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JP Den Hartog about SP Timoshenko: Fifty Years Later

Isaac Elishakoff
Department of Ocean and Mechanical Engineering, Florida Atlantic University, Boca Raton, FL, USA

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Abstract
This study is devoted to Jacob Pieter Den Hartog's views about Stephen Prokopovych Timoshenko. Both were outstanding contributors to the mechanics-based design of structures and machines. Additionally, both were refugees, who were running from hardships in their own countries. Den Hartog ran away from economic hardships that befell the Netherlands after World War I. Timoshenko escaped two Russian revolutions that took place in 1917, in addition to the takeover of Kiev by several armies, including foreign ones, and imminent Soviet rule in Ukraine. Their destinies led them to meet at the Westinghouse Electric Corporation in the USA. This study reviews two prime documents associated with their interaction. The first document is the newly discovered letter sent by Den Hartog to Timoshenko half a century ago, specifically, on the occasion of the latter's 90th birthday in 1968. The second document is the review of the book *As I Remember* by SP Timoshenko that Den Hartog published in *Science* magazine, also in 1968. A complex interrelationship emerges between these two scientists. On the one hand, there is a tremendous appreciation felt by Den Hartog toward Timoshenko; on the other hand, one clearly observes Den Hartog's disapproval of Timoshenko's ingratitude to the USA, as expressed in Timoshenko's autobiography, in numerous passages.

Keywords
JP Den Hartog, SP Timoshenko, biographical information, Den Hartog's review of Timoshenko's book, Den Hartog's letter to Timoshenko

1. Introduction

It was a turbulent time, in the 1920s. Because of World War I, four Empires found their end. Specifically, the Austro-Hungarian Empire, Russian Empire, German Empire, and Ottoman Empire collapsed. The communist Soviet Union replaced the Russian Empire. In the beginning, Hungary was governed by the communists, who established the Hungarian Soviet Republic. The Bavarian Soviet Republic emerged in 1919 in Germany. People in the countries that won and in the countries that lost the Great War were afraid of communist takeovers. The economic situation worsened considerably. Hyperinflation in Germany made money nearly worthless. People were on the move, in search for stability and confidence.

The New World, with its geographic distance from the European turmoil, became a natural attraction for Europeans. In two decades, between 1900 and 1920, over 14.5 million people immigrated to the USA [1]. They felt, not unlike Steven Spielberg's mice dreaming that "There are no cats in America!" in the animated musical film *An American Tail*. Among the immigrants were the heroes of our story, two unlikely immigrants: Stephen Prokopovych Timoshenko and Jacob Pieter ("Japie") Den Hartog.

Corresponding author:
Isaac Elishakoff, Department of Ocean and Mechanical Engineering, Florida Atlantic University, Boca Raton, FL 33431-0991, USA.
Email: elishako@fau.edu

2. SP Timoshenko: Brief biography

Stephan Prokopovych Timoshenko was born in the village of Shpotovka in the Chernigov Governorate on 23 December 1878 in Ukraine, then part of the Russian Empire. At every turn, good fortune found its way to Stephen Timoshenko. The blessings started before his birth. His father was a serf. The nobleman who was also the landowner fell in love with Timoshenko's aunt, his father's sister, and then married her. As a result, Timoshenko's father became part of the landowner's family, rather than spending his life in serfdom, or near slavery.

In 1901, he graduated from the St. Petersburg Institute of Engineers of Ways of Communication. He continued to teach in this same institute during the years 1901–1903 as a teaching assistant and then moved to St. Petersburg Polytechnic Institute under Professor Viktor Kirpichov (1845–1913), where he was employed in the years 1903–1906. In 1905, owing to the first Russian Revolution, the university was not functioning. This was the year when the czarist troops opened fire on a group of workers marching to the winter palace in St. Petersburg to petition their grievances to Czar Nicholas II. Timoshenko was sympathetic to the workers' cause. Fortuitously, Karl Marx's book *Capital* was "much too heavy" for him, according to his testimony. He then left for Germany, where many Russian students pursued postgraduate studies. There he attended lectures by the famous mechanic and author August Föppl (1854–1924), in Munich, as an auditor. He also attended lectures by Ludwig Prandtl (1875–1953) in Göttingen. The city of Göttingen at that time was perhaps the scientific center of the entire world, not unlike present-day Cambridge, Massachusetts. There, Prandtl assigned him a topic for his dissertation, which Timoshenko completed in St. Petersburg.

