At the Wheel of the World: The Life and Times of Michael Polanyi

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[Editor's Note: The following essay is a revised version (dated May 2, 1991) of the lecture Professor Scott delivered on April 12, 1991 at the Kent State Centennial Conference. This essay was published by the Polanyi Society in the proceedings volume for the conference, *From Polanyi to the 21st Century* (1997) which was edited by Richard Gelwick.]

ABSTRACT: Key words: Pollacsek/Polanyi family, Michael Polanyi biography
This essay provides some interesting elements of early Polanyi family history as well as comments on Budapest and Hungarian history and culture at the turn of the century. It presents the Polanyis as intellectuals immersed in a worldly environment, led by "Cecil-Mama," the radical mother of Michael Polanyi.

When Michael Polanyi was a boy of sixteen, he accompanied his mother Cecile on a vacation to the Tyrolean Alps. Soon Cecile and a group of her lively friends left him behind to attend a socialist gathering in Stuttgart. Michael sent her a teasing appeal: "I beg little mother to let somebody take your place at the wheel of the world for a few moments and write a letter to your Misi because he loves you a lot."

It was natural for young Michael to think of a member of his family "at the wheel of the world." Mama Cecile Pollacsek and Papa Mihaly Pollacsek were part of the small coterie of Budapest intellectual elite who put forward new ideas as if they had an army behind them. Cecile and Mihaly were ambitious for themselves and for their six children who adopted the new family name of Polanyi to better fit them for leadership in Hungarian affairs. The children expected to be at the wheel of the world as well.

Cecile herself was the daughter of Andreas Wohl, a scholar of distinction in the city of Vilna, the center of Russian Jewry, now Vilnius in Lithuania. A teacher of Jewish history, Wohl refused the honor of becoming chief rabbi of the city because he disliked Jewish ritual. Liberal in religious attitude, he wrote an article relating the Talmud and the New Testament and regularly sent Christmas greetings to the Pollacsek-Polanyi family who did not take part in traditional Jewish religious practices.

Michael's father Mihaly was the descendent of a line of prosperous Jewish mill-owners who were also liberated in their religious practice. He studied civil engineering in Switzerland and Germany. While working for the Swiss National Railways Mihaly became so adept at designing railroad systems that he was sent to study the layout of the London and Edinburgh rail stations. The visit imbued him with a lifelong admiration for the Protestant work ethic and English ways of doing things.

Mihaly and Cecile met in Vienna, then the seat of the Austro-Hungarian Empire, a city alive with European culture. There Mihaly became a successful railroad financier, and there the first four children were born: Laura, called Mausi by everyone, in 1882; then Adolf, a year later; then Karl, in 1886; and Sophie, in

1888. When Mausi was eight years old, the Pollacseks moved to Budapest, drawn by new opportunities in the Hungarian railroad system and the expanding economy.

The move was an auspicious one for the young family. Budapest was a vigorous metropolitan city. The imperial Habsburgs appreciated the role of Jewish financiers and industrialists in building the Hungarian economy and had given new freedoms to Jews. Among Hungarian intellectuals, the search for social betterment was a subject of intense concern. The spirit of the 1848 revolutions was alive in those liberals who looked to the English system with its steady procession of reforms; others turned to the Marxists with their conception of class struggle and the supposed necessity of violent revolution to overcome oppression. Soon these political and social issues would be part of the nightly conversation around the Pollacsek dinner table.

Mihaly set up his family in an elegant apartment, an entire spacious floor at 12 on the great new boulevard Andrassy ut. There the younger children were born, Michael in 1891 and a few years later Paul, who was institutionalized as retarded. In these pleasant quarters the children were provided with English and French tutors, a German governess, Hungarian servants, a fencing instructor and a groom to take care of their horses. Karl's wife Ilona later described the rigorous education that Mihaly set up for his children: "In the morning a cold shower, an hour of gymnastics, hot cocoa with a roll, Schiller and Goethe, Corneille and Racine, all this with private teachers." The family spoke German at home and considered the grasp of English and French fundamental to a European education. Surely one needed more than German and Hungarian to take one's place at the wheel of the world!

