

Chapter 2

Youth

My secondary school. The question of our further education was painstakingly considered by my father. From the time of Tsar Alexander 1st, who had set out with such zeal and success to improve the cultural development of his empire's Baltic provinces, there existed in Riga a Latin school administered from the government in St. Petersburg. This secondary school laid emphasis on Greek and Latin and was organised along the lines of the schools which had been established in Germany since the start of the nineteenth century under the pernicious influence of Wilhelm von Humboldt. It was the "obvious" preparation for an academic career and, except for a short period in the eighteen seventies, the University in Dorpat, just like the universities in Germany, only accepted as students those who had passed the school leaving certificate exams of a secondary school specialising in the classics. As everybody knows there exists to this day in Germany the absurd situation that a university does not have the right to decide who may enter it, but must leave this central decision in the hands of the school examination committees.

The second possible school was the old Cathedral School that had been founded as a priests' seminary before the reformation. It was now run by the town administration which had organised and expanded it as the town's secondary school. The competence of the town council and guild authorities in educational matters can be judged by the fact that they appointed the brilliant young Johann Gottfried Herder as Director of the Cathedral School and gave the 20 year old a free hand to reform and organise it. His success there was outstanding. Herder probably had his happiest years in Riga where he developed the main ideas of his influential work. He left after 5 years in 1769 to develop his work in a broader arena and in the following year he met Goethe in Strasbourg.

In the meantime the progressive attitude of the school authorities in Riga had led to the founding of a Polytechnic which, it was hoped, would stimulate the development of productive industry which the country lacked. In order to attract suitable pupils, the Cathedral School was converted into a technically oriented secondary school and this was pushed through in the face of opposition from the monopoly of educational classicists, although some considerable concessions had to be made to

them. In particular the Director of the new school was a dyed in the wool classicist called Haffner of whom I will have more to tell later on.

My father was luckily so well advised that he agreed to entrust his sons to this new school. This was a most important decision for my whole future development, because there is no doubt at all that my scientific and organization potential would have been stunted or even smothered at the secondary school specialising in classics. The technical secondary school in Riga was a thoughtfully constructed institution. The entrance exam showed that attendance at the elementary school had been sufficient to satisfy its entrance criteria. The school education was spread over 5 years and hence the institute was divided into five classes. The curriculum was such that only highly gifted and diligent pupils could complete the course in this time so that even a “good” pupil was forced to repeat one or other of the classes. As to foreign languages; there was only French in the first class together with the obligatory Russian, while Latin started in the second class and ended in the fourth where it was replaced by English. Physics was taught from the second class on and Chemistry in the fifth. Maths was taught up to the stage of analytical geometry but did not include differential calculus. At the end of the fifth year there was a final exam which initially only qualified one for entrance to the Polytechnic but not to the University. Shortly before I left the rules were changed so that this school leaving certificate enabled one to study mathematics and natural sciences at the University. This was the result of a long fought battle and my father’s decision had been based on the hope that it would turn out this way. Not long afterwards the classicists saw to it that this decision was rescinded.

My best teacher. I look back happily on the 7 years in this secondary school. Not, I must say, that the school itself gave me much, but it introduced me to the comradeship of the large and varied pupil population and this opened many new vistas for me beyond what was available in the narrower family circle. There was, however, at least one of the teachers to whom I am indebted for his outstanding support. This was Gottfried Schweder who had studied astronomy and now taught maths, physics, and biology at the school.

Schweder was a tall man with a broad chest and powerful shoulders, who had the reputation of having been one of the best fencers at the university. His short curly beard, full blond hair and blue eyes made him look like an archetypal German. He had a cheerful and friendly nature so that it was no wonder that we boys, from the youngest to the oldest, were ready to follow his lead and would have gone through fire for him. Afterwards he was for many years director and this was a blessing for the school.

The beginnings of independent thought. In the first years I was the same willing and diligent pupil I’d been in the preparatory school. Then, however, a new vista opened up which was to have the greatest effect on my development. This was the opportunity of getting hold of all sorts of books from my fellow pupils.

Books in my circle were quite rare and costly. They were largely restricted to what one could get from the lending libraries which stocked mainly contemporary novels. At home we also had the weekly magazine “Gartenlaube”¹ whose well bound volumes constituted the main part of our house library and for many years they were my main source of intellectual nourishment. Looking back it’s fair to say that this nourishment was both ample and healthy. At this time—the start of the 1860s—there was the great outgrowth of science and the start of modern technology and industry in Germany. The editor of the “Gartenlaube” had responded to this by publishing many articles on these subjects which both stimulated and informed me. In addition, the strong patriotism which was constantly expressed in the articles had the effect of making our family more conscious that we were unquestionably German.

Our German heritage. The political situation in my home country was that the strident pestilence of Slavic nationalism had begun to threaten our special status, within which a rich and fruitful culture had flourished. We felt—without any special pride but also with no particular wish for change—that we were politically part of the Russian empire but intellectually part of German culture. No political alignment with Germany was possible at that time because the German empire (Reich) had not yet been formed.² The Russian rulers had always acknowledged and fostered the special status of the Baltic provinces from which they drew many of the leaders of the military, the administration and the professions—people who could not be so easily recruited from Russian sources. Because of this there was a considerable degree of gratitude and affection felt in the Baltic provinces not to the empire or to the dynasty but rather to the individual Tsar.

Russification. The special status of the Baltic provinces was anathema to the developing pan-Slavic movement. Already during my childhood this movement had achieved sufficient influence to force through an increasing use of the Russian language in schools where up till then the lessons had been entirely in German. We pupils despised everything Russian as belonging to a lower class and met the increasing load of Russian lessons with passive resistance. As a means of justifying and anchoring Russian ways of thinking, the theorists of the pan-Slavic movement demanded and got an increasing weight given to Russian history in the schools. At least for the mentally alert pupils this had the opposite effect than that intended, because Russian history is a good deal bloodier than that of Western nations and thus gave them a historical basis for their anti Russian attitude.