Victor Lvovich Kirpichov (1865–1913) [2] played a major role in the life of Timoshenko. Kirpichov greatly appreciated the works of Lord Rayleigh and recommended that Russian engineers use the methods exposed in Rayleigh's book *Theory of Sound*. Timoshenko eagerly started to study this classic book. Fortunately for Timoshenko, Kirpichov was the founder and first provost of the Kiev Polytechnic Institute (currently the National Technical University of Ukraine or "Igor Sikorsky Kiev Polytechnic Institute"), which was established in 1898. Indeed, Kirpichov is widely considered the organizer of higher technical education in Ukraine, and the "father of Russian engineering" [3]. In 1906, a position opened at Kiev Polytechnic for chairperson of the Strength of Materials Department. Timoshenko applied for the job. Not without the active help of Kirpichov, Timoshenko got the position. This was despite the fact that he had never, prior to that, served as a lecturer.

On the recommendation of his teacher, Victor Kirpichov, Timoshenko was appointed chairman of the Strength of Materials department at the Kiev Polytechnic Institute. In 1909, he was promoted to the deanship. In 1911, he was fired from the Kiev Polytechnic Institute, owing to "political reasons," as he writes in his essay about his school-time friend Abram Ioffe (1880–1960) [4]. In 1911, he returned to St. Petersburg, where, luckily, he met Paul Ehrenfest, who came to Russia following his mathematician wife, Tatyana Afanasyeva (1876–1964). According to his own testimony, in his book [5] on the theory of elasticity, Timoshenko and Ehrenfest jointly developed the beam theory that incorporates both rotary inertia and shear deformation. In 1918, after the February and November Revolutions that had taken place a year earlier in Russia, Timoshenko returned to Ukraine, which then declared independence. In Kiev, he participated in the establishment of the Ukraine Academy of Sciences, assisting Vladimir Ivanovich Vernadsky (1863–1945).

In 1919, Timoshenko moved to Rostov-on-Don. Later, he decided to leave his native Ukraine, and, in 1920, arrived, through Constantinople (present-day Istanbul), in the Kingdom of Serbs, Croats, and Slovenes. Luckily for Timoshenko, the new Polytechnic Institute was established in Zagreb, and Timoshenko was offered a professorship. There, too, destiny treated him well. The students did not protest despite the fact that Timoshenko gave his lectures in a strange language, representing a mixture of Russian and Croatian. Again, he had good fortune: His former student, Victor Tseloval'nikov (in Russian, meaning the "kisser"), arranged for him to get a job at the Vibration Specialty Company owned by Akimoff [6] in Pittsburgh, in the USA. Timoshenko recalls in his autobiography [7] that he got "a letter from America from a pupil of mine at the Petersburg Polytechnic, one Zelov." According to Soderberg [8], Tseloval'nikov changed his name to Zelov, and "subsequently became a well-known industrialist in the United States and was founder and president of the VIZ Manufacturing Company in Germantown, Pennsylvania."

Napoleon Bonaparte (1769-1821) French miitary and political leader observed: "Ability is of little account without opportunity (as quoted by Moore [9])." The USA offered Timoshenko great opportunities. The University of Michigan offered him a professorship with little time allotted for teaching, primarily for graduate students, at a salary that was double that of other faculty members in his position. The university allowed him to spend large amounts of time during the day at home, composing his textbooks.

The books he wrote in this US period include:

(a) *Applied Elasticity*, with JM Lessells, 1925;
(b) *Vibration Problems in Engineering*, 1928, 1937, 1955 (3rd ed. with DH Young);
(c) *Strength of Materials*, Parts I and II, 1930, 1940, 1955;
(d) *Theory of Elasticity*, 1934, 1951 (with JN Goodier);
(e) *Elements of Strength of Materials*, 1935, 1940, 1949 (with GH MacCullough), 1962 (with DH Young);
(f) *Theory of Elastic Stability*, 1936, 1961 (with JM Gere);
(g) *Engineering Mechanics* (with DH Young), 1937, 1940, 1951, 1956;
(h) *Theory of Plates and Shells*, 1940, 1959 (with S Woinowsky-Krieger);
(i) *Theory of Structures* (with DH Young), 1945, 1965;
(j) *Advanced Dynamics* (with DH Young), 1948;
(k) *Mechanics of Materials* (with JM Gere), 1972.

