

Teaching Chess History to Students in Natural Sciences: How to Do It and Why

Vuk Uskoković^{1,2,*}

¹ Advanced Materials and Nanobiotechnology Laboratory, TardigradeNano LLC, Irvine, CA 92604, USA

² Department of Mechanical Engineering, San Diego State University, 5500 Campanile Dr., San Diego, CA 92182, USA

* Corresponding author: vuk21@yahoo.com; vuskokovic@tardigradenano.com; vuskokovic@sdsu.edu.

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Abstract Lying halfway between science and art, chess presents an excellent model for instructing the new generation of scientists about the merits of artistic senses for the exhibitions of scientific creativity. With this goal in mind, a course for intermediate to advanced chess enthusiasts and aspiring scientists was designed and taught in a condensed form to a group of K-12 students as a prototype for a course that could be included to higher education curricula in the near future. As per the course design, each of the twenty weekly lectures in the semester elaborates a single chess game in a chronological order of their play, starting with the mid-19th century games played in a romantic style and ending with the recent computer engine games, where the romanticism of chess playing styles is being rediscovered, thus closing the circle of dominant chess playstyles throughout the history. This closed circle is interpreted in the context of the author's lifelong effort to romanticize modern science. According to this effort, science, which has garnered over time increasingly unromantic traits and is associated today with managerial entrepreneurship, exploitative capitalism, cutthroat competition and fake elitism more than with quixotic ideals of arts, beauty and poetry, must be actively infused with lyricism and inspirational ideas and challenged for its retrograde reductionism. Each game in the course is explained in the context of the cultural zeitgeist of the decade in which it was played and also tied with famous experiments or general trends in natural sciences of the time. As the class proceeds along the 180-year long

timeline encompassed by the course, it becomes increasingly obvious that developments in chess have closely reflected the trends in arts and natural sciences of the corresponding times, which is a parallel that is being drawn in this paper for the first time in the history of this board game. Because the major trends in chess and in natural sciences appear to have mirrored each other throughout the history, familiarizing oneself with the chess history up to the present times can be used as a means of evidencing the nascent and predicting the upcoming trends in sciences, and *vice versa*. Correspondingly, one major objective of the course has been to accustom students to recognize in chess games analogies for phenomena in distant domains, including those where their creativity in scientific research is being exhibited. The satisfaction of the students expressed in surveys distributed at the end of the condensed course attested to their finding in it a useful stop in their quest for the sources of inspiration for the further tracks of their scientific careers.

Keywords: Chemistry; Chess; Creativity; History; Pedagogy; Physics.

Introduction

The semantic power of the analogy is primordial, practically as old as the human thought. Narrative arts, for one, resonate strongly with humans because of providing analogies with their lives. Scientific discoveries also frequently owe to analogies with phenomena from distant domains of experience. Although chess is not commonly interpreted as a narrative, the course of a chess game or its hidden variations can be perceived as a plot, meaning that chess games can relate to our intellects in the same way as stories do¹. This ability of chess to serve as an analogy for our lives lies embedded in the storylines of numerous books and movies. In Ingmar Bergman's *The Seventh Seal*, for example, a medieval knight is being summoned by Death to play a game of chess that would determine the course of his life². Likewise, in *Blade Runner*, the replicants are all chess masters who communicate with their creator through games of correspondence chess³.

The systematic lack of creative thought capable of conceiving conceptually novel ideas haunts today's scientific community like a plague. Today's young scholars and seasoned scientists are solidly trained to design technical novelties, but not so much the conceptual. Compared to the technical novelties, which are usually based on implementing greater processing speeds or introducing more robust devices to experimentation, conceptual novelties are more subtle but also more groundbreaking, bringing about fundamental changes to methods, models and modes of performance in science. These changes need not be as profound and substantial as those introduced by the frameworks of, say, theory of relativity or quantum mechanics, notwithstanding that the seminal findings of these two theories illustrate well what is meant by the conceptual innovation in science. Conceptual novelties, in fact, can be more modest and take the form of, for example, reversal of the cores and shells of typical composite nanoparticle compositions used in tissue engineering and drug delivery⁴, or the reversal of the mainstream idea of controlling the differentiation of stem cells into various phenotypes by focusing instead on the conversion of differentiated primary cells to a pluripotent phenotype⁵. Conceiving of a nanoparticle modeled after an astral body^{6,7}; creating models for predicting cell fate based on the indigenous arts of African storytelling⁸ and Micronesian canoe voyaging⁹; proposing alternative biological models for assessment of material properties^{10,11} and models for assessing the journey of a nanoparticle through the body¹² also count among such modest conceptual innovations in the materials science world. Another example can be that of lipid bilayer vesicles, aka liposomes, as drug delivery carriers – proposing them for this role counts as a remarkable conceptual innovation, but altering

their composition and structure or studying the many ways of achieving synergies in therapeutic safety or efficacy via different vesicle/drug combinations does not, except for very special conditions. As yet another example, the prediction, the discovery or the explanation of a physical phenomenon such as superconductivity may count amongst conceptual innovations, but the dreary search for materials with a lower and lower critical temperature by adding up chemical elements in different orders and amounts would not.

Sadly, however, today's scientific climate is such that scientists are much more prone to come up with incremental ideas that are mere derivatives of concepts already in place than to conceive of experiments that could change the outlook of whole fields of science for good. To distill a cure for this pervasive dearth of creative thought, it pays off to reach with our interests outside of the writer's blocks, that is, boxes, and acquaint analogies applicable readily to the scientific problems of interest. The hypothesis that chess can serve as one such source of analogies that boost creativity, which may currently be at an all-time low in natural sciences, pervades this paper and the idea behind the course on chess and natural sciences that it describes. In fact, numerous studies demonstrating how the exposure to chess instruction at various educational levels improves learning in different domains, ranging from math^{13,14,15} to reading¹⁶ to poetry interpretation¹⁷ to general learning capacity^{18,19}, are a strong indicator that analogies such as those explored here can prove useful for replenishing the dried wells of creativity amongst both the new and the old generations of scientists.

The academic course elaborating these analogies was designed in the form of one-credit hour weekly sessions, each discussing in-class a single game of interest from the history of chess. The twenty games to be discussed over the twenty weeks of a single semester follow a chronological order and form a closed circle, starting, symbolically, with the romanticism of chess in the 19th century and ending with the romanticism rediscovered by the contemporary chess engines. The importance of providing this historical perspective on the evolution of chess playstyles can hardly be overestimated. The reason is that familiarity with the history of any art or communicational medium in general encourages scientists to put their own science in a historical perspective, which presents the first step in coming up with conceptual novelties. Such novelties are inextricably tied to the historical line of progress and the turnover of trends in a given discipline.

Most academic courses on chess have revolved around the building of fluency in the game under the assumption that this would positively affect learning in other academic subjects, primarily those integrating mathematics, logics and analytical reasoning. However, there are ways to go beyond simply teaching the rules and the principles of chess and expecting that students would spontaneously form neural connections that foster the learning process in other disciplines, notwithstanding that even through the exposure to one such relatively rudimentary coursework, a lot can be achieved, including the enhancement of analytical intelligence, the building of a general learning capacity, proliferation of intercultural bonds, promotion of the inclusion of underrepresented and underprivileged social groups, and the fosterage of integration of high technologies, all of which count among the advanced priorities of bringing chess to educational settings²⁰. Among the many possible syllabi that would cover these more advanced grounds where chess, art and science intersect, no academic course, to this author's knowledge, has yet attempted to correlate through analogies chess games with scientific phenomena or with principles governing the experimentation or theorization pertaining to these phenomena. The course described here, therefore, strays from the beaten path and explores pedagogic grounds not probed before.

Each game selected for this course was the result of long and exhaustive analyses and over thirty years of personal experience in the theory and history of chess. Each of these twenty games is discussed with the students in its entirety, from the first to the last move, so as to build chess fluency alongside exploring its subtler strategic and tactical features. Given the topic of the course, most attention, naturally, is being paid to particularly relevant moments and positions in each game, from which valuable analogies applicable to natural sciences could be derived. Moreover, because chess is a game that inspires, the elaboration of the analogies between the arts of chess and science tried to be as inspirational as possible, with the understanding that this inspiration is the key to boosting the students' creativity in natural sciences. To elicit this inspirational potential, chess is being treated in the course as a form of art rather than a sport, let alone recreational mental gymnastics, and the competitive aspect of the game is being steadily deemphasized, while the aesthetic aspect is accentuated.

Portable game notations (PGNs) of all the games for which no such information is included in the corresponding figure captions are retrievable from www.chessgames.com. The list of games discussed in the course of the semester includes private, uncompetitive games played by the author 30 or more years ago, either against human opponents or engines, so as to encourage the students that even purely amateurish games and those played in training against an engine can be researched for analogies that could mean millions, for their lives and their sciences alike. For the sake of promotion of inclusivity and diversity, a portion of the games chosen for the discussion were played by female chess players and also by children, either at various official competitions or in casual settings. For such private games discussed in this paper, PGNs are given in the relevant figure captions. A whole lot of discussion about the games anticipated to occur in a real-life instructional setting is not captured in the paper because of the space limitation, meaning that the readers as well as potential students should still find the attendance of the class a valuable learning experience. This is additionally so because the in-class discussion should always follow a partially improvisational style and be open to changing the flow impromptu depending on the interests and points brought up by the class. Hence, even a complete explication of discussion from a single exemplary course captured here need not discourage future students from attending it.

Week 1, Year 1844: Hoffmann vs. Petrov

For hundreds of years preceding the late 19th century, the game of chess at its highest level was played in a romantic fashion. As per this style, sacrifices of minor and major pieces were made casually in the effort to heroically and resolutely attack the opponent's king, which would often take valiant strolls up and down the board, fearlessly facing the attack. Meanwhile, gambits were favorite openings of the romanticists and pawns were regularly being given away, either to distract the opponent or to open files and diagonals so as to facilitate the attack. The simplistic premise underlying this style was that the side having the initiative is the only one that could emerge as a winner. In turn, any defensive tendencies were looked down upon, not only as ineffective, but also as displeasing for the eye, as nearly all victories, especially the most prized of them, were owing to a sharp middlegame attack. Occasionally, the chess theory did venture into analytical territories showing that the pawn structures and formations were important, as in studies by the French composer, André Danican Philidor, and that the correct defensive play could neutralize almost any attack, as in analyses by the German player, Louis Paulsen. However, the world's best players for most of the 19th century, including the likes of La Bourdonnais, Adolf Anderssen and Paul Morphy, could be classified as pure romanticists. Although basic positional principles started to

emerge sporadically by the mid-19th century, they never got rooted in the dominant chess culture until later in the century, when Wilhelm Steinitz became inaugurated as the first world chess champion. Beethoven, famously, started off as a classicist, but then drifted into romanticism, the movement in music he singlehandedly defined, while Steinitz, conversely, was a romanticist who gradually adopted the positional playstyle. The direct correlation between the adoption of this new style – which anti-Semite Aryans, who gravitated toward romanticism, classified at the time, casually albeit scandalously for today’s standards, as dull and “stingy”²¹ – and Steinitz’s success at winning and then retaining the world champion title helped it establish itself as the dominant approach to chess by the time the new century rolled around. Today we know from the history of very productive but also very inhumane political systems that concluding about the benevolence or progressiveness of such systems solely based on their production capacity and wealth that they generate is as wrong as the deduction of trueness of logical premises because of the congruency of their inferences with empirical observations, which William James and pragmatic philosophers of science demonstrated early on in the 20th century. However, in the late 19th century, one such observation would hardly be supportable by facts and, as a result, romanticism began its slow decline in the hands of rationalists and departure from the chess world. Nevertheless, transitions between developmental stages, in any existential domain, are such that the features of a new stage initially mix with and gradually take over the traits of an old stage²², and a similar effect occurred in chess, which had to wait for the times of Capablanca in 1910s to encounter for the first time a style completely devoid of any romantic predispositions and propensities.

The trends in art mirrored closely those in chess, or *vice versa*. The romantic movement in arts emerged in the late 18th and the early 19th century from the backlash of poets and spiritualists against the rising rationalism and the dryness of the intellect that had become pervasive during the age of enlightenment and in the wake of the industrial revolution, and this turn of tides was reflected very well in the chess playing style adopted by the leading players of this period. Moreover, only when chess started shedding the skin of romantic aspirations did arts start doing the same too. Romanticism in visual arts and music peaked in the first half of the 19th century and simultaneously with the shift in the dominant chess playing style to the more prosaic positional grounds from the middle of the 19th century onwards, mainstream art started shifting toward realism, which is typically tied to the period between 1840 and 1870, and then toward less long-lived movements, such as naturalism, symbolism, impressionism and others. In science, too, the approach existent since the times of renaissance and all the way to the second half of the 19th century was such that the most prolific scientists were either art aficionados or aspiring artists. Even during the age of enlightenment, when the emphasis on emotionless empiricism and rationality began to suppress the free expression of emotionality and the transcendent aesthetic experience²³, which romanticists would later try to revive, scientists were far more polymathic than they are today and were nurturing a variety of interests. These interests commonly transcended their sciences, which were freely cross-fertilized with impressions from art and philosophy. In other words, there were times, not so long ago, when science and art coexisted and complemented each other in a more holistic approach to studying the wonders of the physical world than it is the case today, when science is wholly divorced from arts. Scientific texts were, as a result, often pervaded with aesthetic observations and one example comes from the seminal works of Michael Faraday on the segregation of grains of sand on sonorously vibrated beds²⁴ and on the production of the first gold nanoparticle colloids²⁵ from 1831 and 1857, respectively, the former of which mentions the words “beauty”, “beautiful” or “beautifully” whole 35 times in its course and the latter of which opens with a 153-word long sentence starting with a blatantly poetic

exclamation: “That wonderful production of the human mind, the undulatory theory of light...”. Given that chess is arguably more proximal to art than natural sciences are, the papers and books on chess analytics from the same, mid-19th century period were suffused with poetic wordings to an even greater degree. The writings of Howard Staunton, for one, who is nowadays remembered as the pioneer of the scientific approach to the game, abound with such statements, as when he calls gambits “the most brilliant and animated of all the openings, full of hair-breadth 'scapes and perilous vicissitudes, but affording an infinitude of beautiful and daring combinations”, or when he christens the knight “at once the most striking and most beautiful of all the Pieces; the singularity of its evolutions, by which it is enabled to overleap the other men and wind its way into the penetralia of the adverse ranks, and if attacked leap back again within the boundary of its own, has rendered it the favorite Piece of leading players in every country”²⁶. This freedom to sidetrack one’s trains of thoughts into sundry aesthetic and philosophical directions is also reflected in the writings by the second world chess champion, Emanuel Lasker from later in the century, as in the instance where he tops his digression toward philosophical territories in a book on chess with the following quixotic remark: “What ripens soon, fades soon. To good and weighty theories public recognition comes late. The theory of struggle, divined by men like Machiavelli, Napoleon, Clausewitz, molded by Steinitz in accurate detail for Chess-board, longingly desired by some philosophers, established by myself in universal validity, therefore philosophically, will some day regulate the life of man. I do not in the least hesitate to say so”²⁷. Alas, around the same time chess divorced itself from its romanticist past, science started distancing itself from it too and strong, sincere emotions began to be increasingly seen as an adversary instead of a companion of good science. The quantum mechanics and the relativity theory can be said to have been swan songs of a generation of young and starry-eyed scientists who still nurtured the hearts of artists inside them. Everything after this period has belonged to science to which any exhibitions of lyricism became foreign. This is how we have reached today’s era, where poetry and lyricism in scientific texts are classified as acts of lunacy and singled out for rapid extermination by the authorities, whichever the form they take – journal editors, peer reviewers, department chairs, tenure committees, funding agencies, corporate R&D sector, and so on.

The game between two Alexanders, Hoffmann and Petrov, played in Warsaw in 1844 is also known as Petrov’s immortal and is a paradigmatic illustration of the romantic style. Considering that the first official chess tournaments were held in the 1840s and that the London chess tournament of 1851 was the first international chess tournament, many of the chess masterpieces from the romantic era were played either as parts of impromptu organized matches or in informal private or social settings, and such was the case with Petrov’s immortal. The game displays an encounter of heroic inclinations from both players, resulting, expectedly, in a firework of valor that was short-lived and ended with a checkmate in 20 moves only. The game opened solidly, with *Gioco Piano*, meaning “quiet game” in Italian, but only for the first couple of moves, after which Black sacrificed a knight by taking on f2 to disable the white king from castling. In discovered check, the white king courageously stepped from f2 onto the g3 square instead of retreating to f1, and soon thereafter, White went on to sacrifice his own knight on f7, trying to deprive the black king of his own right to castle (Fig. 1). And then a moment of magic struck, with Black cold-bloodedly castling, playing the exact move that White wanted to prevent and thus giving away his queen, which the white knight readily captured, at which point Black had a hardly foreseeable forced checkmate in 13 moves, which was executed flawlessly. How deep, in fact, this castling move by Black is may be best illustrated by the fact that the calculation by the leading engines today has to be extensive enough in order for them to see it. Otherwise, Stockfish’s initial

evaluation, for example, is -4.4 before the 0-0 move by Black and - 8.9 after it. The Elo ratings of these engines are estimated at around 3500, which is as higher compared to the rating of a super grandmaster as super grandmasters' Elo ratings are higher than those of the average coffeehouse player, yet facing a romantic masterstroke like this, albeit played nearly two centuries ago, even they need to think for prolonged periods of time to make sense of it. Castling is usually performed to put the king to safety, but here this move had a dual purpose: aside from protecting the king, it also launched an unstoppable attack on the white king. And when a retreating move has a quiet offensive effect is when we, the aestheticians of chess, know that we are witnessing a very special moment on the chessboard.



Figure 1. Hoffmann vs. Petrov, Warsaw, 1844, 0 – 1. Position on the board after 12.Nxf7 and before 12...0-0. Black started the game with a display of romantic gallantry, sacrificing a knight on f2, but White deemed it necessary to respond with an even greater dose of audacity and so he went on to push his king closer to the center of the board and then give away his own knight on f7 to prevent Black from castling, which he did anyway, thus creating a position where Black has a forced checkmate in 13 moves.

Seven years after the game between Hoffmann and Petrov was played, in June 1851 in London, in-between the tournament play, Adolf Anderssen and Lionel Kieseritzky played another casual game. In this game, which would eventually enter the annals of chess as the most immortal of all chess games, White sacrificed a number of pawns, a bishop, two rooks and the queen and checkmated the opponent in the end; although this game is elaborated in the course as yet another instance of romanticism in chess, it is skipped here for brevity reasons. A few years down the road from the time Petrov's immortal game was played and only a few months before Anderssen's immortal, the two games exemplifying the romantic era in chess, a scientific experiment chosen to illustrate the era of romanticism in science was performed. It was an experiment conducted by Leon Foucault, first in a cave in January 1851 and then on a bigger scale from the ceiling of the Paris Observatory. Only a few days after the second of the two experiments was performed, on February 3, 1851, Foucault presented his findings at the weekly conference of the French Academy of Sciences and then promptly published them in the Academy's journal, *Comptes Rendus*²⁸. A month after the publication, in March 1851, the experiment was repeated on an even grander scale from the top of Panthéon in Paris, and by the end of the summer 1851, as strange as it may seem

for the days preceding the instant communication channels of the digital age, the experiment was performed in many cities of the world, including 25 in the United States alone²⁹.

When Foucault devised the proof of the Earth's rotation with the use of a pendulum, the fact that the Earth rotates around its axis had been known for several centuries. However, for the first time, instead of marking the positions and monitoring the minute movements of planets and stars, the proof of this rotation could come from a simple, everyday object; hence the elegance and the beauty of Foucault's experiment. In simplest terms, the experiment showed that the plane of a swinging pendulum does not go through a full-circle, 360 ° rotation in a sidereal day (23 h, 56 min) at any point on the globe except at the two poles. The angular rate of the pendulum at these two points would correlate directly with the diurnal rotation of the Earth around its axis. At any other point on the globe, the angular rate of the rotation of the plane along which the pendulum swings is equal to the angular rotation rate at the poles (360 °/day) times the sine of the latitude (hence, it is equal to zero on the equator)³⁰. This explains why the repeated performances of the experiment in Paris were followed up by performances at numerous other points on the globe in order to arrive at an irrefutable proof of the hypothesis that the pendulum swing correlates with the Earth's rotation around its axis.

Aside from the intrinsic aesthetics of correlating a phenomenon occurring on an astronomical scale and a physical effect occurring on a scale observable with the naked eye, there are numerous other aspects of this experiment that can be instructive and inspirational. For example, 200 years before Foucault's experiment, in the late 1650s, a student of Galileo, Vincenzo Viviani tried to set up a large pendulum for oscillation measurement purposes. Irked by the veering of the pendulum, he used a pair of ropes instead of one to fix its trajectory³¹ and prevent the oscillations that Foucault would later use to provide the first evidence of the rotation of the Earth around its axis. This is to say that experimental errors and any deviations from our empirical expectations are to be welcomed with open arms instead of being despaired over, for they usually provide a path toward more extraordinary discoveries than those conforming to the expectations.

In compliance with romanticism elaborated here, Foucault can be said to have exemplified a renaissance scientist with a broad range of interests. This can be illustrated by his wide array of scientific contributions across many topics and disciplines. He started off as a medical student, but later switched to physics because of various medicinal phobias. However, he was unable to find an employment as a researcher and so he worked instead, at least initially, as a journalist, converting major findings from the physics world to popular press reports, which is said to have "contributed to his wide scientific culture and favored his exceptional creativity"³². This breadth of knowledge may have helped Foucault to see the pendulum with fresh new eyes, as he, himself, hints at in the opening, 63-word long sentence of his 1851 *Comptes Rendus* paper, which is translated here from French: "The observations, so numerous and so important, of which the pendulum has hitherto been the object, are especially relative to the duration of the oscillations; those which I propose to make known to the Academy have mainly concerned the direction of the plane of oscillation which, moving gradually from east to west, furnishes a sensible sign of the diurnal motion of the terrestrial globe". In other words, practically all experiments with pendulums up to the point of Foucault's work were about measuring the frequency and the amplitude of its oscillations. It is conceivable that the creative propensities and the renaissance background of Foucault helped him view pendulum from a new perspective and look at its plane of rotation instead, specifically how it linked to a physical effect, in his case the diurnal rotation of the Earth. His having only a bachelor degree in science and approaching the latter from a semi-amateurish angle may have been a key factor that endowed him with this flexibility of perspectives and

allowed him to propose and subsequently evidence the bold correlation between the swing of a pendulum and the rotation of the Earth. This is by all means an observation that empowers the outsiders because it suggests that everyone, even complete amateurs, can make stunning discoveries with the most grandiose social repercussions if they only start to see the same old things with brand new eyes. Science, correspondingly, need not be a rigid profession where the freedom to profess is conditioned by the conformity to various authorities posed along the academic pyramid. It could rather be a kingdom where everyone is invited to for the investment of their ideas, which, someday, may develop into fruits and treasures that the whole Earth could reap.

On a side note, the undying length of expression, evoking streams of passion bordering complete breathlessness, arising from the want to pack a whole world in each line of text, like that we have encountered in the aforementioned opening sentences of papers by Foucault and Faraday, has a long history of ties with romanticism, perhaps starting with the fact that the first elaborate romantic musical piece, Beethoven's Symphony No.3, Eroica, had its first movement alone longer than the entire typical symphony from the preceding, classicist period. Despite that, Foucault's seminal paper was a brief one, containing hardly over 1,000 words and not a single reference or an equation, let alone a scheme or a figure in its course. The paper only verbally described the observations and provided vague correlations with the prior work by Poisson on predicting the movement of projectiles through the air depending on the latitude. The latitude effect on the rotation of the pendulum plane was the cornerstone of the correlation between this rotation and the rotation of the Earth, yet nowhere in the paper could one find this key formula pop up. Nevertheless, the freeness of expression is authentically romanticist, and the history of music illustrates nicely all the plethora of emotions that were virtually forbidden in the eras of renaissance, baroque and classicism, but then, by the early 19th century, began to be expressed through romantic art. Today, of course, papers of the form like Foucault's would never even be sent out for peer review, let alone published in a technical journal, yet it is this battle against the windmills of the guardians of the gate of scientific publication for the unbound freeness of expression throughout it that has been a perpetual plight in the life of myself as a scientist. This plight I have found to be inherently romantic and many victories, such as those of publishing the first-of-a-kind papers written as a stream of consciousness³³, written in the "reality", diary-like form³⁴, written as theatrical plays^{35,36,37}, enabling the authorship of the world's youngest author of a scientific paper³⁸, containing dreamlike sequences³⁹ or a poetic triptych in their center⁴⁰, and comprising amorphous beginnings and ends to reflect the form of creative thought⁴¹, have been nothing short of heroic given the circumstances.