¹Founded in 1853, this was the first mass-circulation German newspaper and a forerunner of modern magazines.

²Ostwald means here the *German Reich*, which was proclaimed in 1871 in Versailles and ended in 1918 with the abdication of the German emperor following World War I. The First *Reich*, better known as the Holy Roman Empire, existed from 962 to 1806. The Third *Reich* was the Nazi state existing from 1933 to 1945 (1943–45 called Greater German Reich) and ending with World War II.

Russian lessons were in the hands of a German renegade called Haller whose political and ethical decay was instinctively detected by us children and so we made his life rather hard. The uncontrolled fury of the harsh punishments with which he'd respond from time to time, only made matters worse, for we regarded it as more or less a matter of honour to do as little as possible in his lessons. On top of that Russian is a very primitive language full of forms and endings but lacking rules, and therefore hard to learn. Even the attempts of Russian linguists to remedy these faults with appropriate rules did not improve the situation much. Meanwhile the government tried by imposing strict regulations to force us to learn Russian. This led me often enough into unnecessary conflicts.

Order and Beauty. To begin with, all this didn't bother me. The stimulating lessons of Schweder released a latent love of nature in me which to begin with expressed itself in the usual collection of plants, butterflies and beetles. We were expected to prepare for our teacher a certain number of pages on which herbs had been properly dried and pressed. I remember how I took up the challenge of arranging stems, leaves and flowers all to the best advantage and how this somehow resulted in beautiful sheets for which I got special praise. This was the first flowering of a perception which only ripened in my old age.

Another experience, whose relationship to that one I only later discerned, took place about the same time in the drawing class. We were supposed to draw parallel lines by moving a triangle along a ruler and had been told to do this for the different sorts of lines—bold, soft, close together, far apart, continuous, punctate, dashed, and so on. I wanted not just to draw the lines but to give them some sort of context. To do this, I used an ornamental border to define the top of the wall of a room and accentuated this impression by the choice and distribution of the lines. This drawing earned me special praise from the teacher who was otherwise not particularly pleased with my work. I wondered how the effect had been achieved, but I didn't get very far with this line of thought.

The beginnings of chemistry. In my first year in the secondary school I was a model pupil who quickly absorbed and mastered whatever was being taught and so I had no trouble being moved to the next higher class at the end of the year. After that, however, my personal development began. Because of the lively exchange of books between the pupils I managed to get hold of one about making fireworks—something that had interested me for some time. The author was someone called Websky³ and he had treated the methodological aspects thoroughly. He began appropriately enough with a description of the materials required and used here, in addition to their trivial names, also the chemical formulae. To begin with they didn't mean anything to me because I was just fascinated by the instructions for

³Probably, Ostwald has had either the book (i) Websky M (1850) *Schule der Lustfeuerwerkerei*. Hirt, Breslau, or (ii) Websky M (1842) *Lustfeuerwerkkunst, oder leicht fassliche und bewährte Anweisung zur Verfertigung von Lustfeuerwerken*. Hirt, Breslau.

producing the various different fireworks. For the future however they were going to play an important role.

At the beginning it wasn't so easy for an 11 year old boy to follow the instructions because there was nobody to offer any help and, in addition, it was not easy to get hold of the necessary materials and equipment. Finally I found a friendly apothecary from whom I bought small amounts of saltpetre, sulphur, antimony and so on, and he gave me some help. However, for the most part I had to rely on the printed instructions and it was decisive for my future life that I discovered at this early age that all the art and science of mankind is stored in the form of printed words and that it can all be recovered and brought back to life at any time by an eager and dedicated reader. I also learned, even if I could not have consciously expressed it so, that the written words alone are seldom enough, and that the more experience the reader brings to the matter the more he will be able to extract from the text. That was a problem because none of my school friends could help me, though they were, to be sure, happy to join in when the fireworks were set off. So playing with fire opened for me a door to the world with all its wonders, and by wonders I mean the opportunity to experience myself all sorts of strange things that grabbed my youthful imagination.

I am thankful to my parents who tolerated all this, despite the fact that my new hobby was potentially dangerous given that my father's business meant that there was always a large stock of wood and readily flammable shavings lying around. My mother helped out by letting me have all sorts of kitchen utensils like a mortar, sieves, bowls and so on. Even when once a whole batch of flares which I was drying in the oven went off and terrified the kitchen girl they did not forbid my activities but rather gave me a little room in the attic for my magic games. I didn't disappoint their trust for I never caused a fire. My experience with fire did, however, make it possible for me occasionally to help put out a fire in the workshop when the guilty worker who'd accidentally started it had rather lost his head.

The fireworks gave me for the first time that happiness which comes from putting into practice things which had been up till then mere thoughts and ideas and this is exactly what spurs a researcher or explorer to his efforts. At the beginning, of course, youth is satisfied with much less. Looking back subjectively, I see that this sort of experience was a constant and inexhaustible source of joy throughout my whole life. Even today when I am much less active I experience that same anticipatory excitement before a decisive experiment and the almost painful happiness when it succeeds that I did when I was a boy. In this case the strength and duration of the emotion are not as in most situations inversely related; on the contrary the joy of the researcher is both strong and lasting.

Work style. Although the family became more affluent around this time, life remained frugal. I had only very meagre resources for my experiments; my small amount of pocket money would sometimes be supplemented by a little additional allowance from my mother—but only in the most urgent cases. Because of this I got used to making for myself almost everything that a boy my age could, and I enjoyed doing that. This habit of getting by with few resources and with simple equipment

and, as far as possible, putting together whatever was needed myself, is a work style that remained with me for my whole life.

Even in times when money was not limiting I kept to this way of doing things and I usually spent as much time and effort on simplifying the technical aspects of my experiments as on their conception. This style later made it possible for me at a relatively young age to give up my teaching position, together with the large laboratory and all the equipment and material that went with it, because I was sure that I'd be able to finance all the research I wanted to do out of my own pocket. And that is exactly how it turned out.