Timoshenko also composed a book on the history of the strength of materials and the theory of elasticity. After visiting the Soviet Union in 1958, Timoshenko wrote about the Russian education system in engineering. Finally, in 1963, when he was 85 years old, he wrote a book *Remembrances*, in Russian. Addis translated this book into English. It appeared in 1968 under the title *As I Remember*, in conjunction with Timoshenko's 90th birthday.

3. JP Den Hartog: Brief biography

Jacob Pieter Den Hartog, later nicknamed Jaap or Jaapie, was born in Ambarawa on the island of Java in the Dutch East Indies, now Indonesia, on 23 July 1901. His family returned to the Netherlands in 1916, during World War I. He graduated from high school in Amsterdam in 1919, and from the Delft University of Technology in 1924, with a master's degree in electrical engineering. He was not able to find suitable work in the Netherlands, so he immigrated to the USA in 1924.

According to Stephen Harry Crandall (1920–2013) [10], Jacob's "father, Maarten, had been a school teacher in Amsterdam until he was dismissed because of radical activity. Maarten had been an outspoken supporter of Alfred Dreyfus in the early phases of that famous [or, rather, infamous, IE] affair when the popular view was strongly against Dreyfus. The family was forced to go to the Indies, and Maarten taught school in the colonial system in Ambarawa, Makassar, and Batavia."

Furthermore, "the following eight years were difficult for the Den Hartog family, Maarten, the father, died in Java soon after the family returned to Holland, and his wife was left with three children to support. Jaap was such an outstanding high school student that some of his relatives undertook to pay his expenses at the Technical University of Delft. Entering Delft in 1919, young Den Hartog decided to become an electrical engineer after seeing a dramatic physics demonstration in which lightning jumped from one charged sphere to another. He was a good student, but because of his limited financial situation, he was unable to participate in sports or social activities. He compensated for this by developing a strong prejudice against the rich. Economic conditions in Holland were sufficiently bad in 1924 when he graduated that even the best Delft students could not be sure of finding a job. For some reason, Den Hartog did not try very hard. He made only two applications, and he was rejected, then impulsively decided to leave Holland to seek his fortune in the USA. Arriving in New York without connections and essentially penniless, Den Hartog took to USA with great enthusiasm. He worked briefly at a series of temporary jobs until he learned that Westinghouse was hiring electrical engineers in Pittsburgh. Luckily he was accepted to Westinghouse just in time to be placed in an in-house training course for new engineers."

4. Meeting Stephen P Timoshenko at Westinghouse

Crandall [10] also tells us how Den Hartog met Timoshenko: "Among the lecturers was Stephen P Timoshenko, an émigré Russian professor of mechanics who had been hired by the Westinghouse Research Laboratories the previous year. The eager young Dutchman impressed Timoshenko. None of the US engineers had even heard of a Bessel function. When the training course was completed, Timoshenko requested that Den Hartog be assigned to the mechanics section of the research laboratories to work as his assistant. It was here that Den Hartog served his real professional apprenticeship. In the next three years, Timoshenko converted the young electrical engineer into a mechanical engineer by assigning him a wide variety of vibration problems across the whole spectrum of Westinghouse products: electric motors and generators, steam turbines, hydropower turbines, railroad electrification, etc. While working at the research laboratories during the day, Den Hartog studied mathematics in the evenings at the University of Pittsburgh."

Elsewhere, Cannon and Crandall [11] describe the meeting between Timoshenko and Den Hartog as follows: "Through a series of fortunate accidents, he soon found himself in Pittsburgh working for Westinghouse as the assistant of a Russian émigré, Stephen P Timoshenko, ten years his senior and venerated world guru in applied mechanics (Fig. 1). Timoshenko's selection process was to compose a written examination for the group of Westinghouse candidates to try their hand. When he saw Den Hartog's solution set he pronounced, 'Bring me this man!'."

