinctive characteristics from that practiced in the US, United Kingdom, France, and elsewhere in the West. Although there was a clear emphasis on English, Soviet labs also designed dictionaries and programs to implement MT into Russian from Chinese, Japanese, German, French, Hungarian, Indonesian, Arabic, Burmese, Norwegian, Spanish, Turkish, Armenian, Georgian, and more. (Precise numbers are hard to pin down, but the estimate was roughly twenty language pairs,

20. See Hutchins, *Machine Translation: Past, Present, Future* (New York, 1986), chap. 6, which offers an overview after it was all over. For contemporary assessments and surveys of Soviet work, see V. Yu. Rozentsveig, "The Work on Machine Translation in the Soviet Union: Fourth International Congress of Slavists Reports, Sept. 1958," trans. Lew R. Micklesen, *Machine Translation* 5 (Dec. 1958): 95–100; Bel'skaia, "Machine Translation of Languages," *Research* 10 (1957): 383–89; Kenneth E. Harper, "Soviet Research in Machine Translation," in *Proceedings of the National Symposium on Machine Translation: Held at the University of California, Los Angeles, February 2–5, 1960*, ed. H. P. Edmundson (Englewood Cliffs, N.J., 1961), pp. 2–12; Anthony G. Oettinger, "A Survey of Soviet Work on Automatic Translation," *Mechanical Translation* 5 (Dec. 1958): 101–10, which also comes with a helpful bibliography; Panov, Lapounov, and Ivan Moukhine, "La traduction automatique," trans. E. Calcshi, *Recherches internationales à la lumière du marxisme* 7 (1958): 162–93; N. D. Andreev, V. V. Ivanov, and Mel'chuk, "Nekotorye zamechaniia i predlozheniia otnositel'no raboty po mashinnomu perevodu v SSSR," *Mashinnyi perevod i prikladnaia lingvistika* 4 (1960): 3–24; and A. P. Ershov, "Automatic Translation in the USSR," in *Mechanisation of Thought Processes: Proceedings of a Symposium Held at the National Physical Laboratory on 24th, 25th, 26th and 27th November 1958*, 2 vols. (London, 1959): 1:352–54.

21. See Rozentsveig, "The Work on Machine Translation in the Soviet Union," p. 97, and Harper, "Soviet Research on Machine Translation," p. 3.

including translations among these languages without a Russian intermediary.)<sup>22</sup> These are, in part, the languages of the Soviet Cold War and postwar decolonization, and eloquently speak to the particular foreign-policy vision that motivated state support of MT, especially by contrast to the American monolingual goal.

For practitioners, besides the differences in the languages, the most obvious contrast with Western research was a shift of emphasis from “direct” approaches—hard-coding a specific language pair, often in a single direction, as had been the case for Georgetown-IBM as well as the Kulagina French-to-Russian pilot program—in favor of what its most vigorous advocate, Igor Mel’čuk (born in 1932, only recently retired in Montreal, where he emigrated in 1977 after being fired for political dissidence), called interlingual methods.<sup>23</sup> Instead of building an algorithm that would transfer morphological, syntactic, and semantic features on a one-to-one basis, thus needing to be redesigned for every new language, Mel’čuk insisted on developing a machine *interlingua*, the same for all the linguistic codes, into which each language would be translated into and then out of.<sup>24</sup> This theoretical approach was more thoroughly investigated in the Soviet Union than anywhere else, an emphasis explained by two features. The first was the very strong Soviet commitment to structuralist linguistics after Stalin’s death, a structuralism that Mel’čuk found uniquely helpful in designing theoretical approaches to machine-translating from Hungarian and then in general for other languages.<sup>25</sup>

22. See Harper, “Soviet Research on Machine Translation,” p. 3. On the English emphasis, see T. N. Moloshnaia, “Voprosy razlicheniia omonimov pri mashinnom perevode s angliiskogo iazyka na russkii,” in *Problemy kibernetiki* no. 1, ed. Liapunov (Moscow, 1958), pp. 215–21, and Belskaya, “Machine Translation Methods and Their Application to an Anglo-Russian Scheme,” in *Information Processing: Proceedings of the International Conference on Information Processing, UNESCO* (Paris, 1959): 199–217. Before Congress, Dostert estimated between seven hundred and a thousand Soviet researchers were dedicated to machine translation, focusing on fifty languages, and that all these efforts were coordinated; see United States House of Representatives, Committee on Science and Astronautics, *Research on Mechanical Translation* (Washington, D.C., 1960), p. 104. Each of those three claims seems to have been an exaggeration.

23. On Igor Mel’čuk’s dissidence, see Zhores A. Medvedev, *Soviet Science* (New York, 1978), pp. 186–88.

24. This interlingua is not to be confused with Alexander Gode’s constructed language Interlingua, which received substantial publicity at precisely this time; see Alexander Gode and Hugh E. Blair, *Interlingua: A Grammar of the International Language* (New York, 1951).

25. See Igor Mel’čuk, “O mashinnom perevode s vengerskogo iazyka na russkii,” in *Problemy kibernetiki*, ed. Liapunov (1958): 222–64 and “Machine Translation and Formal Linguistics in the USSR,” in *Early Years in Machine Translation*, pp. 212–13. On Soviet theoretical work in general, see the 1967 summary in Kulagina and Mel’čuk, “Automatic Translation: Some Theoretical Aspects and the Design of a Translation System,” in *Machine Translation*, ed. Booth (Amsterdam, 1967), pp. 137–71. See as well the comprehensive international bibliography coedited by Mel’čuk, which unlike Western sources has heavy representation of Czech and Polish research; see Mel’čuk and R. D. Ravich, *Avtomaticheskii perevod, 1949–1963: Kritiko-bibliograficheskii spravocnik* (Moscow, 1967). On Soviet structuralism and MT, see George

The second stemmed from the economic demands of a multilingual environment. The Americans were really only interested in one source language, and that meant direct methods were the most efficient form of attack. For a multilingual context of  $N$  languages, you would need  $N(N-1)$  distinct direct programs to handle the problem, but only  $2N$  using an interlingua (or  $2N-1$ , if your interlingua happened to be a natural language). Once  $N$  gets beyond 2, as it clearly was in the multilingual Soviet Union and communist bloc, costs would be much lower with Mel'čuk's favored model.<sup>26</sup>

There was plenty of criticism both within and outside the Soviet Union about the Soviet emphasis on theoretical linguistic research as opposed to practical trials on the computer, attributed by many to the more limited computing resources in the Soviet Union or alleged pigheadedness of individual linguists.<sup>27</sup> Mel'čuk—whose longevity makes him the last commentator standing on many undocumented debates—scribed a good deal of resistance to the linguistics establishment, which resisted publishing MT research in journals like *Voprosy iazykoznaniiia* unless a directive from above demanded it. Soviet scholars had to content themselves with publishing in the specialist journal *Mashinnyi perevod i prikladnaia lingvistika* (Machine Translation and Applied Linguistics), which had a print run of only twenty to thirty copies, or publishing their more mathematical results in *Problemy kibernetiki* (Problems of Cybernetics), edited by Liapunov himself, which naturally stressed computational questions.<sup>28</sup>

The Americans emphasized the hardware obstacles. As an unnamed CIA witness (probably the chemist Paul Howerton, Dostert's contact) told a Congressional hearing in 1950:

When MT is discussed there is invariably an expressed interest in what the Soviet Union is doing in this field. I will not dwell on this except to say that the Soviets have a program which considerably exceeds our own in scope and size, and that they are doing very good theoretical work, though restrictions on the availability of computer time has limited opportunities to practice.<sup>29</sup>

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Mounin, *La machine à traduire: Histoire des problèmes linguistiques* (The Hague, 1964), p. 59, and Bar-Hillel, *Language and Information*, p. 186. For Stalin's repeated interventions in linguistics, see Ethan Pollock, *Stalin and the Soviet Science Wars* (Princeton, N.J., 2006), pp. 104–35.

