VYSOKÉ UČENÍ TECHNICKÉ V BRNĚ
BRNO UNIVERSITY OF TECHNOLOGY

FAKULTA ELEKTROTECHNIKY A KOMUNIKAČNÍCH TECHNOLOGIÍ
ÚSTAV JAZYKŮ
FACULTY OF ELECTRICAL ENGINEERING AND COMMUNICATION
DEPARTMENT OF LANGUAGES

Komentovaný překlad

Bakalářská práce
Bachelor's thesis

AUTOR PRÁCE
AUTHOR
Tereza Nováková

VEDOUCÍ PRÁCE
SUPERVISOR
doc. PhDr. Milena Krhutová, Ph.D.

KONZULTANT
CONSULTANT
prof. Ing. Jaromír Brzobohatý, CSc.

Brno, 2015

VYSOKÉ UČENÍ TECHNICKÉ V BRNĚ

Fakulta elektrotechniky a komunikačních technologií

Ústav jazyků

Bakalářská práce

bakalářský studijní obor
Angličtina v elektrotechnice a informatice

Studentka:	Tereza Nováková	***ID:***	154656
Ročník:	3	***Akademický rok:***	2014/2015

NÁZEV TÉMATU:

Komentovaný překlad

POKYNY PRO VYPRACOVÁNÍ:

Překlad odborného nebo populárně naučného textu s analýzou rozdílů a podobností v přístupu obou jazyků k přesnému přenosu zprávy.

DOPORUČENÁ LITERATURA:

Krhutová: Parameters of professional discourse, Tribun EU, 2009
Knittlová: Překlad a překládání, Palacký University, 2010
Widdowson: Discourse analysis (vybrané části)

Termín zadání: 9.2.2015 ***Termín odevzdání:*** 22.5.2015

Vedoucí práce: doc. PhDr. Milena Krhutová, Ph.D.
Konzultanti bakalářské práce: prof. Ing. Jaromír Brzobohatý, CSc.

doc. PhDr. Milena Krhutová, Ph.D.
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ABSTRACT

The aim of this bachelor's thesis is to translate a scientific text and then comment on the various changes and modification it had to undergo in order to attain the approach on the transmission of information as well as the transmitted information itself. Several linguistic viewpoints were implemented, both syntactical and lexical, and the field of "Czenglish" is discussed, a linguistic field closely associated with scientific translations. Additionally, a brief theoretical introduction concerning forms of scientific texts and their properties is included.

KEYWORDS

Translation of scientific text, scientific text, language of scientific texts, relationship between original and translated text

ABSTRAKT

Cílem této bakalářské práce bylo přeložit odborný text a okomentovat změny, jak syntaktické tak i z pohledu slovní zásoby, které bylo nutné zakomponovat do finálního překladu, aby se zachoval původní přístup autora k podání informace a také to, aby se zachovala původní informace samotná. Jedna kapitola je také věnována problematice odborného překladu obecně, s charakteristikou odborného textu. Poslední kapitola se krátce zabývá problematikou tzv. „Czenglish“, která právě s překladem odborného textu úzce spojena.

KLÍČOVÁ SLOVA

Překlad odborného textu, odborný text, jazyk odborného textu, vztah originálu k překladu

Nováková, T. *Komentovaný překlad*. Brno: Vysoké učení technické v Brně, Fakulta elektrotechniky a komunikačních technologií. Ústav jazyků, 2015. 51 s., 3 s. příloh. Bakalářská práce. Vedoucí práce: doc. PhDr. Milena Krhutová, Ph.D. Konzultant: prof. Ing. Jaromír Brzobohatý, CSc.

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V Brně dne ....

(podpis autora)

I would like to thank my thesis supervisor doc. Krhutová for her invaluable advice while writing my thesis. I would also very much like to thank my thesis consultant, prof. Brzobohatý, for his guidance and fruitful debates on the topics of my thesis.

TABLE OF CONTENT

1 INTRODUCTION

Translating a scientific text is a complex adventure. The aim is often not on the proper translation by the translator, but on the proper comprehension of the receiver. Translating a text to the translator's mother tongue is not as impacted by improper translation as when translating to a foreign language.

My task was to translate a scientific text and then comment on the changes and possible alteration between the source and translated text in order to transmit the intended message. I chose an article dealing with microelectronics, as that is the field I would like to continue studying. In order to translate the text with the appropriate level of expertise, apart from studying the phenomenon at hand I also consulted with professor Brzobohatý, who offered me invaluable insight into the field of microelectronics as well as Czenglish, which is discussed briefly in the last chapter.

In order to evaluate the translation, a brief description of the generic scientific text will be provided, to serve as a baseline for the assessment of the translation. Several factors will be discussed as well as a concise analysis of the features o the text as a whole. Two distinctive areas will be assessed, the syntactical and lexical, comprising both cohesive devices and improper/proper use of stylistic markers.

After the assessment is complete, I hope to compile a complete summary of the marked features complying with the expectations of both the formal and discourse analysis.

Additionally, resulting from my translation I will enclose a complete dictionary detailing various terminologies implemented while describing a purely microelectronics oriented topic.

In order to properly reference the examples in question, the English translation is marked with line numbers, the Czech original with page numbers.

TRANSLATION

2 Memristor and its place in circuit theory

Dalibor Biolek[1,2], Zdeněk Biolek[3], Viera Biolková[4]
[1]Katedra elektrotechniky; Fakulta vojenských technologií UO Brno,
dalibor.biolek@unob.cz
[2]Ústav mikroelektroniky; Fakulta elektrotechniky a komunikačních technologií VUT, Brno, biolek@fekt.vutbr.cz
[3]SŠIEŘ, Rožnov pod Radhoštěm, zdenek.biolek@roznovskastredni.cz
[4]Ústav radioelektroniky; Fakulta elektrotechniky a komunikačních technologií VUT, Brno, biolkova@feec.vutbr.cz

2.1 Introduction

Time-honored articles written by professor Leon Chua, dating back to 1971 [1] and 1976 [2], in which he defined a memristor as the fourth fundamental passive circuit element in electrical engineering and presents the memristive circuit as a representative, had been until last year beyond the interest of the expert community. It was in May 2008 when the dramatic change occurred as a Hewlett-Packard (HP) research team published an article in the Nature magazine, reporting the discovery of the memristor as a passive element in a solid-state structure [3]. The advancements in nanotechnologies made such a discovery possible, they revealed that a memristive behavior is a naturally occurring phenomenon in the nanoscale domain.

Ever since May 2008 and the discovery of the memristor, Hewlett-Packard has been heavily funding further research, namely with regard to the soon-to-be revolution on the memory market. It is in fact expected for the memristor acting as a switch [4] in the Resistive Random-Access Memory (RRAM) to succeed the latest flash memory [5]. Purely analog features are also being researched, as such an application could subsequently be implemented into the high-capacity analog memory designated for brain cell simulations and thus accelerating the artificial intelligence development [3], [6]. A great increase in memristor-related publication of both technical solutions [5], [6], [7], and fundamental research followed these events. The development progresses so swiftly that a number of authors do not wait for their works to pass the lengthy procedure of external examination in high impact-factor magazines and opt for e-prints [8]-[11] on the Internet or blog posts [12]. In November 2008, University of California, Berkeley released a complete video recording of an international symposium detailing the memristor and memristive circuits.

The memristor history (**Mem**ory **Res**istor) officially began, however, on the 5th of September 1971, when Chua published his article [1] titled “Memristor – The Missing Circuit Element”. In this article he deduces that in order to retain the symmetry between the four fundamental electrical quantities – voltage v, current i, charge q and magnetic flux φ – a fourth fundamental passive element should exist, to complement the resistor (R), capacitor (C), and inductor (L). Such an element - the memristor (M) - has so far been eluding the attention.

The original article [1] contains detailed parameter derivations of this new element, with the ability to "remember" the total amount of electric charge passing through being quite salient. In practical terms, this means that the memristor resistance can easily be increased or decreased by the passing current in either direction over a period of time. The theory being that should the current supply be suddenly terminated, the memristor would "remember" the last value of resistance for an arbitrarily long period of time.

Such an element would act as the perfect analog memory and would have great implementation possibilities. It could also be employed in computer technologies as a one-bit memory or even as a multi-level energetically independent rewritable memory.

While passive elements such as R, L, or C are simple to manufacture, the search for the proper physical principle that would allow for the production of a memristor as a passive element has long been unsuccessful. However, as early as in 1972 Oster and Auslender published an article [14] describing the mechanical, hydraulic, and chemical systems that had their motion equations formally equal to those of the electrical memristor. It was at the beginning of 1970s when some researchers begun to realize that a number of phenomena they experience daily within their fields of expertise are, in fact, exhibiting the characteristics of a memristor. Chua once again crowned this development. He cooperated with Sung Mo Kang and in 1976 published an article [2] called "Memristive Devices and Systems". Within this paper he defined a class of memristive systems – dynamic systems with memristive properties, listing the memristor as a special case. His work [2] lead to the identification and unified description of various systems with the inexplicable property of hysteresis. Principally, there is no difference between the mathematics of a light bulb, car shock absorbers, or a neural synapsis, for their behavior can formally be described using the identical equations.

Even though the fact that a number of common phenomena manifest memristive behavior has been known for a long time, it has not influenced the scientific research whatsoever. This, however, changed in May of 2008 with the Nature magazine publishing an article [3] titled "The missing memristor found". A Hewlett-Packard research team based in Palo Alto, California and lead by S. Williams has officially announced that the memristor predicted in 1971 has been manufactured as a semiconductor element. The story behind this discovery is told by S. Williams in [15].

On the other hand, it is necessary to note that some of the vital articles by Chua date back to 1980s. Within these articles he established a new and axiomatic system of higher order elements, one of these elements being the memristor. In 2003, five years prior to the discovery by Hewlett-Packard, he published an accomplished paper in the IEEE Proceedings magazine, inspired by certain findings and latest questions in the nanotechnology domain. It is quite likely that had the HP researchers been more familiarly acquainted with these papers, the discovery of a solid-state memristor would have come earlier on.

The article depicts the memristor as a circuit element and deals with its parameters. Turning to a number of Chua's papers that have been nearly forgotten, it is possible to analyze the purpose of the memristor and of a number of other elements within the present circuit theory currently being "rediscovered" due to the advancements in nanotechnology.

2.2 Hewlet-Packard discovery, what is memristor

A memristor is in fact a resistor; its resistance can be altered using the current flowing through in either direction. Should the current supply be cut, the state and thus also the resistance value will be stored within the element.

The operating principle is shown in **Fig. 1**, depicting a hydro-mechanical analogy. The tube with water flowing through represents a memristor with passing current. The water flow turns the propeller, moving the stopper in either direction of the flow. Altering the stopper's position changes its cross-section and thus the resistance of the tube with respect to the flowing liquid. Should the water flow stop, the stopper would cease its motion. The tube would then store its state (and also its resistance) until the liquid started to flow again, moving the stopper.