Meanwhile Cecil-Mama, as she became affectionately known to generations of Hungarian intellectuals, established her famous salon where she attracted the new poets, artists, dramatists and writers influenced by the West. Talk was intense and wide-ranging. Cecile had the knack of finding something in a new visitor's work that would evoke stimulating conversation.

On some evenings the whole family took part in home theatricals. These were times of high hilarity. Cecil-Mama assigned roles to everyone, even to father Mihaly who was himself an amateur actor and the handsome subject of a family treasure, a large portrait in dramatic theatrical costume. While their mother dreamed up the script as the play went on, the cast of delighted children became wilder and wilder in the family act of creation. Michael remembered these happy evenings through the more sober years ahead.

As the children grew older, the talk around the dinner table reflected the range of the family interests: avant garde theater, an exhibit of Impressionists, Russian politics, a new rural branch of the railroad, Tolstoi and Dostoievsky, Ibsen and Nietzsche. Mausi, the eldest, became an early feminist and historian, one of the first women to get a Budapest Ph.D. Adolf was the distant, brilliant one, later to be expelled from his law studies at the University because of his part in the creation of a socialist student movement. Karl, the outgoing debater and always the closest brother to Michael, was already showing interest in questions of economic history and social policy. Sofie, the gentle young homemaker, did not take up with the excited political and philosophical discourse. But young Michael was all ears.

The joyful life on boulevard Andrassy ut came to an abrupt end in 1900. When the railroad line Mihaly had been building from Budapest north into Poland was washed out by three months of steady rain, he conscientiously paid his laborers and all his other creditors and entered into bankruptcy. Subsequently, he was reduced to consulting jobs and traveling on hard third-class railroad seats in his new job for the Frankfurt Fair.

The family was forced to give up their servants and move to a modest fourth-floor apartment.

Five years later the Polanyis were crushed by another unexpected tragedy. Mihaly caught pneumonia going into the snow after a hot sauna and died soon after. The family responded to this new grief in a variety of ways. Cecile was struck with indolence, depending on Mausi and Sofie to care for the household. Adolf hurriedly returned from Japan to a job in Budapest and Karl found ways to continue his University studies while earning his living on the side. When Mausi married Sandor Stricker, a well-to-do textile manufacturer, he helped support the rest of the family.

Michael was fourteen, fortunately by then well established in the *Minta Gymnasium*, a model humanistic school. While other schools stressed piety and patriotism, the *Minta* fostered creativity and thought. The school attracted some of Hungary's best teachers and bright students like Michael who enjoyed the chance to think for themselves. Michael thrived in the heady academic climate of the *Minta*, earning part of his school costs tutoring rich boys in whatever subject they needed.

In his eight years at the *Minta*, Michael studied Hungarian and German literature, Latin and Greek, religion, history, art, geography, natural history, descriptive geometry, mathematics and physics. Physics and art were his favorite subjects with poetry and drama close behind. He wrote a scientific paper on the specific heat of gases (later he said it was "nonsensical"), and like many of his classmates also wrote poetry, mainly in German. With his earlier grounding in English, he was able to read the science fiction novels of H. G. Wells as they came from the press, revelling in the idea of using science to make a better world. As president of the school's student association he lectured on Endre Ady, the controversial Hungarian poet and political revolutionary, at the holiday celebrating the 1848 uprising.

A special source of excitement during Michael's school days was a series of vacation visits to old family friends, Russian emigres Samuel and Anna Klatschko at their home in Vienna. Klatschko devoted a large part of his income as a patent official to helping Russian refugees with subsistence and false passports, sometimes sending them to Budapest where the Pollacseks helped in finding places to stay for a while. The Klatschko family told many tales of heroism and escape and also introduced Michael and his brothers to the works of many notable Russians: anarchist Bakunin, playwright Chekov, early leaders of Marxism Plekhanov and Axelrod, composer Tschaikowsky and others.