26. See Archaimbault and Léon, "La langue intermédiaire dans la traduction automatique," p. 119, and Hutchins, *Machine Translation*, pp. 54–55.

27. See Jurij N. Marčuk, "Machine Translation: Early Years in the USSR," in *Early Years in Machine Translation*, p. 249; Bar-Hillel, "The Present Status of Automatic Translation of Languages," p. 125; and Kulagina, "Ob odnom sposobe opredeleniia grammaticheskikh poniatii na baze teorii mnozhestv," in *Problemy kibernetiki*, pp. 203–14.

28. See Mel'čuk, "Machine Translation and Formal Linguistics in the USSR," pp. 209–10.

29. CIA witness in US House of Representatives, *Research on Mechanical Translation*, p. 87.

Nevertheless, the leaders of American programs were still nervous about Soviet progress, ironically compounded by the fact that their Russian-language knowledge was limited and they were not always able to read the relevant publications. Enthusiasm was high notwithstanding, and Reifler in 1960 was confidently able to proclaim that “It is clear that the impact of MT on human culture and civilization will by far surpass that of the invention of book printing.”<sup>30</sup>

Yet storm clouds had already begun to gather around American MT. Consider MT’s first full-time employee, Bar-Hillel, who in 1953 returned to Hebrew University in Jerusalem but remained an active consultant and commentator. After years of inspecting various programs, he invoked his training under Rudolf Carnap as a philosopher of language and developed what by 1960 he determined to be “an argument which amounts to an almost full-fledged demonstration of the unattainability of FAHQ [Fully Automatic High-Quality Translation], not only in the near future but altogether” (“P,” p. [3]). Building on Ludwig Wittgenstein’s anti-positivist classic *Philosophical Investigations*, Bar-Hillel showed the reader this sentence:

The pen is in the box.

How would a computer translate this? The program would need to know the relative sizes of the box and the pen in question in order to determine whether the latter is a writing implement or a pig’s home—but this is precisely the kind of contextual comparison that algorithms cannot do. To see the force of such an argument, consider the following Russian sentence, which is my invented example but captures the worry:

МАТЬ ЛЮБИТ ДОЧЬ.

How to translate *this* sentence? If you know Russian, you immediately see the problem, which goes beyond the ascription of definite and indefinite articles. Russian does not have a fixed word order, instead using case endings to indicate syntactic function; but the nouns for “mother” (the first word) and “daughter” (the third word) are identical in their nominative and accusative forms. Thus, this sentence could just as easily be “The mother loves the daughter” or “The daughter loves the mother.” An algorithm would be at a loss. As Bar-Hillel noted looking back in 1971: “It seems, then, that we

30. Reifler, Washington (State) University, Department of Far Eastern and Slavic Languages and Literatures, *Linguistic and Engineering Studies in the Automatic Translation of Scientific Russian into English: Technical Report, Phase II, Prepared for Intelligence Laboratory, Rome Air Development Center, Griffiss Air Force Base, New York* (Seattle, 1960), p. 23.

have turned full circle in MT research and are now approximately back where we started some 19 years ago.”<sup>31</sup>

In fact, by 1971 the situation was considerably worse than it had been in 1952. Back then, the field was impoverished but full of optimism. In 1971, the funds were gone and so were the hopes. The contrast between the peak and the trough was drastic. By 1966, it was estimated that roughly twenty million dollars (in contemporary dollars) had been spent on MT in the US, with Georgetown, at 1,317,239 dollars (93.5 percent from the CIA, 6.5 percent from the NSF) being the largest and Harvard, with a total of 1,261,460 dollars, the runner-up.<sup>32</sup> In 1958, Bar-Hillel observed, in the US roughly one to one and a half million dollars had been spent on various MT programs employing 150 researchers full or part time, of whom eighty had masters or higher degrees; “no comparable figures are available for Russia, but it is generally assumed that the number of people engaged there in research on MT is higher than in the States.” That would generate an estimate of between two hundred and 250 researchers working all-out on MT. “In comparison, let us notice that in June 1952, when the First conference on Machine Translation convened at MIT, there was probably one person in the world engaged more than half-time in work on MT, namely myself” (“P,” p. [2]). The budget had been roughly ten thousand dollars.

Alarmed by the growth of these budgets and the diversity of organizations (Army, Navy, Bureau of Standards, intelligence agencies) that had been sponsoring them, the National Academy of Sciences in Washington, D.C., was asked to convene a panel—the Automatic Language Processing Advisory Committee (ALPAC)—to evaluate the efficacy of the expenditures and the degree of technical progress. After investigating the state of the art in various research centers, the ALPAC verdict issued in November 1966 was damning: “There is no emergency in the field of translation. The problem is not to meet some nonexistent need through nonexistent machine translation.”<sup>33</sup> In response to the ALPAC report, American government agencies began pulling their funding. Within two years, *machine translation* was so toxic a term that it had been removed from the title of the Association for

31. Bar-Hillel, “Some Reflections on the Present-Outlook for High-Quality Machine Translation,” in *Feasibility Study on Fully Automatic High-Quality Translation*, ed. W. P. Lehmann and R. Stachowitz (Austin, Tex., 1971), p. 75.

32. See Hutchins, “Machine Translation and Machine-Aided Translation,” *Journal of Documentation* 34 (June 1978): 119, 125. Comparative figures taken from Automatic Language Processing Advisory Committee, *Language and Machines: Computers in Translation and Linguistics* (Washington, D.C., 1966), p. 17. On the breakdown between CIA and NSF, see Muriel Vasconcellos, “The Georgetown Project and Léon Dostert: Recollections of a Young Assistant,” in *Early Years in Machine Translation*, p. 88.

33. Automatic Language Processing Advisory Committee, *Language and Machines*, p. 16.

Computational Linguistics. The bottom fell out across the board. The Americans had started this boom, and they started the bust too.

The carnage was not as total in the Soviet Union but it was significant, compounded by the death of leading researcher Izabella K. Bel'skaia in 1964, one of the architects of the original French-Russian translation. (She was replaced by V. V. Ivanov.) Mel'čuk later recalled the dramatic reduction of support:

The effect of the ALPAC report in 1966 was as great in the Soviet Union as in the United States. Many projects were not funded any more; machine translation went into decline. The authorities had seen the ALPAC documents and concluded that if the Americans did not think it worthwhile to support MT, if they did not think there was any hope of MT, then nor should we. If the American specialists say that MT research had not produced anything reasonable so far, if they say there are no good applications in sight, then what could be expected from Soviet specialists who are not as good as the Americans and do not have computers.<sup>34</sup>

(Then again, he added that he was not personally strongly affected because “we had never pretended that we were doing actual machine translation, we were doing formal linguistics.”)<sup>35</sup> Outsiders saw a dramatic decline in Soviet interest, but not down to zero.<sup>36</sup> The American scene was dilapidated: “By 1973, the early part of the third decade of MT, only three government-funded projects were left in the U.S., and by late 1975 there were none.”<sup>37</sup>

That was the Golden Decade of Soviet Machine Translation. What kind of narrative does that leave us? The form of the story is familiar: the Americans and Soviets were engaged in mutual competition during the 1950s and 1960s, with one side's announcement of an achievement encouraging reciprocal investment from the other, in the push-me-pull-you of spiraling budgets and escalating investment in science and technology—what one American MT specialist would later call “a kind of amiable conspiracy to extract

34. Mel'čuk, “Machine Translation and Formal Linguistics in the USSR,” p. 221.

35. *Ibid.*

36. See Rajmund Piotrowski and Yourij Romanov, “Machine Translation in the Former Soviet Union and in the Newly Independent States (NIS),” *Histoire Épistémologie Langage* 21, no. 1 (1999): 105–17. Even though they document continued work by Andreev in the 1960s, the authors still blame ALPAC for damaging progress; see p. 106.