By storing its instant position x the propeller also recognizes the total volume q of the liquid that had flown through, creating a continuous resistance R of the whole system, $R=R(q)$. When the stopper is positioned in the left section of the tube depicted in **Fig. 1**, water flows not only through the propeller but also around the stopper and the system has a minimum resistance R_{on}. The maximum resistance R_{off} is when the right section is blocked by the stopper and the water can only flow through the propeller. With the stopper moving alternately in both directions and staying inside the tube (see the third picture in **Fig. 1**), the whole system behaves like an ideal memristor - that is as a resistor that changes its resistance continuously according to the volume of the current flowing through.

The HP memristor is a nano-element, created by a thin layer of titanium dioxide TiO_2 with the cross-section D≈(10-30) nm, enclosed by two platinum electrodes. The TiO_2- is a fine insulator. One of the electrodes is, however, deprived of oxide atoms, which creates a layer of positively charged holes (denoted as TiO_2- in **Fig. 2**) behaving precisely like a semi-conductor with a decent conductance. The total resistance between the electrodes is a sum of both the semiconductor and insulator layer resistances.

The boundary between the conducting and non-conducting layer moves due to the current in its direction, the width of the conducting layer w changes, and the memristor changes its resistance (see **Fig. 3**). The maximum resistance R_{off} is in the state a), whereas the minimum resistance R_{on} is in the state b). The current can shift the boundary to either side. If the memristor disconnects from an external voltage, the current ceases to flow. The boundary will then stop its motion. The element is thus capable of storing its resistance theoretically for an arbitrarily long period of time.

Comparing the hydro-mechanical and semiconductor memristor in **Fig. 1** and **Fig. 3**, it is possible to conclude the following analogies:

Tab. 1: Hydro-mechanical to electrical analogy.

Memristor	
Hydro-mechanical	Semiconductor
Pressure gradient in the tube *p* [*Pa*]	Voltage *v* between the memristor outputs [*V*]
Velocity *v* of the flow of the liquid [m^3/s]	Electric current *i* [*A*]
Stopper velocity *V* [*m/s*]	Boundary velocity *V* [*m/s*]
Volume of the liquid *q* that passed through the tube [m^3]	Electric charge *q* that passed across the memristor [*C*]
Stopper position *x* [*m*]	Boundary position *w* [*m*]
Tube resistance *R* [$Pa\ s\ m^{-3}$]	Memristor resistance *R* [*Ω*]

Table lines are organized in series, demonstrating a progression of events resulting in the memristive effect. A torque or voltage external force puts the fluid or the electric charge in motion. The propeller in the stopper or the semi-conductor boundary integrates these motion changes in the time domain, resulting in the position. The memristive effect then lies in storing the very last position, whether it be the position of the stopper or the boundary between the layers. The resistance value of the memristor is then derived based on the position.

Fig. 4 depicts this memristive effect as a structural diagram. The memristor acts as a resistive port driven by the state *x* (boundary, stopper position) with a memory element to store the state. The memory is in fact a mechanism (like the propeller on a turn) that integrates the velocity *dx/dt* (the flow velocity, the boundary velocity) over time. This velocity is directly proportional to the current passing through with the proportionality constant *k* (slope of turns, migration velocity of charge carriers). According to the direction – the sign – of the current, the coordinate *x* either increases or decreases, and changes the value of the resistance in the corresponding direction. After disconnecting the memristor from an external excitation source, the very last state is recorded into the memory and with it also the last resistance value.

Taking into account the above-described memristive effect, it is evident why the memristor is such a lucrative element for a company like Hewlett-Packard. Should the long-term memory effect of the memristor be confirmed, such an element would then behave as a single bit nonvolatile rewritable memory utilized in boundary states R_{off} and R_{on} as well as an analog memory with a continuous scale of states. The energy, in this case, is needed only when writing and reading the memory, not for maintaining the information. Considering the fact that it is indeed a nano-element, the estimated record density is several times greater than that of the flash memory.

The diagram depicted in **Fig. 4** provides a clear guide to equations describing the memory of the memristor as well as its resistive port. Assuming that the state x is *x=w/D* (**Fig. 2**) and taking into account the previous equation, the dimensionless x will then range between 0 and 1. This is then the state equation for the memristor memory:

$$\frac{dx}{dt} = ki(t) \tag{1}$$

and for the resistive port:

$$v(t) = R_{mem}(x)i(t). \tag{2}$$

The resistance of the memristor is as follows:

$$R_{mem}(x) = xR_{on} + (1-x)R_{off} = R_{off} - x\Delta R\ , \Delta R = R_{off} - R_{on}. \tag{3}$$

Its adjustable limits are from $R_{mem}(0) = R_{off}$ to $R_{mem}(1) = R_{on}$.

These equations may be the starting point for memristor manufacturing and also for computer simulations of the memristive behavior, utilizing a number of simulation programs such as Matlab or SPICE. (…)

2.3 Memristor properties

When obtaining the memristor ampere-volt characteristics it is clear that this is no ordinary element. If connected to any nonzero voltage source, the memristor boundary between the conducting and non-conducting layer starts to move, and after a short period of time the device enters one of its boundary states (depending on the polarity of the voltage). It is thus impossible to measure its static ampere-volt characteristics. On the other hand, characteristics obtained by exciting the memristor by a defined periodic signal that moves the internal boundary in either direction there and back, is quite interesting. **Fig. 5** represents memristor excitation by a harmonic voltage with non-zero RMS value of the following three elements: linear resistor, non-linear resistor, and memristor.

The memristor is a passive element, just like a simple resistor, its ampere-volt characteristics thus have to pass zero, and lies solely within the first and third quadrant.

The ampere-volt characteristics of the linear resistor are depicted in **Fig. 5 a)**. Its slope marks the instant conductance, and since it is constant it has the shape of a line. **Fig. 5 b)** demonstrates that the instant resistance of the non-linear resistor depends on the instant value of voltage (current); its slope is hence derived from its operating point. The memristor represented by **Fig. 5 c)** has its resistance dependent not only on its instant state but also on previous states leading to the latest one. Since the memristor state is defined by the total charge, its state history is unique for each quadrant and, accordingly, also its slope. That is the reason why the memristor has to return to zero in a different manner than in which it reached its respective state. This resolves the shape of the memristor characteristics – a loop.

Such a hysteresis loop is a typical feature of the memristive behavior, originally described by Chua [1]. Due to this unique fingerprint the researches from HP confirmed that the element they have just created is indeed a memristor [15].

Increasing the frequency of the sinusoidal excitation voltage forces the internal boundary to move faster. This phenomenon leads to the decrease of the subtraction between minimum and maximum resistance as well as the amplitude of the current passing through the memristor. The hysteresis loop then changes its shape to reflect the higher frequencies, thus shaping into a line. The slope of this line is then given by its conductance, which corresponds to the mean value of the x position – the center of boundary oscillation. At higher frequencies the memristor behaves as a common resistor.

Simulations depicted in **Fig. 6** confirm these general conclusions. The excitation sinusoidal voltage has the amplitude of 1 V, at frequencies 1 Hz and 5 Hz. The three sections denoted in each graph represent the following signals in time: boundary state x, voltage and current through the memristor, hysteresis loop of the ampere-volt characteristic. Following these graphs it is clear that with higher frequencies comes the loss of memristive qualities. These simulations are based on a new SPICE memristor model for the Micro-cap program. (…)

2.4 Memristor as a memory

According to the information obtained at seminars [13] and [15], the memristor future is tied to the so called crossbar structure, in which each memory segment is interconnected into a matrix (see **Fig. 7**).

A grid of crossing conductors creates the crossbar structure. At each crossing, horizontal and vertical conductors are separated by a memristor. Since the memristor is an energetically independent memory, its memory matrix does not consume any energy when in quiescent state.

The addressing for each memory cell when reading or writing is fairly simple, it requires only the activation of corresponding conductors x and y.

The process of writing into the analog memristor cell means changing the resistance value to any value ranging from R_{on} to R_{off}. The memristor resistance can be continuously changed by the amount of charge – by adding an external source of voltage or current over a period of time.

The reading process of the analog memristor cell means determining the last resistance value. This can be achieved by measuring the current (or voltage) while applying a known voltage (or current). The issue arising from such a procedure is that the original resistance value changes, as the current of any value puts the internal boundary to motion. One way of avoiding such a change is reading the cell utilizing a perfectly symmetrical sinusoidal signal of low amplitudes. See **Fig. 8** for an example.

A voltage pulse causes data to be written to the cell by supplying the charge necessary to alter the resistance of the memristor. **Fig. 8** depicts a constant width of the pulse with alternating amplitude and pulse polarity. **Fig. 8** also illustrates that the first write pulse magnifies the width of the layer (setting a higher x value), thus decreasing the memristor resistance. The second write pulse of inversed polarity raises the resistance to a different value. After each write pulse end, the memristor saves the respective resistance values that are later read in the subsequent reading cycle. During the reading process a harmonic voltage with low amplitude is applied, and the latest amplitude value is read. Following the simulation results it is visible that a small reading voltage only causes the internal boundary to fluctuate around its latest value. However, if the reading signal has its mean value equal to zero, the reading cycle will not influence the measured state.

With respect to such an example, further memristor implementation will require new *analog* methods even if it is to be used in *digital* technology.

2.5 Memristor as a special case of memristive systems

The component emerging from the HP laboratories is not in fact an ideal memristor, as its resistance cannot deviate from the (R_{on}, R_{off}) range. As soon as the boundary between the conducting and non-conducting layers, influenced by the passing current, reaches either one of its edges, the x state can no longer change, not even with additional current passing through. At the edges of the memristor it no longer applies that the memristor resistance is directly proportional to its charge. In other words, the memristor "loses its memory", as the charge that passes across yet does not alter its state, is in fact forgotten.

There is a number of passive systems capable of partially storing the amount of passed substance. All of them exhibit a hysteresis behavior, indicating a memory. A simple example is the light bulb.

The resistance of a light bulb is based on the temperature of the wire that partially depends on the total current that passed through. The wire temperature is influenced not only by the passing current, but also by the current that has flown through up until now. This feature makes the light bulb a memory element with hysteresis ampere-volt characteristics.

Fig. 9 illustrates computer simulation results, where a sinusoidal voltage of 12V/50Hz powered a 12V/21W light bulb. The state quantity is the wire temperature. The computer simulation assumes that the rate of the rising temperature (*dx/dt*) is directly proportionate to the supplied input power minus various losses due to heat radiation. These losses cool the bulb and correspond to the fourth power of the wire temperature. The state equation of the bulb and its resistive port are the following:

$$\frac{dx}{dt} = f(x, i), \quad (4)$$

$$v(t) = R(x.i)i(t), \quad (5)$$

where $f(x,i) = (a + bx)i^2 - cx^4$; a, b, c are material constants and $R(x,i)$ is a function describing the thermal dependency of a common non-linear resistance of the bulb wire.