Another point that characterised my work style back then was that I was not averse to rather monotonous repetitive work. For my fireworks I sometimes had to glue and fill hundreds of paper casings or do similar repetitive chores. I never found this horribly boring, but instead tried to find ways to get it done in a more efficient way, and the search for such a solution gave the work a new attraction. Moreover I gained the satisfaction that comes when repetition leads to ever increasing dexterity and efficiency in the work. Finally, I have to admit that I got real pleasure from seeing the products pile up, perhaps rather in the way that the miser gets the joy of his life from the accumulation of money. There is no doubt that my parents' genetic constitution and habits played a role in all this. My mother was endlessly involved in housework and my father, even after he was well off, spent his mornings in business meetings and then, after lunch, put on his working clothes and went to the workshop to do himself all the things which needed particular care and skill. Nevertheless, there was some personal element at work here for this character trait was stronger in me than in my brothers.

In this way I found myself involved in an ever increasing round of work and interests. I'd have liked to have a lathe to make the rods round which the paper casings were formed. Sadly there was no lathe in my father's workshop, and so I decided to make one myself and actually managed to build one out of simple material. Once it was finished—which took quite a while—my interests had turned elsewhere and in the end I scarcely used it. I have to admit that this also is a characteristic that was typical of my later life.

Painting. Apart from fireworks my main interests then were collecting butterflies and beetles as well as sketching and painting. A neighbouring family called Schwendowski was a major influence on me in the matter of painting. The father was a minor official in Riga's town administration where his drawing abilities were put to use in preparing Diplomas and other calligraphic works of art. Most of his many children were considerably older than me, and one of them was a professional painter. It was always a great joy to me to be allowed to look through his sketch book with its lively water colour pictures whose colours were astonishingly appealing. Some of these I can still see in my mind's eye to this day.

I very much longed to be able to produce similar things myself. I tried, but given the small amounts of unsuitable material available to me it was a vain endeavour. There was no other way out—I'd have to manufacture the paints myself! By busily questioning my school friends I managed to get hold of a book in which I found the

description of a milling stone and instructions for the proper amount of gum Arabic to use as a binding agent. I bought these things from the friendly apothecary and set to work. It turned out, however, that the colours alone don't make an artist, for my new paintings were no better than the old ones. I couldn't find anybody to teach me how to paint. The artist Schwendowski lived elsewhere and came home only now and then for a few days, and apart from him no one else in the neighbourhood knew anything about painting. Once he gave me some left over oil paint. It didn't go very far, but it was enough to show me that I'd get a lot further with it than with the more difficult water colours. And so I began to make oil paint which, in the old fashioned way, I stored in pigs' bladders because zinc tube had not yet crossed my Riga horizon.

In a paper shop there was a large stock of printed lithographs which I'd look through for hours on end, and then if my pocket money was enough I might buy one or two which I'd colour in using the water colours. To be honest the results were disappointing even for me. There were no good examples from which I could learn. The only paintings I ever got to see were in a gilder's shop window where occasionally an oil painting he'd been given to frame would be displayed for a few days. There was at that time not a trace of the flood of pictures that threatens to drown humanity today. The reproduction of works of art was restricted to lithographs and to the woodcuts which were coming back into fashion. Coloured reproductions were rare and costly and the first attempts at photomechanical techniques were just being carried out in their inventors' workshops. Because of this I was restricted to the odd example that passed by chance before my hungry eyes and I tried with my scanty resources to reproduce the strong effect it had made on me. Right from the beginning I had more luck with colours than with form: I could easily envision the impact of the colours I was applying while, on the other hand, I never dared compose a picture of my own in my younger years.

The relationship to later work. I mention these childish things because they later had consequences for me. I want to stress here that I consider the establishment of the quantitative theory of colours my most important work. I have not the slightest doubt that I would never have solved this problem, on which the best and brightest from Goethe to Hering racked their brains in vain, had I not from my youth been involved in producing dyes and, by doing so, been made constantly aware of the most important problems in colour theory which always have to do with non luminous colour (Körperfarbe). In particular one sees how the commonly available physical techniques using lenses and prisms available to Helmholtz led him to conclusions which have nothing to do with non luminous colours.

All in all, when I look back on my working life it becomes clear that all of the many interests and hobbies of my youth, no matter how useless my parents and teachers viewed them, all turned out later to be worthwhile and some even essential for those of my efforts which my peers hold to be not just useful but valuable. By collecting facts and the relationships between them in the boundlessly compliant memory of youth, a store of data is compiled from which the building blocks for the mental efforts of the future researcher can be drawn, for he has to form things which

do not currently exist—and yet they must not be mere castles in the sky. For this he has no other guide than his memories of earlier experiences and so the mental constructs he produces take on a form dictated by these memories. We are therefore not dealing here with the operation of some mystical power that had given me in my childhood just those things which I would later need. Rather the style, and to a large extent the focus, of my later work was largely determined by what fell into my hands and senses in my youth.

What I am describing here from my personal experience is undoubtedly generally applicable. Goethe for example emphasised that the concept of the main figures and events of his literary works were established in his youth and that his whole long life was devoted to developing these early structures. In this case one can see even more clearly how the work of the man was determined by the material which he accumulated at a young age.

Outlook. If one follows this line of thought then one can come a long way. Goethe's instinctive rejection of Newton's theory of colour had its basis (Goethe was not conscious of this) in the fact that though it provided information about the "physical" nature of colour, that is to say information derived from the colours of refracted light, it told nothing either about the perception of the colour of light reflected from a surface nor about the properties of dyes. Newton's explanation of non luminous colour as reflecting the colour of thin sections was apparently not known to Goethe. He certainly never referred to it and in any case it would not have led to any scientific explanation because it is quite simply wrong. Goethe, for his part, was acquainted with dyes and non luminous colours because of his personal involvement in drawing and painting and he had the strong feeling that these colours are somehow completely different from the spectral colours. His warning, "My friends, abandon the darkroom", was surely largely due to the fact that he felt unsure of himself there and therefore made a virtue from necessity—but all the same his instinct was correct. He felt sure that there was no justification for the simple transfer of the spectral colour theory to the perception of colour in the environment, though he was unable to justify this view in physical terms. Physicists on the other hand viewed the whole matter as solved and therefore not worth further discussion.