37. Jonathan Slocum, “A Survey of Machine Translation: Its History, Current Status, and Future Prospects,” *Computational Linguistics* 11 (Jan.–Mar. 1985): 1. See also Harry H. Josselson, “Automatic Translation of Languages Since 1960: A Linguist's View,” *Advances in Computers* 11 (1971): 1–58.

money from their respective governments.”<sup>38</sup> This looks extraordinarily similar to the now-standard, high-quality historiographies we have for the space race and the atomic bomb in terms of mutual upward ratcheting, with the slight modification that the story ends in a collapse—but that, in turn, resembles the historiography we have for Soviet computing.<sup>39</sup> This is precisely the framework in which I myself have situated the technology competition in this period, most recently with the story of MT itself.<sup>40</sup>

This story is so familiar as to barely raise a shrug, and I may have simply added another case to the somewhat comforting pattern that places the bulk of the agency (and the innovation) with the Americans. To an extent, I plead guilty. The story of US/Soviet MT *does* look like an escalating seesaw similar to the arms race; just because this story has been told before doesn’t mean it’s wrong. But I only plead guilty to an extent, for this history is incomplete. This is only one narrative we can tell about Soviet MT. The second story causes us to recast the picture substantially, decentering the Americans.

## 2. 1959

What if the story did not start with the Americans? Perhaps, in the beginning, it was a Russian story—a *Soviet* Russian story. From almost the very moment that Soviet researchers began to publish on questions of machine translation in the mid-1950s, one heard repeated hints that this was not the first time MT had been proposed in the Soviet Union. The tale went back decades earlier than their own work, and certainly earlier than the Americans. Recapturing this story of forgotten Soviet primacy was a high priority for the Russophone MT community, and it brings us closer to a history of algorithms as embodied in persons. In this case, one specific person, dead for nine years.

The most significant coming-out for Soviet MT had been the special issue of *Voprosy iazykoznaniiia* in 1956, which articulated some of the theoretical and practical challenges of the field. Included among this limited set of papers

38. Anthony G. Oettinger, “Machine Translation at Harvard,” in *Early Years in Machine Translation*, p. 80.

39. These literatures are enormous, and I only cite here the accounts I consider excellent, lest one suspect I am selecting strawmen. On the space race, see Asif Siddiqi, *Challenge to Apollo: The Soviet Union and the Space Race, 1945-1974* (Washington, D.C., 2000), and Walter A. McDougall, . . . *the Heavens and the Earth: A Political History of the Space Age* (Baltimore, 1985). On the atomic bomb, see David Holloway, *Stalin and the Bomb: The Soviet Union and Atomic Energy, 1939-1956* (New Haven, Conn., 1994), and Gordin, *Red Cloud at Dawn: Truman, Stalin, and the End of the Atomic Monopoly* (New York, 2009). On computing, see Slava Gerovitch, “Internyet: Why the Soviet Union Did Not Build a Nationwide Computer Network,” *History and Technology* 24 (Dec. 2008): 335-50, and Benjamin Peters, *How Not to Network a Nation: The Uneasy History of the Soviet Internet* (Cambridge, Mass., 2016).

40. See Gordin, *Scientific Babel*, chaps. 8-9.

was one by Lev Ivanovich Zhirkov, the long-lived doyen of Soviet linguistics who had been trained back when Leningrad was St. Petersburg. He concentrated on a memory:

In 1939 the inventor-technician P. P. Smirnov-Troianskii appeared at the building of the A[cademy of] S[ciences] USSR and announced that he had worked out a means of mechanical translation from one language to another; the inventor requested a consultation about his invention from the linguistic side. One must say that at that time P. P. Smirnov-Troianskii's invention was met by linguists with deep skepticism; it was considered unrealizable and completely unnecessary. Only a few admitted the possibility of machine translation. In the course of the subsequent consultations, in which I also took part, it was gradually revealed that P. P. Smirnov-Troianskii had not connected the means of machine translation he had worked out with the idea of electronic calculating machines, but that this means created the possibility of the translation of, let us say, a Russian text in Moscow and the output of it in French, let us say, in Paris. And if machine translation in the languages of the peoples of the Soviet Union were possible, then we could receive any kind of document, so to speak, as a "circular" immediately in several languages. The affair stretched out for rather a long time and ended on 31 June 1944 in the Institute of Automation and Telemechanics of the AS USSR when an authoritative statement was issued with the participation of specialists in the area of mechanics and electrotechnology and linguists. One must say that the specialists in mechanics and technology came out in the statement more with proofs of the "impossibility" of machine translation and, touching on linguistics (an area foreign to them) spoke about synonyms, about the precision of their semantic nuances, in a word—they spoke about what had no connection to their specialty. As a result an experimental model of the translating machine (with a dictionary bank of 1000 words) was not built. Soon the inventor P. P. Smirnov-Troianskii himself, as far as I am aware, left Moscow; and now, by the information I have received, P. P. Smirnov-Troianskii is already deceased.<sup>41</sup>

Parallel to the innovation-heavy discourse launched in 1956 about the future of MT, Zhirkov opened the door to the past. Smirnov-Troianskii (he had adopted his wife's name "Smirnov" in addition to his own in the

41. Zhirkov, "Granitsy primenimosti mashinnogo perevoda," *Voprosy iazykoznaniiia* 5 (Sept.–Oct. 1956): 122.



1940s) became a vibrant subject of reference and discussion, and is a gateway into a different history of Soviet MT.

The Presidium of the Academy of Sciences responded to Zhirkov's article by impaneling a commission in October 1957 to excavate Smirnov-Troianskii's *Nachlass* (obtained from his widow) and offer a historical interpretation and validation of Soviet priority.<sup>42</sup> Panov, a figure we met in part 1, was appointed the chair, and in 1959 his editorial collective (which included MT luminaries such as Bel'skaia) released a slim volume entitled *P. P. Troianskii's Translating Machine*. This volume consists of a brief introduction on the mandate of the historical commission, two articles by Smirnov-Troianskii in reverse-chronological order—the first dating from 1946, mapping out the linguistic assumptions of his translating machine and the second from 1933 with some of the technical details of the prototype—each followed by detailed commentary from members of the MT community.

This volume is our major surviving source into the mystery of Smirnov-Troianskii, and it is far from perfect. Panov's commentary makes clear that he elected not to reproduce additional manuscript material (some of which he quoted), and Bel'skaia in her own observations on the 1946 linguistic piece mentioned in passing that she redacted segments that were polemical or ad hominem. (She did not tell us how many or where they were.)<sup>43</sup> This is an even more compromised source than one has come to expect in the history of Soviet technology but nonetheless holds its own store of revelations.

For one, it contains the only biographical material available on Smirnov-Troianskii. He was born in January 1894 into the large family (fourteen children) of a worker at a railroad workshop in Orenburg. This was a hard life for the young Smirnov-Troianskii, but he obtained elementary education at a local religious school, moving on to a place as an external candidate at a gymnasium, and finally moving to St. Petersburg/Petrograd University right before the outbreak of the Great War and the death spiral of the Romanov dynasty. We know next to nothing about what he did in the war, but he enthusiastically embraced the new Bolshevik regime. He studied at the Institute of Red Professors and later taught social sciences and the history of science and technology at several institutions of higher education, alongside writing for the *Technical Encyclopedia* and the *Great Soviet Encyclopedia*. On 5 September 1933, he again surfaced in the records of the Soviet state, having received author certification number 40995 for his proposed translation

42. See Bel'skaia, Korolev, and Panov, "Predislovie," in *Perevodnaia mashina P. P. Troianskogo: Sbornik materialov o perevodnoi mashine dlia perevoda s odnogo iazyka na drugie, predlozhennoi P. P. Troianskim v 1933 g.* (Moscow, 1959), p. 3.

43. See Bel'skaia, "Kommentarii," in *Perevodnaia mashina P. P. Troianskogo*, p. 29.

machine. This became the main focus of his work, as chronicled in the Panov pamphlet, until he died from stenocardia on 24 May 1950.<sup>44</sup>

There seem to be two reasons for the chronological inversion in the presentation of Smirnov-Troianskii's materials. The first is that the 1946 linguistic analysis, entitled "On a Translation Machine, Built on the Basis of a Monolingual Translational-Linguistic Methodology," offers a more developed and articulated vision of the project, and thereby helps to explain the shorter and more elliptical technical exposition. The second has to do with the rationale of the priority dispute Panov and his Soviet colleagues were initiating. I will treat each in turn.