Week 2, Year 1883: Zukertort vs. Blackburne

Common to the aforementioned immortal games by Petrov and Anderssen, as it was to the games of Paul Morphy, was that both sides in such games opened rapidly, with the obvious idea to go all out to launch an attack on the opponent's king. Such, indeed, was the romantic style of play in the early and mid-19th century. As the century progressed, however, the ideas of positional chess gradually began to solidify in the style of the leading chess masters. The romantic spirit continued to reign, but positional principles were increasingly being employed. The example used to illustrate this can come from the style of Johannes Zukertort, the first player to lose the world championship match, in his case to Steinitz, in the United States in 1886. The game of choice is his immortal, played against Joseph Blackburne at the London tournament in May 1883, which

effectively served the role of the world's first candidates tournament, where the players at the first two spots, namely Zukertort and Steinitz, earned their right to play for the title of the world champion three years later.

Compared to most of his contemporaries, who strictly played open games, starting with 1.e4, Zukertort preferred closed games, starting them commonly with 1.c4 or 1.Nf3, which was extremely uncommon in the early 1880s. King's gambit was on his regular repertoire in the 1870s, but in the new decade his preference for closed games became more prominent. To someone not familiar with this fact, Zukertort's occupying one of the two central squares, d4 and e4, only on move 6 of his game against Blackburne would come as very surprising. Zukertort's mode of play was about creating a solid and defensive pawn structure first and only then planning the attack, which is exactly how his game against Blackburne progressed. Black was standing fine until 22...Nxf6, at which point White's patient play exploded into a romanticist blast, involving two decoy sacrifices (Fig.2), first of the queen and then of the rook, and a handful of other spectacular and entertaining moves. However, despite Zukertort's decisive win at the London tournament in 1883, with 22/26 points, ahead of Steinitz with 19/26, the world championship match in 1886 was won relatively easily by Steinitz, which was mostly owing to Steinitz's outplaying Zukertort in the positional understanding of the game rather than in romanticist tactics. This success of the positional play added winds to the sails of this new philosophy and chess began to drift farther and farther from the exotic romantic lands.

As for science from this period, more and more discoveries were coming out of the work of thinkers who had pure analyticity on their minds, not zested with any artistic appeal. Yet, the romantic spirit was still omnipresent, and one example can come from the two scientists who proposed the black body radiation law in 1884, a year after the London chess tournament was held, aka the Stefan-Boltzmann law. The older of the two, Jožef Stefan was a Slovenian physicist, who, as not many people know, was equally engaged in poetry writing as he was in research in physics. Lest this be forgotten, a quote of his that I cited in my PhD thesis, which was, coincidentally, defended at the Slovenian institute bearing his name, said the following: "Practical field is still large, and a lot else is needed for the growth of our people. However, to write such books is a hard thing; we need people who have science in their heads and love in their hearts"⁴². At another place, Stefan made the following romantic observation: "If a man thinks about the connections in his natural surroundings, if he is careful about the feelings that come to him during observations of natural objects and reflections on them, when he walks through the woods, fields and valleys, when he climbs the hills, he may find many threads that link his heart to sensibility and thinking in accordance with nature. And the more he knows about these links, the more he penetrates into knowing oneself. Therefore, in order to know, we need to unravel all the aspects of our spiritual living. If we want to get to the whole, we ought to start from the parts"⁴³. Three years later, in 1877, Stefan's student, Ludwig Boltzmann derived one of the most fascinating equations in science, namely the statistical definition of entropy (S), $S = k \cdot \ln W$, where k is Boltzmann's constant and W the number of possible states of the system with an equal energy. One revolutionary aspect of this equation, which is all that is inscribed on Boltzmann's tombstone in the Viennese Zentralfriedhof, was that it provided a definition of a physical quality that had a purely thermodynamic meaning from a completely different, statistical point of view. Entropy, from that moment on, was no longer a heat-related quantity alone, but rather one that can be used in innumerable physical and abstract contexts. From the realm of science, entropy suddenly entered the vocabularies of poets and philosophers and even laymen. To see a physical quality from a completely new angle and to bridge with a single equation two distinct disciplines, in this case

thermodynamics and statistics, may be enough to grant Boltzmann's definition of entropy the title of perhaps the greatest equation ever derived. Yet, this bold romanticism of creating one's own language to describe events standardly described using another, more traditional language, was just about to disappear from the world of science for good.

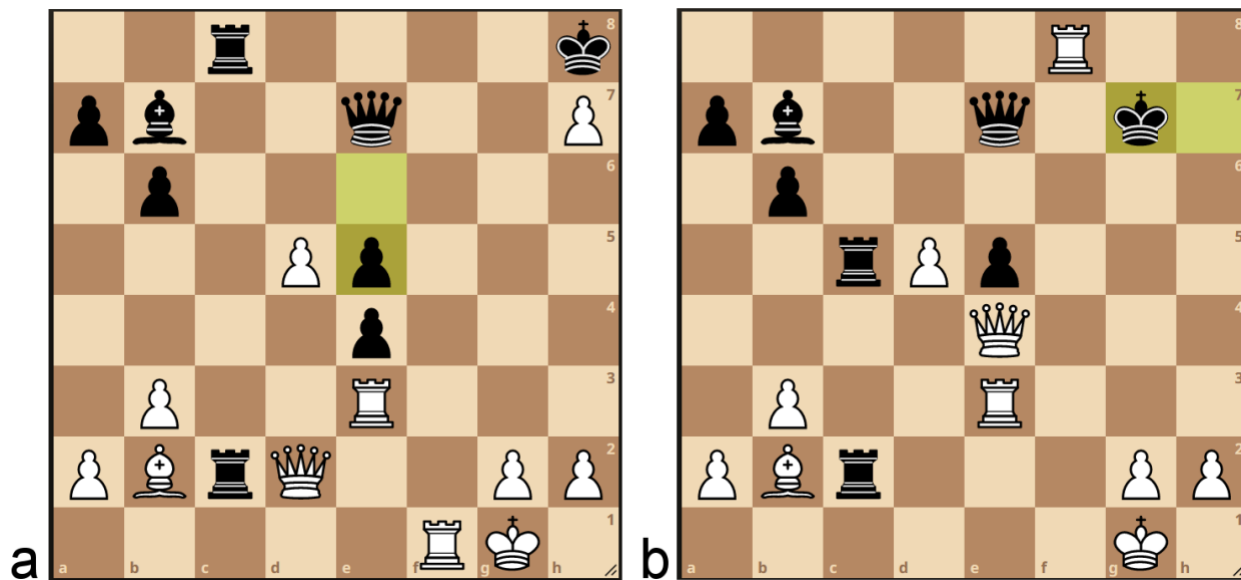


Figure 2. Zukertort vs. Blackburne, London, 1883, 1 – 0. In the position shown in (a), White correctly assessed that Black's pawn in e5 was more valuable than either White's queen or rook, and so he decided to sacrifice first his queen and then the rook to detract the black queen from defending the pawn on e5 by playing 28.Qb4 R8c5 29.Rf8+. Although Black denied both sacrifices, White did not give up and ended the game by enforcing checkmate in twelve with a combined rook and bishop sacrifice in the position shown in (b), playing 31.Bxe5 Kxf8 32.Bg7+, but missing an even more effective checkmate in seven with 31.Rg8+.

Table 1. Undisputed world chess champions and the accompanying data.

Name	Country	Year of becoming the champion	No. of years of being the champion	No. of times defending the title	Dominant style
Wilhelm Steinitz	Germany	1886	8	3	Static
Emanuel Lasker	Germany	1894	27	5	Dynamic
Jose Raul Capablanca	Cuba	1921	6	0	Static
Alexander Alekhine	Russia/France	1927	18	2	Dynamic
Max Euwe	Netherlands	1935	2	0	Static
Mikhail Botvinnik	USSR/Russia	1948	14	2	Static
Vassily Smyslov	USSR/Russia	1958	2	0	Static
Mikhail Tal	USSR/Latvia	1960	1	0	Dynamic
Tigran Petrosian	USSR/Armenia	1963	6	1	Static
Boris Spassky	USSR/Russia	1969	3	0	Dynamic
Robert Fischer	USA	1972	3	0	Dynamic
Anatoly Karpov*	USSR/Russia	1975	10	2	Static
Garry Kasparov*	USSR/Russia	1985	8	3	Dynamic
Vladimir Kramnik*	Russia	2006	1	0	Static
Viswanathan Anand*	India	2007	6	3	Dynamic
Magnus Carlsen	Norway	2013	10	4	Static
Ding Liren	China	2023	0	0	Static

* World champion reigns increase to 15 years for Karpov and Kasparov, 7 for Kramnik and 8 for Anand if disputable years were taken into account. Alexander Khalifman of Russia (1 year), Ruslan Ponomariov of Ukraine (2 years),

Rustam Kasimdzhanov of Uzbekistan (1 year) and Veselin Topalov of Bulgaria (1 year) are included amongst the disputable world champions, none of whom managed to defend their titles. Challengers who lost due to the tie rule include Carl Schlechter of Austro-Hungarian Empire in 1910, David Bronstein of Soviet Union/Ukraine in 1951, Vassily Smyslov in 1954, Anatoly Karpov in 1987, and, in the only disputable match, Peter Leko of Hungary in 2004. Challengers who lost in speed chess tie breaks include, in the disputed format, Viswanathan Anand in 1999, and, in the undisputed format, Veselin Topalov in 2006, Boris Gelfand of Israel in 2012, Sergey Karjakin of Russia in 2016, Fabiano Caruana of USA in 2018, and Ian Nepomniachtchi of Russia in 2023.

Week 3, Year 1895: Steinitz vs. von Bardeleben

As the 19th century was coming to an end, romanticism started to fade away, in chess, science and art alike. The era of the subtle accrual of positional advantages was born, the major proponents of which were the likes of Tarrasch, Paulsen and the first undisputed world chess champion (Table 1), Wilhelm Steinitz. Sacrifices on the board simultaneously became rarer and more subtle and adjusted as such to the contemporary aesthetics, one example of which comes from Steinitz's game against Curt von Bardeleben played at the Hastings tournament in 1895. A particularly momentous move in this game was the giving away of the central pawn with 17.d5 (Fig.3), whereby White opened the space for his knight and file for the rook and created conditions for an unstoppable attack on the black king. The game ended in a very illustrious manner, with the black king being forced to move, funnily, from e8 to f8 to g8 to h8, the very corner of the board, with 21. Ng5+ Ke8 22. Rxe7+ Kf8 23. Rf7+ Kg8 24. Rg7+ Kh8 25. Rh7+, after which Bardeleben, who was second in the lead at the tournament by that point, having scored 7.5 out of 9 possible points, simply walked out of the hall, without officially resigning. Although this has been unequivocally denounced since then as an act of poor sportsmanship, I have always considered it more of a classy and humorous act; after all, where else could he, the king go except beyond the board and out of the room and then who knows where after this masterful sequence of moves pulled off by Steinitz?

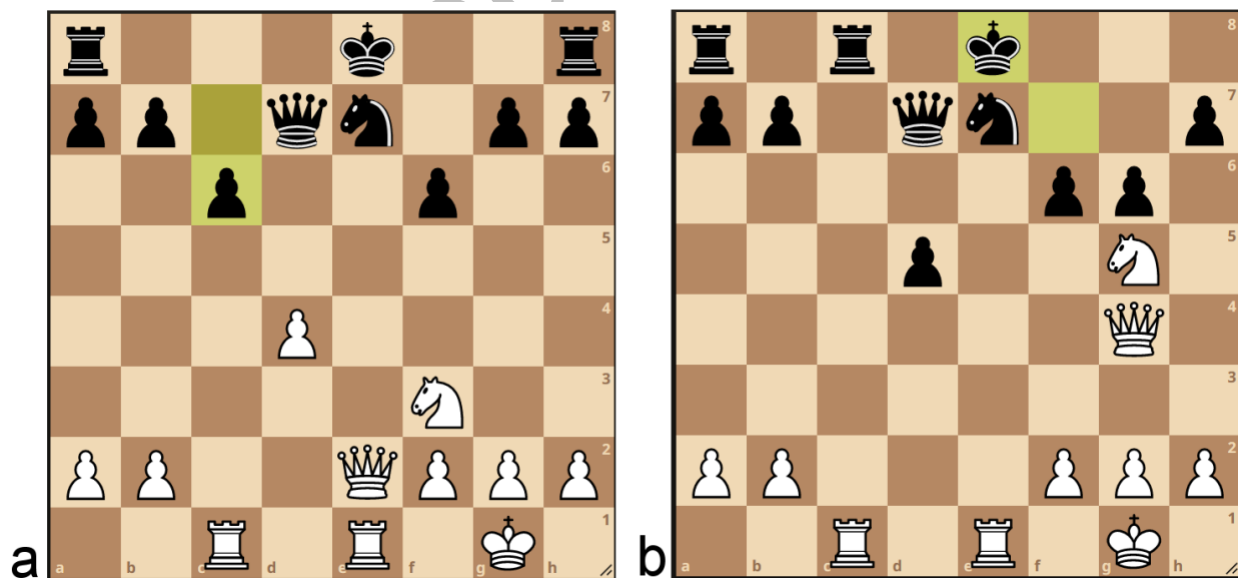


Figure 3. Steinitz vs. von Bardeleben, Hastings, 1895, 1 – 0. Position shown in (a) is after 16...c6 and before 17.d5 cxd5 18. Nd4. Steinitz's pawn sacrifice in the center was dynamic, giving away the center completely in return for a gained initiative, but it was also rooted in rigorous tactical calculations, as the capture on d5 by the pawn on c6 loses by force, just as well as the only other reasonable move, the unpinning of the king with 17...Kf7, does. Position shown in (b) presents the starting point of the black king's forced walk along the edge of the board and into its corner with

22.Rxe7+ Kf8 23.Rf7+ Kg8 24.Rg7+ Kh8 25.Rxh7+, at which point von Bardeleben exited the room without resigning the game, hinting wittily – or madly – at the ever present analogies between chess and life.

In science around this time, the robustness and accuracy of experimentation became increasingly important, which marked a new dawn, namely that where imagination soaring on the wings of pure fancy and little material resources started ceding place to superior technical advances. One experiment particularly nicely illustrates this: the Michelson-Morley experiment of 1887. The beauty of this experiment is multifold, one aspect of which stems from the wittiness of the experimental design and another one of which stems from its still being considered the most important failed experiment in the history of science. The experiment was conducted in the attempt to prove the existence of aether, the elusive medium that was thought back then to exist and fill up the physical space so as to enable the propagation of light waves. The premise behind the experiment was that, in partial analogy with Foucault's experiment, if the Earth traveled through aether, the speed of light would differ depending on whether the light wave propagated parallel to the flow of aether or perpendicular to it. Hence, the two experimenters spent years assembling an interferometer with the path length of eleven meters, which would be able to bounce light waves between mirrors in perpendicular directions, yet to their dismay, no difference between the speed of light sent back and forth in the vertical direction and that sent in the horizontal direction was ever detected. The experiment ended up being considered a monumental failure for the next fifty years, at which point it was turned into a key evidence in favor of the theory of relativity, which derives the relativism of physical properties such as mass, length and time directly from the constancy of the speed of light in all physical systems and under all conditions. To this day, the Michelson-Morley experiment represents a paradigmatic example of how the results of a failed experiment can turn into invaluable findings once the context of their interpretation becomes enlarged or transposed to a different empirical domain. The search for an immaculate precision of measurements by employing robust, state-of-the-art instrumentation, thus, unexpectedly, found its greatest use not for enabling a new practical application, but rather to gain support for the revolutionary abstract model that the relativity theory was.

Week 4, Year 1914: Lasker vs. Capablanca

As the 20th century rolled around, chess began to be increasingly approached as science, with the similar rigor and analyticity, most notably through contributions by the likes of Tarrasch, Steinitz and Nimzowitsch. With this strict analytical approach to chess, the purely combinatorial play from the days of romanticism started to cede place to positional play and play based on strategic principles proven in practice. The emergence of the second and the longest reigning world champion, Emanuel Lasker, however, coincided with an amalgamation of these two fundamentally different styles. The American writer, Fred Reinfeld divided the approach to chess at the turn of the 20th century to that proposed by Steinitz, “amenable to order, logic, exactitude, calculation, foresight and other comparable qualities”, and that advocated by Mikhail Chigorin, “full of disorder, imperfection, inexactitudes, fortuitous happenings, unforeseen consequences”, the former striving to impose order upon the irrational and “trying to banish the unforeseen” and the latter going to the other extreme, taking delight in the unpredictable. Based on this dichotomy, Reinfeld went on to observe that Lasker “combined the objective laws of Steinitz and the subjective viewpoint of Chigorin”⁴⁴.

Unsurprisingly, the ascent of Lasker to the throne of the chess kingdom coincided with the groundbreaking discoveries of quantum mechanics, which accordantly showed that science,

traditionally seeking order in Nature, has no choice but to embrace the stochastic, the probabilistic and the irrational. At no time before or after did science make an entry into territories of an equivalently rich philosophical and metaphysical relevance, let alone mystical, as then. Another key finding of the quantum theory came from its demonstrating an inevitable influence of the observer of any physical event on its evolution and, correspondingly, the subjective bias engrained in every statement, regardless of how perfectly neutral and objective it may seem. Lasker's style is congruent with this fundamental principle revealed at the beginning of the 20th century through the framework of quantum physics by being allegedly the first chess player of the champion caliber to consciously alter his playstyle with respect to the personality and style he faced on the other side of the board, sometimes playing in the style of his opponent to relax him before delivering a deadly blow and sometimes playing dubiously and perplexing him from the start with strange variations. For example, compelled to win as White the game against Capablanca at the tournament in Saint Petersburg in 1914 in order to retain chances of getting ahead of his rival, who was leading by one point two rounds before the last, Lasker opted for an unexpected exchange variation of the Ruy-Lopez, which is known to allow for a comfortable play for Black and easy equalization, then opened the e5 outpost for Black with the strange and unorthodox 12.f5 (Fig.4a) and undoubled the black c pawns by exchanging bishops on d6, and only then, in nearly the endgame, played the stunning positional king's pawn sacrifice (Fig.4b) to surprise the opponent and secure a win.

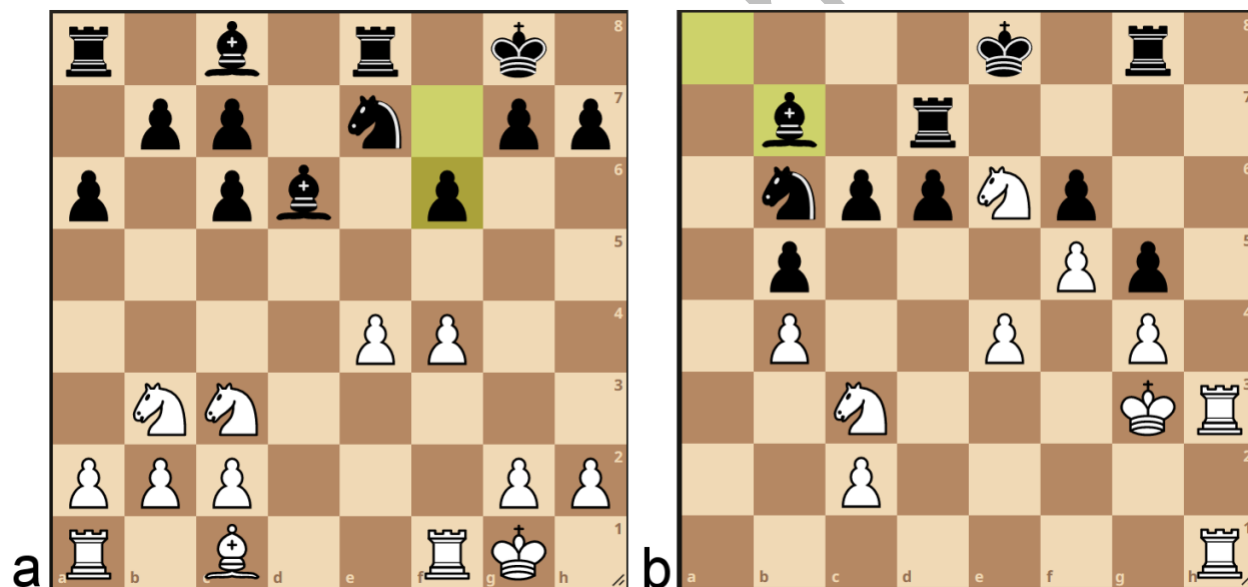


Figure 4. Lasker vs. Capablanca, Saint Petersburg, 1914, 1 – 0. After Capablanca played 11...f6, Lasker decided to create an outpost for Black's pieces on e5 and undouble his pawns by playing the seemingly friendly 12.f5 b6 13.Bf4 Bb7 14.Bxd6 cxd6 (a), and only then, when the opponent had been lulled, deliver the blow with the unexpected pawn sacrifice, 35.e5 dxe5 (b), which would open the space for the white knights to enter Black's fortress and ravage it.

One year after this encounter between Lasker and Capablanca, an exemplar of a scientist with multidisciplinary outlooks, D'Arcy Thompson wrote *On Growth and Form*, the publication of which was delayed by several years due to World War I⁴⁵. In the context of the course built around analogies between chess and natural sciences, it is natural to select this notable work by Thompson for in-class discussion because it is a classic treatise on analogies in form between different organisms and natural objects. Thompson was mesmerized by the beauty of the natural world and his writing was motivated by the craving to explain its forms, which is obvious from

him surpassing even Michael Faraday in the usage of the words “beauty”, “beautiful” and “beautifully”, which appear whole 102 times in the book, one occurrence of which was used to praise Faraday’s aforementioned experiment on vibrating beds, calling it, simply, “beautiful” in one of the footnotes. Because of its spanning multiple disciplines due to the power of analogies, the book inspired developmental biologists, mathematicians, solid state chemists, architects, anthropologists, computer engineers, and thinkers from many other niches.

Week 5, Year 1921: Alekhine vs. Teichmann

As era of one style slowly transitions to that of another, the transitional times are often marked with juxtapositions of the two styles, and such was the case with Emanuel Lasker. He understood that studying chess with scientific rigor is the way of the future, but he also kept the romantic spirit alive, all along with the appreciation of mysticism and irrationality as the driving forces leading toward excellence in performance. As the best illustration of the pivotal traits of his style, we could refer to the description of it by his chess contemporary, Richard Réti: “With the perfect technique in chess that is dominant today, a peaceful, correct play almost always leads to draw. To avoid that, with theoretically wrong moves, Lasker would draw himself onto the very edge of a cliff. However, owing to his exceptional strength, he succeeds in clinging onto this edge while tossing the opponent down the abyss”⁴⁶. Lasker developed the habit of playing moves that engines might classify as mistakes or inaccuracies, as it is with 12.f5 in Fig.4, but were in reality puzzles for his opponents, putting the positions in states of imbalance, from which complexities ensued and a player with the greater foresight and positional fluency would emerge as a victor. This principle, however, could be said to have culminated a decade or so down the timeline of chess history, in the playstyle of Alexander Alekhine, who intuitively understood that middlegame wizardry could be put to display only insofar as the balance of the static position is disrupted, with the caveat that this disruption inevitably proceeds at the cost of destabilizing one’s own position to some extent. Even further down the road, the 8th world chess champion, Misha Tal would convert this principle into an allegory talking about one player, that is, usually him, taking another into “a deep dark forest where $2 + 2 = 5$ and where the path leading out is only wide enough for one”⁴⁷. One example from Alekhine’s oeuvre may be his game against Bogoljubov in Hastings in 1922, one of the most outrageous games ever played at the top level, in which Black, that is, Alekhine, sacrificed three queens and two rooks to end up with a single pawn advantage in a king and pawn endgame. A less known example, but more illustrious for the concept at hand, may come from the game Alekhine played against Richard Teichmann in Berlin in 1921, where he deliberately gave away his f pawn for the more centralized king in a rook and bishop endgame (Fig.5), having correctly assessed that this would give him a decisive advantage. Today, with the use of computers we could assess the position after the loss of the pawn as nearly equal, but with a slight advantage for White, attesting to the correctness of Alekhine’s calculation. In all, the fourth world champion mastered throughout his career a remarkable and unprecedented skill to execute towering middlegame conceptions, both positional and combinatorial, by first creating deliberate complications on the board.