If we look at the work on this theme of the great physicist Helmholtz, then we see how his lack of knowledge of painting techniques and of paints rendered him unable to grasp these problems. In his three volume book on the physiology of optical perception the term "non luminous colours" does not even appear in the index and on the page where colours and dyes are supposed to be dealt with one looks in vain for something on this topic. On the other hand, in his insightful speech on his seventieth birthday he told us that already as a boy he'd spent the Latin lessons, which bored him stiff, working out the light path in optical instruments. He said nothing about experiments at sketching or painting. The structure of his mental world was set in his youth and did not change at all throughout his life.

Technical and commercial experiments. No matter how elementary my drawing and painting skills were, they nevertheless turned out to be a great help in

developing my many interests all of which suffered grievously from the limitations imposed by my meagre pocket money. My parents kept me on a short rein partly from thriftiness and partly because they rightly feared that my skylarking with this and that would interfere with my school work. I therefore had to find some other way to get hold of the necessary “kopecks” as the smallest coins were called.

Just at that time transfers had become all the rage. They would be moistened and then pressed onto any surface to which they’d stick after which the paper support could be peeled off. Often the outer side would be varnished bronze so that the picture only became visible after transfer. All of this was a great attraction for us boys. In line with my passion for doing everything myself, I invested a lot of thought and experiments in making these transfers myself. To begin with I didn’t have any way of making the delicate transfer film on which the picture is painted. However, I did know that soaking silk paper with oil or better with turpentine produced a glassy translucent sheet. I therefore painted pictures on silk paper, made them translucent, cut them out, stuck them onto ordinary writing paper and covered the front side with a good thick layer of Arabic gum. In this way I produced pictures which, just like the bought ones, could be transferred—but they had the advantage that they showed scenes which were of particular interest to us. My school friends were more than ready to give me a few kopecks for them and so I could now buy mortars, glass tubes, and other necessary treasures which I’d wanted for a long time. The joy, however, did not last long because in some way a teacher came to hear of this and he strictly forbade the trade. The usual exchanges between boys were tolerated, for there was in any case no way to stop them, but he believed that as soon as money, no matter how little, was involved it became a serious and dishonourable offence. How much I would have liked to get hold of the things I needed by way of exchange rather than having to pay money to buy them, but there was nobody with whom I might have exchanged these things.

Music. The memories of one’s own childhood are like the experience of entering the Finnish or Swedish Archipelago (Schären) To begin with only the occasional bare islands of consciousness give form to the featureless sea. They are at first very small and have little content. Then the islands become more numerous, larger and contain more diversity until they fuse into the solid land of permanent memory. Even here some incidents stand out like mountains in the plain of experience but they are now embedded in a continuum instead of being just perceived as islands of memory. Exactly this sort of island contains the memory of the first time I experienced great music. My parents had decided that the best way to introduce me to music was to take me to a church where a Christmas or Easter oratorio was to be performed. This indeed fitted to the “biogenetic law” of Haeckel, which at that time had not yet been formulated, that every organism during its development runs through a synopsis of the developmental history of the species. In this sense music had been developed first in the service of the church and all of us children knew at least some of the first steps along the path of its development in the form of songs. I no longer recall what it was I heard. However the ethereal sound of the violins soaring above the choir in a peaceful section, to be followed by the power of the

combined organ, orchestra and choir, was an unforgettable experience. By chance, from where I sat I was able to see the conductor, and the power which he exercised over all the musicians with his short thin baton seemed to me to be the most wonderful height of human striving that I'd ever seen or could imagine. From all the many ideals that such experiences awoke in me and whose achievement in later life gave me pleasure, this was one of the few that I never managed to achieve. Of course, realising my limitations, I never really tried to reach it.

At an appropriate time my parents also took us to the theatre. "We" in this case means my elder brother and me. I was a precocious child, while my two brothers developed somewhat more slowly, and so it was only natural that I was taken along for company to all of the events to which my elder brother, on account of his age, was initiated. That saved me a lot of time.

The first visit to the theatre was to an opera—The Magic Flute. The fact that we children didn't understand a word of the text didn't in the least detract from our enjoyment.

The serpent at the beginning and after that the comical Papageno and Papagena, and the evil Moor went straight to our hearts. Tamino and Pamina were less interesting until the magic of the theatre let them stroll through fire and water. In line with my natural predispositions the optical memories are much stronger than the acoustic ones. And when I come to think of it, the memories of the oratorio seem to be a mix of the acoustic memory with the sight of the illuminated choir against the dark background of the church nave.

My parents regarded music as an important part of general education. My elder brother was given piano lessons from an early age and became quite adept. His teacher was called Askenfeld. He was a peculiar little man in an old faded coat and with a white sailor's beard shaved around his pock marked, brown-red cheeks. But he was a good musician. It was his habit to play the first fuge in C major from "The Well-Tempered Clavier" ("Das Wohltemperierte Klavier") to recover from the drudgery of the lesson. For a long time I had no idea what this strange piece of music was until, hearing it much later, I recognised again the sounds from my youth. The violin was chosen for me, and I was to take lessons from a member of the theatre orchestra called Scholz. He was no use as a teacher and some years later he lost his job through drunkenness. But though I never managed to learn the violin properly, my incompetent teacher can be blamed only to a small extent for I simply lacked the acuteness of hearing on which the surety of touch on the strings and the melodiousness of the bowing depend. Later I transferred my meagre skills to the less demanding viola and in this way gained access to the inexhaustible treasures of our chamber music. Domestic string quartets were a source of happiness to me from my last years in school and throughout my years as a student and professor. I got from them not only the direct joy of music but also insights into the Aladdin's cave of thematic work which was of enormous help to me in developing my own theories of art.