Crandall [10] provided the following characterization of Westinghouse: "Technically, Westinghouse was an exciting place to be during the twenties. This was a period of industrial growth and expansion. Highly talented individuals were successfully solving challenging engineering problems in innovative ways. In the mechanics section, the most influential person was Timoshenko. With his powerful personality, he was an inspirational leader for the young men in the division. He made them feel they were capable of great accomplishments and encouraged them to publish their results as technical papers. The five years that Timoshenko spent at Westinghouse have been called the 'golden era of mechanics' in which rational analysis blossomed and took precedence over empirical method. By the time Timoshenko left to join the faculty at the University of Michigan, the mechanics sections had grown to include JM Lessells, GB Karelitz, RE Peterson, J Ormondroyd, AW Wahl, and Q Nadai, in addition to Den Hartog. They also worked closely with outstanding engineers in other departments, such as CR Soderberg in the generator department and LS Jacobsen in the motor department."

In his Timoshenko medal acceptance speech, Crandall [12] noted: "In my case, I owe a great deal to my mentor, the late Jaapie Den Hartog and indirectly to his mentor before that. When I joined the ME department at MIT in 1946 Den Hartog was my first boss. Many of you already know that Den Hartog's first boss, 22 years earlier at Westinghouse, was none other than our Stephen Prokopovych [Timoshenko]."

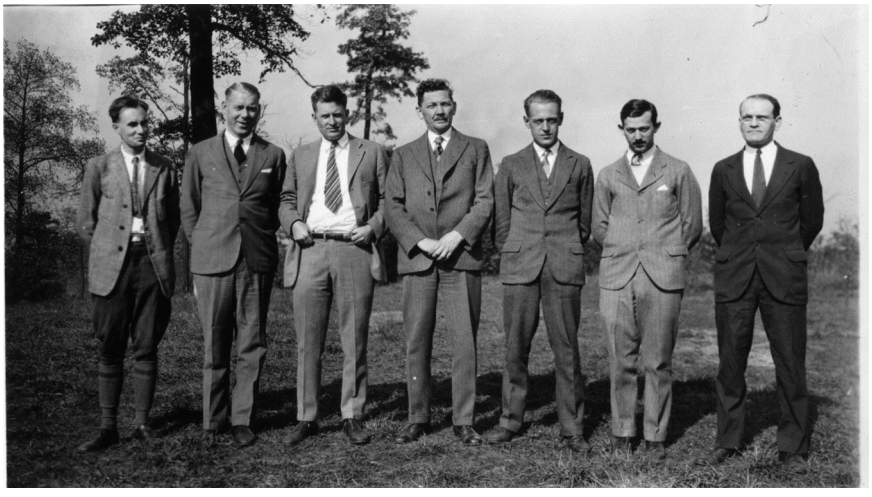

Figure 1. JP Den Hartog is on the extreme left, SP Timoshenko is in the middle of the picture.

5. Testimonies of Timoshenko medalists

Ted Belytschko (1943–2014) [13] recollects, in his Timoshenko medal acceptance speech in 2006: "I still vividly remember one of the first talks I heard by Den Hartog—in those days every Timoshenko lecturer could still start with a reminiscence of their contact with Timoshenko. Den Hartog had worked for Timoshenko one summer, and when he wrote his study up as a report, Timoshenko told him to submit it for publication. Den Hartog responded that he did not think that this work was something the world was waiting for. Timoshenko replied—'How many publications that have appeared in the literature do you think the world was waiting for?'."

Yuang-Cheng Fung (b. 1919), in his Timoshenko medal lecture of 1991 [14], puts the story of Den Hartog's paper somewhat differently: "Another good description of Timoshenko I heard from Den Hartog in his Timoshenko award acceptance speech. Den Hartog said that he was working under Timoshenko at Westinghouse Research Lab when he finished a paper on torsion and hesitated to publish it because he did not know whether it was important enough. Timoshenko told him 'Who do you think you are! One contributes what one can!'."

6. Testimony of GS Pisarenko

Georgy Stepanovich Pisarenko (1910–2001) was a Ukrainian scientist working in theoretical and applied mechanics. He wrote a biography [15, 16] of SP Timoshenko. Pisarenko [15, p. 21] writes: "In the 1960s, Kiev was visited by [Jacob Pieter] Den Hartog, Professor of the Massachusetts Institute of Technology. It turned out that he was a co-worker and student of Timoshenko, working with him at Westinghouse Company. A Dutchman by descent, he lost his father early and considered Timoshenko as his second father. Den Hartog visited the Department of Strength of Materials of the Kiev Polytechnic Institute, which was chaired by the author of the book [Pisarenko], at that time. When he learned that this department was headed by Timoshenko during the years 1907–1911, Den Hartog remarked that his visit to the department which was chaired by his teacher, was 'equivalent to visiting sacred places for him'." (For more about Den Hartog's correspondence with Professor Kozhevnikov, see Pryn et al. [17].)