In the science world, this idea of disruption of the static equilibrium in order to breathe life and sneak an opportunity for a victory into a position is best illustrated by the principle derived a couple of years after this game was played, in 1927, by Werner Heisenberg. This relation, known as the uncertainty principle, presents possibly the most fundamental and important physical equation ever derived. Ironically and symbolically for the quest of all the world’s sciences and

philosophies toward perfect knowledge, this equation is an inequation and a statement of the fundamental impossibility of arriving at the perfect knowledge about anything. According to this inequation, *i.e.*, $\Delta x \cdot \Delta p \geq h/4\pi$, the more precisely one measures the momentum of a system, the less precisely one can measure its trajectory, and *vice versa*; or, as another formulation of it has it, *i.e.*, $\Delta E \cdot \Delta t \geq h/4\pi$, the more precisely one measures the energy of a system, the less precisely one can measure its temporal component, and *vice versa*. In broader frames, this is to say that the ideal of Laplace's omniscient, demonic computer and of perfect knowledge of anything is illusory and that irrational intuitions must be embraced as essential complements of stringent calculations in order to come up with perfect knowledge, the perfection of which will be, understandably, conditioned by its perfect imperfections.

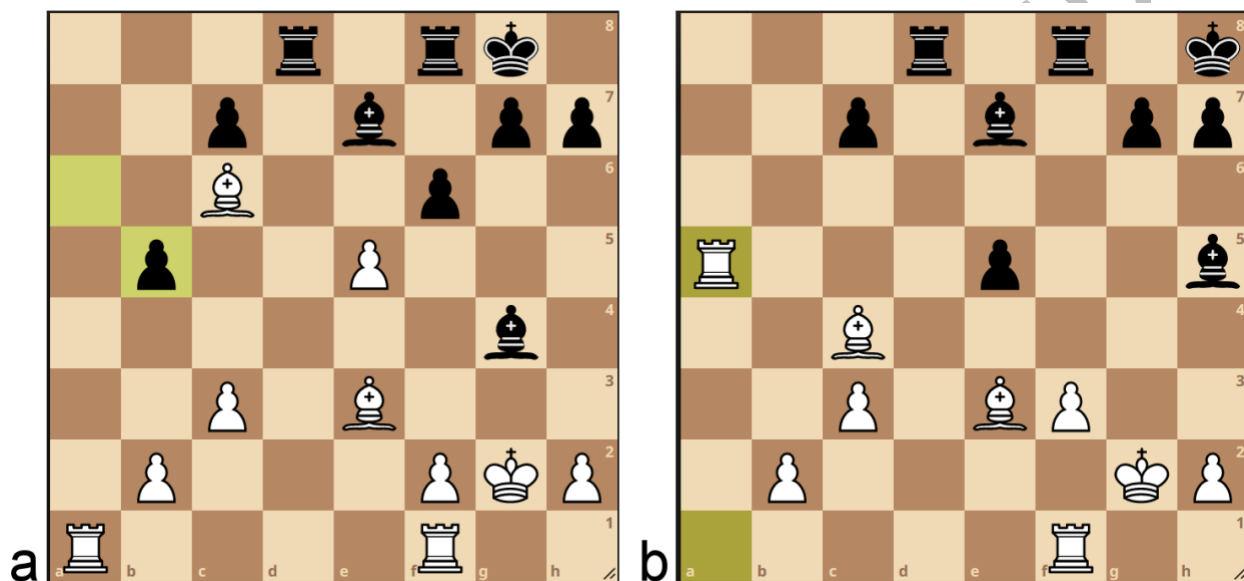


Figure 5. Alekhine vs. Teichmann, Game 4, Alekhine - Teichmann Match, Berlin, 1921, 1 – 0. Position shown in (a) is before 19.Bxb5 fxe5. White realizes that maintaining the material equality on the board, even at the cost of swapping its sole central pawn with a black pawn, gives White a better position than capturing the pawn on f6 and giving Black an extra tempo in activating its f file rook. This activation of the rook by bringing it to f6 square would lead to an unstoppable discovered check threat following 20...Rg6 if White immediately takes on both f6 and b5 (19.exf6 Rxf6 20.Bxb5), which would be instantly losing for White. Position shown in (b) is after 22.Ra5 and before 22...Rd1 23.Bd5 Rxf1 24.Kxf1 Bxf3 25.Bxf3 Rxf3+ 26.Ke2. Alekhine's dynamic nature comes to full prominence in this materially equal endgame position, where he sacrifices the f3 pawn for a more centralized king, having correctly assessed that one such exchange would increase the winning chances for White.

Week 6, Year 1927: Alekhine vs. Capablanca

Jose Raul Capablanca went down in chess history as the first world champion and perhaps the world's first top player to whom poetics of pieces matter nil and all in his sphere of interest was the elicitation of technical precision *en route* to a cold and mechanical victory. He was gifted with the ability to see how minor and seemingly negligible middlegame maneuvers could convert to a small but accruable advantage as the game progressed toward the endgame. A special class of moves that he mastered and generously employed were those with dual purposes, having recognized not only how a simultaneous attack on two distinct squares in the opponent's position is hardly defensible against, but also how much tempo can be gained by playing moves that serve both offensive and defensive roles. One such exemplary multipurpose move may be 14.Qf3 from

the game Capablanca played against Frank Marshall in New York in 1918, with which the white queen attacked the black rook on a8, blocked the development of the black light-squared bishop to b7 and protected the white kingside, all at once. Notably, this was the game in which Marshall played the gambit in the Ruy-Lopez opening now known under his name; 'twas the gambit he had prepared for a whole decade prior to this game and then lost it due to Capablanca's immaculate defense.

As fate would have it, however, this exact multimodal style of play pioneered by Capablanca was eventually employed against him, nowhere more efficiently as in the game that ended his time on the throne of the chess world, the last one from the world championship match he played against Alekhine in Buenos Aires in 1927. In his autobiographic annotation, Alekhine particularly commended the quiet sidestep of his queen from e2 to d2 on move 21 (Fig.6), with which he eyed the weak pawns on a6, e5 and h6 at once, being ready to strike on the queenside, the kingside or the center depending on the circumstances. Specifically, if Black were to deploy a counterattack with 21...Bc6, Alekhine was ready to play 22.Nh4, as after 22...Nxe4, White wins with 23. Nxf5+ gxf5 24. Nxf5 Kf6 25. Qxh6+ Kxf5 26. g4#, and after 22...Bxe4, White plays 23.Qe3. In the game, Capablanca deemed it wisest to give away the a6 pawn after White's dual attack on the pawns on a6 and e5 with 23.Qa5 and allow White a passed pawn on the queenside in return for an initiative, but Alekhine precisely predicted, in Capablanca's style, that the endgame grind would be winning for White, and so it was, after no less than 82 moves.

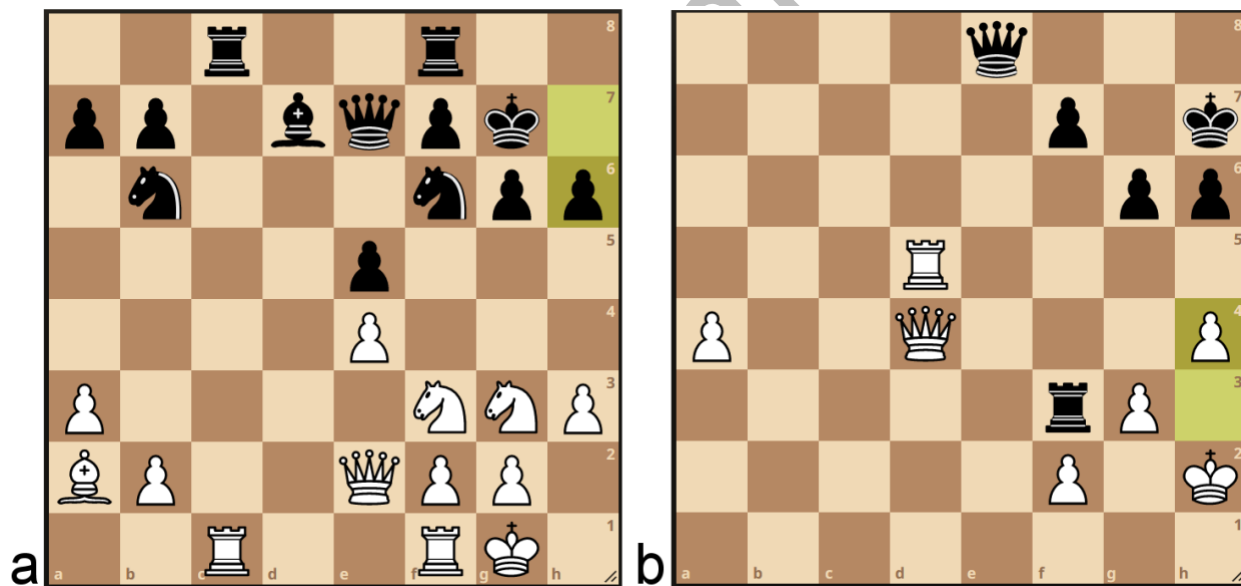


Figure 6. Alekhine vs. Capablanca, Game 34, World Championship Match, Buenos Aires, 1927, 1 – 0. After Capablanca played 20...h6, just subtly weakening the pawn structure around the black king, Alekhine, in response, played quiet 21. Qd2 in the position shown in (a), posing a triple long-term threat against Black's queenside, kingside and the weak central pawn. One extra pawn in a queen and rook endgame became winning only after Alekhine's fine maneuver with which he first denied the exchange of queens on h8 and then enforced this exchange three moves later: 46...Qh8 47. Qb6 Qa1 48. Kg2 Rf6 49. Qd4 Qxd4 50. Rxd4 (b). The only difference was that in the former case the black rook would have stepped behind the passed pawn on the a file, whereas in the latter scenario it had to step in front of it. This subtle difference executed very much in Capablanca's style imparted a decisive advantage onto Alekhine and won him this four-day long game and the world champion title. Of note is also that White's 48th move, quiet 48.Kg2 was not only the one and only winning move in the position, but all the others were instantly losing, too, except for 48.h5, which would have led to a draw, at least in theory.

Having brought to mind these moves with dual purposes, it is not coincidental that on this very same year, 1927, Davisson and Garner would perform Young's double slit experiment with electrons and demonstrate that, like light, so do elementary particles have both particle-like and wave-like properties, being describable by de Broglie's relation of equivalence between the mass and the wavelength, *i.e.*, $\lambda = h/mV$. And then, a year later, in 1928, Paul Dirac derived the relativistic wave equation applicable to all mass particles with the spin of $\frac{1}{2}$, including quarks and electrons susceptible to the symmetry operation known as parity inversion, thus effectively predicting the existence of antimatter, alongside referring back to Alekhine's strategy of mirroring the style of his opponent to provoke his loss and dethronement.

Week 7, Year 1930: Ståhlberg vs. Khan

In the years following World War I, a positional theory in chess, more radical than any other proposed before or after, began to emerge from the studies by the central European players including Aron Nimzowitsch, Richard Réti, Ernst Grünfeld and others, known by the name of hypermodern theory. The dominant view at the time, crafted along the lineage extending from Philidor to Steinitz to Tarrasch, held that the goal of the opening is to control the center with pawns. The hypermodern theory challenged this view and asserted that this is not needed and that the control of the center with minor and major pieces and only then breaking through the center with pawns presents the right positional approach. As a result, a number of hypermodern openings began to pop in the 1920s, ranging from the soft, such as the Nimzo-Indian defense, to the extreme, such as the four pawn attack variation of Alekhine's defense. The hypermodern theory was short-lived in its full form, but some of the positional principle it insisted on continued to pervade the later schools of positional chess. Still, today, this theory mostly serves as a testament to the rule-breaking thought that marked the given era, not only in chess, but in arts and sciences as well. These days, however, a theory as radical as the hypermodern would never be embraced by the chess pundits, nor would its analogs be adopted by the scientific community either, but a 100 years ago the openness to such innovative stances was evidently greater than today. For example, according to a general consensus among the editors of the world's most prestigious scientific journals⁴⁸, Einstein's theory of relativity, proposed in the same decades that saw the birth of quantum mechanics, given its radical theoretical outlook without a solid empirical evidence, scanty referencing and obscure affiliation, would not see the light of the day in any of these journals today. It is disheartening to realize that one century ago the climate was more open to paradigm-shifting ideas than it is today, but truth, in the words of the chess analyst, Ben Finegold, hurts, if not, as the Danish philosopher Søren Kierkegaard had it⁴⁹, paralyzing the one who comes face to face with it. What drives the innovation in sciences and technologies today is not an intellectual climate more conducive to creative thought, but only the more massive investments in research and development, where the mantra of 3 %, that is, the expectation that 3 % of research funded will lead to practical innovation, holds the central place. Without much dedication to train scholars in innovative thinking from the basic educational levels onwards and with thinking instead that wealth is sufficient to generate new knowledge, however, this innovation pyramid will continue to stand on shaky legs and the most creative mindsets will continue to slide down its edges and fall into the mud while the skilled entrepreneurs and sly self-promoters will keep on climbing to the top. Yet, we should remember that there were times when openness to innovation was greater than it is today, and, as we see from this argumentation, it was present in parallel in both the worlds of chess and of science.

Like the leading art movements of the early 20th century, be they cubism, Dadaism, fauvism or futurism, the hypermodern theory was short-lived in its essence. Logically, therefore, the illustration of it calls for the reference to an equally short but illuminative chess career, which will be that of Sultan Khan, a native Punjabi who won the British chess championship in 3 out of 4 attempts and who achieved victories over many notable players, including the world champion, Capablanca, at the tournament in Hastings in 1930/31. After a couple of years he spent in Europe, though, Khan returned to his homeland, where chess was not as popular, and worked as a farmer for the rest of his life. In this example, Khan, playing as Black against Gideon Ståhlberg of Sweden⁵⁰, shows what was meant by the hypermodern idea of eyeing the center with the minor pieces and only then breaking through the center, which he attacked by playing 9...b5 in the position in Fig.7, thus sacrificing a pawn in order to create an outpost for his knight or bishop on the central d5 square. This outpost, however, in the game, was utilized very shortly, as the advance of the white queenside pawns proved the sacrifice dubious, illustrating how ideas in chess and life alike can be beautiful, but also crumble under the feet of bandwagon-chasing pedestrians. Anyway, like the careers of Paul Morphy before him and Bobby Fischer after him, Khan's was short-lived and he withdrew at the peak of his prowess from the chess world. He made his journey from the British Raj to England at around the same time when a fellow Punjabi, Subrahmanyan Chandrasekhar made the same trip, on which he derived what is today known as the Chandrasekhar limit and predicted the existence of black holes, but then ended up being ridiculed when he presented those findings to the Royal Astronomical Society of the UK. However, unlike Chandrasekhar, who had a healthy habit of moving each decade to a new topic of study and leaving all the preceding research behind him, Khan left chess for good upon his return to Punjab and devoted himself to the tending of, literally, greener pastures. Similarly, there have been countless scientists who have left brief but impressive marks on their fields, even though the public and the peers have never heard of them. Very often, whether it was due to their modesty and being fed up with the various toxicities and injustices abundant in the scientific community, the incongruence of their ideas and models with the reigning paradigms, the natural tendency of creative masterminds to clash egos with the authorities and later be discarded by them, or some other unforeseeable reason, they left the world of science prematurely. In the end, what the fate of the hypermodern theory shows is that radical ideas may spur creativity, but may also be destined for prompt marginalization, if not a drift straight into oblivion.

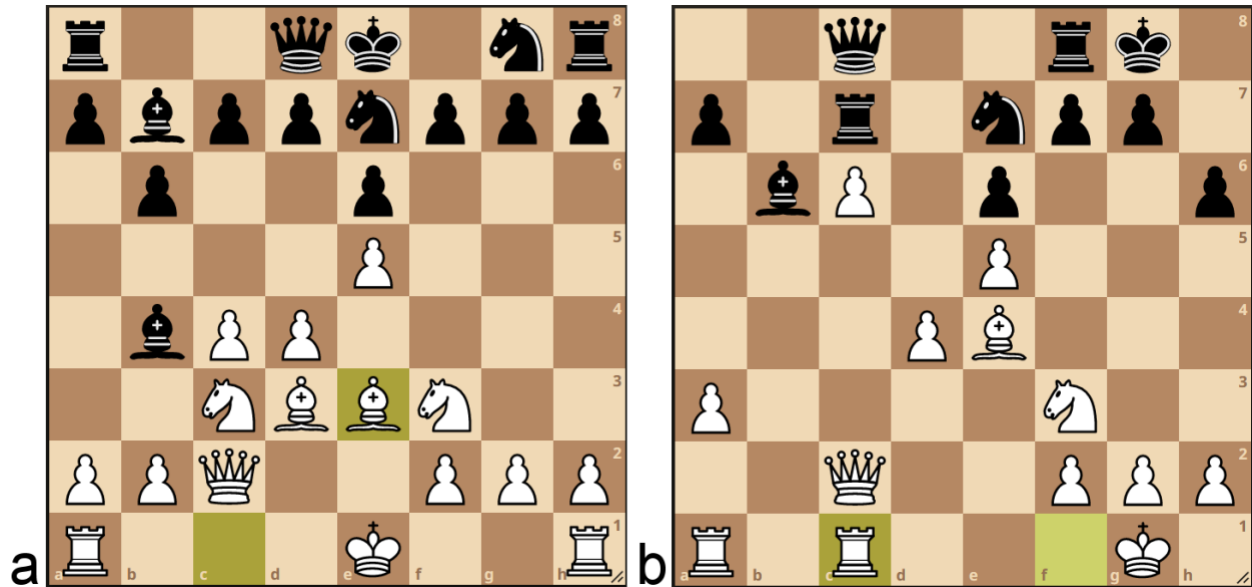


Figure 7. Ståhlberg vs. Khan, Prague Olympiad, 1931, ½ - ½. Khan follows the hypermodern principle of leaving the center to the opponent's pawns and then undermining them from the side by opting for a dynamic play involving a pawn sacrifice in the position shown in (a): 9...b5 10.cxb5 Nd5. By move 23, Black is two pawns down, but is saved by another instance of undermining the center occupied by white pawns, playing 23...f5 24.exf6 gxf6 in the position shown in (b), which helped him finally acquire a counterplay and secure a draw.

Week 8, Year 1947: Euwe vs. Najdorf

World War II had a profound influence on virtually every scientific and nonscientific field and discipline. Perhaps most significantly for this discussion, the urgency of defeating the enemy in this war necessitated the recruitment of a workforce directed to produce practical and tangible technologies based on the preexisting scientific concepts in lieu of exploring new abstract and theoretical concepts. This stance coincided with Franklin Roosevelt's founding the Office of Scientific Research and Development in June 1941, with the objective of dividing federal research funds between government, academic and industrial sectors with one single objective in mind, summed in the words of the inaugural director of this office, Vannevar Bush: "Will it help to win a war; this war?"⁵¹ The period following World War II was, then, that of a grand awakening into an age of relativism as a natural response to the suddenly risen awareness of the dangers of the intrinsic totalitarianism of all ideologies, be they called fascism, communism or something else. In 1955, Carl Theodor Dreyer would film *Ordet*, a remarkable movie where the prophet becomes a healer only after he shuns any mystical presumptions and becomes an ordinary citizen, reflecting the zeitgeist of these times. This emphasis on the merits of pure rationalism can be illustrated by the style of the 5th world chess champion, Max Euwe, who is said to have directly transcribed his skills as a mathematician to the chessboard and thus played in a very dry, but precise way. Of course, as with every chess player, when an opportunity to launch an attractive attack arises, they would attack, and so did Euwe too, as in his notable games against Szabo in Groningen in 1946 or against Tartakower in Venice in 1948. However, the example shown in Fig.8 comes from the opening, Round 1 game Euwe played at the tournament in Mar del Plata in 1947, against the local favorite and the best Argentine player in history, Miguel Najdorf, who, himself, was a World War II refugee from his native Poland. Najdorf, namely, found himself at the chess Olympiad in Buenos Aires in 1939 when Nazi officers arrested his entire family and confiscated all his property, and

so he decided to stay in Americas, playing record-setting simultaneous blindfold chess games in hopes that the news of him being well would reach his family. In this game, Najdorf launched a fierce attack as Black, but Euwe defended precisely and at the right moment returned the exchange sacrifice (Fig.8) to secure the winning advantage. In recognition of his orthodoxy, in 1970, the World Chess Federation (FIDE) would appoint Euwe as its president, who to this day represents the most successful chess player to have held such an esteemed position in the world's main chess organization. Creative renegades, of course, are never deemed appropriate for such functions, unlike the rather formal and moderate individuals, as Euwe was, on and off the board. Transposed to the scientific domain, this type of leadership spurs conformity and toeing the line of tradition instead of reveling in exploration of revolutionary novelties. Expectedly, the post-World War II era brought about the rise of Mikhail Botvinnik to the top of the chess world and marked the period of solidity and logicity in not only the dominant chess style, but also the mainstream mode of doing science. The opening preparation and play by the principles instated themselves as the central and only possible approaches to chess, whereas play for play's sake, for uplifting the spirits of the gazers and for earning insights into the deep nature of creativity was sidelined in Botvinnik's method. At the same time, in natural sciences, the smidgeons of the romantic spirit were shunned as Dionysian and Wagnerian traits that were deemed dangerous and capable of only causing problems in a domain that is to be composed of pure logic, untainted by any dark intuitions or emotions. When one form of tyranny is uprooted, another one, as a rule, instills itself somewhere else, and science has yet to recover from this expulsion of the great romantic spirit from it that has happened to a most drastic degree in these decades and that continues to this very day.

The romantic streams in the realm of science of this time continued to exist, albeit shyly. Rather than being bluntly suppressed, as it is the case today, they were more channeled into logical means of expression. One such case was with the early cybernetics movement, which was being given birth to at the Macy conferences on cybernetics, held between 1946 and 1953 in the Upper East Side of New York City. As influential as the Solvay conferences on physics earlier in the century, the Macy conferences enabled prolific congregations of intellectuals, many of whom were romanticists at heart, but who channeled this romanticism into the effort to create a whole new field of science, which would, even more importantly, provide an outlook on every other field of science imaginable. This metalogical aspect of cybernetics was particularly notably elaborated by Gregory Bateson⁵² and by the second-order cybernetic models of Heinz von Foerster⁵³, along with their ardent methodological followers^{54,55,56}. In all, with their work, these giants carved cornerstones of today's computer science and information technologies, but what is especially important for this discussion is to note how frequent their excursions to the spheres of philosophical thought were upon conceiving and refining their scientific models and worldviews. This is to say that romantic aspirations were starting to be subdued and sublimed, and their free expression became less socially acceptable than ever before in history, even though they continued to live as a powerful undercurrent, conforming to Gregory Bateson's adage: "There seems to be something like a Gresham's law of cultural evolution according to which the oversimplified ideas will always displace the sophisticated and the vulgar and hateful will always displace the beautiful. And yet the beautiful persists"⁵⁷.