Since I was making no progress with the violin I asked instead for piano and harmony theory lessons and for years I practiced Richter's strict harmony with Askenfeld. This early hankering after the scientific side of music, and the fact that it

was supported by my parents, was an important part of my inner development, even though it only bore practical and scientific fruit in my old age.

By way of the book exchanges with my school friends, which I mentioned above, I came across some fragments of A. Hoffmann's "Kater Murr" and they made such an impression on me that I didn't rest till I'd managed to get hold of other texts from him. I learned from Hoffmann to understand the emotional side of music. It was a truly decisive experience for me to listen to a performance of "Don Juan" after reading his masterly analysis of this profound work. The deep veneration for Mozart which I developed at that time has stayed with me in undiluted form ever since.

Literature. Since my mother's thirst for reading was not quenched by the two family magazines which came every week, she also always had books from the local lending library. Early on I asked for and was given permission to read them as well. It was soon my job to go to exchange the books and I had a say in which books would be borrowed. Since I was always finished with them more quickly than my mother, who could only read in the odd quarter of an hour that the house work left her, she generously let me exchange most of the books as I wanted.

And so I got to learn the ways of the world beyond the narrow circle of family and school from the inadequate and one sided descriptions in the romantic novels of the 1850s and 1860s. The prevailing view was that of, for example F. Spielhagen, whose novel "Problematic Characters" ("Problematische Naturen") absorbed me in my last school years. The naturalistic movement was just beginning to appear on the horizon and had not yet challenged the domination of the newer romantics. Soon after this, science totally engaged me and I rather lost interest in questions of human relationships. The consequence of this was that I frequently made the gravest mistakes in judging the thoughts and actions of those I came into contact with later in life. Science never lost its hold on me and so to this day I devote less time than I should to the proper assessment of my personal relationships. I'd probably have managed to push through some of the scientific advances which I felt it my duty to support, quicker and more easily had I had more opportunity and interest in the ways of the world in my youth.

The art of human interactions. In particular I have always found it—I don't quite know where this came from—ignoble and even rude to try to influence others to act in a way that seemed preferable to me. I'm not talking here about personal relationships but rather about my scientific efforts in which it never became clear to me that success was almost always dependent on the goodwill of people who, at least initially, felt wounded by my impetuous reform zeal. Every advance faces all the leaders and authorities in the field with the question why they themselves hadn't seen it. In this sense each advance brings with it an implied criticism which thus tends to result in its rejection. I had always just assumed that others would share the passionate joy I felt at each advance and, though sometimes they did, in the majority of cases they did not. I failed to learn from my experiences.

I recently read H. Zschokke's book "Selbstschau" in which he describes his efforts to increase the level of education in his adopted homeland Switzerland. He

first posed and then answered the question of how he should present his thoughts and evidence without drawing general antagonism, because, “no one is surer of his knowledge than he who knows nothing and no one believes he understands things better than he who grasps nothing”. Zschokke knew this at the age of twenty eight. I still hadn’t learned it at the age of seventy.

The embryonic author. As to my own writing ability, I soon got praise from my teacher for my German essays. However, from an early age the wish to express my thoughts and feelings in written form went beyond these school assignments. Of all printed matter, novels were most easily accessible to me and so it followed that my wish to do everything myself manifested itself here too.

True, the novel I tried to write got stuck after the first page or two, because the breadth of personal experience which I could call on was just too narrow. However, things went somewhat better with a newspaper which I brought out with the title “Humour”. It was produced by hand and given to my friends to read. I suppose I managed to produce half a dozen issues. When, however, I thought about writing criticism of the performances in the reading of assigned roles in classical drama, which we were doing at the time, I was met with a storm of opposition, because I had decorated the first letter with a huge scissor that was cutting a pitiable victim through the middle. I had to abandon any further issues. Even before that I’d earned the serious disapproval of my readers when I’d described, in the style of Amadeus Hoffmann, incidents which all my school friends could recognise about ice skating with girls of our age. The stories were written as tragic and passionate tales which, at the moment of greatest tension, turned into farce. My readers were perfectly happy to be overcome with emotion—but they didn’t want it to be interrupted.

Difficulties at school. It will be easy to understand that these diverse interests soon enough came into conflict with the demands of schoolwork. Already in the second class my results at the end of the year were insufficient to allow me to be transferred into the next class and I had to repeat half a year. In the third year class where, as I’ll shortly relate, I fell for chemistry, I had to repeat the whole year. But then things got better: I completed the fourth year in three terms and the fifth year in two. Not that I’d developed any greater diligence for my school work in the upper classes—quite the opposite—but rather because I’d gained the goodwill of some of my teachers who were prepared to accept my general intellectual progress as being, at least in part, equivalent in value to the school curriculum, and in consequence they allowed me a lot more freedom.

In particular I’m indebted to that splendid teacher Schweder, whom I already mentioned, because he put in a good word for me at the teachers’ conferences and in this way spared me the enormous waste of energy which I would otherwise have had to make to fulfil the strict letter of the regulations.

My marks in maths were always good; even better were those in physics which began in the third year (chemistry didn’t start until the final year). Schweder’s excellent and stimulating lessons caused me once again to want to repeat for myself the beautiful experiments he’d demonstrated. He lent me the practical textbook from Frick the early editions of which were splendidly adapted to the making of

useful instruments from simple components. Here I remember how excited I was to discover that for a collecting lens there are two positions where a sharp image is formed and that for this the distances between object and image remain the same and are merely exchanged. Afterwards I found out that this had been known for ages, but I'd tasted the delight that follows an independent discovery and that left me with a craving for more.

I was soon allowed to help the teacher I venerated with the experiments and could suggest and carry out some technical improvements. For example I cut a radial slit in the disks of paper for the colour top so that one could put two or more disks with different sized coloured sectors on top of each other and thus mix these colours. Here as well someone else got there first; in this case, as I discovered years later, it was the great physicist J.C. Maxwell.

On one occasion I actually managed to catch my honoured teacher out in an error in physics. It was typical of him that from that point on he was even friendlier and supported me even more strongly in the teachers' conferences.