Michael's letters home from vacation were full of ideas and philosophizing. He talked about the Heraclitean changes below his window and lifted his eyes to the Eleatic realm of ideal permanence. Discussing the scientists who judge the world by appearances and cannot get at the *Ding an sich*, he conjectured that this reality behind appearances might be movement, energy, aether or molecules and observed that this ultimate cause affects him although he has nothing to do with it. In more intimate moments, he wrote to Mausi about his impressions of healing among the diverse and very strong personalities of their family.

After his graduation from the *Minta*, Polanyi matriculated in the medical program at the University of Budapest along with a fourth of his school classmates. While the idea of physical chemistry appealed to him—it was like physics but more intuitive—he may have been daunted by fear of the mathematics that would be involved. Certainly his interest in science was more visual and experimental than abstract and mathematical. Perhaps he simply recognized that there would be greater financial opportunities as a medical doctor than as a professor of physical chemistry—in those days most scientists were people of independent wealth. Or

perhaps it may have been only in medicine that he could find a University professor to sponsor him.

We have little record of Michael's university days. But we do know from his classmate and close friend the mathematician George Polya of their respect for the lectures given by the famous physicist Lorand Eötvos. Polya and Polanyi enjoyed great discussions after each of these physics lectures. We also know that Polanyi found an opportunity to work in the Pathology Laboratory of Ferenc Tangl. Tangl was convinced that pathology must be founded on physics and chemistry, and Polanyi's six papers on pathology show that his main interest was in the precise physical and chemical methods rather than in the pathological findings.

There were no formal courses in sociology at the University and Karl Polanyi helped found a student group called the Galileo Circle, to explain the scientific point of view on various areas including the social sciences. Professor Gyula Pikler was adviser, an economist, physiologist and philosopher of law who stated "Scientific research and speculation must never give way to religious, social, or political considerations." The 256 members elected Karl Polanyi as president. Michael joined the Circle's "Committee on Natural Science" and gave occasional talks on physics and chemistry.

In the spring of 1912, Michael decided to take time out from medicine to explore his growing interest in physical chemistry. This discipline was new in academia and well-developed at only Leiden and Karlsruhe. Since Karlsruhe was nearer Budapest and had already attracted a congenial group of Hungarian students, Polanyi decided to go there. Professor Ignaz Pfeifer of Budapest, experienced in helping impoverished but talented students, located a wealthy young man whom Michael could tutor for his room and board and encouraged him to enroll in the summer term.

Polanyi's course work at Karlsruhe included advanced thermodynamics—he very much liked its neat logic. He was especially interested in the Nernst Heat Theorem, which says that the measure of disorder called entropy should go to zero in a substance as its temperature T goes to zero on the absolute scale because all molecular motion ceases at absolute zero and the molecules become perfectly ordered. Polanyi reflected on this claim and it occurred to him that the disorder should also disappear if the pressure p on a piece of matter got stronger and stronger.

Although the faculty at Karlsruhe was competent, only Polanyi's mentor Professor Georg Bredig knew the new developments in the theory of thermodynamics. Bredig told Polanyi that his conception seemed valid but he would like to find an expert to judge it after Polanyi had written it up carefully. At the end of the term, Polanyi went back to Budapest and devoted six months to study all the relevant material he could find in the literature on the Nernst theorem.

Polanyi finally produced a short letter to the editor and a fully explicated larger paper and sent them to Bredig who promptly sent them to Einstein as the best expert in such matters. Einstein replied immediately: "The papers of your Mr. Polanyi please me a lot. I have checked over the essentials in them and found them fundamentally correct. The thought that the entropy would behave at $p = 4$ as at $T = 0$ is a happy one."