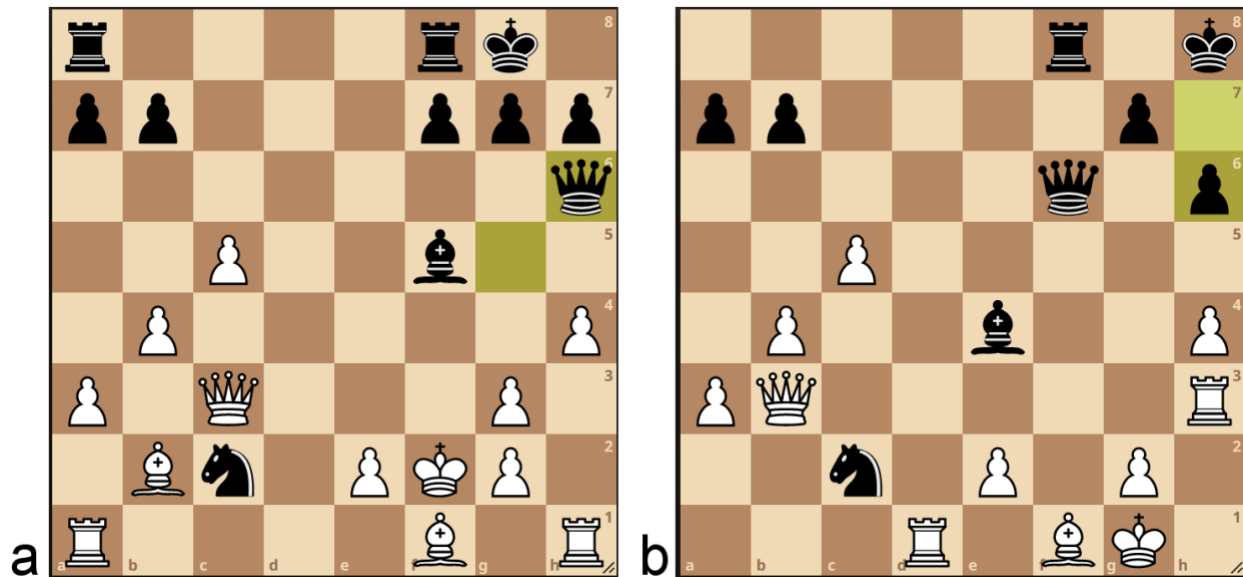


Figure 8. Euwe vs. Najdorf, Mar del Plata, 1947, 1 – 0. Euwe peters out the resilient attack by the black pieces, first by playing 18.g4 in the position shown in (a), having realized that the white king would find a safe harbor after 18...Bxg4 19.Qxc2 Qf4+ 20.Kg1 Qe3+ 21.Kh2 Qf4+ 22.g3 Qf2+ 23.Bg2, and then, in the position shown in (b), by choosing to return the exchange sacrifice at the right moment, playing 26.Rf3.

Week 9, Year 1957: Śliwa vs. Bronstein

“Exhaustive search for move selection rules chess out as a game of intelligence”⁵⁸, David Bronstein noted once, but this despondent remark has a brighter side, for it can be considered a gateway to Bronstein’s lifelong consideration of chess as a game that is halfway between art and literature⁵⁹. It can also explain his perpetual quest to accomplish beauty in over-the-board contests instead of focusing on pure exhibitions of intelligence and petty strivings for victory. Besides, when expressions get suppressed, dreams abound, not only in chess and science, but in every art and every walk of life. And if there ever was an epitome of a daydreamer among the world’s top chess players, then it must be David Bronstein, himself, who once spent 40 minutes deliberating over his first move as White and on another occasion was so deeply immersed in his thoughts that he thought that the game was over and that he was analyzing it at home. The blunder he made in that instant, touching the king instead of the knight in Game 6 of the world championship match against Botvinnik in Moscow in 1951 and having to play 57...Kc2 instead of 57...Ne6+, in fact, cost him the world champion title. As a result, no chess player in the 20th century except him and Carl Schlechter ended up being so close to becoming the world champions, yet they both squandered their opportunities through staggering blunders^{60,61}. Still, what Bronstein’s career in chess can illustrate is that losers can often inspire more than the winners. In a way, it is a testimony to the witty truism: “Winning is for losers”⁶². Therefore, his dreamy and daring style of play, where imagination was valued more than the achievement of winning, can provide a definite source of inspiration for students in search of creative outlooks and ideas. Bronstein’s throwing himself into a lost position already by move 13 of the game against the Polish chess master, Bogdan Śliwa in 1957 and then complicating the position via a number of sacrifices topped with a triple queen sacrifice (Fig.9), in fact, earned this game the epithet of an immortal losing game. Unfortunately for Bronstein, his opponent played prudently and correctly, accepting only those sacrifices that were acceptable. Nonetheless, the epithet that the game earned since it was played suggests that

losing need not be an obstacle for delivering beauty to the world of science, or world in general. As Bronstein, himself, pointed out in one of his two most popular chess books to date, the one portraying the 1953 Zurich chess tournament, “How sad it can be to end up minus both piece and attack, to sit and wonder: ‘How did all this happen? Where did I go wrong?’ ... but at the very end, fortune favored the brave”⁶³.

Coincidentally or not, a year before this game was played, in 1956, the British physicist and mathematician, Paul Dirac formulated the principle according to which having beauty in one’s equations is more important than having them match the reality⁶⁴. To this day, the explication of this principle, coming from the least likely of sources, namely the realm of elementary particle physics, where semantic connections were thought to be made based on the rules of math and logic alone, represents a seismic shift in the way natural sciences could and should be perceived if our goal is not the engagement in the reiteration of the trite old paradigms, but the production of revolutionary fundamental novelties. Yet, what must be noticed is that from today’s entrepreneurial climate of modern science, worldviews such as those of Dirac and Bronstein have been ruthlessly expelled and kept at bay. Neither do scientists any longer look for ethereal beauties inside their equations and scientific models nor are the merits of quixotic dreaminess for rational conceptualization recognized in educational or research institutions of the day. Prosaic pragmatics and coldblooded careerism have instead suppressed and put into chains any romantic aspirations to turn a game of chess, a scientific paper or any other intellectual project into a piece of art, notwithstanding the cost.

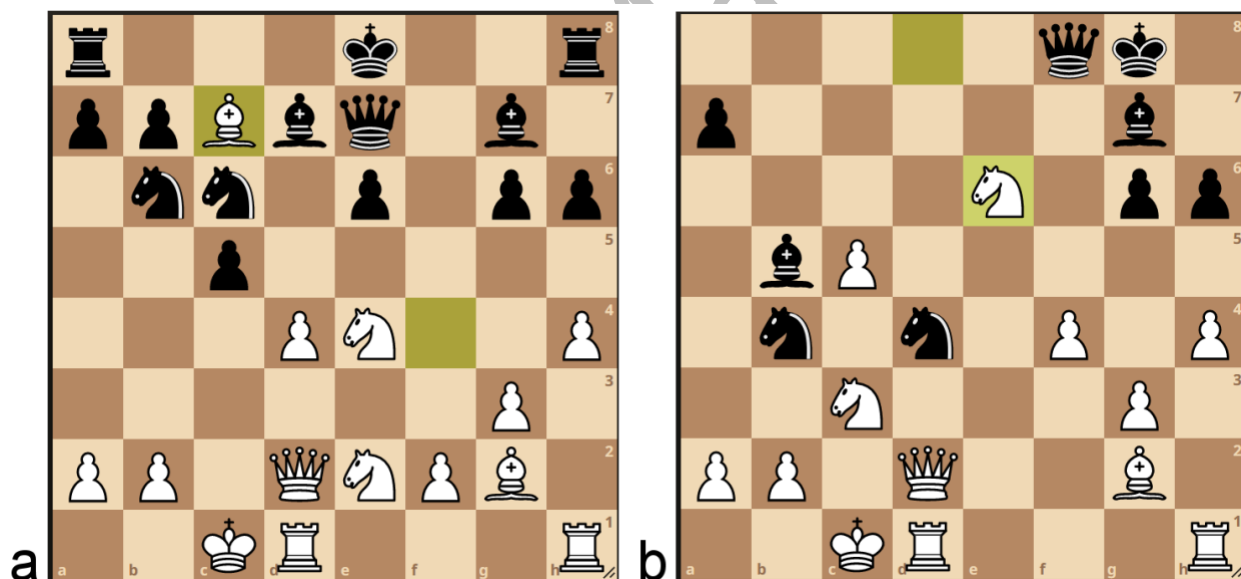


Figure 9. Śliwa vs. Bronstein, Gotha, 1957, 1 – 0. In the position shown in (a), White has just taken the pawn on c7, expecting that this would prevent Black from castling on either side, but Black, in the spirit of Petrov’s immortal, castled anyway, giving up the exchange after 15...0-0 16.Bd6 Qf7 17.Bxf8 and also neglecting to take the free pawn on d4, giving away its own central pawn instead after 17...Rxf8 18.dxc5. Five moves later Black would sacrifice his second rook and then the queen: once by playing 24...Bd3 in the position shown in (b), the second time with 25. Bd5 Qf5, and the third time with 26. Nxd4+ Qxd5. In none of the scenarios can the black queen be captured or else White loses after 25.Nxf8 Nxa2 26.Nxa2 Nb3#, 26.Nxd4 Qxd5 27.Nxd5 Nxa2#, or 27.Nxd5 Nxa2#, respectively. White did not fall for any of the queen sacrifices, having correctly assessed that the value of either of the two white knights, which dominated the game both offensively and defensively, was greater than that of the black queen. The game continued with 27.Nc2 Bxc3 28.bxc3 Qxa2 29.cxb4, at which point Black resigned.

Week 10, Year 1960: Tal vs. Botvinnik

After World War II and the era of Alekhine's reign as the world champion were over, in 1945 and 1947, respectively, most developments in chess playstyle revolved around static positional principles. The dynamic unsettling of the equilibrium, by comparison, was rarely employed in a systematic manner. This solid and highly principled style of play is usually tied to Mikhail Botvinnik, who is considered the patriarch of the Soviet chess school, which ended up dominating the world of chess for over half a century after the death of Alekhine. From this post-World War II period, a similar era of sanity emerged within the scientific community, the toll of which came in the form of a stall and dwindle of revolutionarily profound, conceptual innovations, the trend that is actual today just as it was back then. The major opponent of Botvinnik's school came to prominence from the same country in the late 1950s, representing to this day the most rebellious of all chess players: Misha Tal. The clash between them for the world champion title was analogous to that between Edison and Tesla, the former of whom represents the modern principal investigator as a capitalist, an autocrat and an exploiter of young graduate and postdoctoral talents through his own talent for entrepreneurship and fundraising, and the latter of whom represents a solitary scientist and a creative genius, albeit unable to relate to the mundanities of the social reality. As a reminder, one essential message handed to us by Tesla's legacy is that if he managed to be guided by mystical, authentically romantic visions in his work on invention of high-tech appliances, then virtually every other field of science, from the least to the most theoretical or practical, can and should feed on ideas that border art, philosophy and theology, just the way it was done in ancient Greece, where philosophical treatises, theatrical plays and scientific discussions formed an indissoluble concoction. Yet, this romantic and renaissance attitude has been largely abolished from the modern science by the lineage of entrepreneurial mindsets whose exploitative approach is traceable to that of Edison. To them, materialistic drives and diligence sprinkled with a bit of the wit of the intellect is all that counts, whereas any digressions into lyricism or metaphysics are perceived as foreign and need be averted at all costs.

Hence, as we see, the encounter of the principled patriarch of the game, Mikhail Botvinnik, and the lone pirate and the gambler, Misha Tal, was an encounter of values of far greater significance than those pertaining to mere wood-pushing on the chessboard. While the former founded an entire school and a system of chess, leaving an immense and lasting practical impact on the game, the latter was an ever present source of inspiration for the artists, and who among the two the students in arts or sciences would pick as their favorite in this match is always curious to see: the suit and the tie and the airs of grandiosity and the lusher of a managerial lifestyle feeding off of capitalist exploitation that Mr. Correct represented or the life of a "Napoleon in rags"⁶⁵, a renegade and perpetual outlaw that Mr. Incorrect was. Their first world championship match, in 1960, was won by Tal and the second one, a year later, by Botvinnik, meaning that Tal, like Vasya Smyslov earlier, only shortly interrupted the decade and a half long residence of Botvinnik on the world champion throne. In any case, given the poetic peculiarities of his style, Tal's accomplishment is as fantastic as the scientific and technological feat of sending the first man to space, which coincidentally happened a year after Tal upset the chess world and became its king. The sacrificial and speculative style of Misha Tal, a self-proclaimed chess gambler, was curbed in these memorable matches, but a moment from Game 6 of the 1960 match nicely illustrates its essence (Fig.10). Tal's oeuvre, of course, contains hundreds of games with more ecstatic and mind-boggling sacrifices, but the one from this example stands out because of its historical importance and for the famous uproar it caused among the audience both during the game, when cheering in

the hall started to get so loud that the players had to move to the backstage to be able to play, and also after the game, when the excitement of the crowd spilled out to the streets of Moscow.

The sacrificial style of Misha Tal can be an endless source of inspiration for the explorers of creative ways of impression and expression in virtually every type of art or science. After all, to break the rules and habits of “good” behavior, which Tal carried out regularly on the chessboard, is the first step toward being enlightened by new ideas, and this is where creativity, really, begins. One experiment converging with this principle was being conceived during Tal’s short reign at the summit of the world; it is nowadays known as the Milgram experiment. According to the findings of Milgram’s study from 1961⁶⁶, people faced with the choice of either following the moral obligation not to hurt other people or obeying the authority overwhelmingly opt for the latter, even when this entails the infliction of staggering levels of pain onto fellow humans. Conversely, if our goal in life is to be benevolent to other people, then we have no other choice but to disobey the authority, whichever the form it takes – administrative, physical, abstract. After all, exhibitions of creativity in sciences are preconditioned by the ability to recognize and the freedom to pinpoint the deficiencies in the existing fabric of knowledge, and from there on propose the means of amending them, which is a stance that sooner or later brings one at odds with the powers that be. Tal’s style of play, wild and anarchic, free like a bird, epitomizes very well these clashes with the authority, without which, as we see, no human hearts could be touched and hardly anything poetic and beautiful could be brought to life.

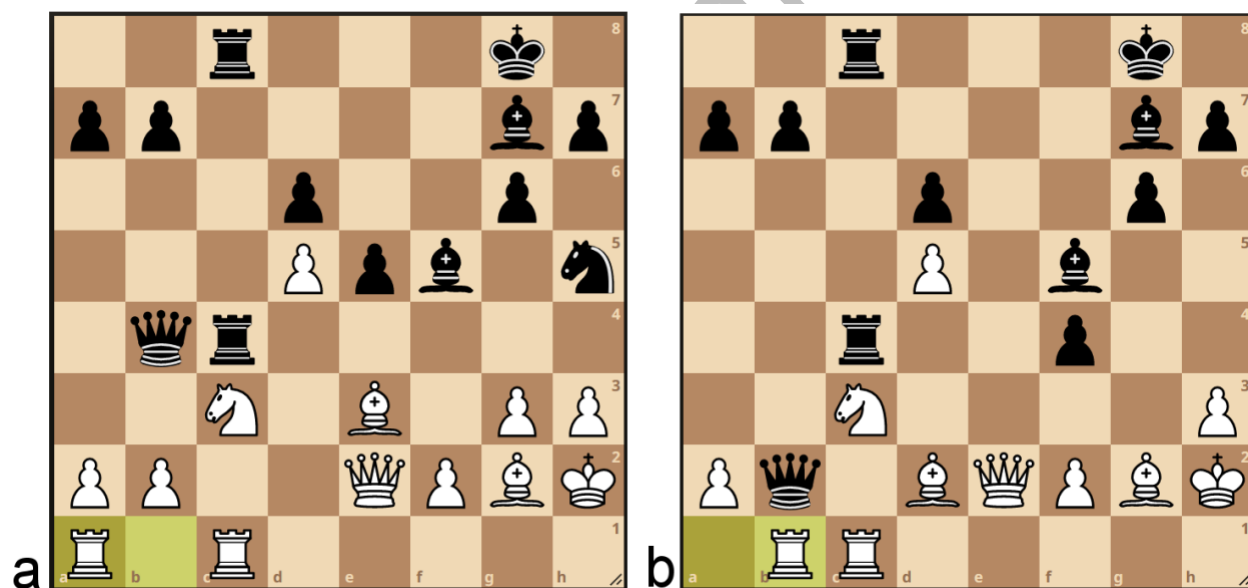


Figure 10. Botvinnik – Tal, World Championship Match, Game 6, Moscow, 1960, 0 – 1. In the position shown in (a), Tal intuitively sacrificed the knight with 21...Nf4, which was followed by 22.gxf4 exf4 23.Bd2 Qxb2 24.Rab1. At that point, the position shown in (b) was reached, in which Tal sacrificed the f pawn by playing 24...f3, thus continuing to create dynamic complications characteristic for his style and prompting White to make the key mistake of the game by taking the queen on b2 with 25.Rxb2.

Week 11, Year 1972: Fischer vs. Spassky

Bobby Fischer was active in professional chess since the mid-1950s. However, as the 1970s began, something strange happened; it was as if a source of inexhaustibly creative streams were unleashed in his head. He suddenly managed to open a backdoor to the crypts of human

consciousness, showing how immense the powers latent in it are and how everybody on the other side of the board is vulnerable and can be crushed into pieces with a right frame of mind. Many of Fischer's games were similar to watching a boxer deliver punch after punch, with moves naturally flowing from one into another, each posing a threat and then the threats multiplying until the opponent's position crumbles like a deck of cards. One example of this is Game 6 of the world championship match he played against Spassky in Reykjavik in 1972 (Fig.11). In this memorable game, Fischer did not only decide to play a closed game for only the third time in his career, surprising everyone in the audience, but he also opted for the Tartakower variation of the queen's gambit declined, in which his opponent had never lost a game. That Fischer in those days unlocked a secret bolt in his mind, from which the streams of a mountainous prowess began to gush out, is evident from the fact that no player before or after him could win 6-0 and 6-0 in two rounds of the Candidates tournament, as he did against Taimanov and Larsen, and score 20 wins in 20 straight games at the Interzonal and Candidates level, playing all the while all alone, with no seconds, against opponents who worked with whole teams of trainers and seconds. Neither did any player before or after him begin the world championship match with a deliberate blunder, *i.e.*, 29...Bxh2 in Game 1, and then not showing up at all for Game 2, thus starting with a 0-2 score, but only to win 5 out of the next 8 games and eventually get crowned as a new world champion. Neither did any player before or after him concede the world champion title without a match, but such are the paths of extraordinarily creative personalities: strange, stranger, strangest, irrational, illogical, impossible to understand, but with something unspeakably sensible peeking from their hearts.

To this day, Bobby Fischer represents a living proof that the creative brain is an iceberg, only the tip of which is usually prominent. Fischer's display of this extraordinary mental power, interestingly, coincided with the decade of unusually inhumane experimentation in psychology in the United States, predating the Belmont report of 1979 issued by the American Psychological Association. Further, on the same year when Fischer became the world champion, the first experiments on quantum entanglement, aka "spooky action at distance", were conducted at UC Berkeley⁶⁷, while the legitimate research experiment on parapsychology aka the Philip experiment was performed by a research group associated with the University of Toronto. For better or worse, the global fascination with mindreading, with clairvoyance, with tuning into collective consciousness and with other forms of action at distance has toned down since those days, yet all these phenomena remain bottomless wells of inspiration for the seekers of stupendous creative powers inside them. As for sciences, Fischer's fantastic skills can inspire the scientists to come to terms with the belief that solutions to even the most complex puzzles in science and life can be glimpsed in the blink of an eye, if they only be stormed by intuition and reason walking hand-in-hand, in Bobby Fischer style.

However, nearly as soon as he became the champion, he, the king, walked away from the throne and into shadows, never again to play an official chess game under the auspices of FIDE. In 1975, the world champion title would be handed over to Anatoly Karpov and this would mark the precedential moment in the 20th century, where politics would interfere with the best play on the board. In 2023, as this paper was being written, the longest reigning world chess champion in the 21st century, Magnus Carlsen, would become the first world champion after Fischer to refuse to defend the title, yet unlike after Alekhine's untimely death as the world champion in 1946, after Fischer's own declining to defend the title in 1975 or after the unification of two chess federations in 2006, when tournaments were held to decide the new champion, a strange system was implemented, forcing Ian Nepomniachtchi, who decisively won the Candidates tournament, to play a world championship match against the tournament runner-up, a match he would eventually

lose. All this suggests, between the lines, that politics continues to stream like an undercurrent in every human profession and discipline, guiding every decision-making process and power distribution protocols therein. Party politics, geopolitics and micropolitics have always influenced segregation in chess and in any other social domain, yet there is the impression that the long lineage of the crude political influence in chess, rising with the tide of the Cold War and taking tolls on the careers of the likes of David Bronstein or Viktor Korchnoi by the Soviet communist propaganda, culminated in the early 1990s, first with Fischer's criminal prosecution for playing an unofficial world championship rematch against Spassky in 1992 in my native country, Yugoslavia, and then with the splitting of the Professional Chess Association (PCA) from FIDE in 1993, at which point the question of who the best player in the world became a blatantly political one. In chess, however, as in individual sports in general, there is still an over-the-board contest, some may say, and there is only so much politics can do to interfere with the fundamental skills of the players, whereas in science, there are none of such face-to-face encounters to determine the better performer, meaning that politics can be and has been a far greater determinant of the ascents and descents in careers in science than the objective skill, affecting particularly adversely the prodigious and heterodox individuals of the likes of Bobby Fischer. It is in the nature of the romanticists, everywhere and at all times, to mistrust politics, yet it has been nothing short of ironic that the fosterage of chess as a competition, where over-the-board contests decide who progresses to the top and who slides toward the bottom, which the romanticist equally abhors, has come up as the conventional remedy against this inflow of politics, when viewing chess as a form of art and chess players as its co-creators could have provided a much better solution. As for these clutches of politics hovering ominously over everything, one key aspect of the romantic thought is the embracement of cosmopolitanism and freeness from political prejudices, but so is the intense search for truth and for bold ways to express it. This is exactly what puts the romanticist at perpetual odds with the establishment, which, like the Grand Inquisitor⁶⁸, holds the keys to this very truth, relativist by nature, in its hands. Paralleling the intense emphasis on constructivist, psychological effects in sciences, sociologically inclined philosophers of science of the 1960s and the 1970s, including, most prominently, Thomas Kuhn, were busy pointing out the relativism of truth in science⁶⁹, specifically how what is true and what is not is predominantly determined by the degree of acceptance by the scientific community⁷⁰, a process that favors those who are skilled at bowing to the mob as opposed to the nonconformists who always find themselves at odds with it. However, rather than humanizing natural sciences, the proliferation of these relativistic attitudes has taken the energetic enthusiasm that is romanticist in essence and diluted it in the bland waters of pervasive pliancy and "anything goes"⁷¹ attitudes.

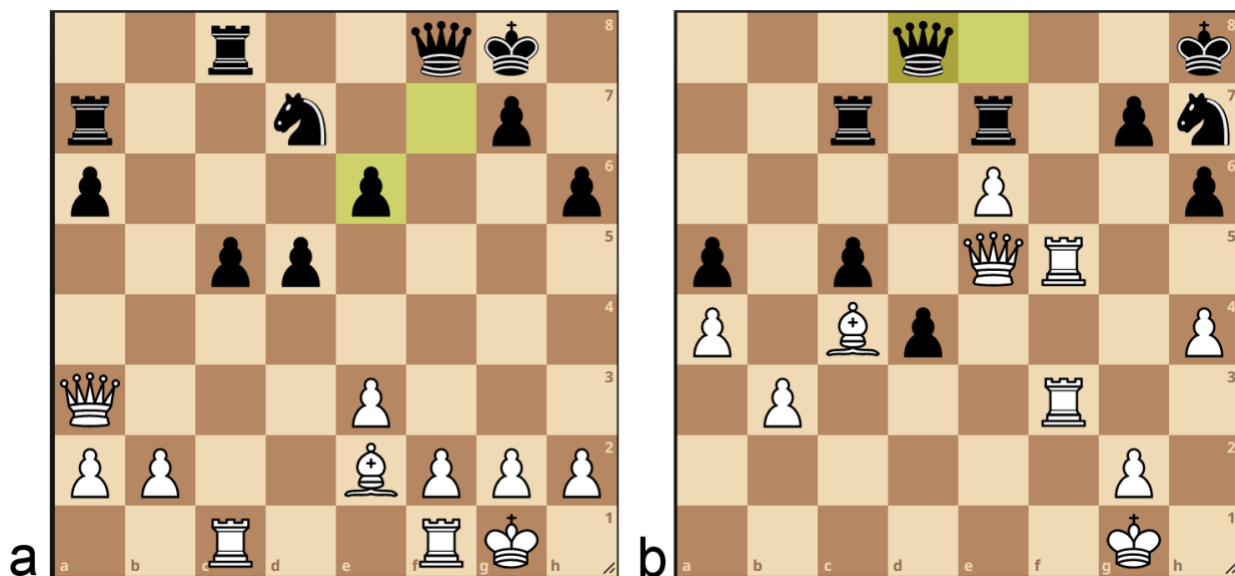


Figure 11. Fischer vs. Spassky, Game 6, World Championship Match, Reykjavik, 1972, 1 – 0. Position on the board (a) before Fischer played 20.e4, sacrificing the central pawn to open up the a2-g7 diagonal for the light-squared bishop and undermining Black’s seemingly sturdy pawn structure in the center. The move was followed by 20...d4 21.f4, with which Fischer started the attack on the kingside, as black pawns would soon be immobilized on the queenside by the bishop stationed on c4. After ten moves, Black was reduced to a completely passive position shown in (b) and the aimless wondering of the queen from d8 to e8 and back a couple of times, at which point White launched the final assault by moving the bishop to d3, performing an exchange sacrifice and then returning the bishop quietly to c4, where it would stay until the end of the game: 36.Bd3 Qe8 37.Qe4 Nf6 38.Rxf6 gxf6 39.Rxf6 Kg8 40.Bc4 Kh8 41.Qf4.