Equations (4) and (5) represent the generalized equation (1) and (2) and describe a non-specific memristive system, first named and described in [2]. Its structure adheres to the above-mentioned equations and is depicted in **Fig. 10**.

Following the scheme in **Fig. 10** it is evident, that the memristive system is once more a resistor with a memory. As opposed to the memristor however, this memory can now be of more variable shape. The state equation (4) detailing this memory is an equation of a universal non-linear dynamic system, where a whole vector of internal variables can represent the *x* state.

Such a system does not necessarily have to be electric, for any physical quantities can represent the state vector and the port variables v, i. Due to this feature it is possible to distinguish signs of any memristive behavior exhibited by a wide variety of systems; also, it does not matter whether the system is a living organism or a machine (see [10] for an example).

Memristive systems can literally be found everywhere. Taking into account the light bulb, even every conductor with a current passing through is a memristive system. In Chua's [2] the following elements are presented as examples: thermistor, discharge tube, and ion system of a neural cell.

Comparing structural schematics in **Fig. 4** and **Fig. 10**, the memristor is simply a special case of a memristive system. Since the integrator does not contain any feedback, the memristor holds the "perfect memory". Such a passive and energetically independent element is ideal for storing information permanently in various technical devices.

2.6 Memristor as the fourth fundamental element of electrical engineering

In his famous article [1], Chua predicts the memristor on the basis of the so-called square symmetry. **Fig. 11** is in this context often referred to, which was taken from [18]. The quartet of electric quantities *v, i, q, and φ* adds up to six pairs: *v-i, q-v, φ-i, φ-q, φ-v, q-i*. The relations between *φ-v* and *q-i* are given by time differentiations – integrals. The relationship between the voltage and current, charge and voltage, and flux and current are defined by the resistor ampere-volt characteristics, capacitor coulomb-volt characteristics, and inductor weber-ampere characteristics. Differential quantities arising from these characteristics are resistance, capacity, and inductance. The last pair *φ-q* indicates, according to Chua [1], a fourth passive element – the memristor, with a corresponding differential quantity – memristance, defined as a ratio of $d\varphi/dq$. A dimension test shows that the unit of memristance is ohm.

In his elemental work [1] Chua also adverts that none of the trio of passive elements *R, L, C* can be fully synthesized solely via combining the remaining elements, and the same applies to the memristor. Considering this line of thought, the memristor is also a fundamental passive element.

It is a known fact that a synthetic inductor can be created using resistors and capacitors, and an active element, such as an operational amplifier. In this manner Chua [1] describes, how to implement a synthetic memristor into practice utilizing known elements and mutators. Chua then concludes with hopes that in the future, the memristor will be fashioned as a passive element. Hewlett-Packard fulfilled his hopes 37 years later.

At this point, the memristor may seem merely as a simple resistor with unique resistance-charge dependence. Explained below, however, is that this "odd" behavior defined by hysteresis dependencies is merely due to the choice of quantities that are used to study various circuit phenomena. Opting for a different pair than voltage-current means moving to a different coordinate system, which will allow for the fundamental discovery of memristor principles.

Coordinates of each point of the hysteresis curve depicted in **Fig. 5c** are bound by the Ohm's law $v(t)=R(q)i(t)$. Using as few physical quantities as possible, it is viable to simplify this equation. Since the current represents the speed of charge change $i=dq/dt$, elemental adjustment will result in $v(t)dt=R(q)dq$. The left component of the equation is a differentiation of the equation

$$\varphi(t) = \int v(t)dt. \tag{6}$$

In the end, the Ohm's law for memristor is as follows:

$$R(q) = \frac{d\varphi}{dq}. \tag{7}$$

Quantity φ defined in (6) is the time integral of voltage, in electrical engineering called the magnetic flux. Depending on its application, it may not necessarily represent the magnetic field and thus would be referred to only as *flux*. The flux is an alternative to the momentum (or the force pulse), one of the fundamental quantities in theoretical mechanics.

The equation (7) describes the instantaneous (dynamic) memristor resistance studied via the magnetic flux φ and charge q, equals to the slope of the curve. This slope represents the dependency

$$\varphi = f(q)\,. \tag{8}$$

Memristor creates a direct link between the flux and charge. **Fig. 12**, expanding the known concept in **Fig. 11**, portrays the relevance of such a device for theoretical electrical engineering.

Each passive element in **Fig. 12** has a corresponding graph depicting its **constitutive relation**. For instance, the constitutive relation for a capacitor is the relationship between its electric charge and voltage, graphical representation being the coulomb-volt characteristics. If the capacitor is nonlinear and stationary, then the relation is a unambiguous function. Differential and static capacities can then be derived for particular operating points, based on this equation. Similarly for the memristor, the webber-coulomb characteristic represents its constitutive relation and is a unambiguous function even despite the memristor ampere-volt characteristics being hysteresis. Furthermore, the level of hysteresis effect depends on the memristor excitation, on its circuitry implementation. Following the explanation above, the choice of coordinate system for the memristor study is vital.

Opting for time integrals and not their respective voltages and currents, it is possible to transform the ambiguous ampere-volt characteristics into the unambiguous constitutive relations.

In a sense of full disclosure, **Fig. 11** or **Fig. 12** representing the idea of four fundamental elements are not the only schematics available. In his work [19], Kraemer published a triangular scheme, depicted in **Fig. 13**. When comparing all of the abovementioned diagrams it is clear, that the triangular offers no new information; it is merely a geometrical modification of respective graphical objects. (…)

2.7 Conclusion

Since 1971, the memristor has been regarded merely as a hypothetical element in the scientific literature. Despite its characteristics being available, very few people believed that it would actually be discovered and utilized as a passive component, just like resistors, inductors or capacitors. The memristor was defined by a number of memristive behaviors occurring on a regular basis. As of today it is clear, that researchers have been searching the "wrong fields". Scientists clung to the fact that the memristor has to be linked with *magnetic* flux, as predicted by prof. Leon Chua. The proof that memristive behavior is a natural phenomenon in the nanometric domain came no sooner than in May 2008.

The memristor was not the intended goal of the research in the Hewlett-Packard laboratories; its discovery was thus an unexpected but welcomed surprise. According to [15], the vital breakthrough could have been missed had it not been for Greg Snider, who noticed that the hysteresis curve, measured regularly every day, resembles all to precisely the graphs of the long-forgotten paper on memristors [1] from 1971.

The story behind the memristor discovery provides a perfect lesson on the importance of education. Despite the theory on memristive systems being very well developed and providing a clear insight into the behavior of dynamic systems, not many people are familiar with it. Luckily, G. Snider, HP researcher behind the memristor discovery, was among the few knowledgeable.

It is crystal clear that a number of vital theoretical works that surfaced right after the memristor discovery could have been written any time in the 37 years of memristor silence. The memristor offers us a lesson of sorts, knowledge detailing some of the fundamental principles of our world is often deemed of no value, unless it leads to revenue. Topics, such as the "instant turn-on computer", are more media-friendly and attract more visitors to the international scientific conferences [27].

The memristor will still be for a time unavailable as a component that can be experimented with. Interested parties can either utilize a SPICE representation of the memristor or use the Micro-Cap program directly. It is available from the Spectrum Software website [28].

2.8 Figures

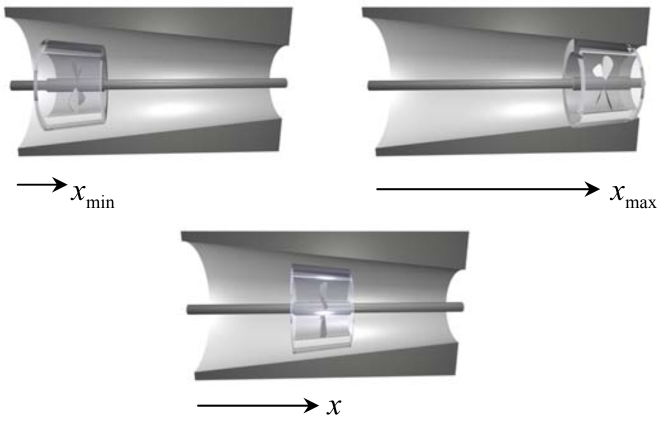
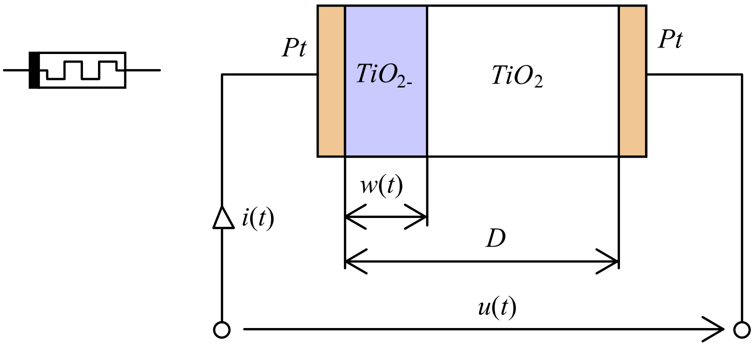
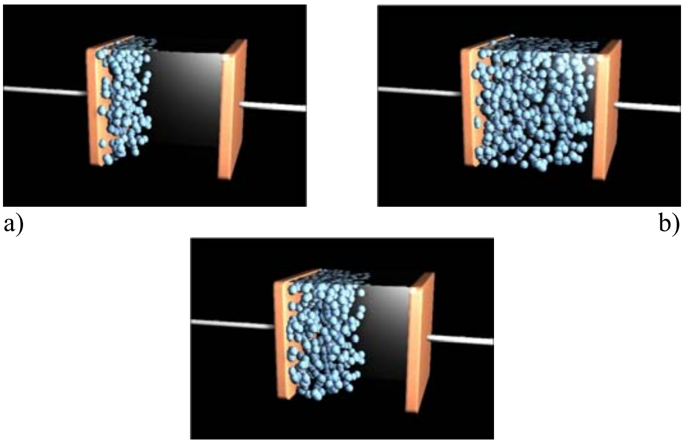


Fig. 1: Hydro-mechanical memristor model. The propeller is embedded on a stick attached to the stopper. Its movement depends on the liquid flow and oscillates within the range of x_{min} and x_{max}. (Author: P. Mich).



$u(t) = v(t)$

Fig. 2: Semiconductor memristor, Hewlet-Packard laboratories.