However, as scientists know today, there is a practical difference between $p = 4$ and $T = 0$: it is possible to get the temperature low enough to show the zero-value effect, but one cannot get p anywhere big enough to show the approaching-infinity effect. Perhaps the center of a black hole has the right conditions, but I do not know.

So no useful results actually came of it, but Einstein recognized Polanyi's competence. "Bang!" as Polanyi said later, "I was created a scientist". The two papers were soon published as a piece of creditable work that took Polanyi from apprenticeship status to membership in the scientific community.

Polanyi then tried to develop a new derivation of the Nernst theorem, one that would be more physically satisfying. When Polanyi wrote to Nernst with his ideas, Nernst replied unpleasantly. He saw no need for a different derivation and that there were errors in Polanyi's letter. However, Einstein kindly corresponded with Polanyi and helped his younger colleague get his mathematics of limiting processes cleared up. To jump ahead a bit, Polanyi and Einstein exchanged six letters between November 1914 and July 1915 followed by seven later letters in the next two decades without any substantial exchange of views. I am sorry to disappoint whoever it was who thought there was evidence of a real collegial sharing between Polanyi and Einstein on philosophical questions. I could not find any.

Obviously at that time Polanyi's interests were not with his medical studies. Although he planned to return to Karlsruhe to continue his work in physical chemistry, he completed his medical courses and received his M.D. degree in Budapest in April of 1913.

The spring of 1913 brought a dramatic change in Michael's life. At the age of 22, he fell in love—his first real love affair. She was a graceful young dancer from Geneva named Jeanette Odier who had come to Budapest to teach eurythmics in Mausi's progressive kindergarten. Jeanette was included in many family dinners though she herself seldom participated in the fierce debates in German and Hungarian on Kant or Ady or whatever subject was riveting the family's attention. Jeanette told me many years later that she first really noticed Michael when he shared his excitement over hearing from Einstein.

Jeanette knew nothing about thermodynamics. But in the sweet spring of Budapest there were other things to think about. She remembered leaving the intense talk of the dinner table "exhausted by what seemed to be a true circus spectacle" to walk along the Danube with Michael, speaking quietly together in French and sharing their common interest in poetry and painting. Michael, always a romantic, loved reciting from his favorite poets: Goethe and Shakespeare, Musset and H`lderlin. It is easy to imagine the petite dancer from Geneva being swept up by the charm of the strikingly handsome young Hungarian and by the dazzling diversity of his mind—qualities that continued to impress Polanyi's friends, both men and women, throughout his long life.

In the summer, the Striker family moved to Austria so Mausi closed her little kindergarten, and Jeanette's job of teaching harmonious bodily motion to pre-schoolers came to an end. Jeanette stayed in Budapest to teach in Cecil-Mama's feminist-oriented Lyceum for Women and Michael left for a year of study in physical chemistry at Karlsruhe.

The young lovers were too poor to consider marriage until Polanyi had the security of a Ph.D. and a well-established position in his field, a reality Cecil-Mama unhesitatingly pointed out. They were engaged for a time but Michael broke the engagement in March of 1917 and not long afterwards Jeanette met and married a Swiss physician.

At Karlsruhe for the year 1913-14, Michael immersed himself in a full set of courses: theoretical,

experimental, technical and mathematical. Although he did little experimental work later in his career in chemistry, the cleverness of some of his experimental designs and his intuitive ability to guide his experimental students showed the influence of his technical work in Karlsruhe. In June at the end of a productive year, he returned to Budapest for vacation, little expecting what lay ahead for himself and for European civilization.

War was declared at the end of July and the guns of August soon took their bloody toll. Although Michael's M.D. training did not include the necessary internship for practicing medicine, the Austro-Hungarian generals needed doctors for the men at the front, experienced or not. Michael enlisted and in September was assigned to a regimental hospital in Zombor. Many enemy soldiers carried cholera, typhoid, and other communicable diseases and infected the Austro-Hungarians. Polanyi reported seeing more men killed by disease than by gunshot. Either way, the carnage was terrible.