Chemistry. From physics the dominant passion of my youth switched to chemistry. It had all started with the fireworks. As I mentioned before, in Websky's book chemical formulae—which meant nothing to me—were written next to the trivial names of the chemicals. Slowly I worked out that wherever the word sulphur appeared in the name of a chemical the letter S was present in the formula. But the other letters remained un-interpretable. A question to the teacher elicited the short answer that these were chemical formulae and we'd do them in the last year. I, however, didn't want to wait till the last year, especially since at that time it looked as if it would take an age for me to reach it.

So once again I turned to that small but many sided source of knowledge: the books available to me through my school friends. This time luck was really on my side because I got hold of a copy of the "School of Chemistry" ("Schule der Chemie"⁴) from the excellent agricultural chemist Stöckhardt. It was well worn and, having more or less fallen apart, it consisted mostly of loose pages. However, I soon learnt to treat it as the greatest treasure that had so far fallen into my hands.

This book turned out to be a pedagogic masterpiece. Of course I could only judge the book subjectively, but far more than Frick's experimental physics—"Practical Physics" (Praktische Physik)—Stöckhardt's book satisfied my desire to do for myself all the wonderful things I read in it. At the beginning he set only very low hurdles in terms of the materials needed and the skill of the pupil and then, in carefully considered steps, he moved on to more difficult things. Because of this, these chemical experiments were for me much more accessible than the physics ones had been and I drank deeply from this spring.

Of course here as well I was short of money. My father was less ready than ever to support my dawdling with my schoolwork, and my mother was placed in a

⁴This book was published in 22 editions from 1846 to 1920. Several English editions were published under the title "The principles of chemistry: illustrated by simple experiments". In its time, it was one of the most important books popularising chemistry.

difficult position between her kind-heartedness towards her favourite son and her duty to her husband. What little she gave me was nothing like enough and so I looked around for some means to earn the desperately needed money. To buy the retort which I needed to make concentrated nitric acid for gun cotton I once cleared the ice from the whole yard and this cost me two days hard work in the Easter holidays.

The goal of my chemical experiments, in so far as I could carry them out according to Stöckhardt's directions, was to try to understand the underlying phenomena. Only those who have seen a child becoming totally absorbed with something new, taking it in through every pore and anchoring it in his memory, can imagine how I abandoned myself to this new world and with what eagerness I sought for ways to get round the problems that lack of materials posed. Of course I showed my school friends as much as they wanted to see and so my teacher also got to hear of it. In a friendly exchange Schweder made me promise to work at the other school subjects—which I could do quite easily. At the same time he examined my knowledge of chemistry and then lent me other text books the most important of which was Strecker's German edition of Regnault's textbook of chemistry. By this I was introduced to a more purely scientific view of my favourite subject and was so well prepared that my wasted first year as a student at university didn't hold me up.

Photography. All these activities brought me a special status amongst the other pupils and my head became quite swollen, so that I was not shy to boast about the many important things that I was going to do. This elicited of course protest and derision; one thing led to another and then I declared that I'd provide proof of my abilities by making a photograph of one of those present using only self made materials. A date for this was set. I didn't have a camera or any other equipment and what I knew about photography was restricted to the short description of its chemical basis given in the textbooks. None of my acquaintances was a photographer and all I knew about the technical aspects of taking pictures was what the "object" could glean when being photographed. At that time—in the 1860s—a wet collodion plate served as the light sensitive surface. Ammonium iodide and cadmium iodide were dissolved in a cellulose nitrate solution which was then poured over a carefully cleaned glass plate. This had to "ripen" for the proper period of time before it could be used. At the right moment, when the coating had gelled but was still damp, the plate was immersed in a tray of silver solution that also had to have just the right constitution (weakly acidic and saturated with silver iodide). Once silver iodide crystals had been formed, the plate had to be drained and placed wet in the cassette. From this point on it could be used for 5–10 min so that photography was only possible close to the darkroom. I gleaned these details from a book on photography by Monkhoven which I'd managed to get hold of.

I don't want to go in detail into all the difficulties I faced, but I built the camera out of an empty cigar box of my father. My mother's opera glass provided the lens. Thus far it was fairly easy. To make the silver solution I scrounged a broken tea spoon which unfortunately turned out to be rather rich in copper and so I had a lot of work before I could make pure silver nitrate from it. The trays were made of

varnished paper while bits of broken window were cut to make the plates. Finally everything was ready and with breathless excitement I watched the development of the negative of my first picture—the view from my window. The feeling of happiness was no less than that I'd experienced when I'd set off my first rocket. A few further experiments gave me the necessary experience and I did indeed manage to produce a photograph of my school friend and print it on albumin paper by the appointed date. He'd managed to freeze the scorn he'd felt for what he thought was a hopeless venture on his very expressive face and kept it there for the thirty second exposure. In this way an extraordinarily lively portrait emerged and I am only sorry that I no longer have it.

I learnt a very great deal from this bet. The necessary chemicals could not be bought in Riga and so I had to prepare them from available substances. Even the gun cotton needed to make the collodion was on this list and the retort for which I'd cleared ice from the yard was part of the story, because I'd needed it to make concentrated nitric acid. The ammonium iodide and cadmium iodide both had to be prepared and the latter pleased me particularly by the sheen of its crystals. I also made my own ether. In addition to all this there were quite a few mechanical and physics problems to be solved such as getting the exact fit of the cassette and the best position for the lens etc. From making fireworks I'd learnt that enough information is available in books to let you do almost anything you want—and that was confirmed here. This all had a decisive influence on my future because I knew that my progress was not dependent on personal instruction. I was, of course, able to benefit from personal instruction, and I'll relate with thanks incidents of this as we go along, but it was not an indispensable necessity for me and in fact I owe a lot more to my books than to my teachers.