Week 12, Year 1985: Karpov vs. Kasparov

The world champion title matches between Anatoly Karpov and Garry Kasparov in the 1980s were the last time two players with distinct, diametrically opposite personalities and playstyles met at the highest stage in chess, with the corresponding ability to polarize the globe. Both of them were Soviets, but while Karpov epitomized the law and order of the bureaucratic establishment, Kasparov personified the free spirit of rebels against the convention and dissidents against political oppression. Their first match, played in 1984/85, having Kasparov as the contender and Karpov as the defender of the title, started unfavorably for the former, who played in his own characteristic style, aggressively and boldly, but got crushed by the system, finding himself trailing 5 to 0 in a match played up to 6 wins. At that point, Kasparov decided to soften up his approach and play more conventionally, the result of which was an endless series of draws intercepted by three wins for Kasparov. After 48 games played and the score of 5-3 in favor of Karpov, both players complained of exhaustion and the match was aborted, with the sequel being scheduled for later in the year in a different format. Kasparov, now more harnessed, started playing with more success and after 23 games played, he was in the lead by one point, meaning that if he was to at least draw the last, 24th game as Black, he would become the new world champion. And when most players would play one such game defensively and cautiously, he opted to fight the fire of Karpov’s attack with the fire of his own blasting attack, sacrificing two pawns (Fig.12) and winning the game that he needed not win. Like the chemists who twisted and curled graphite at around this same time⁷², all until the sheets folded into a new allotropic modification of carbon known as fullerenes or buckyballs, Kasparov twisted the minds of mediocre minions who followed the game, bent them into balls and rolled them down imaginary hills and valleys. The audacity of

his approach in this last game can serve as inspiration on how to approach science, too: boldly, not bending under the pressure of the opponent or the authority, but rushing to face the lion in the most direct and daring ways possible. Although both chess players and scientists tend to lose this valiant impudence of their outlooks as they mature, a room for it always remains in mindsets determined to come up with stunningly creative ideas, regardless of one's age and discipline. In other words, dissentience and creativity have been but two sides of the same coin jingling in the holey pockets of romanticists all the world over⁷³.

With Kasparov's win in this game, chess romanticism popped its head higher than usual from the subterranean canals to which it had been confined. This is how the discovery of the wreck of *Titanic* somewhere in the Atlantic Ocean on September 1, 1985, only two days before the match that would decide the new world champion began, can be an analogy that extends its semantic rays of meaning to multiple levels, including those within the multiverses of chess and science. Albeit discovered for just a little while, though, this romanticism was, likewise, a wreck and was to be left where it had been found, in the dark depths of the ocean, surrounded by mermaids and anemones. Science, after all, is still more interested in the surface of things and continues to neglect these dark philosophical depths where romantic ideals slumber to this day. Yet, to grow independent and then shun the roots of philosophy from which it sprang to life cannot do anything good to science. Like a soul haunted by the bad karma, science as such may be destined to roam godlessly, like a headless fly, in hope that, someday, it gets reunited with these forgotten roots and reach out to philosophy and art and theology so intimately that everything in sciences from then on becomes a renaissance concoction of disparate points of view. To make this possible, a lot of hard work, a lot of inspiration and a lot of courage, like that exhibited by Kasparov here, is needed. One thing is certain, though: chess, the game that is a form of fusion of science and art, can inspire us and show us the way.

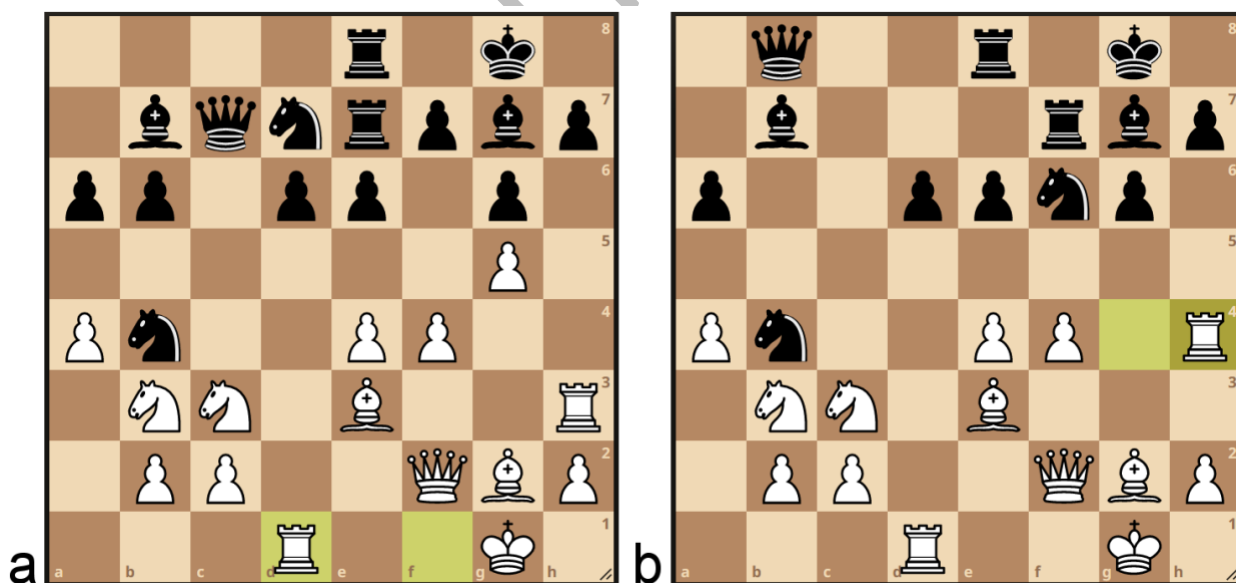


Figure 12. Karpov vs. Kasparov, Game 24, World Championship Match, Moscow, 1985, 0 – 1. Needing only to draw the game as Black to win the title of the world champion, Kasparov sacrifices one pawn after 25...f5 26.gxf6 Nxf6 (instead of more logical 26...Bxf6) (a) and then another with 31...g5 (b) to gain initiative and win the game as Black.

Week 13, Year 1991: Uskoković, V. vs. Colossus Chess 4.0

The early 1990s, when I, a teenager at the time, nurtured the dreams of becoming a professional chess player, was the first time computers reached the level of play comparable to those of masters or candidate masters. As an expert player and computer buff, logically, chess programs were my regular partners and I produced numerous exciting games from that period⁷⁴. Many of them can be a proper illustration of how whenever romanticism is dying on the big stage, it is being reborn in darker corners, which need be sought with great patience and insight. Although the games of choice from the years of my daily clashes with the computer may vary depending on the interest of the class or the inspiration of the moment, the game described here is one of the universally interesting ones because it was my first win against a computer engine, which took a little less than 100 moves to reach the checkmate. It started off with opposite side castling in the Panov transfer variation of the Scandinavian defense (Fig.13a), but its key point was the ambitious, albeit rather dubious and seemingly unsound positional sacrifice of a knight in the middlegame (Fig.13b). Although at the very first sight 23. Nxe5 seems completely irrational compared to the logical 23.Nxd4, today, with the use of supercomputers, we know that this move was nowhere as ridiculous as it may seem. Firstly, Nxd4 is met with ...Bxd1 in every variation and Black would stand better, whereas meeting 23.Nxe5 with 23...Bxd1 would give advantage to White according to Stockfish after the white queen takes on d5. The move 23.Nxe5, in fact, represents Stockfish's second best choice in the deepest mode, right after 23.Nxd4 and before 23.Re1. In all these circumstances, Black, that is, the engine, preserves the advantage, but the strange and counterintuitive 23.Nxe5 allows White to muddle up the position and give away the knight for doubled rooks along the now open e file, a better positioned light-squared bishop and a connected passer in the center. Refusing the sacrifice does not favor Black, as after 23...Ne2, 24.Qa5 Nf4, for example, Stockfish gives a 0.0 evaluation. In fact, the only move that preserves the advantage for Black is accepting the knight sacrifice, the cost of which was slightly improved positioning of white pieces after the moves played in the game: 23. Nxe5 Qxe5 24. Re1 Qf4 25. Bd5+ Kh8 26. Rhe3 Nc6 27. Be4. The correct plan for Black in this position is to engage in defensive play that would prevent the marching of the connected white e pawn toward promotion, but Black, instead, started chomping on one white pawn after another, which were becoming increasingly poisonous, first the f2, then the h4, and then, the most forbidden of them all, the c4. Taking on c4, in fact, turned the tables around and gave White a solid advantage because after 32...Qxc4 33.Rc3 (Fig.13c), the black bishop better be given away or else the pawn would promote to queen. Namely, if Black tries to defend the bishop with 33...Qg4, then 34.Rxc8 Rxc8 35.Bf5 wins for White and if Black defends it with 33...Qh4, then 34.Rxc8 Rxc8 35.d7 follows and Black cannot stop the promotion. In the game, Black deemed it smartest to drop the bishop, which turned the game into a queen versus rook and knight endgame, of a similar type as that which Magnus Carlsen won against Ian Nepomniachtchi in the rollercoaster of Game 6 of the world championship match in 2021, albeit from the opposite, rook-and-knight side of the board. Here, White managed to once again allure Black to take all of the remaining white pawns, but at a dire cost, namely that of losing the coordination between the rook and the knight, which we know from the aforementioned game between Carlsen and Nepomniachtchi to be of crucial importance in this type of endgame. Here, White found a move that is decorated with an exclamation mark by Stockfish in 2023: 50.Qh2+ (Fig.13d), which led to the overtaking of the initiative and a win against Colossus Chess 4.0, a computer software programmed by Martin Bryant in 1985, containing 3,000 opening positions and the rating reaching up to nearly 2000 on the USCF scale on the Commodore 64 8-bit platform. Games like this one, played in a children's room against a computer, in the years when chess software on home computers for the first time started being interesting to play against for experts,

may be obscure in the global context and may even abound with a whole lot of inaccuracies and errors, but can also be a greater joy for students to relate to and learn from than many of the superbly precise technical grinds that are common at the grandmaster level. The same goes for homemade research, carried out in more intimate settings than those of the mainstream labs of academic institutions and industrial sites: they connect to the young people, according to my experience, much better than the formally conducted research, alongside transmitting the noble idea that everyone at any time can be a creator and conductor of experiments that can change the world. At this spot, an excursion is made to the aforementioned research from my personal oeuvre in the early 2020s, when the excommunication from academia for political reasons, the loss of employment and the closure of an institutional lab inspired me to involve myself and children in research carried out in home bedrooms⁷⁵, garages⁷⁶, kitchens^{77,78}, backyards⁷⁹, lakes⁸⁰, parks⁸¹, pools⁸² and playgrounds^{83,84}, arriving at far more stimulating findings and presenting them in far more inspirational ways than ever before.

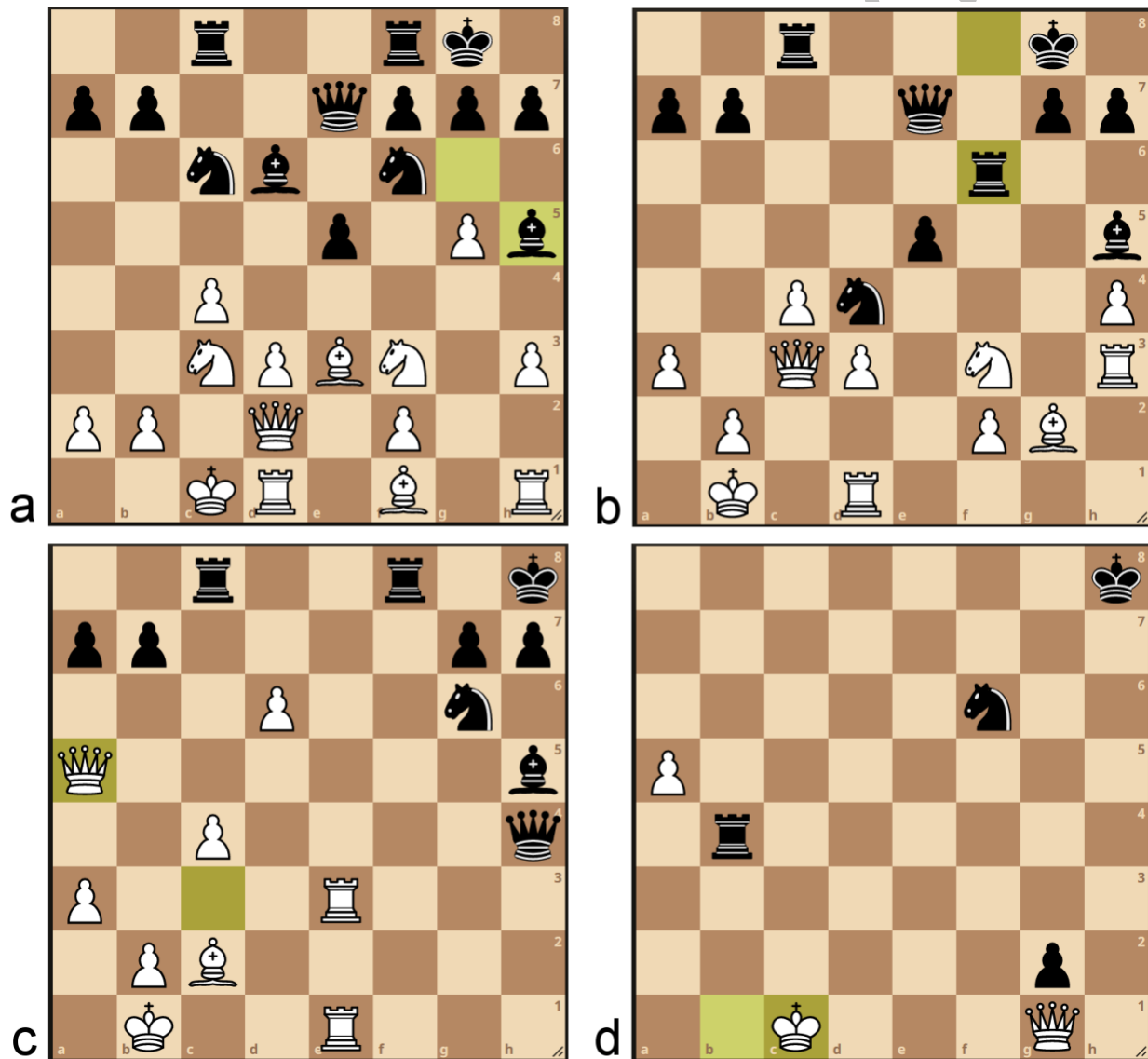


Figure 13. Uskoković, V. vs. Colossus Chess 4.0, Belgrade, 1991, 1 – 0. (a) In this position, White chooses to develop cautiously with 14.Bg2 instead of blasting the g file open with stronger 14.gxf6. (b) Position on the board before the

key dynamic move of the game, 23.Nxe5, which appears counterintuitive, but presents the second best choice by Stockfish 15.1. (c) In this position, Colossus plays 32...Qxc4 and chomps on the third pawn in a row, but blunders the bishop after 33.Rc3 and loses the advantage. (d) Position on the board before Black played 49...Ra4 and White found the winning move, 50.Qh2+, which spiked the Stockfish evaluation from 0.0 to +4.0. PGN: 1. e4 d5 2. exd5 Nf6 3. c4 c6 4. dxc6 Nxc6 5. d3 e5 6. Nc3 Bf5 7. Nf3 Bc5 8. Be3 Bd6 9. Qd2 O-O 10. O-O-O Rc8 11. h3 Qe7 12. g4 Bg6 13. g5 Bh5 14. Bg2 Nd7 15. h4 Bb4 16. a3 Nc5 17. Kb1 Nb3 18. Qc2 Bxc3 19. Qxc3 Ncd4 20. Bxd4 Nxd4 21. Rh3 f6 22. gxf6 Rxf6 23. Nxe5 Qxe5 24. Re1 Qf4 25. Bd5+ Kh8 26. Rhe3 Nc6 27. Be4 Qxf2 28. d4 Qxh4 29. d5 Ne7 30. Bc2 Ng6 31. d6 Rff8 32. Qa5 Qxc4 33. Rc3 Qd4 34. Rxc8 Rxc8 35. Qxh5 Qd2 36. Re2 Qxd6 37. Rh2 Nf8 38. Bxh7 Qxh2 39. Qxh2 Nxb7 40. Qg1 b6 41. Qh1 Rg8 42. Qb7 g5 43. Qxa7 g4 44. Qxb6 g3 45. Qg1 g2 46. b4 Nf6 47. a4 Rg4 48. a5 Rxb4+ 49. Kc1 Ra4 50. Qh2+ Nh7 51. Qe5+ Kg8 52. Qd5+ Kf8 53. Qxg2 Rxa5 54. Qf3+ Ke7 55. Qe4+ Kd6 56. Qxh7 Rd5 57. Kc2 Ke5 58. Kc3 Rc5+ 59. Kb4 Rd5 60. Qh8+ Ke4 61. Qh1+ Ke5 62. Qh2+ Kf5 63. Qh3+ Ke5 64. Qe3+ Kf6 65. Kc4 Rf5 66. Kd4 Ra5 67. Qf4+ Ke6 68. Qh6+ Kd7 69. Qg7+ Ke6 70. Qg6+ Ke7 71. Qc6 Rg5 72. Qe4+ Kf6 73. Qf4+ Rf5 74. Qd6+ Kg7 75. Ke4 Rf1 76. Qd4+ Kf7 77. Qd5+ Kf6 78. Qe5+ Kf7 79. Qh5+ Kf8 80. Ke5 Re1+ 81. Kd6 Rg1 82. Qf5+ Kg8 83. Ke7 Rg7+ 84. Ke6 Ra7 85. Qg4+ Rg7 86. Qd4 Rg6+ 87. Ke7 Rg7+ 88. Kf6 Kh7 89. Qh4+ Kg8 90. Qh5 Rg1 91. Qd5+ Kh7 92. Qe4+ Kg8 93. Qa8+ Kh7 94. Qa7+ Kg8 95. Qxg1+ Kf8 96. Qg7+ Ke8 97. Qe7#

At the time this game was played, in May 1991, a bigger conflict was looming over my world than that taking place on the chessboard before me. It was the Yugoslav civil war and the breakup of Yugoslavia, which would begin a month later with the secession of the former Yugoslav republic of Slovenia. In the couple of years that followed, my home country rapidly drifted into international isolation and destitution like that unseen in Europe since World War II, and so the dream of competing on the big stage as a professional chess player, naturally, deflated. Simultaneously, a country that once organized a number of notable chess tournaments, including the last chess Olympiad before the breakup of the country, in 1990, and up to that point won most medals in these Olympiads after Soviet Union, deteriorated to a state where it could organize only events of dubious credibility, such as the Fischer vs. Spassky world championship rematch in 1992, with financial incentives trickling through illegal banking schemes. The urgency of directing intellectual efforts to skills enabling emigration from a country that rapidly sank into destructive nationalism thus became a priority and this is how chess was replaced by science from the center of my sphere of interests. Meanwhile, I could observe first-hand the desperation of scientists, such as my fathers', when aspirations to share their discoveries with the whole world were discriminatively stood in the way of⁸⁵ only because they originated from a country vilified by the international community, regardless of the fact that scientists and other intellectuals, including myself, protested loudly against the war and the warmongers and often put their lives on the line to defend people of all nations who were endangered by it. Be that as it may, this is how a dream of a career in chess was cut short before it even took off, but a lesson was learned. It was a lesson on how circumstances can obstruct people's aspirations, which is a humbling insight that should always stand in the way of thoughtless judgments. In other words, knowing how profoundly the existential history can affect the paths one walks on in the present and the horizons toward one drifts in the future raises the awareness of how everyone's effort is appreciable. This universal appreciation is the stance of first and foremost importance that academic instructors and mentors ought to be equipped with in the times of the ongoing epidemic of oppressive arrogance and prickly egos that proliferate abundantly across the academic multiverse.

Week 14, Year 2000: Kasparov vs. Kramnik

The end to the era of Kasparov's dynamism came in the classical world championship match he lost to Vladimir Kramnik in 2000. The most notable detail about this match was how

Kasparov's usually effective attack bumped into the Berlin Wall variation of the Ruy-Lopez that Kramnik employed as Black. In the example shown in Fig. 14 from Game 3 of the match, Kasparov as White controlled both open files with his rooks, yet Kramnik as Black left no squares for him to penetrate Black's position and disrupt it⁸⁶. This rather dry and defensive Berlin Wall variation dulled and neutralized one of the most imaginative and dynamic attackers in chess history. After bumping his head against the Berlin Wall in Game 1, Kasparov would lose patience and blunder with 39...Ke7 in Game 2 and then fall into an opening trap in the Nimzo-Indian defense in Game 10, thus losing the match and conceding his title. Since then, chess analysts have frequently observed that with Kasparov's defeat in this match, the chess world lost both of the players⁸⁷, as neither of the two were the same again: Kasparov's style lost its invincible flair and attacking creativity, while Kramnik's youthful fervor, boldness⁸⁸ and drive settled in a state of stale statics and infectious indifference, the occasional ventures into more dynamic territories notwithstanding, as in the final game of the PCA world championship match against Leko in 2004. But what the world did gain was the Berlin Wall defense, which is employed by players in search of simplification and lackluster draws intensely to this day. Symbolically, in other words, the personality was lost on both sides of the board, while the wall was raised, which very nicely sums the direction toward which science was moving at the turn of the millennium and the global entrance to the digital age. This walling of the people in an increasingly isolated and alienating world has since been a trend that swept the planet across many other social domains, including the scientific. As for the feverishly awaited turn of the millennium, neither did it end up being a remarkable time for celebration of newness and the enthusiastic search for unthinkably inventive conceptual novelties. Rather, it turned into a time of global Y2K anxieties, the tick-tock of the Radiohead clock, and complacency of the intellectuals about the neoliberal economies that have now conquered every corner of the globe, creating grave repercussions on mental health, ecology and human intelligence that will be felt by many future generations on Earth. Scientists, in the wake of this raising of a Berlin Wall, have raised similar walls of protection around their personalities and their professions. Not only can academia at every one of its levels be considered a wall⁸⁹, but the western civilization as well, including the people, fortified by a guard after guard and a façade over façade, can be considered as walls, big or small. And if science, specifically, is a wall, who can help us raze it? The help would come from an unexpected source, as we shall see, from the partner in the shadow played with by a child in his spare time, away from the limelight, for the sole love of the game.

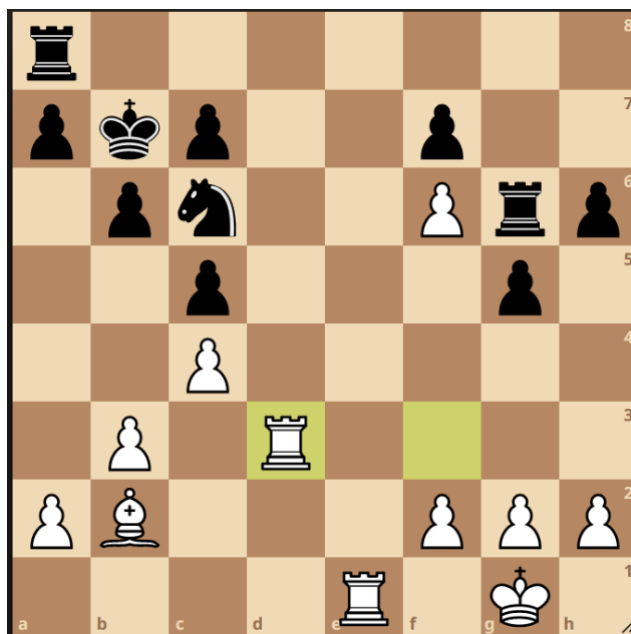


Figure 14. Kasparov vs. Kramnik, Game 3, World Championship Match, London, 2000, ½ - ½. Position on the board after 24.Rd3. White pieces cover most open squares whilst their black counterparts mostly stare at their own, yet White, somehow, has no opportunity to infiltrate Black's camp.