Michael found military life a continued flurry of orders and counter-orders with little chance for doctors to practice their profession in the face of the military command's ineptitude. Michael wrote to Karl "Nothing could have destroyed more brutally the illusion that we are self-responsible persons." For this highly organized young doctor/scientist, these autumn days were both frustrating and heart-breaking.

By mid-October, Michael was himself coming down with something. A week later, he was isolated in a Budapest hospital with a mild case of diphtheria. In a fortnight he recovered enough to work in bed, writing professional letters and working on five scientific papers. Meanwhile, he devoured H. G. Wells' newest novel, *The World Set Free*, a fantasy about the invention of an atomic bomb—yes, an atomic bomb—and the response of heads of state who discovered independent sovereignty was no longer possible and joined in creating a world government. "Beeinflussung!" Michael wrote to a scientist friend in Munich. "Influence!"

After his discharge from the hospital in early December 1914, Polanyi returned to Zombor for two months' ward duty and a month's assignment at a field post with the troops. He became sick again, this time with a chronic bladder infection that meant a combination of periods of furlough and light military duties in Budapest until his complete discharge in August 1917. He turned to earning his living by industrial consultation on chemical matters.

Watching the devastation of war strengthened Michael's concern for peace. As part of an Austrian popular movement, Mausi and her children made up ribbons with the motto (in German) "For a Negotiated Peace." In 1917, Mausi traveled to the international Peace Conference in Stockholm as one of the two women delegates from Austria. Later that year, Michael wrote an impassioned plea to the Peacemakers to go to the roots of the war. He declared the fundamental cause was competing sovereignties—not business—and urged Peacemakers to overcome their extreme nationalism and form a supranational community with a European police force to encourage international cooperation towards a new age of wealth and well-being. The influence of Wells' novel is clear.

Of the five scientific papers Polanyi wrote or revised in the wartime hospital, the most important for his career was one that developed a multi-layer theory of the adsorption of gases on the surfaces of solids. The most desirable result of such a theory would be to obtain the curve of the volume of gas clinging to the surface, the so-called adsorption isotherm. However, the law of force between gas and solid was not known and Polanyi cleverly proposed to avoid the trouble by only calculating the change in the curve as the

temperature changes, which could be found by basic thermodynamics. After much revision, his article on adsorption appeared in the *Proceedings of the German Physical Society* for February 1916. After publication, Polanyi translated the article into Hungarian and submitted it as a Ph.D. thesis to Dr. Gustav Buchb'ck of the University of Budapest who accepted him as a doctoral candidate. A neat reversal to publish first and then find a Ph.D. advisor! Polanyi's oral examination was not held until September 1918 and the degree itself not granted until July 1919.

Just a note about the thesis: Although the theory was impressive it later ran into trouble after a 1921 presentation to the Physics Colloquium in Berlin where Albert Einstein and Fritz Haber severely attacked it. They saw that according to the prevailing ideas about electrons and Bohr's atomic theory, electrons would move freely into the bottom layer of the gas and shield the upper layers from any attraction. The whole idea wouldn't work. It was only because by then Polanyi had achieved success in another field that his reputation was saved from catastrophe. Six years later after quantum mechanics was discovered, Fritz London showed that the required type of forces could perfectly well exist and Polanyi's theory was justified. It is now part of the complex of theories that account for adsorption.

Back to wartime Budapest Michael found inspiration for the life of the mind in weekly meetings of the "Sunday Afternooners," a group of artistically and philosophically minded individuals who met in the home of poet Bela Balasz. Discussions were led by philosopher Georgy Lukacs. They began at 3 PM and continued through the night till 3 AM. The subjects of discussion were ethical problems in questions suggested by writings of Dostoevski and Kierkegaard. Michael had already come under the influence of Dostoievski's Grand Inquisitor and Tolstoi's confessions of faith. At that time he considered himself a thoroughly convinced Christian.