First, the linguistic analysis. Smirnov-Troianskii fundamentally assumed that the underlying logical structure of all languages was uniform. All his examples were Russian, French, or German, a closely related Indo-European set, but he implied that all languages were more or less amenable to grammatical parsing in terms of parts of speech. Hence Smirnov-Troianskii's proposal: when one receives a text in an original language that one wants to translate (A), an editor who is a fluent speaker of A must append affixes to all of the terms in the text to indicate part of speech, verb tense, and oblique cases. These affixes indicate what is general to all languages, while the specific forms of the roots are what is specific to each individual tongue.<sup>45</sup> This "logically parsed" text (A') will then be fed into a machine, which generates an annotated logically-parsed text in the target language B; call this output B'. Finally, a fluent speaker of B will remove the affixes and edit the text into its "National-Grammatical Form." The beauty of this system, for Smirnov-Troianskii, is that neither the first nor the second editor has to know anything but his or her native tongue and its grammatical rules; all the translating happens at the level of the machine. The procedure is regular and repetitive—but where is the algorithm?

The two innovations here are the machine itself and the affixes. The images in the Panov volume, as well as the text, do not help us much in understanding the machine's internal workings, but we can figure out a general schematic outline from the description that garnered Smirnov-Troianskii his Soviet patent (fig. 1). The crucial features here are labeled 2 and 6 in

44. See Bel'skaia, Korolev, and Panov, "Predislovie," p. 3.

45. See Petr Petrovich Smirnov-Troianskii, "O perevodnoi mashine, postroennoi na osnove odnoiazychnoi perevodno-iazykovoii metodologii," in *Perevodnaia mashina P. P. Troianskogo*, pp. 5–6; hereafter abbreviated "O." Zhirkov had already mapped out this much in 1956: see Zhirkov, "Granitsy primenimosti mashinnogo perevoda," pp. 122–123. This approach is significantly more difficult, if not impossible, with polysynthetic languages such as those found among the Inuit. The limitations of Smirnov-Troianskii's linguistic analysis, and whether grammatical parsing is in fact universal, did not arise in any of the commentaries on his text.

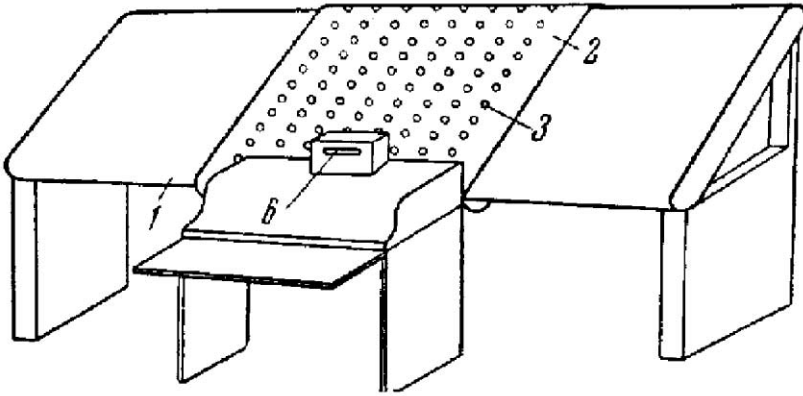


FIGURE 1. A 1933 Diagram of Smirnov-Troianskii's proposed machine.

the drawing. Feature 6 is a photographic device which can be moved horizontally and vertically over the ribbon, 2, which contains multilingual entries for each linguistic root. (Smirnov-Troianskii discussed a six-language repository and offered some suggestions for how this could be expanded essentially indefinitely. He noted that Lev Tolstoi only used twelve thousand roots in all his novels, that Russian had 180,000 roots, English 200,000, and that specialized technical journals confined themselves to about three thousand.)<sup>46</sup> He claimed that by May 1941 he already had a working model, and the basic outline of the device was endorsed by no less a personage than Sergei Ivanovich Vavilov, the president of the Soviet Academy of Sciences, on 30 October 1946 (see "O," pp. 20, 28).<sup>47</sup> By taking images of the B-language root corresponding to each A-language term and retaining the affixes, one would have in the end a complete document which consisted entirely of annotated B roots which then needed to be rendered into fluid B text. Notice, however, that only part of the algorithmic process here is located in the machine—the rest resides in the minds of the annotators who systematically recode each word.

The affixes are thus of primary importance. As he noted in the text (and implemented in his later iterations), one could simply use numerical affixes

46. See Smirnov-Troianskii, "Mashina dlia avtomaticheskogo proizvodstva nuzhdaiushchikhsia tol'ko v literaturnoi obrabotke gotovykh pechatnykh perevodov s odnogo iazyka odnovremenko na riad drugih iazykov," in *Perevodnaia mashina P. P. Troianskogo*, p. 36; hereafter abbreviated "M."

47. This endorsement is preceded in the text by another from Professor I. D. Udaltsov of Moscow State University. On Vavilov's pivotal importance for Soviet science administration, see Alexei Kojevnikov, "President of Stalin's Academy: The Mask and Responsibility of Sergei Vavilov," *Isis* 87 (Mar. 1996): 18–50.

A	A'	B'	Б
Le parti	le parti—o	партия—o	Партия
périt,	pèrir—as	погибать—as	погибает,
s'	si	если	если
il	il	он	она
commence	commencer—as	начинать—as	начинает
\ à cacher	cacher—i	скрывать—i	скрывать
ses	son—afn	свой—afn	свои
erreurs.	l'erreur—ofn	ошибка—ofn.	ошибки.

FIGURE 2. Table showing affixes and the transition from A to Б.

to indicate each grammatical function (see “O,” p. 21).<sup>48</sup> But this is not what he suggested in 1946. Rather, he mapped out a range of specific affixes, as in the annotated French text below—frustratingly, given its rather ironic content, I have been unable to determine a specific source for it—where the affixes are footnoted (fig. 2):

НАЦИОНАЛЬНЫЙ ТЕКСТ: Le<sup>1</sup> parti<sup>1</sup> périt<sup>2</sup> s<sup>3</sup> il commence<sup>4</sup> à<sup>5</sup>  
 cacher<sup>5</sup> ses<sup>6</sup> erreurs<sup>7</sup>. — Le<sup>1</sup> tableau<sup>1</sup> du<sup>8</sup> monde<sup>8</sup> montre<sup>4</sup>,  
 comment la<sup>1</sup> matière<sup>1</sup> se<sup>9</sup> meut<sup>9</sup>, comment la<sup>1</sup> matière<sup>1</sup> pense<sup>4</sup>.  
 ЧОСКИ: <sup>1</sup>—o, <sup>2</sup>—ir—as, <sup>3</sup>si, <sup>4</sup>—er—as, <sup>5</sup>—er—i, <sup>6</sup>son—ajn,  
<sup>7</sup>—r—ojn, <sup>8</sup>de—o, <sup>9</sup>se mouvoir — as. [“O,” p. 27]

I will return to the significance of this particular choice of affixes in part 3; for now, it is sufficient to note that Soviet MT researchers in the late 1950s were happy to present this system without elaboration.

If the first reason to invert chronology was to make the conceptual innovations of Smirnov-Troianskii's approach more salient, the functional reason is no less apparent: the Panov edition of the primary texts was intended as a conclusive intervention in the priority dispute over who actually invented MT. Priority disputes are a structural characteristic of modern science—think of the calculus, conservation of energy, the periodic system, oxygen, natural selection—and they have garnered considerable attention by historians and sociologists of science.<sup>49</sup> Although it is important to recognize that

48. In Zhirkov's initial article, he provided an example which used numerical codes; see Zhirkov, “Granitsy primenimosti mashinnogo perevoda,” p. 124.