7. Competition between Timoshenko and Den Hartog?

The tremendous respect that Den Hartog had for Timoshenko is evident by the fact that Den Hartog's second son, named Stephen Ludwig, in honor of Timoshenko and Prandtl, respectively, was born in 1933.

It appears that there was a competition between JP Den Hartog and SP Timoshenko. Indeed, had Den Hartog considered that Timoshenko's books were the best, he probably would not have engaged himself in writing his textbooks. These are *Mechanical Vibrations* [18], which appeared in 1934, when Den Hartog was 33 years old; *Mechanics* [16], published in 1948; and *Strength of Materials* [20], published in 1949; the text *Advanced Strength of Materials* [19] saw light in 1952. Crandall [22] emphasizes: "He was the author of the best-known textbook on vibrations and was widely acclaimed for his skill in identifying the underlying mechanisms responsible for unexpected vibration problems in machines and structures."

Sofronas [23] calls Den Hartog's book on vibrations his "favorite." According to Moon [24], "Den Hartog's book acknowledges his indebtedness to his former colleagues at Westinghouse as well as to Professor Timoshenko…"

Jazar [26] states: "Although Timoshenko was the architect of modern structure of engineering education and his various books were used for a long time in educating mechanical and civil engineering, it was Den Hartog's *Mechanical Vibrations* that was globally accepted as a classical educational book. Almost all mechanical vibration books that appeared after 1940 follow the structure of Den Hartog's."

Mattheij [27] informs us: "In 1972 [the year of Timoshenko's death, IE] he received the Timoshenko medal, a prestigious distinction of ASME named after his teacher and friend Stephen Timoshenko."

Moon [24, p. 15] continues: "Both Den Hartog and Timoshenko brought advanced analytical techniques to America from Europe and Russia and combined them with experience with practical problems in [the] industry." Moon [24, p. 16] also writes on Timoshenko's "first dynamics book [which] was published in 1928 under the title *Vibration Problems in Engineering*… He also acknowledged his indebtedness to the Westinghouse Corporation as well as Den Hartog, with whom he had worked on several dynamic problems in electricity generating systems for Westinghouse."

In his *In Memoriam* piece, Crandall [22] characterizes Den Hartog's vibration book as "famous." Cannon and Crandall [11] use the adjective "venerable" for this book. They also inform us that, "He is remembered also by MIT's JP Den Hartog Distinguished Educator award to recognize 'excellence … in the tradition of Den Hartog'. The ASME Design Engineering Division established the Jacob P Den Hartog Award for 'sustained meritorious contributions to vibration engineering', of which he was the first recipient."

MIT established a special Den Hartog lecture in mechanics, as a part of a mechanical engineering colloquium series. The announcement for the series describes his book *Mechanical Vibrations* as his *magnum opus* (see, e.g., the announcement of the lecture by Edgar Knobloch of University of California at Berkeley) [28].

Richardson [29] (see Ewing [30]) states: "the large influx of foreigners … has brought to our shores some outstanding figures in the applications to mechanics; we may cite Friedrichs, Den Hartog, Kármán, Mises, Prager, Reissner, and Timoshenko. These and others form a nucleus for instruction and research, which we trust betokens a far-reaching development (see also Daniels [25] and Koiter [33])."

8. Newly discovered letter from Den Hartog to Timoshenko

The present author discovered the following letter by Den Hartog [31] at the Vechorin collection, which is available at the Bakhmeteff Archive of Russian and East European Culture, in the department of rare books and manuscripts of the Butler Library of the Columbia University in New York City.

J.P. Den Hartog
Professor of Mechanical Engineering
Massachusetts Institute of Technology
Cambridge, Massachusetts

1 December 1968

Dear Professor Timoshenko

Congratulations on your 90th Birthday. It is wonderful to know that at this age you are mentally completely alert and physically still as capable as many others 30 years younger.

I feel grateful to you more than I can express. When I met you first in October 1924 you were 45 years old, so that I have known you for half your lifetime. I was then 23 and now not quite 69, so that I have known you 2/3 of my lifetime. You have shaped my career and have made possible all the goals and interesting things that have happened to me in my life. I remember the day in 1926 when I had done a simple calculation and you said I should publish it. That sounded preposterous to me and if you had not pushed me I would never have published anything and never become a teacher!