The war ended for Hungary with a declaration by the Prime Minister on October 17, 1918. Then followed a series of three revolutions and three regimes. The first was a flowers-in-the-gun bloodless liberal revolution leading to a widely middle-class regime under Count Mihaly Karolyi. Michael accepted a position in the Ministry of Health. His most important duty in this new assignment was drafting a parliamentary bill governing the demobilization process, a job he did so carefully that the bill was accepted without change.

Alas, the intellectuals were so much against politics that they could not do what was needed to get two main reforms accepted. Before they even had a parliament elected, Bela Kun and the Communists made a coup and took over the government. This repressive new regime was also inept, never being able to set up the Soviet style of governance they intended. Struggling with ethnic groups wanting independence, Kun hastily formed a Hungarian Red Army and beat off the Czechs. Michael left his government post and found a quiet job at the University teaching physics, the only non-Red young man on the staff. He had a chance in his free time to try out a new research field, that of the rate of chemical reactions.

When the monarchy broke up at the end of the war, the entire economy of the Austro-Hungarian Empire was in disarray. Mausi and Sandor Stricker with their three children Misi, Eva and Otto, decided to move back to Budapest after selling the textile factory in Moravia. They bought a large English-style house in a big park and moved in, Michael with them, just in time to survive the communist regime. They raised food in half of the garden, both animal and vegetable, and were so successful they only needed to buy a few staples at the market. At the beginning, however, everything was "absolutely crazy." Eva remembers a scene of the piglets racing through the vineyards eating the grapes, followed by the French governess who in turn was

followed by the children. The ducks ate the goldfish, the sheep ate the pomegranates, the dogs hunted the poultry, and the neighbors stole some of the chickens and ducks.

When the Romanians came into Budapest chasing the Reds, there were reports of widespread looting. The Stricker family had tied up some money in bolts of textiles from Sandor's old factory and sent Michael to a field across the way with a pile of cloth and the family silver. He remained sitting on top of the heap until the soldiers had passed by.

When Kun undertook to chase out the Romanians, they responded with great force and occupied Budapest in August 1919, bringing in the third, so-called White Regime, under the Austrian Admiral Horthy. This White Regime brought in antisemitic laws and the Polanyi family was uneasy. It seemed a good time to emigrate. Adolf and family went to Italy, Karl and Sofie and family to Austria, and Michael to Germany--his post at the University of Budapest was taken from him. To continue his research he went to Karlsruhe with its peaceful atmosphere, good library, and friendly community of scientists.

In preparation for this major move, Polanyi prudently put his life in order--along with his genius and charm, he was generally prudent. First, he made sure that his Ph.D. would be formally awarded. Then he re-registered his change of name from Pollacsek to Polanyi and opted for Austrian citizenship. With concern for some minimal income until he found a permanent post, he arranged for the maintenance of his Budapest-based consulting business and for financial help from his lawyer uncle Karl Pollacsek and his wealthy brother-in-law Sandor Striker. Already a convinced Christian at heart, he requested the sacrament of baptism in the Catholic Church. Then he packed his belongings and, in early December 1919, boarded the train to a new life in Germany. This time he was leaving Hungary for good, readying himself to take his place at the wheel of the world.

I have spent much time talking about Michael Polanyi's early years because his remarkable life took shape then. I will have to give more cursory glimpses of the fifty-five fruitful years ahead—I've been studying Polanyi's life and thought for more than thirteen years and could tell you a lot more if I had time.

Polanyi found life in post-war Karlsruhe both stable and spartan with little light for night study and simple meals of whatever his landlady could scrounge at the market. But these were minor matters. After all, he had a place to work, a subsistence income, and the world of physical chemistry was opening before him.