49. The literature is quite large, descended from the classic Robert K. Merton, “Singletons and Multiples in Scientific Discovery: A Chapter in the Sociology of Science,” *Proceedings of the American Philosophical Society* 105, no. 5 (1961): 470–86.

for participants the primary function of these disputes is to assign credit to a particular individual (*who* did this first?), as analytic tools the more illuminating question is *what* the historical actors were claiming was discovered and *why* they made an issue of it.

For years before Smirnov-Troianskii's pieces from the 1930s and 1940s were published, there had been a slowly simmering dispute in the West over the idea of machine translation. The pivotal point was a conversation between Warren Weaver, mathematician and a prominent administrator at the Rockefeller Foundation, and Andrew Donald Booth, a British researcher. While there is no question that Weaver's 1949 memo "On Translation" (and his financial resources from the Rockefeller) launched the field, Booth spent a good part of the 1950s and beyond insisting that it had always been his idea. For Booth, arguing as the underdog, it was essential to identify features that were the *essence* of MT, and then to point to things he had done along those lines before 1949.<sup>50</sup>

Panov's resurrection of Smirnov-Troianskii short-circuited this, a goal explicitly noted in the pamphlet and in many other writings from Soviet MT researchers.<sup>51</sup> Machine translation was not yet an actuality in 1959; nobody had developed a device that could perform Bar-Hillel's FAHQT. Therefore, the only question of priority, noted Soviet researchers like Panov, was who had come up with the *idea* that such a device might be possible and a plausible articulation of how to do it. The enthusiasm since the Georgetown-IBM experiment stressed digital electronics, but was it Smirnov-Troianskii's fault that he was so far ahead of his time that he developed his idea fourteen years before the invention of the transistor? In Panov's commentary to the 1959 collection of his

50. For Weaver's side, see Warren Weaver, "Translation," in *Machine Translation of Languages: Fourteen Essays*, ed. William N. Locke and Booth (Cambridge, Mass., 1955), pp. 15–23 and "Translating Machines," *Scientific American* 181 (Dec. 1949): 30, and Reifler, "Machine Translation," *Bulletin of the Medical Library Association* 50, no. 3 (1962): 473–80. Booth was much more prolific; see Booth, "The Nature of a Translating Machine," *Engineering* 182 (1956): 302–304; Booth and Locke, "Historical Introduction," in *Machine Translation of Languages*, ed. Locke and Booth (1955): 1–14; and R. H. Richens and Booth, "Some Methods of Mechanized Translation," in *Machine Translation of Languages* (1955): 24–46. See also Booth, "Calculating Machines and Mechanical Translation," *Discovery* 15 (July 1954): 280–85, "Mechanical Translation," *Computers and Automation* 2 (May 1953): 6–8, and "Mechanical Translation and Its Implications in Data Processing," *Automatic Data Processing* 1 (July 1959): 18–23. See Locke, "Speech Typewriters and Translating Machines," *PMLA* 70 (Apr. 1955): 28. See also the Solomonic take in Hutchins, "From First Conception to First Demonstration: The Nascent Years of Machine Translation, 1947–1954. A Chronology," *Machine Translation* 12, no. 3 (1997): 196.

51. This is made clear in the commentary to the 1933 piece; see Panov and Korolev, "Komentarii," in *Perevodnaia mashina P. P. Troianskogo*, p. 41. See also Panov, Lapounov, and Moukhine, "La traduction automatique," p. 162, and Panov, *Avtomaticheskii perevod*, p. 7. Not all Soviet researchers were obsessed by this question; although Revzin and Rozentsveig, *Osnovy obshchego i mashinnogo perevoda* (Moscow, 1964), p. 15, mention Smirnov-Troianskii, their general account of the history was very Americentric.

writings, he indicated that Smirnov-Troianskii's precocity made his model even *more* impressive: "But there is no doubt that if P. P. Troianskii had been aware of the possibility of electronic computers, then his form of resolution of the task about the mechanization of translation would have been different. Already in 1933 in P. P. Troianskii's works ideas are expressed which prove this."<sup>52</sup> There were really only two individuals who might challenge Smirnov-Troianskii's priority by this reasoning: a Frenchman of Armenian extraction (educated in St. Petersburg), Georges Artsrouni, who also developed what he called his *cerveau mécanique*—a proposal for a mechanical dictionary to translate between languages—in 1933 and was awarded a prize at the Universal Exposition in Paris in 1937, and an enigmatic report of something similar by a man named A. Bakher, printed in a Tallinn newspaper in 1924.<sup>53</sup> In either event, it seemed the origins of mechanical translation lay decisively in the East.<sup>54</sup>

Panov and his colleagues, in publicizing Smirnov-Troianskii, typically did not assert that he deserved credit for every aspect of MT. Their claims were much more specific; they believed that the engineer from Orenburg had divined the necessity, at least in the early stages of development of this technology, of what would come to be called pre-editing (cleaning up a source language text before submitting it to the machine to make processing easier) and postediting (tidying up the output in the target language to make it more readable)—precisely what Smirnov-Troianskii had labeled stages A–A<sup>1</sup> and Б<sup>1</sup>–Б. The American practitioners during the boom period from part 1 assigned credit to Reifler who had coined the English terms on 10 January 1950 in a fifty-five page study.<sup>55</sup> For the Soviets, this was clearly anticipated by Smirnov-Troianskii by at least four years (1946), if not seventeen (1933).

52. Panov and Korolev, "Komentarii," p. 50.

53. On Artsrouni, see Hutchins, *Machine Translation*, pp. 22–23. Hutchins, like all other commentators on Artsrouni, draws heavily from Michael Corbé, "La Machine à traduire française aura bientôt trente ans," *Automatisme* 5 (Mar. 1960): 87–91. On Bakher, see the very cursory "Perevodnaia mashina v Talline v 1924 godu," in *Soobshcheniia po mashinnomu perevodu*, no. 1 (1962): 95–96.

54. Booth was not impressed: "The Russian Troyanskii has been cited as obtaining a patent in the 1930's for so called translating machines, but those details of this application which have become available suggest that the machine was to be principally a scroll-type dictionary operated by an automatic selection mechanism so that the possibilities of direct processing of linguistic data on this machine would be nonexistent" (Booth, "Introduction," in *Machine Translation*, ed. Booth [Amsterdam, 1967], p. vi). Hutchins would later nonetheless dub Smirnov-Troianskii "a genuine precursor of machine translation" (Hutchins, *Machine Translation*, p. 23).

55. For Reifler on these concepts, see his "The Mechanical Determination of Meaning," in *Machine Translation of Languages*, pp. 140–41. For attributions of priority (which Reifler himself did not insist on), see Booth, "Introduction," p. vi; Hutchins, "From First Conception to First Demonstration," p. 215; Locke, "Speech Typewriters and Translating Machines," p. 30. For a more balanced assessment, see B. Buchmann, "Early History of Machine Translation," in *Machine Translation Today: The State of the Art*, ed. Margaret King (Edinburgh, 1987), pp. 3, 6.

To a certain extent, as with the majority of priority disputes, the individuals in question were not talking about precisely the same thing.<sup>56</sup> Smirnov-Troianskii's logical parsing (*logicheskii razbor*) was not entirely synonymous with Reifler's pre-editing. This is not just some Heraclitean point about how everything is different from everything else. Rather, the linguistic rationales behind both formulas were distinct, and one might conclude Smirnov-Troianskii was more ahead of his time than even Panov had imagined. As practitioner-historian John Hutchins characterized the preoccupations of the boom period of MT: "In very broad terms, research in the earlier period from 1954 to 1960 concentrated primarily on semantic and lexicographic problems and research in the later period from 1960 to 1965 tended to concentrate more on syntactic problems and parsing strategies."<sup>57</sup> Smirnov-Troianskii's framework was entirely constructed around syntax and parsing, while pre-editing was essentially lexical in its stress on removing ambiguities and polysemy. In short, the publication of Smirnov-Troianskii's text could have been an opportunity to discuss distinct approaches to the linguistic challenges of MT, but instead it became a struggle for credit.