Week 15, Year 2007: Carlsen vs. Morozovich

As the new millennium commenced and as childlike expectations that something magical would happen deflated like a balloon and gave in to the new millennium depression⁹⁰, the state of affairs in chess and science alike reflected this sentiment. As for chess, the inauguration of Kramnik's defensive, rope-a-dope style in place of Kasparov's contagious dynamism at the top of the world, still split to two federations due to political reasons, was also a win for that long lineage of styles stretching from Capablanca to Botvinnik to Petrosian to Karpov and a defeat for Alekhine and Tal and all those who preserved the seeds of the romantic spirit in their playstyles. Although Deep Blue did win the match against Kasparov in 1997, engines at the time were still playing at an equal footing with the grandmasters and their major weapon was short-term tactics; their weakness, the broad, long-term positional thought. In other words, the computer style at the time was nothing to envy and there was little holistic foresight in it and, thus, very little aesthetics, and that same demerit appeared to have started to plague the human chess as well. Interviewed in 2003, David Bronstein, for example, condemned chess games played by Kramnik and Kasparov against chess engines because they were "not for creativity, but for a grueling match in which there is no art at all"⁹¹. In parallel, in natural sciences, the trend of diminishing the drive for engaging in quests for groundbreaking novelties in models, methods and modes of expression continued. Like in the chess world, any holistic tendencies to expand the scientific thought and have it enter and merge with the realms of arts or philosophy began to be looked down upon like never before in history. In the absence of these transdisciplinary inclinations, the narrowing of scientific thought led science and all things creative and imaginative in it into a state of mere craftsmanship, as the timid mindsets who had entered the profession for every other cushy satisfaction than to strike up the revolution began to burgeon.

One aspect of human play that became a prerequisite for world-class achievements in this period was the universality of style in terms of the readiness to play both tactical and positional

chess depending on the circumstances or the opponent, while constantly expanding the opening repertoire and preserving the impeccable endgame technique. The dichotomy between positional play and tactical play, so often invoked in the past to describe the playstyle of grandmasters, thus became meaningless. Naturally, at the same time, although engaging in a positional thought process had long since been a hallmark of every even slightly successful chess player, let alone of every grandmaster, the positional style of any given player, being a plexus of a plethora of positional principles that s(he) was inclined to stick to, continued to be unique to him/her. For example, Karpov and Kramnik are often colloquially considered to be both predominantly defensive positional players, yet while the former relied primarily on prophylaxis, that is, on the prevention of any threats by the opponent before executing any of one's own, the latter was a player relying on classical principles and, as a result, gravitating around static positions, solid setups and passive lines. Hence, although both Karpov and Kramnik capitalized predominantly on their opponents' minor mistakes rather than on accomplishing some grandiose positional ideas of their own, their styles were profoundly different, even though both earned the epithets of defensive positional players. In fact, similar observations can be made in most team sports and one example that comes to mind is that of two English soccer players that have served to this day as paradigms of box-to-box play, namely Bryan Robson and Paul Scholes. However, while the former was a player who excelled in the defensive box owing to his physical strength and stamina and in the offensive box owing to his powerful and precise headers and the instinct of a striker, the latter was a player who, like myself, having superior vision, solid playmaking skills, diligence when it came to defensive space coverage and fineness in both holding and defensive midfielder roles, excelled in any part of the field between the two boxes except inside them. Interestingly, with relatively poor ball control, sluggishness and low dexterity, Robson was an inferior player in these central areas of the pitch where Scholes excelled, whereas Scholes, with his poor headers and poor striker instincts as well as nil ability to take on the role of a sweeper, was an inferior player inside the two boxes, where Robson excelled. Hence, when one talks about box-to-box players, as in the case of many other midfielder roles in soccer, from *mezzale* to *metodisti*, it needs to be understood that the term may mean many, even diametrically opposite styles. The similar situation is found in chess, but also in science, where describing someone as an experimentalist, a theoretical thinker, a computational modeler, a writer or a speculator may mean little unless it is accompanied by volumes of further insights exemplifying one's scientific research style. Nevertheless, as science became increasingly multi-, inter- and trans-disciplinary around the turn of the century and the millennium, the ability to act in the role of everything at once, from being an intramural politician to being a lab manager to being a self-promoter, networker and advertiser on social platforms to being a cunning fundraiser, emerged as a factor of pivotal importance for a successful career in sciences. One tragic aspect of this expansion of talents required for success was that the scientific world in the aftermath of the arrival of the new century started to be increasingly populated by those who excelled in all these lateral aspects of the life and work of a scientist except in science *per se*, that is, by solid executives and entrepreneurs and not by inventive intellectuals, artists and creative renegades at heart.

Simultaneously, venturing deeper into the new century, hand-in-hand with computer engines, posed demands for the universality of style in order to compete at the world's highest stage. The player that was soon to become considered by many as the most skilled human player in the history of chess, Magnus Carlsen, epitomized this universal style that became imperative by the mid-2000s, and one example of his style of play from this period, but also later on, comes from a game where he took complete control of Alexander Morozovich, a player known for an attacking

and risky playstyle. It used to be said that to beat an incredibly strong defender that Tigran Petrosian was, one would have to beat him three times: once in the opening, once in the middlegame, and once in the endgame. Carlsen's play in this game, at the age of 16 only, 6 years before he would become the third undisputed world chess champion in the 21st century (Table 1), exemplifies this universality, first through the knight sacrifice in the advance line of the Yugoslav variation of the king's Indian defense derived through an extensive opening preparation (Fig.15a), likely with the assistance of engines, and then through the quick transition to an endgame where the one pawn advantage would become converted to a win (Fig.15b), even when the endgame was theoretically the most drawish of them all, namely that of opposite-colored bishops. In parallel with this adoption of universality of style, where combinatorial vision, deep positional play and perfect technique all became blended into one, the culture globally descended into a postmodern apathy, where the aforementioned relativism has killed all the strivings for new ideologies and made everything seem fine, but also infinitely bleak, bland and, just, blah.

In response to this suffocation and suppression exerted by the walls closing in on one from all sides, the voice awakened, screaming and kicking and yelling all across the academic hallways, lecture halls, homerooms and labs, calling for the liberation of this domain from all these agencies of ill. Around the time the game between Carlsen and Morozovich was played, in 2007, everything I did in the realm of scientific research started being paralleled by writing books and papers whose goal was to tilt at the windmills representing the proliferative forces of the intellect that suppressed wisdom, beauty and creativity across all strata of the kingdom of science. At this place, even a blind selection of passages from the five books^{92,93,94,95,96} updated continuously and in parallel from 2007 until this day is sufficient to intrigue the young thinkers and provide a source of enriching conversations.

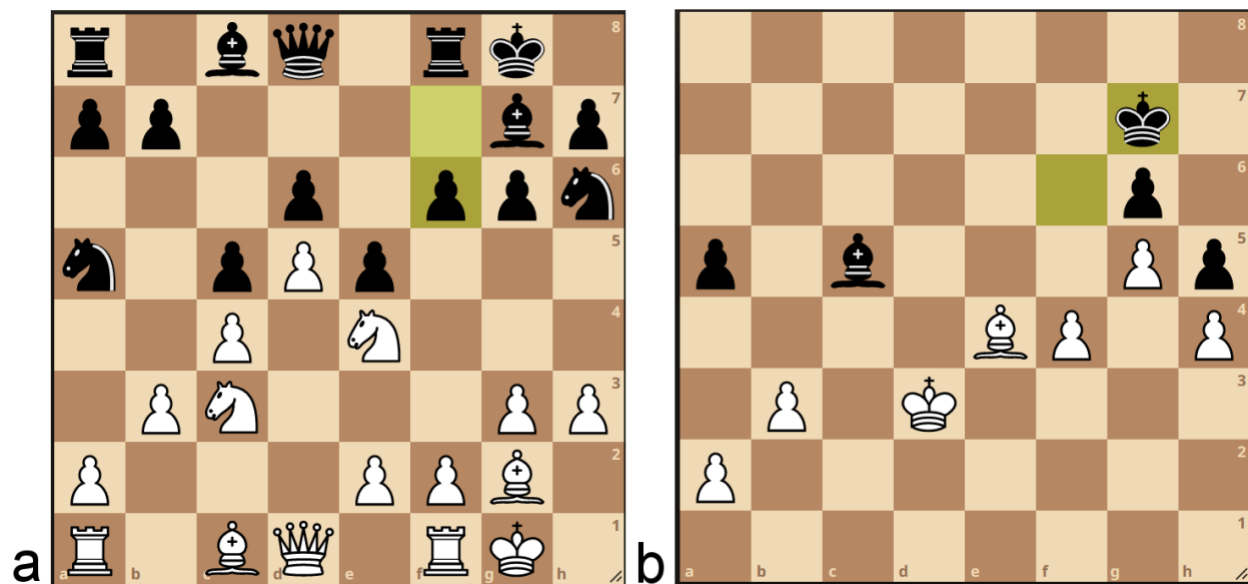


Figure 15: Carlsen vs. Morozovich, Morelia-Linares, 2007, 1 – 0. Carlsen gives away a central knight for an initiative with 13.Nxd6 (a) and then in the opposite-colored bishop endgame plays 53.Kc4 (b) and gives away all three of the white pawns on the kingside for the one black pawn on a5, having calculated that White is winning in every variation.

Week 16, Year 2014: Stockfish 231014 vs. Jonny 6

By the time the two chess federations that split in 1993 reunited and Kramnik's reign as the world champion ended, in 2007, computers started to come to grips with calculations that led to deep understanding of the position and the corresponding positional play. This has helped them provide a key contribution to the opening theory and the early middlegame, the segment of the game where they hitherto could not apply their purely calculative powers as well as they did it in the tactical middlegame and the endgame. A most memorable instance of this engine-assisted opening preparation from this era comes from Vishy Anand's and his second, Rustam Kasimdzhanov's reviving the forgotten dynamic 14...Bb7 line in the Meran variation of the semi-Slav defense and using it to perplex Kramnik in Game 3 of the world championship match in 2008, prompting him to deliberate for a whole hour for the next four moves, which culminated in Anand's extraordinary double pawn sacrifice with 17...Rg4. Despite the decisive score of this famous encounter, death by draw due to the extensive opening preparation in these years started to loom over the chess world more intensely than it ever did since Capablanca had first predicted it, in the 1920s, when he had also proposed that the chessboard be expanded to more than 64 squares.

Meanwhile, as we could see from the preceding discussion, the romantic spirit continued to live at the top chess level, albeit subtly, pervading like an undercurrent the main stage whereon static positional chess played its act. Yet, as far as the world champions of the 20th century are concerned, this spirit found home in the positional central pawn sacrifice by Steinitz in his game against von Bardeleben (Fig.3); in the positional dynamics postulated and put into practice by Lasker and packaged into a perfect blend of static and dynamic positional play in the style of Alekhine; in Botvinnik's experimentations with the deliberate disruptions of the positional equilibrium; in Petrosian's routine exchange sacrifices of rooks for knights; in Tal's valiant sacrifices; in Fischer's uncompromisingly attacking mental attitude; and in Kasparov's specializing in giving away pawns to secure the initiative. However, in the early 2000s, the computers appeared to have impeded the development of this dynamic undercurrent toward more imaginative territories and many blame their intrinsic materialism for this⁹⁷, given that computers are programmed ultimately to calculate the material value of the pieces on the board as the pivotal decision-making factor. Any instances where engines proposed dynamic sacrifices were, in those times, met with disbelief, considering how rare they were. The first English grandmaster, Ray Keene, for example, commended Fritz's recommending 14...d4 to save Peter Leko from losing the aforementioned decisive Game 14 of the PCA world championship match to Kramnik in 2004, adding that "it's a mark of how far computer programs have advanced that Fritz makes this dynamic choice"⁹⁸, alongside observing that no human player would think of a gambit of this kind at the time. By the late 2000s, the best performing engines at the time did begin to come up with a little more frequent deep positional sacrifices of the material, as exemplified by Rybka's disregarding pawns and castling in the middlegame, via 14.Be2 Qb4+ 15.Kf1, then generously giving away more pawns in the endgame, as with 35.b4 Bxb4, in the memorable game against Deep Sjeng from 2009⁹⁹, but this was only a prelude to the fireworks of unexplainable sacrifices that the top computers would engage in a couple of years down the road.

Surprisingly, then, the rescue from this pending drowning of chess in the waters of insipid play came in the 2010s from the least likely of sources: the computer engines, themselves. What was widely deemed to be a problem turned out to be the solution, too. The matter, in a fantastic twist of the plot, spoke back to the mind and altered its course toward diviner destinations, if I be allowed here to use the language of poetry. Using this language, of course, is appropriate when we consider that in 2010s something magnificent started happening in the computer engine world.

Namely, brought face to face, over a virtual chessboard, the engines started producing masterpieces out of games, one of which from 2014 is shown in Fig.16, containing numerous breathtaking maneuvers and demonstrating more romantic style of play than humans have been capable of achieving except on very rare occasions, alongside forming an amusing plot. The game, which was played without the assistance of opening books, opened with the so-called old variation of the queen's gambit accepted, where Black protects the captured pawn on c4 by playing ...b5, just the way it used to be played in the romantic era, before Steinitz and Zukertort refuted it in the 1880s and showed that the c4 pawn better be given away by Black in exchange for developing and creating an isolated d4 pawn in White's camp. In the game, White undermined Black's pawn structure on the queenside with 6.a4 and 8.b3, as it is normally recommended, but then instead of the usual taking over of the initiative and space on the queenside, it let Black have it and allowed it to push the c pawn to promotion in little over 20 moves. Stockfish at first appeared indifferent about giving away its rook for Jonny's passed pawn, and only then, with a rook down, started pushing its own pawn toward promotion, before capturing both of Jonny's rooks for the pawn and enforcing its resignation. Perhaps most amazingly, throughout the entire course of the game, even when Stockfish allowed Jonny to queen a pawn and when it was materially down and its pieces did not seem as coordinated as Black's, its evaluation of the position was overwhelmingly in its favor. Other extraordinary games from this period of mid-2010s may include the explosive encounters of Houdini and Stockfish in Season 2 of the 2013 Top Chess Engine Championship (TCEC)¹⁰⁰ and of Stockfish and Komodo in Season 6 of the 2014 TCEC Superfinal¹⁰¹, both of which contained fireworks of sparkly sacrifices. Another extraordinary game from 2014 was also played between Stockfish and Komodo, where the king whose pawns left him and made him exposed to an attack stood safer and fared better than the king completely protected by pawns¹⁰². In yet another game between these two engines from the same year¹⁰³, Black made an exchange sacrifice and then enforced the exchange of queens and the transition to an endgame with a worse pawn structure, which it won by squeezing the opponent into a prison and making advancements on the side where only the opponent had a passed pawn, defying a number of classical chess principles at once.

After all, if a chess game is perceived as a work of art and blunders its biggest enemies, then computer engines can produce greater works of art because of their immunity to crude mistakes, so long as they can be taught how to play beautifully. What turned out to have been the case was that computers, without even being trained on what constitutes beautiful play from the chess aesthetics angle, started to gravitate toward it in the mid-2010s, simply as the result of the engineers' increasing the robustness and speed of their calculations. By deepening their level of information processing, they have arrived at the open fields of the romantic style of play, which has come to comprise one of the most fabulous discoveries in the modern era.

During the romantic age, sacrifices were made more intuitively and crudely, as well as to give relatively short-term compensation, whereas sacrifices made by the current generation of chess engines are subtler, more long-term and also rooted in robust calculations, which makes their aesthetics even more suited to the contemporary taste. That computer calculations would converge with the intuition of romanticists has been one of the most unexpected and surprising outcomes of the evolution of chess so far. Through analogies, we could be inspired to think of how something similar may be pending in the world of science as well. Just the way chess engines have fostered in the last couple of years a more daring and dynamic play among some of the world's best human players than ever before in history, computers may soon evolve into a stage where they would begin to hand humans ideas on how scientific research is to be approached, helping us craft more

imaginative models and methods than we could have ever dreamt of. If this could really happen, then it is a logical question to ask and explore how artificial intelligence can outline the path that would lead to the old and forgotten, romanticist way of doing science, when art and analytics were merged into one.

A single greatest thing about Cervantes' novel about Don Quixote of La Mancha¹⁰⁴ is its ambiguity, which takes the reader by the hand to a crossroads, halfway between sympathizing with and pitying the protagonist. Which of the two sentiments will globally prevail largely depends on the era in question. In times when realism suppresses fantasy, as it does today in science and everyday life, readers will find the character of Don Quixote pitiful and ridiculous, and with it the very exhibitions of similar fancy. Yet, without a similar imagination, foolish or not, no science or art, which makes life worth living, would have ever been created. So hail to Don Quixote, says the romanticist, hops on his horse and rides off to another adventure. But before that happens for real, let us summarize what the new era of computer chess, which began at the point when computers became superior to the world's best players, has been teaching us. First, it has taught us that death by draw lies farther than humans thought, as exemplified by computer games at Elo 3500 ± 100 level, which, in fact, often end up with a decisive score. In science, likewise, creative ideas are infinite and to go beyond the beating on the humdrum drum of the same old paradigm, as we have in most scientific fields today, it takes a belief in the power of imagination à la that of Don Quixote's. The second major effect chess engines have taught us is that romantic play is not dead and that there is future for it. Compared to the days of the 19th century romanticism, though, when gambits and other sacrifices were expected to bring about an immediate compensation in initiative, today's sacrifices by the engines are significantly more long-term in character, the compensations for which are often impossible for humans to spot. Third, engines have taught us that algorithms could pinpoint the roads more enlightening than those paved by humans for other humans to walk on. Hence, in today's era when computers are still mostly used in sciences to achieve passive effects, be it for efficient data generation or mining, optimization of information processing or experimental protocols, or something else, if artificial intelligence were to be given a more creative role, the destination it may take us may indeed be beautiful. Harnessed to execute routine tasks alone, computers today make research labs only more industrial and more product-oriented, not more romantic and humane, for which to happen the next big stride in the engagement of artificial intelligence in scientific research must be facilitated first. When we consider that the level of imagination in today's natural sciences is exceedingly low, while conceptual copycats appear in ever greater numbers, it is tempting to dream of a time when computers would not only be able to replicate and facilitate the implementation of the existing concepts, but would also produce metalogical algorithms that would work at second-order levels of the scientific quest for knowledge creation. In other words, we are very near the time when computer programs will be able to predict the most effective courses of action in, say, optimizing the compositions of alloys for the best physical or biological response, then derive the experimental protocols for their synthesis and characterization, and, finally, compile all the results and interpret them in the format of a scientific paper, which is today, to start with, not too complex that the right software could not create it from scratch. In fact, in 2022, as the world was exiting the COVID-19 pandemic and entering the 'infodemic' of dissemination of misinformation through electronic media¹⁰⁵, my name appeared on a paper¹⁰⁶ that was obviously fabricated by a computer in the hands of a predatory publisher with the objective of including it in a fake scientific journal and then advertising it to legitimate potential authors ready to pay publication fees, but the quality of this forged paper was abysmal, yet in no more than a decade, it is conceivable that computers would be utilized by

research labs to compose scientific papers based on their generated data. The next step would be to train the computers to think about the scientific progress from the higher, second-order plane, where a science on and about science is being created, at which point they may be able to provide guidance on where the effort is to be invested in the search for extraordinary discoveries and, in fact, play a creative role that would be at first on par with that of the most knowledgeable scientists in the field and would then go beyond it, in just about the same way as today's chess engines have exceeded any realistic expectations that the world's best players could compete with them.

When the potential of computers is put into this metalogical perspective, it becomes both frightening and exciting to think of how codes similar to those employed today by apps such as ChatGPT, Bing Chat, Claude or Bard will be used in the near future to program research methods, dig for literature information and write scientific papers, with only the finest oversight from humans, if any. The most optimistic point that the developments in chess can convey, through an analogy, is that the input of artificial intelligence may be not so creative at first, but over time it may gain a more romantic spirit than that typifying today's human researchers. Gradually, then, the natural scientist may once again start to openly appreciate the beauty of Nature and intermingle analyticity with art, in just about the same way as it was done until the mid-19th century, when objective realism became the dominant philosophy, in art and chess alike. Despite these promises, the questions will always remain, at least to the perpetual sceptics among us, if this pending romanticism will be just an allure to an artifice and yet another prepackaged lie through which humans will lose that little of naturalness and humanity that is in them now, or it will be a hand of the mystical intelligence dormant in the material world, reaching out to save us from the fall. The question like this is best left for future generations of philosophers of science and technology to untangle. It is in the nature of the romanticist to doubt the machine, everywhere and at all times, yet for now we can relish in the central analogy that has come from the evolution of the chess playstyle in the digital age, which is that these two's coming together, the man and the machine, may be indeed "the beginning of a beautiful friendship"¹⁰⁷.

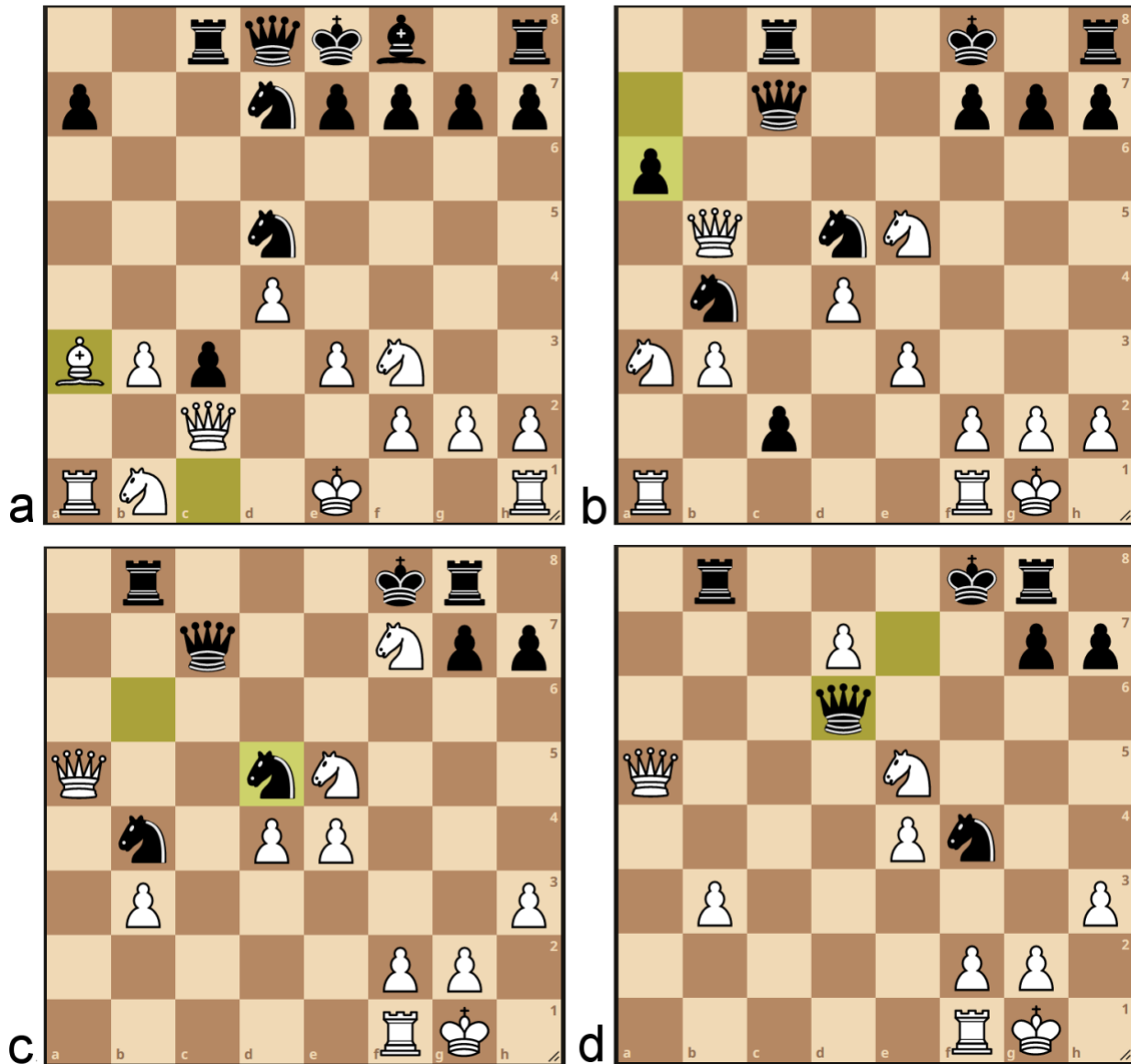


Figure 16. Stockfish 231014 (chess engine, Elo 3243) vs. Jonny 6 (chess engine, Elo 2960), Stage 2, Round 5 TCEC, 2014, 1 – 0. On move 13, instead of the more natural 13...Qa5 or 13...e6, Black plays in the digitally aged romantic style: 13...e5 (a). Next, in the position shown in (b), Black has just attacked the white queen with 20...a6. The squares c4 and d7 seem like the only two good spots for the white queen to move to, yet White plays 21.Qa4, seemingly allowing Black to promote the pawn, albeit planning to cut off the black queen with 21...c1=Q 22.Raxc1 Qxc1 23.Nac4 afterwards. On move 30, White offered Black the exchange of queens, yet once again White ignores the more human way of playing 30.Qa3 to pin the black knight and plays 30.Qa1 instead (c), calmly sliding the queen to the edge of the board, making a mysterious positional point thereby. While finding the pinning of Black's knight unnecessary, White voluntarily pins its own knight on e5, enigmatically, yet fearing no danger, by playing 37.Kh2, followed by 37...Ng6, in the position shown in (d). The quiet move of the king came with the threat of sacrificing the second white rook with 38.Rd1 to distract the black queen from the a3-f8 diagonal. After 38.f4 Ke7 39.Nc4 Qd4 40.f5 Nf8 41.Rf2 Qxf2, White did give away its second rook, but quickly captured both of the black rooks and ended up with two pawn advantage in a knight endgame.