Besides, in the Hungarian student community he met a pretty young chemist with a long blonde braid down her back. Her name was Magda Kemeny. Michael remembered seeing her and her twin sister at a party in Budapest and soon learned that Magda had shifted her studies to the liberal Karlsruhe Technische Hochschule which granted women degrees in chemistry. At Christmas, Michael invited all his Hungarian student friends to a dinner party. Magda remembered there was no wine but Michael had put at her place a single wine glass with one Lily of the Valley. She was charmed.

Michael and Magda began taking regular walks in the hills. Magda confided her ambition of going to Russia to help set up chemical industries and Michael shared his hope for a job in German science. On one occasion, Magda remembered Michael rushing down a steep bank to pick her a special wild flower, thereby dislocating his ankle and needing her help in limping back to town. Magda found Michael "impetuous" as well as charming. "He was a very passionate man," she told me years later. It was little wonder they fell in love. They

were married a year later in Budapest on February 22, 1921.

Since scientific research and publication was his main interest, Polanyi immersed himself in his physical chemistry. When he tried to devise a theory of the rate of reaction of a mixture of bromine and hydrogen gases using known sources of energy, he arrived at a theoretical result that was 300,000 times too slow. Excited to have found what he believed to be a new hidden source of energy, he published papers suggesting that he was on to an as-yet-undiscovered quantum effect in line with the discoveries of Planck, Bohr, and Einstein. It was not until over a year later that he realized that he was wrong. In his excessive ambition, he had overlooked the presence of a fast chain reaction. He wryly dismissed his fascinating idea as his "Zauberei" (magic).

Fortunately, Polanyi's other research activities proved more productive and he was soon offered his first scientific post at the Kaiser Wilhelm Institutes. The move to the Berlin suburb of Dahlem marked the beginning of what Polanyi often referred to as the happiest period of his life. During the following 13 years, Magda and Michael created their first home and became parents of two beloved sons, George and John. And Michael established himself as a physical chemist of very considerable gifts.

Polanyi's new post was in the Fiber Institute, but he really would have preferred to work in physical chemistry on reaction rates. He said as much in his interview with Fritz Haber, the director of the neighboring Physical Chemistry Institute. Haber replied that the rate of reaction is a world problem and that Michael should first "cook a piece of meat", referring to the routine nature of the fiber research immediately ahead. Polanyi got the idea.

Within two weeks after Polanyi joined the Fiber Institute, he found the explanation to a peculiarly puzzling x-ray photograph of cellulose fibers, an answer that was not only far from routine but that represented the discovery of a whole new mode of xray analysis. In recognition of his accomplishment, Polanyi was provided with equipment and resources for a team of assistants to help him tackle problems of the structure and strength of crystal fibers. Over the next 13 years, he and his team produced 53 papers in the field of x-rays and crystals. Nowadays Polanyi and two scientists from other laboratories are jointly credited with beginning the important ongoing study of the mechanical consequences of defects in crystals.

In early 1923, Polanyi moved to the Physical Chemistry Institute, eager to wrestle with a "world problem" and to work on his new idea for measuring the rates of very fast reactions. He used the luminescence of a dilute flame, such as the yellow sodium light, to detect where in time and space the luminescent reaction takes place, and thus get information on what he called "atomic reactions", when just one atom moves from molecule A to molecule B. Polanyi and a second team of assistants studied over a hundred reactions by this method, providing much data for possible theories of the process and establishing the grounds for his son John's Nobel Prize work many years later.

In 1929, Polanyi, with the help of Eugene Wigner, his former doctoral student and Nobelist to be, worked out a scheme for a theory of atomic reactions that can be calculated from a kind of contour map. Just when Polanyi needed the help of a person familiar with contour lines, along came Henry Eyring, an American mining engineer who wanted to shift to physical chemistry. After Polanyi, Eyring, Wigner and coworkers established a theory based on the contour lines approach, Eyring returned to Princeton University to become famous for a great development of it.