My purpose is not to adjudicate these priority disputes, but rather to ask why they emerged at this specific moment. Why was this pamphlet published in 1959? This is the same period, starting in 1957, when a special Committee on Inventors and Discoveries at the USSR Council of Ministers systematically began cataloguing scientific discoveries made in the Soviet Union, publishing them in the special patent journal *Otkrytiia, izobreteniia, promyshlennye obraztsy i tovarnye znaki*.<sup>58</sup> Why was it published in Russian and only in Russian? That latter point exposes the defects of the typical Cold War answer: that this was about showing up the Americans and claiming that the Soviet Union was always already ahead. As Loren Graham has shown for a spate of Soviet assertions of priority, these claims go beyond cheap propaganda: there was often historical merit behind the Soviet accounts.<sup>59</sup> Who

56. For more on the ambiguities of these disputes, see Gordin, "The Textbook Case of a Priority Dispute: D. I. Mendeleev, Lothar Meyer, and the Periodic System," in *Nature Engaged: Science in Practice from the Renaissance to the Present*, ed. Jessica Riskin and Mario Biagioli (New York, 2012), pp. 59–82.

57. Hutchins, *Machine Translation*, p. 150. A similar point is made by Delavenay, *La machine à traduire*, p. 80.

58. A translation of many of these entries was commissioned by NASA in 1972 as Russell R. Zavistovich and Andrey Polushkin, *Soviet Scientific Discoveries* (Washington, D.C., 1972). Soviet legal theorists in the late 1950s took up the question of whether scientific discoveries might be treated in the same way as patents, for example in V. I. Serebrovskii, "Nauchnoe otkrytie kak ob'ekt prava," *Sovetskoe gosudarstvo i pravo*, no. 3 (1959): 47–55. I am grateful to Karl Hall for pointing me to this citation, and Robert MacGregor to the NASA piece.

59. See Loren Graham, *Lonely Ideas: Can Russia Compete?* (Cambridge, Mass., 2013). There is even a history of algorithms analog from the 1970s, when Stanford computer scientist Donald

was the audience for such claims? Panov and others did not insist much on Smirnov-Troianskii's priority when talking to Americans; they insisted on it when speaking *internally* within the Soviet Union.

This suggests a second narrative of Soviet MT, rather different from the Cold War Imitation Game narrative of part 1. According to this narrative, produced by Soviet researchers for a Soviet audience, the emphatic point was that Soviet citizens had developed innovative ideas in the past—in 1933, no less—and then did nothing to develop them, letting the inventor languish in disappointment until his death in 1950. This is not a critique of Western hubris; it is a critique of the Stalinist economy. According to the implied moral, Stalin's economy had no capacity to handle these innovations, and it was unable to encourage and exploit the developments of inventors. This second story is the plot of Vladimir Dudintsev's *Not by Bread Alone*, in which an inventor fails to streamline production due to a calcified and ignorant bureaucracy and echoes the self-presentation of the Khrushchevian reforms. In the Thaw, Smirnov-Troianskii's story was appropriated within a broader context which valorized the domestic energies for innovation that could now be unleashed.<sup>60</sup> The actual outcome of these economic and political reforms was rather less than advertised, as many historians have shown.<sup>61</sup> My point is that in this context, Panov's pamphlet lauding Smirnov-Troianskii made sense. But this version of the history does not tell us where the algorithm came from; for that, we have to step further out of Panov's late-1950s' context and into Smirnov-Troianskii's in the 1930s.

### 3. 1933

Smirnov-Troianskii of course did not know in 1933 that after his death he was going to become a pawn in priority disputes and an exemplar of the Khrushchevian critique of the Stalinist economy. What did *he* think he was up to? Why did it make sense for an engineer committed to the Soviet

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Knuth organized a pilgrimage to Urgench, Uzbekistan, the ostensible birthplace of Abū Ja'far Muhammad ibn Mūsa, known as *al-Ḳwārizmī* (from Ḳwārizm), the mathematician who gave his name to the algorithm. On this quixotic search for the birthplace of the algorithm, see Ksenia Tatarchenko, "A House with a Window to the West: The Akademgorodok Computer Center (1958-1993)" (PhD. diss., Princeton University, 2013).

60. Vladimir Dudintsev, *Ne khlebom edinym* (Not by Bread Alone), trans. Edith Bone (New York, 1957). For the analog within the Academy of Sciences, which restructured itself in part to avoid the overweening weight of Moscow and Leningrad, and in part to sidestep Trofim Lysenko's role within genetics, see Konstantin Ivanov, "Science after Stalin: Forging a New Image of Soviet Science," *Science in Context* 15 (June 2002): 317–38. See also Paul R. Josephson, *New Atlantis Revisited: Akademgorodok, the Siberian City of Science* (Princeton, N.J., 1997).

61. There is much one could cite here. Because it synthetically captures (albeit in fictionalized form) both the optimism and disappointment of so much of this scholarship, I'll just refer to Francis Spufford, *Red Plenty* (Minneapolis, 2010).



cause to devote his time to developing a translation machine? In this final section, I will sketch three distinct contexts in the early 1930s that explain some of the idiosyncratic characteristics of Smirnov-Troianskii's machine, features that were so superseded by the late 1950s that Panov and his colleagues mentioned them only in passing if at all. As much as one might want to see Soviet MT as a Cold War competition or an internal Khrushchevian reform program, it was also ineradicably a product of the Great Break.

All three contexts come together in Smirnov-Troianskii's translation formula: A–A<sup>1</sup>–B<sup>1</sup>–B. What happens in this sequence, recall, is that two separate individuals, a native speaker of A and a native speaker of B, are involved at either side, and the machine only intervenes at the transition between the A half and the B half. Each stage contains its own set of algorithms: the humans no less than the machine. The transition from/to the nonsuperscripted A or B (the everyday written or spoken form of an ethnic language) to/from the superscripted is a process of rendering or undoing a parsing of the separate words of the language into grammatical (Smirnov-Troianskii preferred the term *logical*) categories and canonical forms, of the type one would find in a dictionary. Because of the emphasis by historians and practitioners on the novelty of using a *machine*, it is easy to miss the significance of those transitional moments, which is where we can see the specificity of Smirnov-Troianskii's historical moment.

First, the affixes. If you look back at the sample text, you will see some general characteristics. Singular nouns in the nominative are marked with an *o*, plurals have a *j* appended to that, and oblique cases (plural or singular) also have an *n* affixed. Conjugated verbs in the present tense get *as*, infinitives get *i*, and so on. (Smirnov-Troianskii provided a more complete list.) These affixes represent the logical forms of parts of speech, which Smirnov-Troianskii felt were universal, but he did not arbitrarily invent these representations. He borrowed them from a source he surely knew and would have been able to mention explicitly in the early 1930s but which he was coy about in the late 1940s. These affixes constitute the grammatical framework of Esperanto.

Esperanto, of course, is the language invented by Ludwik Łazarz Zamenhof, a Warsaw ophthalmologist, published in 1887 in Russian in his home city and then rapidly translated into dozens of world languages.<sup>62</sup> Initial growth in the movement was slow and concentrated in the Russian Empire before moving to Sweden, Germany, and eventually Paris in the mid-1890s, where it took off like wildfire, attracting thousands of adherents who were committed to

62. See Dr. Esperanto (Ludwik Łazarz Zamenhof), *Mezhdunarodnyi iazyk: Predislovie i polnyi uchebnik* (Warsaw, 1887). For a general history of Zamenhof and his movement, especially in the early years, see Esther Schor, *Bridge of Words: Esperanto and the Dream of a Universal Language* (New York, 2016); Marjorie Boulton, *Zamenhof: Creator of Esperanto* (New York, 1960).

making this language the universal auxiliary for all peoples. Esperantists did not want to replace all languages, but rather have *la lingvo internacia* serve as everyone's second language, a neutral translation among individuals who had no other common language. That Smirnov-Troianskii selected Esperanto as a universal substrate is no accident.