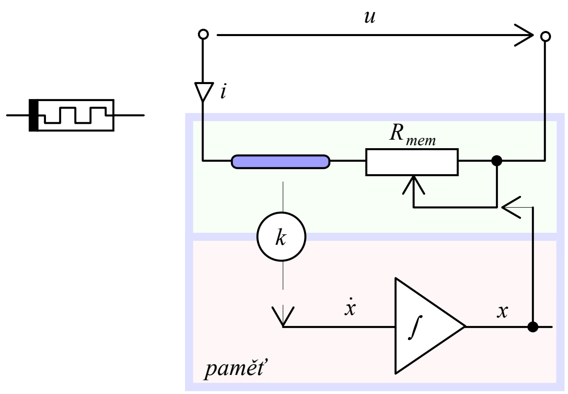


a)

b)

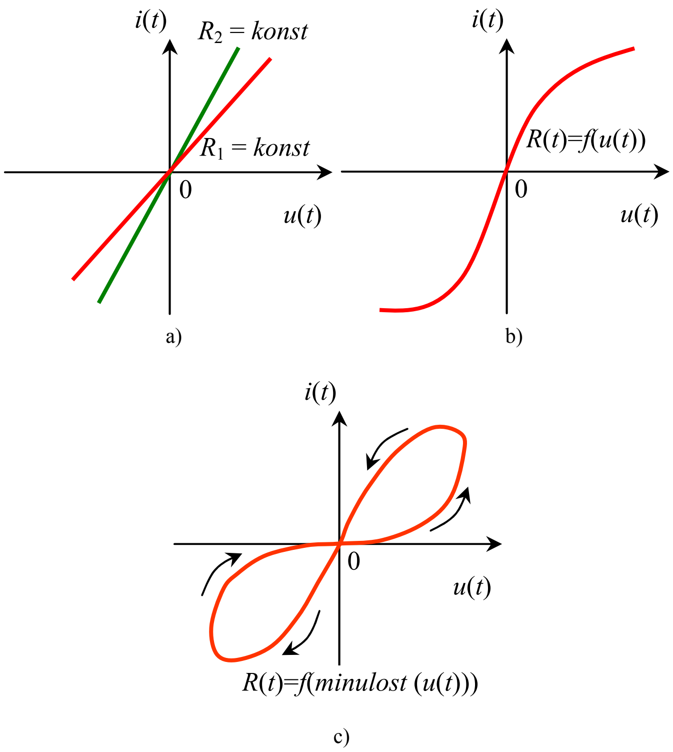
c)

Fig. 3: Dopant movements within the HP memristor.



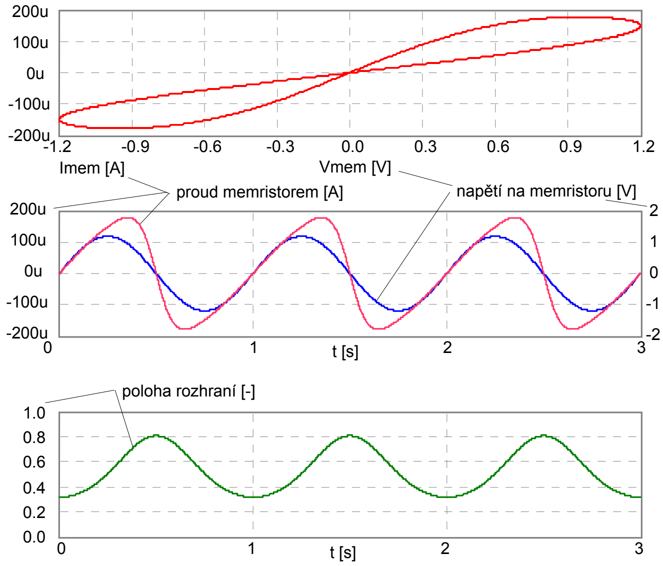
paměť = memory; u = v

Fig. 4: Principles of the memristor memory effect.

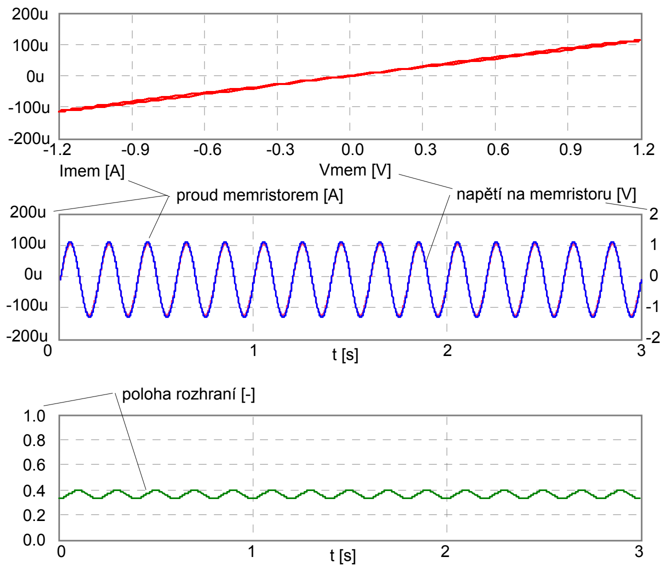


konst = const; R(t)=f(u(t)) = R(t)=f(v(t)); u(t) = v(t); R(t)=f(minulost (u(t))) = R(t)=f(past (v(t)))

Fig. 5: Ampere-volt characteristics of a) linear resistor; b) nonlinear resistor; c) memristor.



a)



b)

proud memristorem = current through memristor; napětí na memristoru = voltage across memristor; poloha rozhraní = boundary position

Fig. 6: Memristor characteristics when excited by a harmonic voltage of a) 1 Hz; b) 5 Hz.

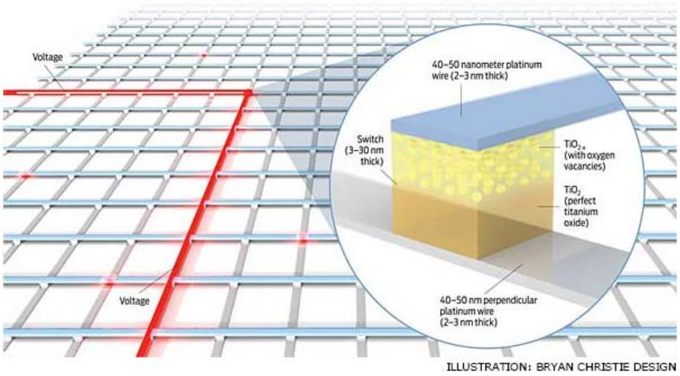
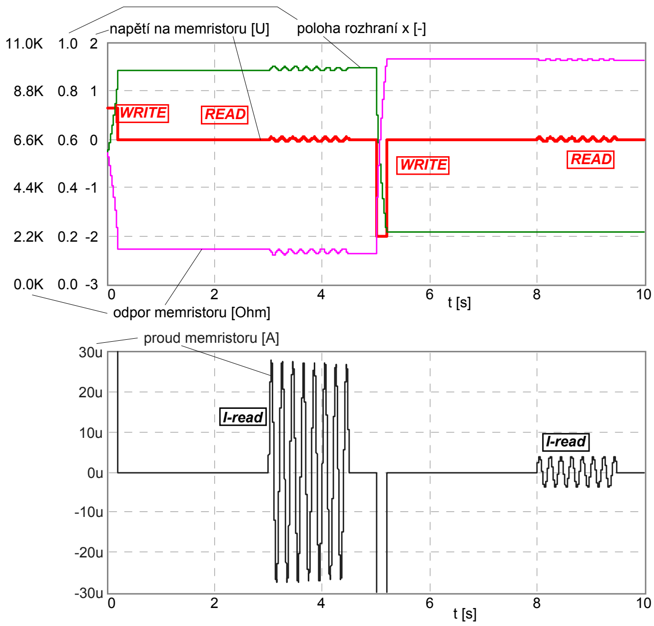


Fig. 7: Memristor matric connected in crossbar structure (source – [15]).



napětí na memristoru [U] = voltage across memristor [V]; poloha rozhraní = position of the boundary; odpor memristoru = memristor resistance; proud memristoru = current through the memristor

Fig. 8: Read and Write processes of the memristor state.

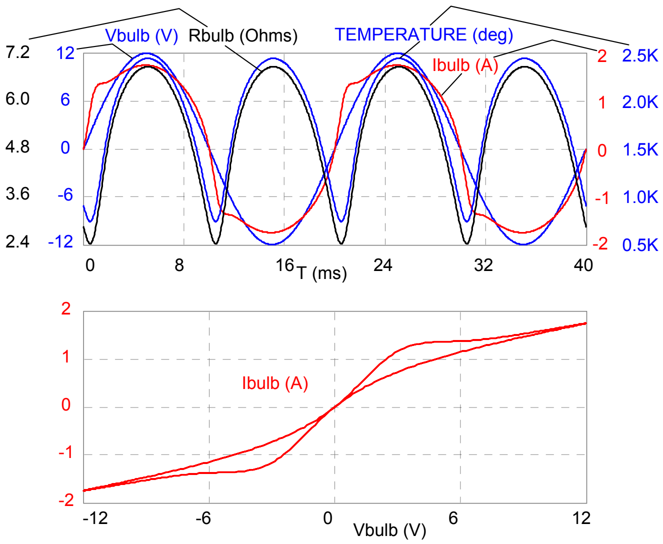
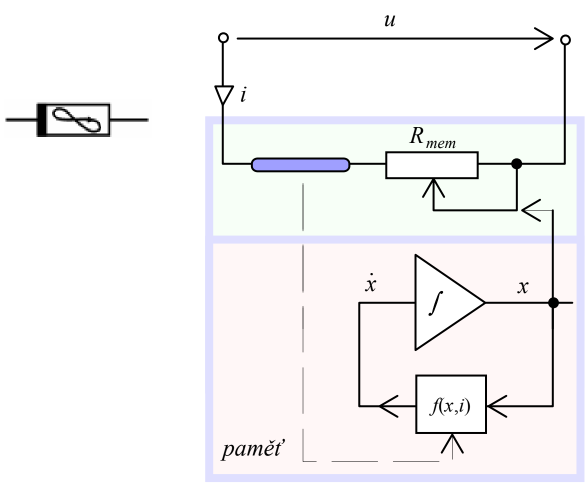


Fig. 9: Simulation of the light bulb 12V/21W hysteresis behavior.



paměť = memory; u = v

Fig. 10: Diagram of a standard memristive system.