The moral flywheel. It was here that I experienced for the first time the operation of the "moral flywheel". As everybody knows a flywheel serves to store a certain amount of energy which can be used to iron out the peaks and troughs of the demands on a machine. This enables a more or less regular speed of operation, despite fluctuating use and load. If a machine is overloaded for a while then it would simply grind to a halt were it not for the flywheel which can cover the excess load with its stored energy. In a similar way I—unconsciously at the time but later quite deliberately—forced myself to an above average effort. In this case I used my ambition as a flywheel to draw the extra energy needed to conquer the field of photography, which combined my twin interests of pictures and chemistry, and thus to win the apparently impossible bet. The success of this first attempt and of a second which I'll tell when we come to the end of my studies, encouraged me to use this procedure often, perhaps oftener than was altogether wise. Nevertheless, although there were failures along the way, it worked pretty well in most cases.

Other activities. These diverse indoor activities didn't prevent me from spending a large part of my time outdoors. Because my father was a cooper there was always a large court yard to store the wood adjacent to our house. After we moved from the house on the Speckgraben, which was soon buried under the Riga-Dünaburger railway, we lived in the Romanowka Street which was also in the "Moscow"

suburb. Outside Riga's old city wall, which I saw in my early childhood and which was later replaced with pretty gardens, there were three suburbs—"Petersburg", "Moscow" and "Mitau", whereby the first was the most genteel one. Mostly non-Germans, Russians and Letts lived in the "Moscow" suburb while the "Mitau" suburb lay on the other side of the three quarter of a kilometre wide river Dūna, and it was a world on its own. In spring and autumn, when the river was full of drifting ice, that suburb was cut off from the town for weeks on end. In summer traffic passed on a pontoon bridge and on some small steamers, while in winter the river was passable on the ice. Because of this the people from "over the river" were regarded as a bit foreign and they were thought capable of getting up to things that a proper citizen of Riga would never do.

The whole family saw it as an important step in our social rise when around 1860 my father managed to buy a house on Alexander Street, the broad main street of the "Petersburg" suburb. That our house was number 100 increased my respect for it considerably. It lay a bit at the edge of the suburb but still inside the built up area which came to an end a few hundred paces further on at the "Great Pump"—a public fountain in a square surrounded by poplars. Beyond this point there were only some scattered summer houses, farms, windmills and factories before the start of the endless pine forest, extensive high moors and beautiful lakes which make up Riga's surroundings. The "Mitau" suburb was also surrounded by woods and moors while on the edge of the "Moscow" suburb lay the sand dunes, which I mentioned before, and these one had to cross to get into the woods.

This was the stomping ground of the explorations which my elder brother and I and two or three school friends made in ever wider circles. Along the way we'd collect beetles and butterflies while a pond with wonderful crested newts gave us the chance to take a few especially beautiful specimens home where we fed them on earthworms. For us it was enormous fun when two of the newts grabbed different ends of the same worm and then, swallowing slowly, met in the middle. Then there started a sort of wrestling match in which the stronger one pulled the already swallowed part of the worm back out of the loser. And then one time I suffered pangs of conscience when I stepped by accident on one of the newts that had escaped from its bowl. The half squashed animal did not recover from its injuries and I had to witness its slow death. After that I carried the other newts back to their pond.

The director. All in all I had a very happy youth. The schoolwork wasn't onerous and I didn't take it all too seriously. For the 7 years I was at the secondary school Mr. Haffner was the director. He was an old ultra-conservative old-fashioned classical philologist who had previously served as the government appointed rector of Dorpat University.⁵ There many stories circulated that centred on his reputation as a petty fogging bureaucrat. Once, when his immediate superior, the chairman of the trustees, was out of town Haffner deputised for him and in this capacity he discovered some minor breach of the regulations which he as rector had committed.

⁵Since 1919 Tartu University, Estonia.

As acting chairman of the trustees, he sent a sharply worded reprimand to himself as rector, and was seen the next day in tears as he read this letter to himself.

However, since he was in essence a benevolent man and since he did not consider himself responsible for the mathematics and science subjects we didn't suffer too much from his classicism. At the start of each semester in the second class he organised a big celebration in which he'd spend one hour telling us how a good pupil would prepare himself for the upcoming Latin lessons. He had a large closely shaved face in which he managed to use the unusually large realm between his nose and his mouth to so dramatically express the various stages of cogitation between the start and the triumphal end of a translation that we boys could scarcely suppress our laughter.

He was, one must add, altogether a conscientious director who every Saturday made the round of all the classes to look in the register books in which each teacher had to confirm that the lessons had taken place and in which the more serious disciplinary offences together with the perpetrator's name were recorded. These culprits then had to suffer a stern philippic and I can assure you that he took care of every single case. He even managed to enliven the inevitable monotony of his punishment sermons by bringing some personal twist to each case.

The teacher. Each pupil at the start of his school career had to nominate a teacher to be his mentor who would keep an eye on him and advise him if he ran into difficulties. My heart had been set on Schweder, but when I asked him it turned out that he already had the maximal permitted number of pupils and so I looked for someone else. I took the teacher my elder brother had chosen. He was called Dr. Groß: his subject was German. He was a short plump man with a round white face, a bald head and a black beard. He was taciturn and had a permanent air of dissatisfaction. I never saw him smile. He was one of those teachers whom a university degree had completely alienated from teaching so that like "Pegasus chained"⁶ he looked down on his job with anger and contempt. He probably spent his free time writing tragedies, though none have seen the light of day. He could have had a great influence on me since he was responsible for setting and marking the German essays and this was an area in which I wanted to make my mark. However, he completely refused to cater to my aspirations and stayed instead with the usual stupid topics: "On the life of man", "Seen from a tower", "Wallenstein's guilt", "Tell's monologue". In other words the sort of thing which then—and even long after—was used to train pupils to spew out empty phrases. Once, when the topic was "Where would we be without hope?", I was so annoyed about the silliness of the subject that to taunt him I wrote the superficial banalities which he expected from us in doggerel modelled on Kortum's "Jobsiade"⁷ which I'd just read with

⁶A poem by Schiller in which the winged horse of Greek mythology was bought by a farmer who used it as a plough horse.