Week 17, Year 2017: Ider vs. Yifan

By 2010s, computers did not only begin to provide an essential creative input to chess, but they also started serving as an invaluable medium for casual and, at times, professional competitions. When most sports came to a halt during the COVID-19 pandemic, many annual over-the-board chess tournaments were held as planned, but in the virtual domain. Given the extensive spread of the global network of computers and their users, this has led to an unprecedented popularity of the game across all continents. Vishy Anand's becoming only the third world champion outside of the European continent, after Capablanca and Fischer, led to an explosion of interest in chess in India, while the game has undergone a recent increase in popularity in China as well.

Another positive effect of this all-around escalation of the interest in chess is that the traditional divisions between genders have begun to melt. This has led to the rise of some notable female players, such as Hou Yifan of China, the only female currently among the first 200 chess players in the world and the youngest women's world champion in history, which she became for the first time as a teen in 2010, at the age of 16. Overall, she is a four-time women's world chess champion, continuing the lineage of women's world champions from China, starting with Xie Jun in the 1990s and ending with the reigning world champion since 2018, Ju Wenjun. Yifan's style at times traces back to the romantic era, as shown in the example from her game against the Mongolian-born French international master, Borya Ider at the Gibraltar tournament in 2017, where she sacrificed her queen to secure a long-term positional advantage (Fig.17), a type of play that is atypical for humans, but seen commonly among today's computer engines. In natural sciences, likewise, especially in cultures that have traditionally been male-dominated in this field, we are witnessing a quiet revolution in terms of empowering women for more creative and recognized roles than it was the case in the past. If science were to regain its romanticist traits, its positivistic stance rooted solely in hardcore calculations will need to cede place partially to softer, more humanistic and qualitative mental routines, which is where the balance between the analytical and emotional intelligence, which the heterogeneous representation of genders naturally brings about, will become increasingly valued. After all, good analytical skills are a prerequisite for engagement in chess and sciences, but these skills alone, deprived of a holistic and emotionally intelligent component, fail their users and all else around them in a bigger picture. And if we take to heart and apply in practice David Bronstein's stance that "intelligence opposes the primitive principles of chess such as winning a tempo and gaining space", then the input to chess ideas and playstyles may open up to human beings with intelligences broader than the deadpan mental analytics, which would provide that final push in the chess culture away from the perception of the game as a sport and closer to the perception thereof as a form of art that is free to develop into unforeseen new directions, if only more imagination and less playing to win – which Tarrasch once renamed into "playing to lose"¹⁰⁸ – be invested in it. This is why the balance of genders, but also of complementary characteristics of a complete spectrum of intelligence within any given sentient creature, are to be spurred throughout the education and postgraduate training on every possible occasion.

Of course, great care must be taken whenever the freedom to practice science is being handed over to one group of people and taken away from others in a top-down manner, through external interventions. Meritocracy may thus cede place to mediocrity and frictions may be created between those very populations that were supposed to be brought together by the regulations, thus creating a diametrically opposite effect from the intended. This is seen clearly in today's natural sciences, where the divisions between genders are now greater than they have ever been in prior

history. Such divisions, sadly, empower politicism in science and distance it from the knowledge about wonders of Nature that it is meant to explore, in as selfless and apolitical manner as possible.

Academic employments made possible through various governmental and institutional affirmative action and gender equity programs can be praised for diversifying the role models for students in natural sciences. To the romanticists at heart, they have also given hope that a wave of feminine sensibility would sweep over the rugged and harsh, masculinely carnivorous coast of the scientific culture and, in the long run, make it more emotionally intelligent, in the true, not merely managerial, sense of the term. Unfortunately, however, given the mechanism by which such appointments are secured, they have often led to strong inferiority complexes, which, in turn, have provoked the feelings of resentment and, ironically, exclusion, the very opposite of the inclusive effect intended to be achieved through such well-meant programs. The remedy to these impressions has been, tragically, found in the burrowing of a deep divide between genders and confinement to the circles of favoritism that include people on one side of this divide only. Meanwhile, to a casual outside observer, the current state of affairs in many academic institutions with regard to genders may appear as all but a far cry from a full-fledged trench war, harming, like any war, particularly those who, as all romanticists should, have stood in the middle of the fiery grounds, calling for the armistice and the arms of friendship to reach out and be held across these divides, an act very much natural at this time of unprecedented gender blending in all spheres of life. Importantly, also, whenever politics in lieu of science is given the primary role in the hiring process in a highly competitive environment, it should not surprise when the newcomers turn out to be more superior (micro)politicians and networkers than scientists in the most fundamental sense of the word. The benevolent nature of such employment programs notwithstanding, they have, sadly, infused the academic world with even more politics, which, we know, is the antipode of poetry and of the imaginative thought accompanying it. Gender-balancing policies may have been expected to soften the hard positivism of male-centered science of the past two centuries and open natural sciences to arts and humanities, but none of this has occurred and the implementation of these programs has only continued to make science more political and thus more ignorant and disinterested about the idea of reawakening romanticism across its antipoetic and politically poisoned pastures. The scientific culture may have been becoming less crude and more socially skilled on the surface of it, but at a dire cost of reducing its depth and leveling it by imposing the same professional standards uniformly across it, without leaving much room for the true diversity, namely the diversity of worldviews and not only of skins, genders and other surface features. This is where we are brought to one major downside of virtual communication, including that of playing chess online: namely, the inconspicuously reduced capacity to empathize with other people, especially those whose views are strikingly different from us. This effect can be evidenced through dramatic reduction in fair play standards in online chess as compared to those of classical, tête-à-tête encounters. And yet, without actively building up empathy, as through exposure to art in its various formats, divides in the world, including the faults occurring along the planes of contact of various -isms and other unilateral ideologies in the scientific culture, will continue to abide because those hands reaching out across them will be, simply, too little. On the contrary, it is in the celebration of littleness and everyday minutiae that this course will soon reach its final and climactic point.

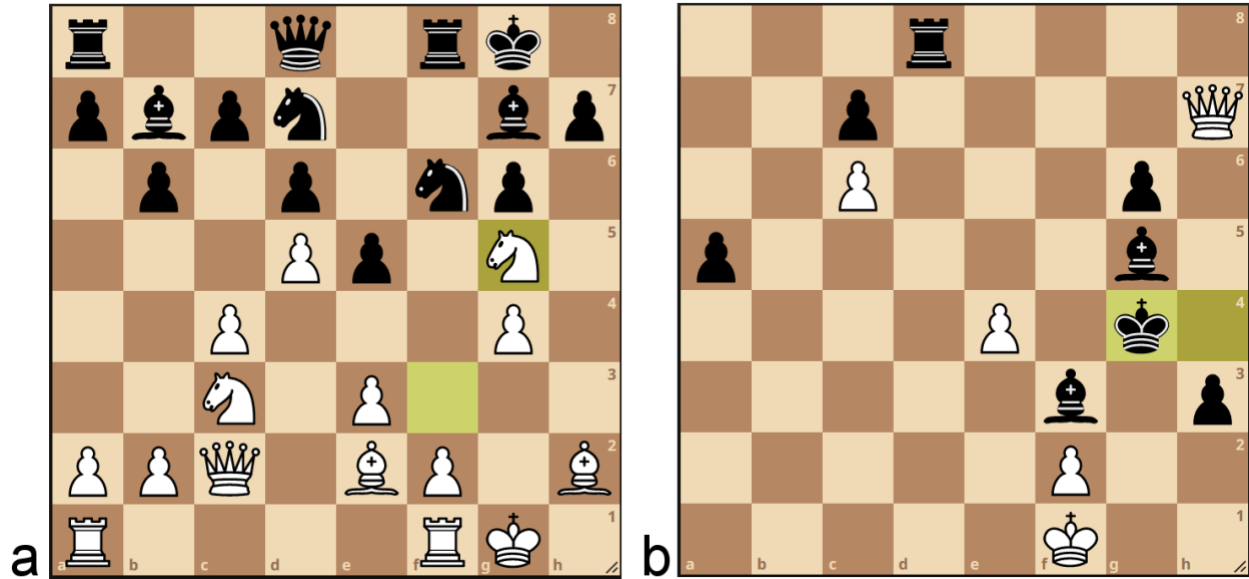


Figure 17. Ider vs. Yifan, Gibraltar, 2017, 0 – 1. Position on the board before Black's positional queen sacrifice with 15...Nxd5 16.Ne6 Nxc3 17.Nxd8. Black correctly estimated that the light-squared bishop implantable on f3, together with another minor piece, comprised a sufficient compensation for the queen. Final position of the game is shown in (b): the black king is sheltered from the checks while the checkmate threat with 53...Rd1# can only be stopped with 53.Qd7, which leads to checkmate in four after 53...Rxd7 54.cxd7 h2 55.d8=Q h1=R#.

Week 18, Year 2023: Arasan 3e6e243 vs. Igel 3.4.0

As the computer engines have become more robust throughout the past two decades, so has their style of play become increasingly romantic, bursting with strange and unexplainable sacrifices that prove right there, on the board, through analogy, that the material value of things matters little compared to the peculiarities of the position and the relationships between pieces. Machines, of course, have no emotions nor intuitive powers, and are programmed strictly to execute logical operations, which, ultimately, calculate the material value of pieces in a complex geometric arrangement. Yet, it is surprising that after passing through a sufficiently large complexity of relationships, this emphasis on sheer material value yields something significantly more sublime. To some, this is a proof that to perceive everything scintillating with mystical energies is to sense a reality realer than the objective realism, materialist in essence and imposed on us by social conventions. To others, this can be the proof of the work of the aforementioned pioneers of the first- and second-order cybernetics, from Ross Ashby to Warren McCulloch to Stafford Beer, who relished in the idea that spirit is but a complex web of neural relationships and nothing more. Like all the powerful and profound analogies, those discoverable in chess are indestructibly ambiguous.

That the relationships matter more than the material values of a collection of individual and isolated pieces is an enlightening insight *per se* and sufficient to secure place for chess in the pantheon of arts, shoulder to shoulder with music, painting, film and literature. Chess, in fact, can be viewed as a form of visual literature, the language of which is not alphabetic and grammatical, but rather composed of rules governing the movements of the pieces and operations among them. Thus, sitting among the mere two to three hundred members of the audience watching TCEC chess engine games live, which I have done over the years as much as I have listened to music, read books or watched movies, can be a source of great pleasure for the intellect. Teaching students

how to find this satisfaction, as it is being argued here, can be beneficial for the creativity they are to learn how to exhibit in every domain of their lives, including the scientific. One example provided here of the style of play that future has in store for humans in not only chess, but also science, is given in Fig.18. The game¹⁰⁹, analyzed move by move, to an average human player or even a grandmaster, would seem like an encounter of two complete patzers, were it not only for the fact that the Elo ratings of the two engines exceed 3400, which is sufficient to beat today's super grandmaster singlehandedly. Here, however, lurks a cautionary tale for anyone exhibiting such and similar romantic traits in today's scientific climate, which is far from being accustomed to them. Namely, any such exhibitions are bound to be denounced as immature and unprofessional, and one such person will likely be excommunicated from the society as a madman or an outlaw. The only solace he should be able to find is that progressive spirits of the past, whose thinking was hundreds of years ahead of their times, were treated with similar carelessness and cruelty. To be rejected and expelled, in other words, is the fate we must be at peace with if the road in sciences that we are willing to walk on is romantic.

Accepted Manuscript

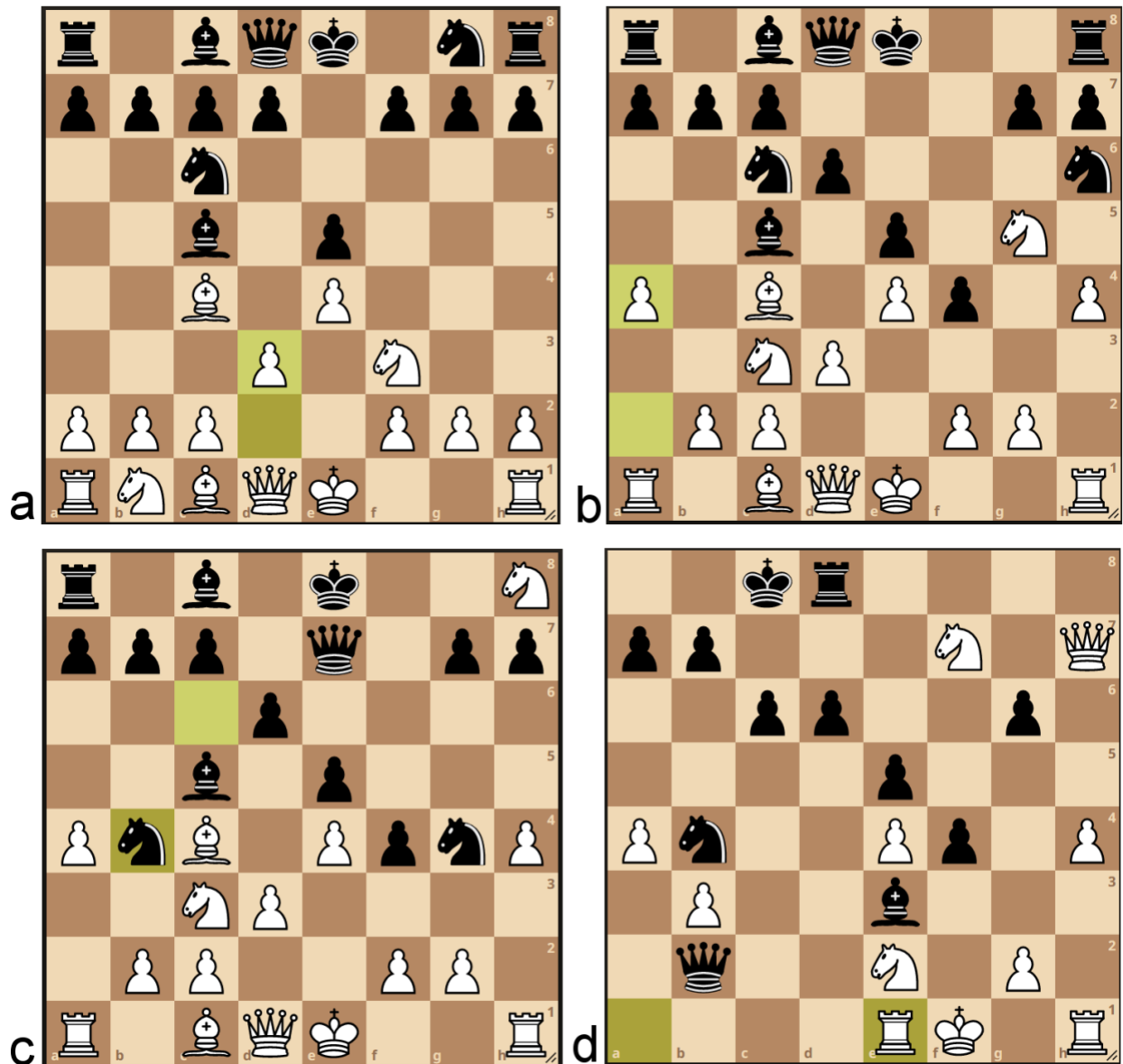


Figure 18. Arasan 3e6e243 (chess engine, Elo 3421) vs. Igel 3.4.0 (chess engine, Elo 3468), TCEC League 2 Igel Gauntlet, 2023, ½ - ½. Already on move 4, Black opted for a very aggressive and risky gambit by playing 4...f5, a type of move that had never before been played in a professional chess game (a). Then, on move 7, Black decided to remove the defender of the f7 square and attack instead with it White's own sensitive f2 square by playing 7...Ng4 (b), leading to a very sharp position. In the position shown in (c), White opted for a two-move sequence puzzling to humans: 11.Kf1 c6 12.d4 Bxd4. As the game developed into a mutual attack on two uncastled kings in the center, a position shown in (d) was reached, where checkmates were hanging on both ends of the board, and the game continued with 23...Qd2 24.Nxd8 Nc2 25.Rb1 Nd4 26.Qxb7+, after which a draw was reached via a perpetual check. From move 11 until move 40, when the threefold repetition occurred, Stockfish 15.1 evaluated each of the positions as 0.0, initially due to complexity and later due to a forced draw sequence.

Week 19, Year 2023: Lu vs. Mkrтчian

The quiet revolution in chess has led to gems produced out of over-the-board encounters of not only teenage boys (Fig.15) and female players (Fig.17), the general underdogs in open competitions, but of girls, too, one example of which is shown in Fig.19. Specifically, the example

comes from the game between 12-year old Miaoyi Lu of China and 40-year old Lilit Mkrtchian of Armenia played in Round 11 of the First Serbian Women's League match day held at Stara Planina near Knjaževac in Eastern Serbia. The 18-move miniature evoking some of Paul Morphy's masterpieces from the romantic era may be not only a testament to the rise of a new style among chess players, but also the hint at where we ought to look at in search of mindsets naturally inclined to exhibit the romantic thought and bold, beautiful play, in chess and sciences alike: children.

Thinking about the evolution of the dominant chess styles throughout the history in terms of the style of world chess champions (Table 1) is customary amongst chess players and analysts, but it supplies any of such discourses with a stale air of loftiness. Although one such method has been employed here as well to a considerable extent, as we approach the end of the course, it is time to dispel this habit and come to terms with the fact that extraordinary chess ideas and novelties can come far from the chess limelight. In science and art, this has been more of a rule than an exception: simply, the most creative new concepts tend to originate far more prolifically from small, intimate settings struggling with funds and resources than from massive, impersonal bureaucracies pampered by luxury. In search of revolutionary novel ideas, for example, the major film studios often contract smaller creative centers and then develop, themselves, these new concepts into something marketable on a more massive scale¹¹⁰. Similarly, big corporations in the pharmaceutical and biotech sectors routinely shrink their own centers for fundamental research and instead acquire small startups in the field that are more prone to come up with innovative solutions, but lack the momentum of a large enterprise to develop these solutions into a marketable product. In fact, the introduction of the novel ways of play by computers, which currently play bolder, more dynamic and more imaginative from the positional standpoints than humans have ever played, owes to the programming efforts carried out initially by moneyless enthusiasts in teenage bedrooms and garages and only then hitting the corporate mainstream. Personal computers, on which all these programming was done, had also been invented by amateur techies in search of engines that would be less expensive to make and maintain than the corporate mainframes¹¹¹. And if we were to extend the timeline relevant for this discussion even farther, we would see that even chess *per se* was born and grew up to its current rule format owing to initially personal and later collective ingenuities whose efforts were neither guided by massive bureaucracies nor had any commercial interests in mind. This is why we have turned to lesser known players and amateurs, including children, toward the end of this journey, because everyone, everywhere, can create chess artwork, be it with computers or fellow humans for partners.

After all, it is not a coincidence that the two earliest examples of romantic play covered in Week 1 both originated from a casual setting, outside of the formal competitions. This is to say that romanticism, in chess and everywhere else alike, may be inherently tied to the darker corners of the world, behind the curtains, in the shadows of the limelight. In fact, as the course at hand has been progressing toward its climax and the conclusion, so have we started to gradually drift from the mainstream sources of chess games to the more obscure ones, in parallel with this grand reawakening of the romantic spirit in chess. The final chess game analyzed in this course will, therefore, come from the most obscure of such possible sources, that is, from a playroom where children equal to or under the age of 10, barely trained in chess, will produce a game with the assistance of a computer, from one and only attempt, especially for the purpose of this occasion.

Symbolically, the path traversed by the course is from one informal, laidback setting to another, but also from games played by grownup experts to those played by amateurish children. Implicitly, this is to say that rescuing science and science education from everything unromantic plaguing them in this day and age may require parting with the province of the interest of adult

professionals and landing straight into the heart of the kingdom of children, for whom a course like this was designed in the first place. This path can also be a reminder to those who consider themselves professors and mentors in today's corporate academic climate that monetary measures of success are vain and that in lieu of titles and egos, students are those who should occupy seats on the pedestal of every instructor's attention, in and out of classroom, for it is around their suns that all educational efforts should revolve.

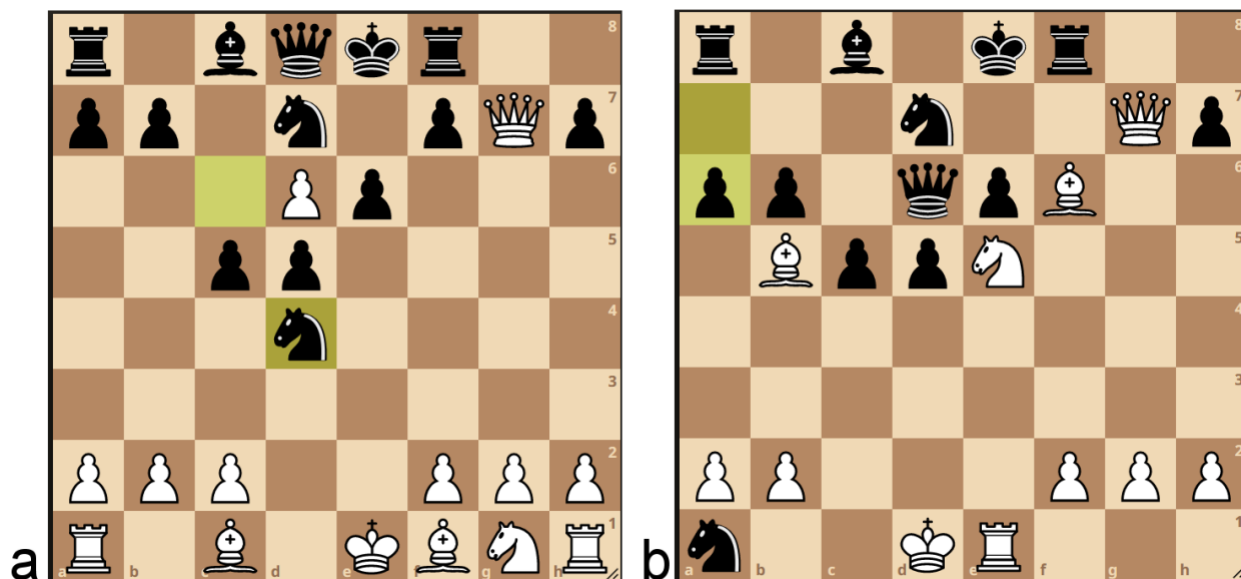


Figure 19. Lu vs. Mkrтчian, 1st Serbian Women's League, Stara Planina, 2023, 1 – 0. Position shown in (a) is right before White sacrificed her rook on a1 by playing 10.Nf3. Black would accept the sacrifice with 10...Nxc2+ 11.Kd1 Nxa1, after which White offered her bishop too with 12.Bb5 Qb6 13.Re1, at which point an unstoppable assault on the black king in the center commenced. On move 17, in the position shown in (b), White gave the final tactical blow to the opponent by playing 17.Nf7, attacking the black queen on d6 as the only defender of the e6 pawn. Saving the queen would lead to checkmate in one with 18.Rxe6#, and so Black played 17...Rxf7, but resigned after 18.Qg8+ because 18...Rf8 (or ...Qf8) 19.Rxe6+ Re7 (or Qe7) 20.Rxe7+ Kd8 21.Rxd7+ Ke8 22.Rd8#. One move quicker checkmate would have come after 18.Rxe6 Qxe6 19.Qg8+, at which point White would have been two rooks and a minor piece down, yet winning in style.