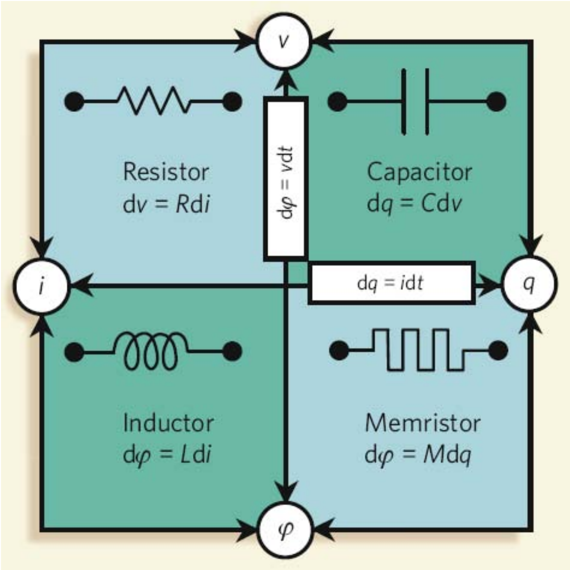
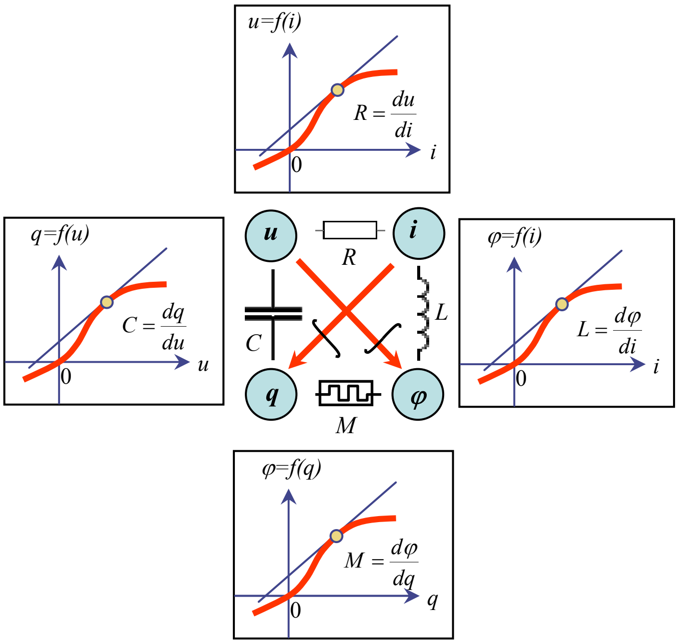


Fig. 11: Four fundamental passive elements of the electrical engineering according to [18].



Equations with u → u = v

Fig. 12: Constitutive relation of passive elements.

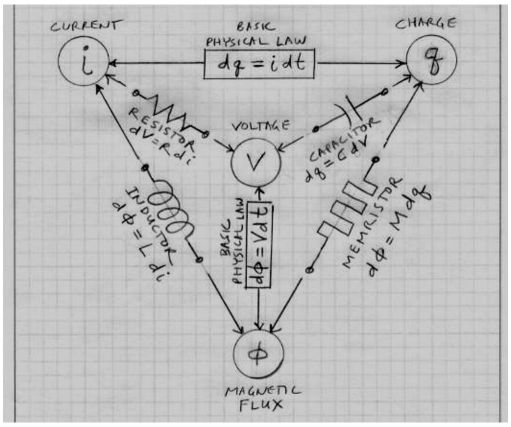


Fig. 13: Triangular diagram according to Kraemer [19].

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[SHORTENED]

ANALYSIS

3 SCIENTIFIC STYLE AS A GENRE

First and foremost it is important to define the term *genre.* Genres, according to Biber (1992), are based on external, non-linguistic criteria. Widdowson says that a genre is: "A type of discourse in written or spoken mode with particular characteristics established by convention, e.g. a cooking recipe, a letter of application, a sermon…" (2007:127). These definitions both state that a genre is a defined category serving a specific purpose; that it has its corresponding and appropriate lexis, grammar, style and audience, and in order to convey information appropriately, these standards should be respected.

According to the audience type the text is meant for, there are two basic genre types – formal and popular scientific. These then contain subgenres based on the required background knowledge.

3.1 Formal and Popular Scientific Style

The first formal scientific text most likely dates to the year of 1949, when Joseph Chapline wrote the world's first user's manual for a BINAC computer. The first technical job advertisement was first published in1951, offering a "technical writer" position (Proedit).

The formal scientific style has been defined numerous times not only by linguists, but also by companies directly involved and actively using the formal type of scientific style. In 2012, Microsoft released its fourth edition of the *Microsoft Manual of Style*[1], a guide detailing the properties and methods for the correct technical writing. The IEEE Professional Communication Society[2] is another authority pursuing the development of standards within the technical field.

The formal style of scientific text is of an impersonal character. Its purpose is to transmit a clear message, to describe and define a certain phenomenon. It should be concise and focused solely on the phenomenon at hand. With the formal style comes a certain expectation of interest, as it is not meant to attract the audience, but to inform already *instructed readers* (Krhutová, 2009) with the appropriate background knowledge (Knittlová, 2010).

On the other hand, the popular scientific style is more "popular", as its title suggests. It creates a bridge between the professional scientific community and the general audience. Knittlová (2010) and Krhutová (2009) both agree that its format is more attractive to the wider audience. Considering that such a text is offered to the general audience, scientific methods and concepts have to be simplified and presented in a more personal and entertaining manner. Utilizing metaphors and analogies can contribute greatly to the correct

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[1] https://www.microsoft.com/learning/en-us/book.aspx?id=15053

[2] Official webpage: http://pcs.ieee.org

comprehension. A scientific text can be of various expertise levels, for the form has to serve the audience (Stevens, 2007).

3.2 Typical Features of Scientific Text

Over the last decades the world of science has seen a tremendous amount of development. Nowadays, the technical writing style has to be divided into further categories, as new scientific departments are constantly being studied. Certain types of "Englishes" (Schneider, 2003) have even become their own study fields and are being taught separately from the classical English, such as the business English, or English for IT purposes, or even the study of American vs. British English. These additional branches of English are, however, not included, as the focus of this thesis is the language of electrical engineering.

When writing a technical text of any form, it is necessary to mind the "informality" of the text, as the main aim of a scientific text is to convey an exact message. Considering the fact that a scientific text contains a great amount of terms, it has to be formed in such a way as to avoid any ambiguity. Composing clear and *straight to point* sentences as well as aiming towards simple hierarchical text structure is the key element for transmitting the message in an appropriate fashion. Knittlová (2010) also notes that the syntax is quite simple. There is no need for extraordinary or expressive sentence structures, only the expository style is used, and the narration is strictly objective. Stereotypical sentence structures are expected, with sentence condensers and complex word formations.

As mentioned in 3.1 however, texts dedicated to a broader audience tend to contradict the above-mentioned rules and focus more closely on the personal approach to the audience.

3.3 Scientific Language

A scientific nomenclature is of a dense character. Each scientific branch has its own set of terminology, giving each term its own and unique meaning. For instance, the term *current* would mean "up to date" for someone with no scientific knowledge. To an expert dealing with nanotechnologies, *current* would represent much smaller values than to an engineer in power plants. Such a distinction is made purely on the person's background knowledge or the level of their expertise (Kuchař, 1965).

With each scientific field generating new word concepts every day, the need to coin new terms is great. Providing new meanings to common words (náboj, *p. 1*), adapting the originals (analog/analogový, *p. 1*), or creating unique terms (kmitočet, *p. 4*) are some of the most common word formation techniques when coining new Czech terms (Kuchař, 1965).

The most frequent lexical category are substantives, scientific texts have the highest density of terms. Linking expressions are used to stress out and to link information, but most importantly to implement a hierarchical structure (Knittlová, 2010) and thus support the appropriate comprehension. To express probability, discourse markers such as "most likely" "definitely" "apparently" are implemented in both languages. On the other hand, when a certain degree of uncertainty needs to be expressed, it is usually achieved via hedging. Yule (2001) notes that hedging is a form of acknowledging the fact that what is being presented may not be sufficiently correct or complete.

Sentences are usually introduced with formal phrases, such as "Taking into account", "Following this line of thought". These expressions add almost no semantic value and are thus only shifting the focus on the scientific idea at hand (Knittlová, 2010). Compounds are another frequent element of the scientific texts, compiling single-word expressions from otherwise multiple-word expression (up-to-date, aluminum-based). Another typical feature are gerunds. To maintain the impersonality and objectivity, the formal tenor is utilized; in the Czech language, to avoid the personal pronoun *I* if required, the anonymous *we* is used instead ("zaměřme se teď na…", "aplikujeme-li tento postup…", "pokud bychom uvážili…"). In English, it is often best to opt for the passive sentence structure ("It should be pointed out that…", "It has been found out that…", "The aim has been achieved…") (Knittlová, 2010; Dušková, 2012).

The scientific style has unique characteristics, as was also mentioned in 3.2. The article (Rulíková, 1978) goes as far as to say that complex and often long sentence structures may aim to reflect the complex scientific phenomena being discussed. Krhutová (2009) adds that not only sentence structures are affected by the transmitted information, but also the style and approach both reflect the complexity of the transmitted data.

3.3.1 Terms and terminology in scientific genre

The expressive medium for technical texts is terminology. Mistrík (1997) defines terms as elements warranting explicitness and unambiguity, these terms then create terminologies specific for each scientific discipline. According to Krhutová (2009), these specific terminologies then "imprint" each text with parameters corresponding to the chosen terminology. Terms are thus independent on the context of the original text and retain their meaning even outside of their appropriate discipline. Mistrík (1997) adds that each scientific discipline possesses, apart from its original terminology, also its unique system of slangs, ranging from those with the lowest level of expertise to those with the highest expertise level.

Newmark (1988) states that such a specific vocabulary should always be translated using their respective counterparts in the target language. However, he continues that at times such action is not possible due to several reasons, when for instance the term in the source language does not yet have its counterpart in the target language or there is a more suitable synonym to be used in that specific context, as to avoid ambiguity with other disciplines or repetition.

An interesting connection follows this line of thought. The translator has to be properly educated on the matter of the scientific discipline in question, otherwise he/she would not be able to note that ambiguity and act accordingly. Newmark (1988) also points out that a translator should be knowledgeable not only in the specific discipline present but in the scientific discipline in general. Hanáková (2010) further supports this idea that a term does not always have to have its respective counterpart within the current scientific field and it is thus up to the translator to act accordingly.

3.4 Translating scientific style

As mentioned in previous chapters, the scientific style has three distinctive features as far as the stylistics is concerned. First, as agreed upon by all linguists, the scientific style possesses a strict standard of logical sequencing of utterances. The utterance is often monological and written and as such does not have feedback (Knittlová, 2010). Second, to complement and stress the sequencing, appropriate use of previously coined and standardized terminology is implemented. Third, to transmit the logical utterance containing complex terms, sentence-patterns have to be utilized. Miššíková (2003) classifies these patterns as postulatory, argumentative and formulative. It could be said that Knittlová (1995) further develops these patterns, presenting fundamental textual components. She presents a general view that the most basic textual element is in fact its semantic meaning. This semantic meaning is expressed using lexical elements that are linked together with one another by following the appropriate grammar standards. Thus follows that there are three aspects to the meaning of a text. First comes the denotation aspect, containing the fundamental transmitted data. The connotation aspect governs the employment of stylistic means. These two factors are then put into practical use via the pragmatic aspect, based, for instance, on empirical schemata – the participant's background knowledge.