And what you have done for me you have done for many others!

Next week in New York, at the Applied Mechanics Banquet at the A.S.M.E. meeting there will be some 300 people who will remember and honor you as the Founder of the Division. Also, the Timoshenko Medal will be given to Koiter, another Dutchman and pupil of Biezeno, who was my first teacher.

Thirty years ago at that ASME banquet we were proud to present to you your "Festschrift" which goes to many successful European professors.

We all wish you many more years to watch the development of the world: a world, which you have helped mold.

Your grateful pupil,
Jaap Den Hartog

9. Den Hartog's review of Timoshenko's autobiography

In 1963, Timoshenko's autobiography, *Remembrances*, was published in Paris, in the Russian language [32]. In an unusual act of kindness, Stanford University sponsored translation of the book into English. The book, titled *As I Remember* [7], appeared in 1968, the year that Timoshenko reached his nonagenarian age.

Den Hartog's [34] review reads: "This is a very interesting book indeed. It is the story of an eminent teacher who literally lived two lives, the first in Russia before the revolution and the second in the United States after it. It is the story of a man whose father was born a serf in Russia; who between the ages of 40 and 44, during the Russian Revolution, wandered all over eastern Europe under frightful

circumstances, with hardly a place to sleep; who at the age of 44 came to the United States barely able to understand English and then in the next 40 years fundamentally transformed the teaching of engineering mechanics in our universities; and who now, nearly 90, is still hale and hearty."

Den Hartog tells us the story of Timoshenko's immigration to the USA: "When the Bolsheviks took hold in 1917, Timoshenko fled, first south to Kiev, where during the short-lived independence of Ukraine[, h]e became one of the founders of the Ukrainian Academy of Sciences, then further south to the Crimea, to Istanbul, and to Zagreb, where he became a professor again. The story of these wanderings and of how he brought his family out of Kiev is truly hair-raising. In 1922 he immigrates [sic] to the United States then began his second life, first for a short time with Mr. Akimoff [6], also a Russian refugee, in Philadelphia, then [at] a Westinghouse research laboratory in Pittsburgh for five years, then at the University of Michigan for nearly ten years, and finally at Stanford University. Between 1922 and 1962 he wrote a dozen books on all aspects of engineering mechanics, which are in their third or fourth U.S. edition[s] and which have been translated into half a dozen foreign languages each, so that his name as an author and scholar is known to nearly every mechanical and civil engineer in the entire world."

Den Hartog stresses: "There is no question that Timoshenko did much for America. It is an equally obvious truth that America did much for Timoshenko, as it did for millions of other immigrants for [sic] all over the world. However, our autobiographer has never admitted as much to his associates and pupils who, like myself often have been pained by his casual statements in conversation. That pain is not diminished by reading these statements on the printed page and one would have wished for a little less acid and a little more human kindness."

This writer was able to correspond with Mr. Stephen Den Hartog, son of the late Professor JP Den Hartog. Stephen Ludwig Den Hartog (Private communication, 2017) writes: "My memory is that pop always thought the best of his 'mentor' but dad disliked Timoshenko's attitude about the United States."

Den Hartog [31] is not alone in his criticism of Timoshenko. Simha [35], most probably borrowing from Soderberg [8, p. 338], writes of: "… a strange love-hate relationship of his feelings toward America, which never left him and sometimes stood in the way of a full utilization of his talents. In reading *As I Remember*, one is astonished at the absence of a single word in grateful recognition of his debt to America, which had awarded him such a rare opportunity (also noted in the review of *As I Remember* by JP Den Hartog, *Science*, vol. 160, 1968)." Soderberg [8] stresses that "…throughout years of turmoil—the late twenties, the depression, and the years just prior to World War II—this attitude of Timoshenko's did not appear to soften…But whatever there was of bitterness was encased within his innermost being," which found full manifestation in his autobiography [7].

10. Conclusion

Den Hartog's [34] critical comments about Timoshenko's ingratitude toward the USA are even more striking, since Den Hartog admired Timoshenko and had a deep appreciation for the role Timoshenko had played in his life as evident by his letter to Timoshenko [31].

Acknowledgements

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