The Soviet Union had an active Esperantist movement in the 1920s. (Famously, Joseph Stalin had learned the language while in Siberian exile.) As Esperanto grew and partially fissioned (in the Ido controversy of 1907), it came to be seen not just as a language of intellectuals but also a vehicle of the universal industrial proletariat. This was represented in the two largest organizations of Esperantists, the UEA (*Universala Esperanta Asocio*, Universal Esperanto Association), founded in 1908 in order to deal with the Idist schism, and SAT (*Sennacieca Asocio Tutmonda*, World Anational Association), created in 1921 by Eugène Lanti as the vanguard of left-wing Esperanto.<sup>63</sup> In the Soviet Union, the point person for organizing Soviet Esperanto societies and workers' clubs was Ernest Drezen, whose writings remain superb chronicles of this movement. (In 1932, in a conflict with Lanti, he founded IPE, *Internacio de Proleta Esperanto*.)<sup>64</sup> Drezen's movement was short-lived. In the mid-1930s Stalin turned against the internationalist linguistic organization, and in 1937 Drezen was arrested and shot. Esperanto remained repressed in the Soviet Union until after Stalin's death, when it underwent a renaissance in the Eastern Bloc.<sup>65</sup>

This connection would have been obvious to Panov and the other editors of the 1958 pamphlet, but they did not stress it, even though the author himself in his 1933 article (but not the 1947 one) suggested relative pronouns drawn from Zamenhof's own invented set (the *tabelvortoj*), noting that "these questions are well worked out in the language Esperanto" ("M," p. 39).<sup>66</sup> Certainly, the typesetters and proofreaders did not recognize Esperanto, since in some of the tables the plural oblique suffice *ojn* was rendered *ofn*, whereas in

63. On these movements, see Schor, *Bridge of Words*. See also Peter G. Forster, *The Esperanto Movement* (New York, 1982). On Ido, see Gordin, *Scientific Babel*, chap. 5.

64. See Ernest Drezen, *Historio de la mondolinguo: Tra jarcentoj da serĉado*, trans. N. Hohlov and N. Nekrasov (Leipzig, 1931) and *Osnovy iazykoznaniiia: Teorii i istorii mezhdunarodnogo iazyka* (Moscow, 1932).

65. See Ulrich Lins, *Dangerous Language: Esperanto and the Decline of Stalinism*, trans. Humphrey Tonkin, 2 vols. (London, 2017). These volumes are a history of persecution of Esperantists, focusing very heavily on Hitler's Germany and Stalin's Soviet Union. Lins expanded his original Esperanto version, which also included discussion of anti-Semitism in France and Japanese and Chinese state persecution of Esperantists; see Lins, *La danĝera lingvo: Studo pri la persekutoj kontraŭ Esperanto* (Berlin, 1990). Most of the additional information in the translation has been in the direction of Soviet history.

66. To their credit, Hutchins and Lovtskii point out the Esperanto connection; see Hutchins and Lovtskii, "Petr Petrovich Troyanskii," p. 218 n. 11.

the text it was correct (see “O,” p. 21).<sup>67</sup> The silence was quite prominent in many of the later commentators on Smirnov-Troianskii as well. Bel’skaia, in 1957, although she praises his innovations, in almost the same breath rejects the premise—“It is, therefore, hopeless to believe that an artificial language can help in machine translating from natural languages”—without mentioning that Smirnov-Troianskii did just that.<sup>68</sup> Perhaps the most interesting elision was from Zhirkov, the elderly linguist who brought Smirnov-Troianskii back from oblivion in 1956 with his article describing the earlier encounter. In that piece, he replaced all the affixes with numbers (as Smirnov-Troianskii, in reaction to Stalinist taboos, had proposed) and made no comment about Esperanto. He surely knew it when he saw it; he had been one of the advocates of the constructed language, having published in 1930 a pamphlet entitled *Why Was Esperanto Victorious?*<sup>69</sup> Esperanto was rather popular among interwar Soviet linguists associated with the Moscow School structuralists, and Zhirkov was prominent in that group.<sup>70</sup>

The second Stalinist context takes us back to that chain of parsing and machine translating. When Dostert began his MT project with IBM, his team specifically looked for a “direct method” to render Russian into English. This would not be reversible, and any new language would require a completely new algorithmic package. No matter: the Americans were really only interested in one foreign language, and only one direction between that language and English. Smirnov-Troianskii, however, explicitly intended his system to enable multilingual translations among an arbitrary number of languages once each was rendered into its Esperanto-suffixed form. Long before Mel’čuk defended his *interlingua* system as more economical for MT among  $N$  languages within the same framework—recall that one would need only  $2N$  codes rather than  $N(N - 1)$  for the direct system—Smirnov-Troianskii had already accounted for it.

Even though it is unclear which languages besides Russian Smirnov-Troianskii knew (his examples were exclusively French and German), he made multiple passing references to Soviet language policy of the 1920s and early 1930s. For him, multilateral translations were not just more efficient, they “were especially important for translation from languages and to languages of the small nationalities of the Soviet Union” (“M,” p. 38).<sup>71</sup>

67. See figure 2.

68. Bel’skaia, “Machine Translation of Languages,” p. 383.

69. See Zhirkov, *Pochemu pobedil iazyk esperanto?* (Moscow, 1930).

70. See Michael G. Smith, *Language and Power in the Creation of the USSR, 1917–1953* (New York, 1998), pp. 20, 65–70, 110.

71. In his article reintroducing Smirnov-Troianskii, Zhirkov agreed in almost identical terms: see Zhirkov, “Granitsy primenimosti mashinnogo perevoda,” p. 123.

The Soviet Union, like the Romanov Empire before it, was a multilingual expanse with many small regional languages coexisting among Slavic, Turkic, and Caucasian vehicular languages across immense geographic space. This had always posed a dilemma for the state, between enforced bureaucratization in a single language (Russification, analogous to the contemporaneous Magyarization of the Eastern half of the Austro-Hungarian Empire and the partial Germanization of the Western half) or allowing regional variation. For early Soviet nationalities policy—assembled, as is well known, by Stalin himself as People’s Commissar of Nationalities—stepping away from Russification in favor of linguistic autonomy became the standard line. The first issue was to make sure all languages larger than a certain (relatively small) size had scripts and that those that had Arabic-derived scripts were moved to Latinized ones—out of Arabic due to fear of Pan-Turkism but not into Cyrillic to avoid the whiff of Romanov Great Russian tyranny. (Zhirkov was active here as well, having since the 1920s made grammars and dictionaries for several North Caucasus languages, such as Avar, Dargwa, Lezghian, Tabasaran, and Lakk.) Script reform was the first step toward the creation of literary languages, standardizing orthographies and grammars for schools. In 1934 one found Soviet textbooks printed in 104 languages, compared with twenty-five languages a decade earlier; even in 1938–39, the school year Russian became obligatory, there were twenty-two languages of instruction in Uzbekistan and seventeen in Ukraine.<sup>72</sup> Roughly a decade after the Great Break, the goals shifted, and Cyrillic alphabets replaced the recently introduced Latin ones, and then World War II deepened the shift as All-Union institutions like the Red Army promoted Russian as a lingua franca.<sup>73</sup> Before those transformations, though, Smirnov-Troianskii was looking at a country where he thought most people were monolingual, and he designed his translation scheme to enable linguistically-isolated monolinguals to communicate.

Both of the first two Stalinist contexts were instances where Smirnov-Troianskii developed his notions within a Bolshevik framework that Stalin later rolled back. The third context, by contrast, shows Smirnov-Troianskii moving very much in the same direction as the Great Break, and it builds on this point about monolinguals translating among various languages. The multilingual Soviet Union that Smirnov-Troianskii saw about him as he started work on his machine concept had only a rudimentary educational apparatus. It was not possible to train enough human translators to meet

72. See Simon Crisp, “Soviet Language Planning since 1917–53,” in *Language Planning in the Soviet Union*, ed. Michael Kirkwood (New York, 1989), p. 38.