Week 20, Year 2023: Uskoković, T. vs. Uskoković, E.

The chronology traced in this course started with the peak of the romantic era in chess in the mid-19th century, when chess was slowly becoming a global sport and a professional call for many, then proceeded to the age of 13 undisputed chess champions, from Steinitz to Kasparov, continuing through the period when the chess federations split and then reunited, and emerging in the end in the current computer era of the game, when engines have spontaneously rediscovered the romantic style that lay buried under the carpet of comparatively dry, insipid play for nearly a century and a half. The chronology at hand also highlighted how the burst in the popularity of the game has meant that ages and genders that do not comprise the mainstream sources of most illustrious chess games can be relied on in producing magnificent pieces of art on the chessboard. On the lookout for such obscure sources of chess excellence, we drifted from the world's top chess players and engines to female chess players first and then to children.

Extrapolating this chronology to the near and the distant future, chess becomes less of a sporting contest driven by the petty desire to win and more of a co-creative and collaborative form

of art. This humanization of chess, in turn, would begin to attract less of the competitive egomaniacs and more of the artistically inclined individuals to it, a change of heart that would be nice to see in natural sciences as well. Simultaneously, chess of the future envisaged here, like the scientific culture, should also become less exclusive and elitist and more open to the creative input of everyone, including children. This is especially so because arguably the best way to fight back the bleak corporate powers that have uprooted science from its renaissance roots and turned it into a callous business for the capitalist moguls and their subservient sycophants to profit from is through displays of unrestrained, rebellious childishness. Besides, since the spiritual goal of the human beings is to trace the way back to that paradise lost of the childhood mind, thereby expelling all the irksome adult traits and becoming infinitely pure, like when one was a child, then it is logical to end this course with children, on our laps and on the highest vistas of inspiration. Moreover, since chess is the everyday game of everyday people, in quest of this inspiration, we can also look at children who need not be trained in chess. This is because even the most amateurish chess games can be analyzed position by position for interesting variations. And so here is an example of the first and only game played especially for this occasion as an experiment that is to show that even a randomly played game of chess by two pupils in this experimental class, children ages 7 and 10, with only the basic understanding of chess principles, can produce an endless source of amusement and inspiration for the analyst. Although a children's chess game played without any external input or advice can be infinitely entertaining to watch and analyze *per se*, the game presented here allowed the children to consult the computer choices in the course of the game, as in analogy with today's correspondence chess, where no restrictions exist regarding the use of computers by the players. Specifically, children were able to consult opening books during the opening stage and then select one out of five choices provided by Stockfish run on the *chess.com* analysis engine for each subsequent move. In such a way they were able to create a solid game of chess instead of a festival of blunders, notwithstanding, again, that both can be equally instructive and enjoyable to analyze. In the university setting, similar games of chess at this stage in the course could be produced by students or by teams thereof, just as well as many of the topics covered each week could be investigated and presented by them in the form of active learning projects¹¹².

To accompany every chess game with a fair, friendly and objective postgame analysis is a part of chess etiquette. Through such analyses, students are instructed about this most critical of all phases that must be passed on the way to deepening one's understanding of chess: the postgame analysis. As a result, chess games, be they produced by children or by students as in-class activities or homework assignments, should be subjected to collective analyses employing constructive discussions and didactics. Each such game need not be analyzed to the finest detail, but it is advisable that it be analyzed to an extent that is sufficient for students to gain the impression that every game of chess, regardless of who has played it, can be an infinite source of insight and novelty. Such was, naturally, the case with the game created by the two children specifically for this occasion (Fig.20). Symbolically, the game proceeded with the building of the tensions in the center, but only up to the 19th move played by White, Be4, after which a series of exchanges occurred, the pawn symmetry was reestablished and a dead draw position was reached. The game could even be classified as a boring or a friendly draw and most masters or grandmasters would discard it as uninteresting, but this is where the doors to wisdom and semantic fields extending beyond those of sheer smartness, cleverness or high IQ open before students – in the awareness that everything, even the most lackluster things in life, hide invaluable treasures somewhere in them.

The game started off as an Indian defense, but by the third move it transposed to queen's gambit accepted, which was followed by a hint at an apparent ease with which children stumble upon innovative ideas. This hint came in the form of an opening novelty introduced inadvertently by White already on move 4. Here, White played a move that appears to have never before been played at the professional level: 4.Bd2 (Fig.20a). The move e4 presents the most common choice in this position, followed by Nc3, Qa4+ and g3, while Na3, a4, Bg5, Bf4, Qc2 and Nbd2 have been the obscure choices, yet Bd2 is not even among them, having not been played once in an official game. The move cannot be classified as a mistake by any means, as it does not give any tangible advantage to Black, so the question is why it has never been tested in professional practice before, where taking the opponent out of the opening book is an essential tool used by masters and grandmasters, and especially so since the move comes very early in one of the oldest openings in the history of chess. In queen's gambit accepted, the dark-squared bishop is normally either the last minor piece to develop or the first to be exchanged for the knight on f6, yet children here reverse this habit, as they do many other ones, and prompt the adults to think about something that they have not thought before. Like all opening ideas, this one must have a multifold purpose, but two of them stood out after the analysis. Namely, in the case of the clearing of the center after ...c5 and dxc5, White could bring the dark-squared bishop to c3 and then combine this with the usually placed light-squared bishop on c4 and queen on c2 to create a powerful attack along the diagonals on the short-castled black king, with one possible variation from the opening being 1. d4 Nf6 2. c4 d5 3. Nf3 dxc4 4. Bd2 c5 5. dxc5 e6 6. e3 Bxc5 7. Bxc4 0-0 8. 0-0 Nc6 9. Qc2 b6 10. Bc3 (0.0). Otherwise, if White continues to play with an isolated queen's pawn, aka *isolani*, then the bishop could be implantable on the e5 square, as, for example, after playing 17.Bf4 and 18.Be5 instead of 17.Ne5 and 18.Rc2, which were played in the game. Whereas the latter sequence of moves was a prelude to simplification of the position, the bringing of the bishop to e5 would have come with a lot of opportunities for attack, especially because the bishop is stable on this outpost and cannot be exchanged by Black's playing 17...Be7 and 18...Bf6, as after 17.Bf4 Be7 18.Be5 Bf6 19.Bxf6 Nxf6, White sacrifices the rook with 20.Rxe6+ (Fig.20b) and Black is lost or checkmated after 20...fxe6 21.Bg6+ Kf8 22.Qb4+ Kg8 23.Qe7 Be4 24.Qxa7 Rxa7 25.Rc8+. Yet another, third potential benefit of 4.Bd2 may be its acting as a prophylaxis against any Nimzo-Indian ideas, which are most meaningful for Black in the Catalan system of queen's gambit, where White opts out of an attack on the kingside and tries to create a positional pressure in the center instead by fianchettoing the light-squared bishop.

In any case, after 19.Be4, the tensions in the position fizzled out before they had a chance to evolve into a combinatorial middlegame. First the minor pieces and then the major pieces were exchanged, and a completely draw rook endgame transitioned to a king and pawn endgame, where the two kings blocked each other's entrance to the opponent's camp, at which point the draw was agreed on. Despite that, the late opening and early middlegame stage, when the game could have developed into something completely different can be a gateway to infinitely valuable instructions about chess and, through analogies, about every possible aspect of our sciences and our lives. For example, if White pushed the f pawn to f5 instead of playing 19.Be4, the game would have proceeded in a much more exciting way than it did, just as it would have if White responded to rather passive 10...Qa7 with the dynamic pawn sacrifice, 11.d5 (Fig.20c), with a possible continuation being 11...Nxd5 12.Nxd5 exd5 13.e4 d4 14.e5 Be7 15.e6 fxe6 16.Ng5 Nf6 17.Bxh7 Rxh7 18.Nxh7 c4, leading to a very unbalanced position and a decent advantage for White. In any case, the final position was reached (Fig.20d) and even there, children could study why, for example, the pawn breaks with a4 or ...a5 lose for both White and Black, respectively, unless for

very specific positioning of the kings. They could also learn the principle of opposition, a form of zugzwang that is essential to king and pawn endgames, as, for example, by understanding why White's playing 56.Kd4 in the final position would force Black to play either 56...Kd7 or 56...Kc8, but not 56...Kc7, which would lose due to the opposition rule after 57.Kc5. Symbolically, the board, in this final position, is populated by 8 pawns only, which is the number suggestive of infinity if it only be laid down and made "lazy". Seeing this, a parent may be prompted to conclude that children split infinity among themselves, and if we seek infinity, we best start searching for it in children¹¹³. And then, if children, at this stage in the game, want to give up playing competitively, they could still promote up to five pawns into all kinds of pieces and have them hop around the board and play and practice checkmates and stalemates and what not. In other words, like in this final position, there is beauty and there is life in everything that seems dead on the surface, if we only dig deep into it.

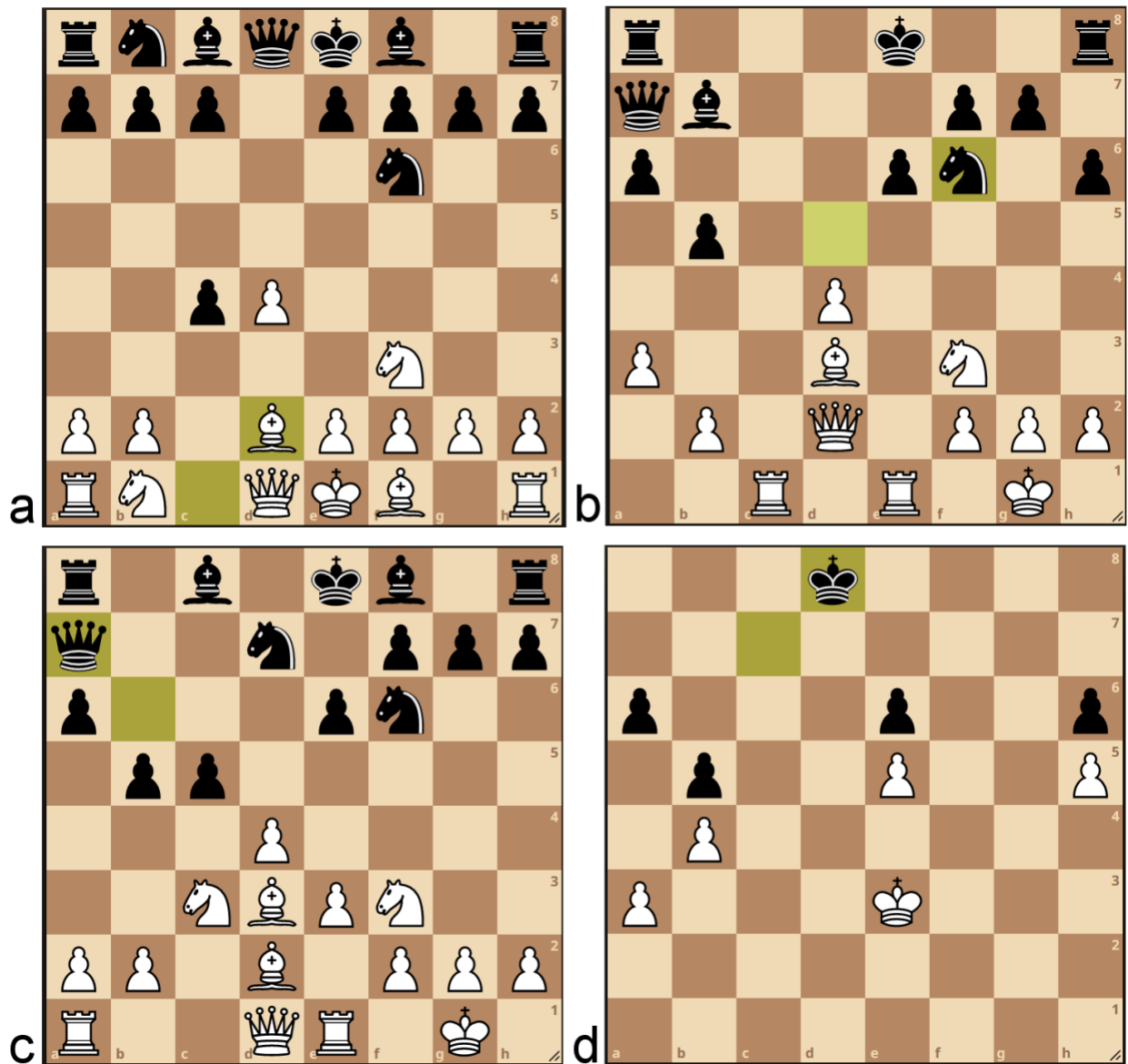


Figure 20. Uskoković, T. vs. Uskoković, E, Irvine, California, April 23, 2023, ½ – ½. Children's propensity for the inadvertent production of novelties comes to prominence with White's playing 4.Bd2 (a), a completely new move already on move 4 in one of the oldest openings in chess history: queen's gambit accepted. Next, instead of playing

17.Ne5 in the game, White could have repositioned the dark-squared bishop to e5. Its exchange for Black's dark-squared bishop would come with a lot of opportunities for the attack, as immediately after the exchange following 17.Bf4 Be7 18.Be5 Bf6 19.Bxf6, if Black took back with the knight by playing 19...Nxf6, the position in (b) would be reached where White wins with an elegant rook sacrifice: 20.Rxe6+ fxe6 21.Bg6+ Kf8 22.Qb4+ Kg8 23.Qe7 Be4 24.Qxa7 Rxa7 25.Rc8+ Ne8 26.Rxe8#. Before the tensions in the center were released through the exchange of all the minor pieces and the reestablishment of symmetric pawn structures, White did have a chance to push the game to more dynamic territories, and one opportunity was to respond to comparatively passive 10...Qa7 with the dynamic pawn sacrifice, 11.d5, in the position shown in (c), the goal of which would be to break through the center and launch a timely attack on the uncastled and insufficiently protected black king. The final position in (d) was reached after 55 moves and the players agreed to a draw. PGN: 1. d4 Nf6 2. c4 d5 3. Nf3 dxc4 4. Bd2 e6 5. e3 Nbd7 6. Bxc4 a6 7. O-O c5 8. Bd3 b5 9. Re1 Qb6 10. Nc3 Qa7 11. a3 cxd4 12. exd4 Bb7 13. Be3 Nd5 14. Rc1 h6 15. Qd2 N7f6 16. Nxd5 Nxd5 17. Ne5 Bd6 18. Rc2 Qb6 19. Be4 Nxe3 20. Rxe3 Bxe5 21. dxe5 O-O 22. Qc1 Bxe4 23. Rxe4 Qd8 24. g3 Rc8 25. Rxc8 Qxc8 26. Qxc8 Rxc8 27. Re3 g5 28. b4 Kg7 29. Kg2 Rc2 30. h4 gxh4 31. gxh4 Kg6 32. Rf3 Rc7 33. Rf6+ Kg7 34. h5 Rd7 35. Rf4 Rd8 36. Kg3 Kf8 37. Kg2 Rd7 38. Rf3 Rd5 39. Re3 Ke7 40. f4 Rd2+ 41. Kg3 Rd5 42. Rc3 Rd1 43. Rc7+ Rd7 44. Rxd7+ Kxd7 45. Kf3 Kc6 46. Ke4 Kd7 47. Kd4 Kc6 48. Ke4 Kb6 49. f5 Kc7 50. fxe6 fxe6 51. Ke3 Kb8 52. Kf3 Kc7 53. Ke3 Kd7 54. Kf4 Kc7 55. Ke3 Kd8

As one final note, it is worth adding that this emphasis on children converges with my personal research oeuvre since the beginning of the 2020s, where children and everyday settings have provided centerpieces for the aforementioned research projects from various fields, ranging from psychology to ornithology to art to physics, chemistry, biology and materials science. This is where science of the poor¹¹⁴ and science of and for the children¹¹⁵ of this world were born, as romantic as the sky can swallow it. For, under the open skies, hand in hand with children, I am free to say, the best research of my life was done. This is the brightest of the bright notes on which this course and this walk through the history of chess and its analogies with science can end, and will end.

And now, at the end of this walk along a thin rope, with one hand reaching out to a world of chess and another to a world of science, bless yourself with a ♥ or ♥♥, tell yourself all is love, and walk on, into the sunset. Who says that we cannot end a scientific paper on this romantic note? If we want the romantic era to be reawakened, then we must start off by being the beauty and the freedom that we want to see in the world, of science and everything else alike.

Even if our last gasp of freedom is that of a randomly typed string of symbols, it is what it is. It is beautiful, as all else is.

So goodbye, bhgyhiuhunjft 4duckhgeeyincdh, and safe ride.

Conclusion

Semantically, chess is multidimensional; a board game for entertainment to one, a mental sport to others, and a geometrically complex and logically enriched narrative art to yet others, amongst infinite other points of view. Although it contains definite artistic elements, the study of chess requires a rigorous scientific approach, too. Perceived as a fusion of the rigor and analyticity of science and the aesthetics of arts, chess can serve as a prolific source of analogies translatable to practices exercisable in various arts and sciences.

Here, an academic course taking students on a journey through chess history and drawing simultaneously parallels with the evolution of trends and major experiments in natural sciences (Fig.21) was being portrayed in a narrative, easily digestible format, with a supposedly captivating flow. The journey was circular, beginning around the peak of the romantic era in chess, in the mid-19th century, and ending with the current, digital age where chess playing style has been heavily influenced by computer engines, which, surprisingly to many, have begun to play often in the same

romantic style that has been traditionally tied to the beginnings of chess as an art form. The astonishing discovery of the most artistic of chess playstyles by engines, through unprecedentedly deep calculations, serves as a call to celebrate the fusion of art and science in every human discipline.

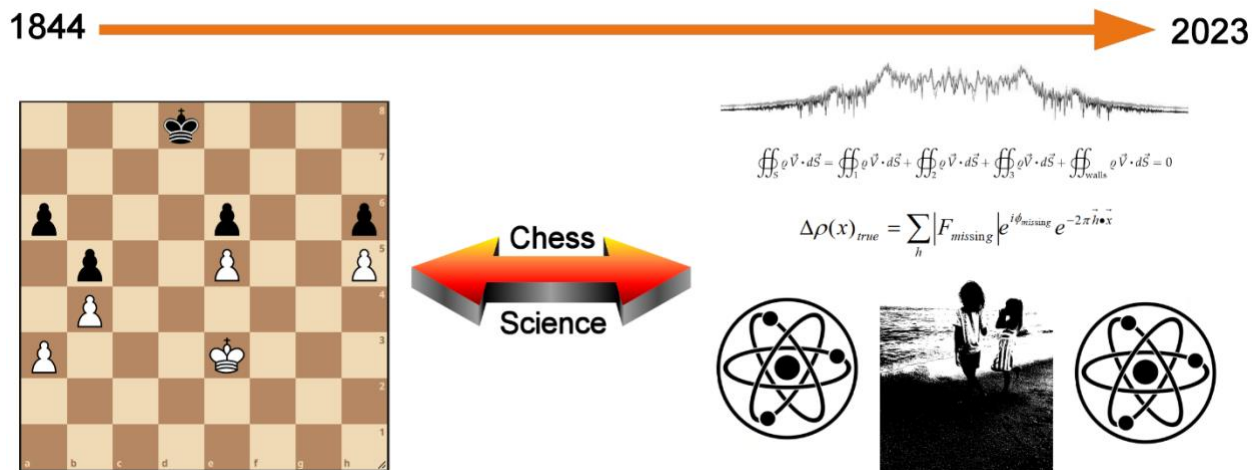


Figure 21. From the mid-19th century to this day, the trends in chess and in natural sciences have twined around one another, paving way for the informed insight into chess history to be relied upon as a predictor of the future developments in sciences, and *vice versa*. The course exploring seminally these historical parallels has ended with the current point in space and time, when the romantic spirit, long gone missing from natural sciences, is being called for by the poets. If anyone will be able to bring back this enchanting spirit and reintegrate it into the equations of modern science, it is, as the content of this course insinuates, children, both real and those who have vowed to always, under all circumstances, remain children at heart.

The story about the evolution of chess playstyles presented here is a sign of brighter things to come. It is a sign that natural sciences, which have been divorcing steadily from anything artistic since the age of enlightenment, may rediscover their romantic, renaissance and neoclassical roots if only computers and artificial intelligence evolve past the point where human intelligence could keep up with their ideas, both the routine one and the inventive, and be given a more creative role than they play today. Although it is conceivable that humanity will have to pass through many a dark tunnel, where algorithms would be used to control the global and local economy and politics for selfish means, serving the vilest in man, eventually we will emerge to the sunlit shore, if only the analogies with the history of chess drawn here were correct. Until then, we, the romanticists at heart, need to be patient and put trust into that very same thing that the romanticists have been most sceptic about: the mind of the machine.

In this interim, in lieu of impatience, we can harbor historical outlooks and do what we can to poke the scientific community and try to awaken it from a long slumber on the flowerless bed of logical positivism. The romantic movement in the 19th century arts emerged from a reaction of poets and soulful thinkers against the epidemics of dry rationalism that was gripping people's minds in the age of enlightenment and scientific revolution, and although it left ineradicable traces in arts, it was a short-lived undercurrent in natural sciences, sporadic on the surface at best. Yet, it was a form of activism, and activism may be what is needed to restore the romantic spirit in the heart of the scientific enterprise today. Crusading capable of converting the unbelievers to believers and proprietors and politicians into poets and poetesses, of course, is always sparked best by those who have suffered most under the tramping of the establishment, a category to which myself, an expellee from the academic system because of the romantic stands I took on its podia,

proudly belongs. This, as the end comes near, is a call to arms, but not of steel. These are arms of soul instead that should be wrapped gently and caringly around the new generation of intellectuals as we show them the beauty of the romantic worldviews while avoiding the trap of the temptation to convince them in the righteousness of these views or enforce any of their elements upon them.

The academic course presented here has emerged from one such aspiration to share with the newcomers to the world of natural sciences the view of the trajectory of the evolution of these sciences and how they extrapolate into something far more beautiful than what the dominant scientific culture of the day has to offer. The idea that this course could inspire them to take part in this new wave has brought about an unspeakable satisfaction to this instructor during the design stage. Last but not least, the course delivered in a condensed form to a group of young chess aficionados and budding scientists was met with approval. This conclusion was deduced based on an informal assessment of the student satisfaction following the accelerated exposure to the blueprint of this course. The attendees' opinions were overwhelmingly positive and they asserted the usefulness of the course for inspiring and preparing them for careers in natural sciences. This has given confidence to the instructor that the conversion of this course to a higher education setting would be viable and that students in all sciences would benefit from it. Because an intermediate knowledge of chess, if not absolute proficiency, alongside the familiarity with basic scientific principles will be required from the students and the teachers interested in attending this course to comprehend its content and engage in meaningful discussion, it would be preposterous not to assume that this process of transition would bring about inevitable challenges. However, with a sensitive approach to instruction, it can still be assured that curiosity is provoked, inspiration enkindled, and no student left behind in the learning process. Where we, as the community of scientists and chess enthusiasts, go from here in the attempt to test this all out and subject this correlation between trends in chess and trends in natural sciences to further scrutiny is future. This future, however, like any other, as the chronological storyline elaborated here implies, can be glimpsed only if we know history well enough and can trace with confidence its lines beyond the horizon.

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