Over the years there has been a shift from the traditional equivalence of the source text to the translated text to a functional equivalence. Now, it is the recipient's reaction that is taken into consideration, as said reaction is desired to be of the same character when receiving the source text as well as the translated text, meaning that the focus is not on the exact transformation of the grammatical structures, for instance, as they may not work the same way in both languages, but on application of said structures, whether they operate on the same principles in both languages. When working with the scientific type of texts, its theme-rheme property can be used as an example, as their position differs in Czech and in English (Knittlová, 1995; Newmark, 1988). This will be further discussed in 5.

3.4.1 Translatological process

Linking the information presented in the previous chapter, Newmark (1988) addresses the following effective method of translation. First, it is important to read the translated text aiming towards proper understanding – to receive the pragmatic meaning. Then, the text should be assessed, with the focus on the stylistic means utilized. Lastly, its semantic devices should be analyzed and translated accordingly.

The translator thus has to focus not only on the original text, but also on its appropriate transcription into the translated language. He/she is responsible for both maintaining a close link with the original text and for the corresponding translation (either cultural or factual). Nord (2005) describes this fragmented focus as *loyalty* to the source and the translated text.

Newmark (1988) then once more puts forth an interesting observation, one that is often neglected even today. When a technical translator translates – or transfers, where appropriate – the source text, he/she should be able to understand the mechanics hidden within the transmitted information and not only the grammatical structures he/she have just created. Such a comprehension ensures that the technical principle is transferred correctly and will be understood the way the author meant it to be understood.

Scientific language is constantly evolving, new standards are being introduced (analyza – analýza, defined in *Pravidla českého pravopisu*, 1957) and new words are coined or adopted (wi-fi, hi-fi) (Tejnor, 1976; Knittlová, 2000). The Czech language especially is likely to use a foreign word, while modifying it slightly. An inexperienced translator might loose perspective while searching for the correct equivalent in his/her target language and as a consequence the overall message is then suppressed. Knittlová (2010) suggests reading and analyzing the specific scientific content first, and then searching for their respective equivalent translations. Knittlová also notes that scientific text has several layers of terms, depending on their level of expertise. The final result of such an analysis could very well be a dictionary devoted to that specific text.

The last translatological factor that should not be discarded, are the cultural standards. When translating fiction for instance, the cultural aspect would lie in transferring those words that mean something only to a certain type of audience. Knittlová (1995) offers a simple example in the form of national food or even idioms to some extent, as they too have to be transferred to the target language.

When working with technical text, such standards may manifest in details, in something semantically as small as a letter. When studying English texts on electrical engineering, voltage is denoted as *v*. However, in Czech to avoid confusion with the quantity of voltage – volts – voltage is denoted as *u.* Even something as fundamental as addressing *figures* in a paper may be complicated, as in Czech these *figures* are called *obrázky* (*pictures*).

3.4.2 Types of translation

Several linguists have classified various types of translation, the more prominent being Jakobson, Newmark, and Vinay and Darbelnet. These methods can be implemented when there is no appropriate use of equivalence.

Jakobson (1959:114) introduces three kinds of translation:

a) Intralingual – in Jakobson's words "rewording", using synonymic expressions and patterns, both in the lexical and syntactical level of a text
b) Interlingual – or "translation proper", using language means of one language system to interpret a different system, to transform the "message" in the source language to the target language.
c) Intersemiotic – or "transmutation", using verbal language system to interpret a nonverbal system.

Newmark (1988) proposes several categories. Word-for-word and literal translation both have in common the fact that they often translate *literally* and out of context. Faithful and semantic translations differ in their approach on the *aesthetic* view of the message, compromising on the meaning of the text. Adaptation and free translation offer *free forms* of translation;

Newmark (1988:41) denotes them as “poor and pretentious translations”. Idiomatic and communicative translations focus on the message of the original text. He then sums up that the most efficient ways of translation are those following the semantic and communicative method.

Vinay and Darbelnet (in Knittlová, 2010) offer seven fundamental translatological methods that can be sorted into two categories, based on the translatological approach:

a) Direct translation
    1. Transcription – transforming a term using a different language system
    2. Calque – literal translation
    3. Substitution – using an equivalent instead of the original
b) Oblique translation – free translation in order to preserve the equivalence of the source
    1. Transposition – changing the term grammatically
    2. Modulation – utilizing a different viewpoint
    3. Equivalence – modifying the original term using expressive, idiomatic or cultural expressions of the target language
    4. Adaptation – substituting an untranslatable situation with a more appropriate

4 FORMAL ANALYSIS

This chapter presents a general view on the article and my translation of said article. It aims to provide a formal baseline of general features of both the original article and its corresponding translation.

4.1 Form

The original Czech article written by D. Biolek, Z. Biolek, and V. Biolková (2009), follows standardized rules of the *Slaboproudý obzor* magazine as to what the composition formalities should be, when compared with other articles. The paper is structurally divided into seven (nine) chapters, number three and four appear twice. In order to comply with the assigned range, chapter five and six were omitted, they contained specific information not directly tied to the theoretical text presented in the first chapters. A header with the magazine information and brief information about the authors' occupation is included. Abstract and keywords are also present.

The body of the article is split into two columns, having both graphical and equation support material to transmit a clearer message. Distinguishing markers such as italic and bold fonts are utilized to mark specific information. Line 224 represents the utilization of italic font to stress the fact that the *analog* and *digital* field of technology are two distinctive scientific areas, which need to overlap in order to provide the necessary features. To mark unscientific data, quotation marks are used – a device cannot "remember" data as this verb corresponds only to human memory, line 38.

The aim was to translate both the content and formal level. However, to implement the layout line numbers to allow for a simpler identification of referenced phenomena, the two-column composition as well as the direct implementation of figures had to be hindered. The header and magazine information stamped on each page were also omitted, as they serve no greater purpose within the translation. Nonetheless, these features serve as formal markers and should be retained when necessary.

4.2 Discourse

The article was written by experts for experts. It bears numerous distinctive formal scientific markers as discussed in 3. Fundamental terminology of electrical engineering is utilized and no terms are explained, relying on the recipient's background knowledge – "spínač ve funkci paměti RRAM" (p. 1), "memristor" (p.1), "rezistivní port" (p. 3), "adresovatelná nevolativní přepisovatelná paměť" (p. 3), "pasivní součástka" (p. 4), "operační zesilovač" (p. 6), and various equations on p. 3 or p. 6 for instance as well as graphical representations of the scientific phenomena at hand.

The article is structured, moving from one scientific fact to another. Passive voice is utilized, focusing the attention on the action and not the agent. The only human agents in this case are twofold – prof. Chua and the Hewlet-Packard research team. The focus is solely on the memristor, the term “memristor” itself appears approx. 20 times on each page, indicating that the cohesive device in this case is repetition, with the exception of cohesive chains containing “memristor-součástka”, the most frequent case of substitution. The text is thus of a dense character, a word as simple as “díra” (p. 2) is marked as a term in the field of electrical engineering.

While bearing discourse markers of a formal scientific field, the text was written as an article, several features of the journalistic style are also implemented.

Plural pronoun “we” was utilized several times, most likely in order to avoid too complex sentence structures the passive voice would cause. In the translation, all these instances were transposed into the passive voice.

The third paragraph on p. 2 offers an expressive verb – “vypráví”. This verb is more consistent with the journalistic approach, opting for “popisuje” would be appropriate in a purely scientific text.

Also, the first paragraph serves as an overall introduction, in journals usually denoted in bold or italic. All the information contained in this paragraph is repeated once more within the text, utilizing deictic expressions – articles – to denote previously stated information, referencing to the first paragraph.

Within the article there are also several distinctive terminology systems. The most prominent are of the electrical engineering, specifically microelectronics, and mathematics. In order to illustrate and properly define the memristor phenomenon, three other sets of terminology are implemented: medical (p. 2 and 6), automotive (p. 2), and IT (p. 5)

5 Syntax analysis

Knittlová (2000) puts forth as one of the most prominent features of any scientific text its logical development of facts. With it comes the structured word order, to supplement and support the natural progress of information. This chapter details the most prominent syntactical properties encountered during my translation.

5.1 Theme and Rheme

For the Czech scientific language it is common to place the rheme of the sentence structure at the very end. Meaning that in Czech it is expected to present the discussed topic – theme – first, and then follow with the new information – rheme. Mathesius first introduced these denotations.

On the other hand, English sentence structure is often quite the opposite. The new or important information is usually placed at the very beginning or as the subject of the sentence, with the additional data or topic nearing the end.

English as an analytic language generally has a fixed word order. Sparling (1991) notes that in English it is not as common to stress certain information by moving them within the sentence structure like in Czech, it is more often achieved using intonation or the general context of the utterance.

Krhutová (2009:78) notes that this *theme-rheme* system creates the "internal textual structure" within each respective sentence. She then follows that this structure is supported by the appropriate use of cohesion, ie. the surface structure supported by grammatical and lexical cohesive devices.

There are several methods pointing to the rheme of a sentence according to Knittlová (2000). The following examples were the most common during my translation.

i. *There + verb + rheme.*

(line 234) There is a number of passive systems capable of partially storing the amount of passed substance.

(p. 5)Pasivních systémů, které si pamatují množství proteklé substance pouze v omezené míře, je kolem náš celá řada.

Here, the English translation mirrors the Czech original, with the exception of the split sentence structure. Combining the first and last part of the Czech sentence it is possible to simplify the sentence structure. If the original sentence pattern were to be followed, the translation would be, for instance: "Passive systems, capable of partially storing the amount of passed substance, are strong in numbers." It is clear that such a sentence is not appropriate and translated too literally.

ii. *Using ING form*

(line 297) Opting for a different pair than voltage-current means moving to a different coordinate system, which will allow for the fundamental discovery of memristor principles.

(p. 7) Přechodem od napětí u *a proudu* i *k jiné dvojici veličin přejdeme do jiné souřadné soustavy, které nám umožní odhalit skutečně fundamentální principy memristoru.*

This example serves also as an instance of transformation of the general "my" to the passive voice, to attain the objectivity of the message. Also, words "přechodem" and "přejdeme" were substituted with "opting" and "moving" to avoid unnecessary repetition.

iii. *It is + rheme, syntactic means of rheme identification*

(line 6) It was in May 2008 when the dramatic change occurred as a Hewlett-Packard (HP) research team published an article in the Nature magazine…

(p. 1) Situace se dramaticky změnila v květnu 2008, kdy tým výzkumníků z laboratoří Hewlett-Packard (HP) publikoval v časopise Nature *článek,...*

In this instance, placing the date as the focus of the message stresses the fact that it took more than 30 years to evolve from the synthetic discovery of the memristor to the discovery of its physical principles. This information is repeated several times in the text.

iv. *Using passive voice + by*

(line 93) …resistance R_{off} *is when the right section is blocked by the stopper and the water…*

(p. 2) …největší odpor má trubička ve stavu, kdy je zátkou uzavřena a proud…

(line 238) The wire temperature is influenced not only by the passing current, but also by the current that has passed through up until now.