73. Especially informative is Smith, *Language and Power in the Creation of the USSR*.

the growing needs of the Soviet state. Smirnov-Troianskii's solution was to insert machines into the process by rendering stages of the translation process algorithmic, making human labor more efficient: "As with any other normal machine, a translating machine also demands from people who want to receive normal work results from it that they observe the rules of its technology, in particular, introducing into the process of working with it not any raw material whatever, but only special material adapted to this process in advance" ("O," p. 6).

Think again of the A-B process. The only part that requires knowledge of more than one language is the transition from A<sup>1</sup>-B<sup>1</sup>; either half needs only someone educated in the rudimentary grammar of his or her own language, the kind of thing taught in aptly-named grammar schools. "Here the necessity of any kind of logical work on the text is entirely absent," Smirnov-Troianskii pointed out. "Thus, two translators, each of whom knows only one language, his native language, as a pair secure the entire translation from beginning to end" ("O," p. 7). This would not only produce a massive cost-savings with a less-educated corps of translators but was a practical necessity with a Soviet population that Smirnov-Troianskii (almost certainly exaggeratedly) estimated as 99 percent monolingual (see "O," p. 13).

There is nothing especially characteristic of the Stalinist 1930s in proposing efficiency; the tight link with the context comes with the analogies that Troianskii employed. For example:

There is no need to be stubborn about it. There are those masters who without machines, entirely with manual instruments, can prepare the most precise watch mechanisms. But after all one would begin to laugh at them if they started to reject the necessity of the employment of machines in the production of watches.

One can sow seeds by hand, and sow them well. But mechanical sowers exist for tractors. ["O," p. 14]

He even gendered the various jobs required in characteristic ways: there would be a female *mashinistka* to do the clerical work of input but a masculine *korrektor* and "literary editor" ("M," p. 37). In short, he wanted to mechanize a process that had previously been intellectual by reorganizing production to streamline labor. This mode of thinking is entirely familiar to the historian of technology; it is the language of Taylorism and Fordism. Developed in the US by Frederick Winslow Taylor and Henry Ford, respectively, the perceived efficiencies of not just the assembly line but of dissecting every labor process into a sequence of maximally economical motions—or, in our case, grammatical manipulations—was enormously popular in the Soviet Union, widely recognized under the acronym NOT (*Nauchnaia organizatsiia*

*truda*, Scientific Organization of Labor).<sup>74</sup> Smirnov-Troianskii's process, both the people and the machines, was Taylorism brought to translation, the kind of story that has been told many times in the cultural history of the 1930s.<sup>75</sup> Similarly, Smirnov-Troianskii's boldness in seeking out the patent fits neatly into the enthusiasm for amateur inventors in the 1920s and 1930s, a movement that in part laid the groundwork for the very state-heavy space program after the war.<sup>76</sup> Smirnov-Troianskii's machine was hardly ahead of its time; it was very much *of* its time. It was also of 1959 and 1966.

#### 4. 2020

With the growing incorporation of neural nets into MT programs, it might seem like the algorithm has been evacuated from this region. The central characteristic of deep learning, after all, is that after the program has been trained by cycling through an enormous number of pre-matched examples, the programmer no longer precisely understands the decision processes within the machine. There may be algorithms, but they are self-generated. When MT started, however, the picture of language it was possessed of required that our ordinary language was in itself generated by internal algorithms that weighed frequencies within preprogrammed structures—and this is what Dostert, Mel'čuk, and others modeled in their programs. The case of Smirnov-Troianskii recalls something often missing in that classical understanding of algorithm: that all algorithms require embedding in a person before they can be realized in a machine. If anything, deep learning has brought us back to his insight, for a human determines that the neural net is making matches correctly. This seemingly discarded technology reminds us of a vision of algorithms, and of language, that have always been with us.

But the case tells us more than that, specifically about how we can think about the history of technology, the Soviet Union, and their intersection. Each narrative of Soviet MT fixates on one feature of the object and walks through a separate set of questions and answers, drawn from distinct sources and preoccupations. The Cold War competition narrative was born of a contemporaneous critique of the escalatory tendencies of the arms race, as well as a Left-leaning suspicion of the military-industrial complex and its potential

74. See Zenovia A. Sochor, "Soviet Taylorism Revisited," *Soviet Studies* 33 (Apr. 1981): 246–64; Thomas P. Hughes, *American Genesis: A Century of Invention and Technological Enthusiasm, 1870–1970* (New York, 1989), chap. 6; and Samuel Lieberstein, "Technology, Work, and Sociology in the USSR: The NOT Movement," *Technology and Culture* 16 (Jan. 1975): 48–66.

75. See Stephen Kotkin, *Magnetic Mountain: Stalinism as a Civilization* (Berkeley, 1995), and David R. Shearer, *Industry, State, and Society in Stalin's Russia, 1926–1934* (Ithaca, N.Y., 1996).

76. See Siddiqi, "Imagining the Cosmos: Utopians, Mystics, and the Popular Culture of Spaceflight in Revolutionary Russia," *Osiris* 23 (2008): 260–88, and Smith, *Rockets and Revolution: A Cultural History of Early Spaceflight* (Lincoln, Neb., 2014).

distortion of research.<sup>77</sup> Although in principle symmetric between the US and the Soviet Union, in the history of technology this storyline emphasizes the former as prime mover, even in those cases (such as the space race) where the Soviets logged the first visible successes. Nonetheless, it is hard to deny that something like this went on in many different sectors during the period 1945–1990, and it remains probably the dominant tale of Cold War science.

The middle narrative—priority disputes and Khrushchevian attacks on Stalin—stresses the instrumental uses of history: either to gain credit for a particular researcher or to mobilize the perceived inequities of the past in favor of reform in the present. A rather substantial body of the history of science and technology serves this purpose, as scientists use a better-or-worse evidenced version of their history to either establish their discipline, claim priority, or mobilize political actors.<sup>78</sup> Here, of course, the worry is that in replicating a narrative that has been fashioned for a particular end, one ends up reproducing the original biases of the actors to be historicized. There is a catch; these kinds of histories often provide the raw material—autobiographical narratives, document collections—needed to write any history in the first place.

Finally, we come to the Stalinist/Taylorist narrative. This is undeniably satisfying to the Soviet historian; it is at the moment of Smirnov-Troianskii's work, and therefore the contexts seem more unmediated. One might imagine that given a certain density of primary sources about Smirnov-Troianskii's background, motivations, and employment history, one might be able to make the connections stick. This is not, however, our evidentiary situation here, and the most stable finding one can take away from the three Stalinist contexts sketched above is that those aspects seem plausibly to be retained in the later discourse about MT, although sometimes in transmuted form (the decided elision of Esperanto or the transformation of internal Soviet multilingualism to external Soviet foreign relations).

The inverted chronological order allows us to see these contexts temporarily in isolation, without subsuming them into a teleological narrative of technological innovation. But it does more than that as well—it bears on how historians might more aptly narrate the history of Soviet technology. In the historiography of Soviet knowledge systems, there is far less on technologies (outside of space and the atomic bomb) than on aspects of science such as genetics, physics, mathematics, and the social sciences. And when

77. A classic instance is Paul Forman, "Behind Quantum Electronics: National Security as Basis for Physical Research in the United States, 1940-1960," *Historical Studies in the Physical and Biological Sciences* 18, no. 1 (1987): 149–229.

78. See *Functions and Uses of Disciplinary Histories*, ed. Graham, Wolf Lepenies, and Peter Weingart (Dordrecht, 1983).

technologies do get incorporated into Soviet history, they are typically periodized and analyzed according to the dominant *political*, even regime-specific, general background. These narratives of the Cold War, Khrushchev, and Stalin are all stories about the same object: MT, more specifically the version articulated by Smirnov-Troianskii. The technology and its associated ideas do not stay confined in one period. Yet the historiographies that each section of this essay drew upon appear to be hermetically sealed from each other, as if Soviet history cannot be matched up at the edges—as if we cannot get, by any algorithm, from A to Б.