⁷Carl Arnold Kortum was a German physician and writer. The "Jobsiade" was a comical heroic poem about the life of the down at heel theology student Hieronymus Jobs. It is a satire on student life and German philistinism.

delight. He reacted to this by underlining in red ink every error I'd committed in grammar, poetic meter and rhymes and gave the now blood red essay an appropriately terrible mark. But the fact that my cheekiness had no further consequences showed me that he hadn't read it without some amusement and that he had used the formalism of the red ink to spare me any worse punishment. Many years later when he was long dead I heard to my great astonishment from one of his friends that I had been one of his favourite pupils and that he had always put in a good word for me in the teachers' conferences. He'd never said a word of this to me.

The other language teachers also had little influence on me. We learnt French to begin with from a very old, very small gentleman with a leathery face that was always shaved smooth. His clothes were always neat and clean, he used silk handkerchiefs and scent, carried a flask of smelling salts in his waistcoat pocket in a ruby-red glass flask decorated with golden arabesques and was called (or called himself) Sire. Soon after I started he died and was replaced by a jaunty young man called Dubois from the west of Switzerland who, apart from his French was so uneducated that it was obvious even to us third year pupils. He was always friendly to me but didn't hide his annoyance that I didn't really apply myself to his subject, for he considered French to be extremely important.

We had English from a long thin middle-aged teacher called Riecke—a talented man, educated in many areas. He was a good mathematician and had a lively feel for the beauty of poetry which he tried hard to awaken in the older pupils. Sadly he was one of those unfortunates who are completely incapable of keeping a horde of active boys under control. He had to instruct the youngest classes in handwriting and the noise we made in that class and the tricks we got up to are simply indescribable. When we got to the last 2 years and discovered what an injustice we had inflicted on this benevolent and sensitive man it was just no longer possible to develop a suitably respectful attitude to the one-time victim of our impudence. Though he would have liked nothing better, an open and friendly relationship with us never developed. Once much later, when I already held office, I met him by chance and was happy to learn that he had retired long ago and had a comfortable house in South Germany and a circle of attentive friends.

I've already described the Russian teacher Haller. If he had any influence on me then it was only negative. Since my progress in Russian was inadequate I took private lessons with him in the fourth class and this at least had the hoped for result that he gave up his opposition to my transfer into the final year. I learnt nothing from him.

As is so often the case, our history teacher was the reason that we regarded the subject as useless drudgery. In the lower classes the lessons consisted of learning by heart lists of names and dates and this was only rarely leavened by an anecdote. Our teacher was called Matschewski. He was an elderly man with a bald head and just a rim of hair at the nape of his neck, the slow growth of which we'd follow with a naturalist's interest until someone could proclaim, "Matschewski has had his hair cut!" As his name suggests he was of Polish descent. Though he was originally well educated he'd fallen on hard times and his family lived in such a shambles that the squalidness of his clothes was obvious even to us boys. He was unable to keep

order and forgave us every irregularity so long as we didn't make too much noise in class. In his younger years he'd studied the French revolution and he had a collection of books about it which, over the years, had fallen apart and were now extraordinarily dirty. In the fourth year he lectured us from these in enormous detail. His strong bias for the French way of life didn't suit us at all because we saw ourselves as German. This became very obvious in 1870 when the French–German war broke out. At the beginning he delivered hate filled prophecies of a sound German defeat and we in turn loved to tell him every day the news of the German victories. These he angrily denounced as plain lies and, when this was no longer possible, retreated behind bitter threats of the retribution which would soon come.

Faith. Religion for all classes was taught by John Helmsing. He was a quiet man of average height with greying blond hair. His long face bore side whiskers and a melancholy expression. In line with his first name, which he always wrote out in full, he tried to dress and act like an Englishman and even lisped a little bit like one. Presumably there was some English blood in his family. In his class he was able to keep order without any great effort. This was made easy for him because the clergy had high standing in Riga society and our respect for his religious office helped him as a teacher.

Helmsing, however, had no great influence on me or on my school friends. My parents stuck to the religion they'd inherited without it impinging much on life at home. My father scarcely went to church, but my mother did to begin with, though later the increasing burden of household duties kept her at home. We children were sent to church—regularly at the beginning and then less so as the spiritual influence on us receded. For a long time I tried hard to sustain the belief in Christianity which I'd picked up as a child. My first teacher (his name was Mr. Fromm which means "pious"), tried to support me in this, but my faith wouldn't last.

Once, worried about some "sin", which I no longer recall, I went into a dark corner and kneeling fervently, prayed to God that he forgive me and free me of the sin. I received no answer, neither from outside nor from within. Everything stayed silent and empty. This was a shattering experience for me and robbed me of my earlier absolute trust. However I didn't fall into a state of religious melancholy as occasionally others of my age faced with a similar problem did. Instead I realised I just had to solve the problem on my own and, given the happy and active nature I'd inherited from my parents, that wasn't so difficult.

I brought this experience with me to the secondary school where my teacher could not bring me back to the path that I had left with so much inner struggle. Most of my schoolmates treated religion with indifference and contempt and the few pious ones were such uninteresting people that I had no connection to them. To begin with I defended my old position against the scoffers but as time went by I gave that up. Confirmation was in the hands of a mild old pastor who had to expend what little energy he had on the uncouth boys and girls of the lower orders and so had little left over for us secondary school pupils. To be honest I was still a little worried about the sinister threat that church doctrine held out for those who dared to take communion while not in a state of grace. But this threat was so inconsistent

with all I had by this time learned from science and art that I decided to take a chance. And when nothing happened I felt that I had separated myself without pain from the religion I'd grown up with.

The others felt much the same so that religious classes were treated as another boring school subject that one had to put up with and for which one should do as little as possible. This terrible inconclusiveness of all his work seemed to bear heavily on Helmsing. He became ever more shy and quiet and after I'd left the school I heard that he had to be treated in a psychiatric hospital for religious melancholia.

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