(p. 5)K aktuální teplotě vlákna totiž nepřispívá pouze aktuální velikost proudu, ale s určitou vahou přispíval i všechen proud, který tekl vláknem v minulosti.

The first example is a typical representation of the *passive voice + by* to focus on the rheme of the sentence – the stopper, prominent in both the Czech text and the English translation.

The second example serves also as an instance of the necessary word order change to attain the original intended message.

5.2 Passive voice

Scientific genre – especially the technical style – is defined most often by the action, not the agents performing the action. Krhutová (2009:45) explains this phenomenon in terms of the objectivity of science: "Objectivity is the essence of technical sciences as they deal with phenomena that are possible to verify either in mathematics or by experiments." She then follows that any signs of subjectivity might be perceived as unreliability and notes that it is more common for technical professionals to collaborate in teams. The agent is thus not as important and the focus is on the action.

Knittlová (2010) states that the most effective way of suppressing the agent and focusing on the action is the implementation of passive voice. On the other hand, to achieve the same objectivity in Czech, the plural pronoun "we" is used.

In my translation I used the passive voice mainly to transfer the "we" agent, to simplify a complex message that might be misunderstood if translated word-for-word, and to clarify and ensure the proper understanding of the message.

The perfect example of simplification can be found on line 238 (p. 5).

(line 238) The wire temperature is influenced not only by the passing current, but also by the current that has flown through up until now.

(p. 5)K aktuální teplotě vlákna totiž nepřispívá pouze aktuální velikost proudu, ale s určitou vahou přispíval i všechen proud, který tekl vláknem v minulosti.

Further examples of transposition:

(line 19) A great increase in memristor-related publication of both technical solutions [5], [6], [7], and fundamental research followed these events.

(p. 1) Úměrně tomu zaznamenáváme prudký nárůst publikací o memristoru. Kromě zpráv o konkrétních technických řešeních [5], [6], [7] vychází mnoho prací zaměřených na základní výzkum.

(line 151) When obtaining them memristor ampere-volt characteristics it is clear that this is no ordinary element.

(p. 3) To, že memristor není obyčejná součástka, poznáme již v okamžiku, kdy se pokusíme určit jeho statickou ampérvoltovou charakteristiku.

5.3 Grammatical cohesion

Halliday and Hasan (1976:4) define cohesion as: "it refers to relations of meaning that exist within the text, and that define it as a text". They note that cohesion is naturally *built-in* into every language system and its potential lies in the linguistic resources of the language. Cohesion can be divided into two categories – grammatical and lexical. In this chapter only the grammatical cohesion is dealt with. The lexical cohesion is further discussed in 6.2.

5.3.1 Reference

Turning back to Halliday and Hasan (1976:31), reference stands for "making reference to something else". Using reference enables the producer of the utterance to point to the exact same thing that has been introduced into the context before. Both Czech and English utilize these linguistic means, below is a list of the different types of reference found in the translation and their appropriate counterpart. Classification of reference is based on that of Halliday and Hasan.

a) Endophora – textual reference
   1. Anaphora – reference to the preceeding text
   2. Cataphora – reference to the following text

Anaphora

…when Leon Chua published his article [1] titled "Memristor – The Missing Circuit Element". In this paper he deduces that in order to retain… (line 27)	… kdy Leon Chua publikuje článek [1] s názvem "Memristor – the missing circuit element". Autor v něm vyvozuje, že v zájmu zachování… (p. 1)

When obtaining the memristor ampere-volt characteristics it is clear that this is no ordinary element. (line 151)	To, že memristor není obyčejná součástka, poznáme již v okamžiku, kdy se pokusíme určit jeho statickou ampér-voltovou charakteristiku. (p. 3-4)

Cataphora

In his famous article [1], Leon Chua predicts the memristor… (line 273)	Ve slavném článku [1] předpovídá Leon Chua existenci memristoru... (p 6)
By storing its instant position *x*, the propeller also recognizes… (line 89)	Vrtulka si tedy svou okamžitou polohou *x* pamatuje celkový objem... (p. 2)

The first two examples are those of an anaphoric reference, which is fairly common within my texts. Without clearly defining to what the "this paper / v něm" + "Leon Chua / he and "this / jeho + Leon Chua / Autor" refer, the recipient might be confused as to what these expression actually belong. After reading the whole article, however, it becomes clear that these expressions refer to the original article, Leon Chua and the memristor, but that is only due to the recipient's previous knowledge.

The last example offers a cataphoric reference in the English translation. The difference between the source text and the translated text lies precisely in the reference, as in English there has to be the possessive pronoun, to comply with the "natural flow" or the dynamics of the text mentioned in 0. It could be argued that this reference is more artificial and that it might not in fact be a true reference as the article was mentioned before as well as referenced *[1]* before. However, it is at the very beginning of a new chapter and thus for all intents and purposes is a cataphoric reference. Titles of the article's chapters themselves are another example of cataphora, as they indeed refer to what the following set of paragraphs will be concerned with. The second example represents a more typical use of cataphora.

b) Exophora – situational reference, signaling that a contextual or situational identification is necessary

Background knowledge that is required to fully understand the translated article may be regarded as an example of exophoric reference. Certain terms, such as *passive element (line 4)*, *flash memory (line 14), ampere-volt characteristics (line 151), harmonic voltage (line 218)* are not explained within the article, as it is simply not necessary, the article alone requires a certain amount of background knowledge.

Another exophoric examples are references to other works, articles and papers.

References can also be sorted according to their type:

a) Personal – referencing through the "person" category
b) Demonstrative – referencing through the "proximity" category, can comprise time or place domain
c) Comparative – using descriptivism as reference

Personal reference

…written by Leon Chua… in which he defines… (line 3)	…články Leona Chuy… v nichž (on) definuje… (p. 1)
… a number of authors do not wait for their work… (line 21)	… mnozí autoři nečekají, až jejich práce… (p. 1)

Both Czech and English most often follow the same referencing pattern. The only exception is the fact that sometimes the subject of the sentence does not have to be named, thus the second reference is often unwritten in Czech.

Personal reference to objects

Each passive element in Fig. 12 has a corresponding graph depicting its constitutive… (line 317)	Ke každé pasivní součástce je v obr. 12 zakreslen (její) graf… (p. 7)
A simple example is the light bulb. Its resistance is given… (line 235)	Snadno pochopitelným příkladem může být chování žárovky. Odpor žárovky je dán… (p. 6)

Personal pronouns can be used to reference not only personal and animate objects, but also inanimate objects. These examples once again show that English, as compared to Czech, needs a certain amount of "fillers" to attain a natural flow of the text. Also, sometimes instead of reference a repetition is used.

Demonstrative reference

… signal that moves the internal boundary in either direction there and back… (line 157)	… signálem, který by pohyboval vnitřním rozhraním tam a zpět na obě strany… (p. 4)

Following the information obtained from the context, the boundary can move only within the memristor itself and the boundary does not leave the device. Also, two boundary states are defined, to which the "there and back / tam a zpět" refers to.

Descriptive reference

If the capacitor is nonlinear and stationary, then the relation is an unambiguous function. (…) Similarly for the memristor, the webber-coulomb characteristic represents the … (line 320)	Pro nelineární stacionární kapacitor je tato konstituční relace jednoznačnou funkcí… Podobně pro memristor je konstituční relací… (p. 7)

This instance represents rather complex descriptive reference. The referring information occurs two/one sentences before the reference is made, forcing the reader to pay closer attention.

5.3.2 Substitution and Ellipsis

Halliday and Hasan (1976) describe the substitution as a relation in the wording, not the meaning. Substitutions cover replacing one item with another. Ellipsis is a form of substitution, where an item is simply replaced by nothing, which is more common, however, in the spoken discourse.

Substitution

a) Nominal
b) Verbal
c) Clausal

Ellipsis

a) Nominal
b) Verbal
c) Clausal

Several examples of frequent ellipsis and substitution in the article are written below.

Nominal substitution

... and in 1976 published an article… Within this paper he defined… (line 50)	…v roce 1976 publikoval s Sung Mo Kangem článek… V něm definuje… (p. 3)
Such a hysteresis loop is a typical feature… This unique fingerprint… (line 173)	Takováto hysterezní smyčka je typickým znakem memristivního chování… Díky tomuto poznávacímu znamení („Fingerprint“)… (p. 3)

Verbal ellipsis

Time-honored articles written by Leon Chua… (line 3)	Klasické články Leona Chuy z let… (p. 1)

In the first example, the English version offers a simple nominal substitution, whereas the original text utilizes referential expression. Translating “v něm” using “in it” did not comply with the rather formal tone of the text, thus a change in the grammatical cohesion was necessary.

The second example uses the original wording in brackets in the translation, which in turn creates the nominal substitution, directly tied to the original text.

The third example is one of a verbal ellipsis, uncommon in the translation. To maintain the flow of the text and avoid any unclear wording, the ellipsis had to be eliminated, the omitted verb was added.

6 LEXIS ANALYSIS

Within this chapter I will attempt at illustrating the necessary transformation my source text had to undergo when being translated into the target language as far as the lexicology is concerned. Modifications on the syntax level were demonstrated in 5.

This chapter will not discuss the broad topic of various methods of coining new words, save one – the memristor, as it was not necessary to introduce any new terminology. Any and all used terminology is standardized and common for the field of microelectronics. Additionally, a dictionary comprising scientific lexis present in the article will be enclosed.

6.1 New term – the memristor

The term *memristor* was introduced by professor Leon Chua in 1971, describing a new circuit element, at that point only synthetic. This term was coined as a blend of **mem**ory and **resistor**, two of its fundamental functions. However, it received more attention in 2008 when the Hewlet-Packard laboratories announced that they managed to create this component. Using the graph in Fig. 1, which represents the popularity of *memristor* in Google Search from 2004 to 2015 utilizing a Google feature called Google Trends, the spike in memristor popularity was indeed in 2008.

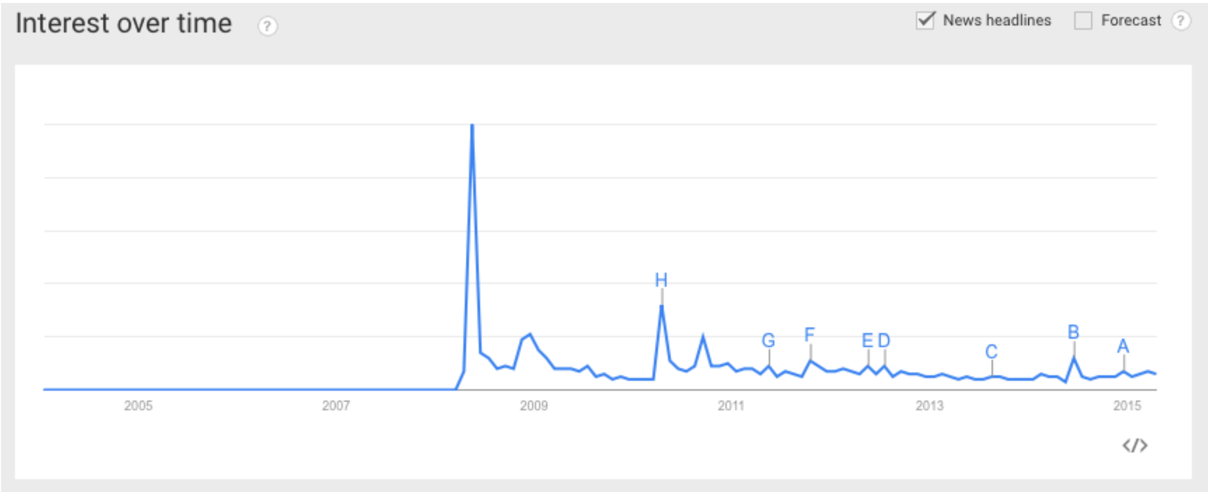

Fig. 1: Memristor in Google Search

Another interesting observation regards the co-text of the word *memristor* in the original article from 1971 and the article of my translation. Chua used the adjective *basic* when referring to the memristor as the fourth <u>basic</u> circuit element, whereas in the article written by Biolek in 2009, the memristor becomes the fourth <u>fundamental</u> circuit element as it surpassed the synthetic stage. In the article he used its direct translation – “fundamentální”. Such a change may represent the shift in the interest of the scientific community, marking it as the true breakthrough of the scientific field.

6.2 Lexical cohesion

As defined by Halliday and Hasan (1976:274), lexical cohesion is a "cohesive effect achieved by the selection of vocabulary". Krhutová (2009:69) adds that in case of the language of the electrical engineering, lexical cohesion is mostly composed of terminology and that a properly instructed reader – a member of the appropriate scientific community – is able to interpret such a link by "relying on the references of the terms". Following the classification of Halliday and Hasan (1976), lexical cohesion can be divided into the following categories:

a) Reiteration
   1. Repetition – using the same exact word
   2. Synonym or near-synonym
   3. Superordinate – using a general class denominator
   4. General word

b) Collocation
   1. Lexical items that usually co-occur.

Cohesive chains

The **component** emerging from the HP laboratories is not in fact an ideal **memristor**, as **its** resistance cannot deviate from the R_{on}-R_{off} range. As soon as the boundary between the conducting and non-conducting layers, influenced by the passing current, reaches either one of its edges, the *x* state can no longer change, not even with additional current passing through. At the edges of the **memristor** it no longer applies that the memristor resistance is directly proportional to **its** charge. In other words, the **memristor** "loses **its** memory", as the charge that passes across yet does not alter **its** state, is in fact forgotten. (line 226)

Součástka z laboratoří HP se ve skutečnosti nechová jako ideální **memristor**, protože **její** odpor nemůže vybočit z interval (R_{on}, R_{off}). Jakmile rozhraní mezi vodivou a nevodivou vrstvou dorazí vlivem protékajícího proudu k jednomu z okrajů **memristoru**, stav *x* se již dále nemůže měnit, i kdyby proud protékal dál. Na okrajích **memristoru** tak přestává platit, že **jeho** odporu je přimo úměrný množství náboje, který **jím** prošel. Jinak řečeno, **memristor** na **svých** okrajích "ztrácí paměť", neboť veškerý náboj, který **jím** protekl a přesto nijak nezměnil **jeho** stav, je vlastně zapomenut. (p. 5)

In this instance, memristor and its lexical links create a cohesive chain. It begins with a superordinate (component / součástka) and then moves to the core of the utterance (memristor), which represents repetition. The most frequent are, however, general words (it, its / jím, jeho). This example also represents the overall monotonous composition of the article. The *memristor* is often referenced to using repetition or general words – pronouns. There are no complex cohesive chains, both in the original Czech text and in the English translation. It might be due to the fact that at that time, the memristor was a brand new and popular source of information (as mentioned in 6.1) and using repetition warrants excluding any possibility for misunderstanding.

7 Czenglish

One of the new linguistic fields introduced to me while studying the issue of English in electrical engineering was the issue of Czenglish. This term was proposed by Don Sparling, a professor at the Masaryk University, Brno and comprises the improper use of English by Czech people. He compiled his findings into "English or Czenghish, jak se vyhout čechismům v angličtině". While not necessarily a book focused on translation, this book comprises a number of the more common translatological mistakes.

Considering recent findings detailed in 3.4, many authors favor the idea of the translator being educated on the matter of the translation, despite the fact that even nowadays it is not so. The "proper" use of Czenglish results from an improper leap from the Czech grammar to English, or the improper interpretation of English utterance to Czech.

Following this line of thought, an inexperienced translator might use "remember" as a direct translation to account for the device's application. However, a device is not able to *remember* data, but to *store*. This distinction is also marked in the original Czech article via quotation marks (p. 1).

While translating, the word "aktuální" was quite frequent. The most appropriate formal translation would be "current". However, the word *current* also represents the fundamental electrical quantity. Having an example on line 37: *"the memristor would "remember" the* ***last*** *value of resistance for an arbitrarily"* Substituting *last* with *current* might decrease the notable coherence of the sentence, forcing the receiver to question which scientific quality is being discussed. Precisely for that reason, the word "current" is replaced with *last* or *latest* as often as possible. Similar example can be found on line 178: *"as well as the amplitude of the current"*. The combination with *of* allows for a precise transmission of data, eliminating this expression: *as well as the current amplitude* might lead to misinterpretation as to the fact that the amplitude is *the latest* and not *of the current*.

A common misconceptions arises when translating "napětí na součástce, proud součástkou". While the voltage is always *across* a device, the current flows *through*. Translations such as "voltage on the device" and "current across the device" are incorrect.

8 CONCLUSION

Following the analyses presented in 4, 5 and 6, several conclusions can be drawn. The article bears distinctive markers of both the journalistic and the technical style of writing. Complying with the journalistic style, the first paragraph of the article, should it be marked in italics (or bold) would serve as the introductory paragraph, which often summarizes the main points of the following article, for every piece of information within said first paragraph is repeated throughout the whole of the article, marked with definite articles to support referencing. Additionally, a few instances of expressive vocabulary were used.

On the other hand, specific terminology and scientific terms were left unexplained, thus presenting the requirement of background knowledge, which is consistent with the formal scientific genre.

On the syntactical level, structures utilizing references to link sequential information as well as the implementation of the passive voice are consistent in both the Czech original and the English translation, with the exception that in Czech, the collective pronoun "my" supplements the role of passive voice in English. Referencing structures follow the same patterns in both languages, both languages, however, save the exceptions of "filler" words to provide a constant textual flow.

The main difference lies in the theme-rheme structure. While English favors placing the important information at the very beginning or marking it with complex sentence structures, the Czech language operates with the same information more freely, forcing the translator not only to comprehend the technical data, but also to distinguish the working rheme of the sentence. Such a notion that the translator should be knowledgeable in both the translatological and technical field at hand was repeated numerous times and listed in all linguistic sources.

Lexically, both Czech and English have their own respective terminology counterparts. This terminology was standardized, present even in the original article written by Leon Chua, warranting a certain degree of timelessness. Both texts create their own specific cohesive chains, which are rather monotonous. The agents in scientific texts are frequently somewhat hidden as the focus is not on them but on the action itself. The only rather complex cohesive chains were featuring the term memristor itself and its various substitution. The English proves itself once more to demand more words – fillers – as ellipses that are common and often expected in Czech would translate poorly in English. They often serve as a substitution for definite or indefinite articles, thus pointing to the corresponding piece of information.

While translating, several instances of incorrect or misrepresented translation were present, they are all listed in the very last chapter 7 dealing with Czenglish.

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10 APPENDIX

10.1 Dictionary

analogové aplikace memristoru	analog memristor applications
automobilový tlumič	car shock absorber
axiomatický	axiomatic
budit	excite
buňka	cell
čtecí cyklus	reading cycle
elektrická veličina	electric quantity
hustota záznamu	record density
hystereze	hysteresis
hysterezní smyška	hysteresis loop
induktor	inductor
integruje v čase	integrates over time
jednobiová nevolativní přepisovatelná paměť	single bit nonvolatile rewritable memory
jednoznačná funkce	bijective function
kapacitor	capacitor
klidový stav	quiescent state
konkrétní technická řešení	specialized projects
konstanta úměrnosti	constant of proportionality
konstituční relace	constitutive relation
krajní stav	boundary state
libovolně dlouhou dobu	arbitrarily long period (of time)
magnetický tok	magnetic flux
migrační rychlost nosičů náboje	migration velocity of charge carriers
mutátor	mutator
náboj	charge
nanometrický rozměr	nanometric domain
napětí	voltage

nervová buňka	neural cell
nervová synapse	neural synapsis
obvodový prvek	circuit element
odborná veřejnost	scientific community / expert community
odpor	resistance
operační zesilovač	operational amplifier
paměťové chování	memristive properties
paměťový efekt	memristive effect
pasivní součástka v pevné fázi	passive element is solid-state structure
pevná fáze	solid-state structure
pohybové rovnice	motion equations
polovodičová součástka	semi-conductor element
polovodičová součástka	semi-conductor device
pracovní bod	operating point
v praktické rovině	in practical terms
příčková struktura	crossbar structure
příkon	input power
přímo úměrná	directly proportional
proud	current
prvky vyšších řádů	higher-order elements
rezistivní port	resistive port
řetězec událostí	progression of events
rezistor	resistor
rozhraní	boundary
rozkmit proudu	current amplitude
rozměrová zkouška	dimension test
spínač	switch
spojité	continuous
stavová rovnice	state equation
stavová veličina	state quantity
stoupání závitu	slope of turn

strukturní schéma	structural diagram
teorie obvodů	circuit theory
tlaková příčina	torque external force
tlakový spád	pressure gradient
trh s paměťovými médii	memory market
vektor proměnných	vector of variables
víceúrovňová energeticky nezávislá přepisovatelná paměť	multi-level energetically independent rewritable memory
vodič	conductor
vrtulka	propeller
vysokokapacitní analogové paměti	high-capacity analog memory
základní výzkum	fundamental research
zápisový impuls	write pulse
zátka	stopper
závit	turn
zdroj proudu	current source
zpětná vazba	feedback

10.2 Original article

See enclosed CD.