Through the Dahlem years, the most important event of Polanyi's week was the Physics Colloquium at the University of Berlin. In the twenties these Berlin lectures were the center of the physics community of the world—it was rare not to have at least three Nobel Laureates taking part. Fifty years later Polanyi recalled: "The seminar ... where Planck, Einstein, Schr`dinger, von Laue, Hahn and Lise Meitner met every Wednesday for informal discussion is still the most glorious intellectual memory of my life." In those days, Polanyi himself gave an occasional paper. All the physics students knew him by sight--the "remarkably good-looking" young physical chemist from Hungary who had the knack of putting difficult things in a simple way.

Polanyi also had the knack of directing his students and assistants in a fashion that encouraged their abilities to think and work independently. His first team of research assistants were given the name of *Assistentenrepublik* for their democratic spirit in sharing in the direction of the lab, as well as for tackling together with their wives the problems of daily cooperative food buying in a rapidly inflating economy. Michael and his assistants frequently played tennis together on the nearby courts, where vigorous scientific discussion would be interrupted by a volley, then resumed at the net.

In contrast to Michael's experience of professional success, Magda met delay, frustration, and discouragement in pursuing her own Ph.D. Although she was able to do some work on her dissertation under the guidance of Michael and his protJgJ von Gomperz, the mounting German inflation closed the Technische Hochschule in Berlin just as she prepared to matriculate. Magda had once hoped to be somehow an equal partner in science with her husband, but now she saw herself slipping far behind. She did some translating but no real research, and no longer spoke of her chemistry. Only later, in midlife, did she use her scientific and linguistic gifts in writing a dictionary of textile terms in four languages.

Nonetheless, Berlin provided much good life for the Polanyis in their early married years. They found the community of Dahlem a satisfying place to work and live—even though the acute housing shortage forced them at first to manage in cramped quarters "like poor people" as Michael explained in a letter to his mother. They found ways to get around the problems of space, taking off the door of their little kitchen so they could set up a table and reciprocate in entertaining their colleagues at dinner.

When George was born in 1922, Michael learned to change diapers and shared with Magda the joys and worries of young parents. By 1925 when Polanyi realized he had no prospect of finding a large enough apartment, they contracted to build a house of their own, an economical wooden one that was unusual for that time and place. It had a lovely lawn and a garden for the pleasure of family and friends. They were living in this house when John was born in 1929.

In those days there were excursions to the mountains, walking and tennis nearer home, social entertaining and occasional times of escape to solitude for reflection and note taking. In times apart Michael reflected on how to create what he called a "life that turns out well;" challenging himself to develop an opus incorporating tradition and memory but also channeling "the intellectual passions with which the mind rushes on ahead of the string of events."

Polanyi's scientific opus proceeded well but gradually he lost his intense motivation and began to yearn for his own philosophical wheel of the world. He liked to think of himself as a medieval knight, disciplined in body and spirit, serving the values of civilized life and called into action by the widespread breakdown of these values. However, the philosophical puzzle of the arbitrariness of moral laws led him to

see that people have to make decisions on their own responsibility in the context of the cultural heritage they have accepted. For Polanyi, this was an early acknowledgement of the personal character of knowing and being.

Life in the sometimes idyllic suburb of Dahlem did not shield Michael and Magda from the dark clouds then gathering over Germany. As early as 1919, Michael had written Cecil-Mama of the power of German antisemitism, especially in the universities. In the political upheavals and insecurities of the twenties, an even stronger power was growing, that of pervasive individualism cut off from its heritage, which led to an increasingly crude and violent political scene. Michael believed the inescapable issues of the time were economic and attempted to keep up with them through vigorous correspondence with his brother Karl in Vienna and through Karl's economist friends Gustav and Toni Stolper who had moved to Berlin. Later, he formed an *Arbeitsgemeinschaft*, a working group of natural scientists who met at Harnack House in Dahlem every few weeks to attempt objective discussion of economic issues.

By 1933, most of Polanyi's Jewish colleagues were losing their jobs under Hitler, but he was temporarily spared because of his wartime medical service and because of his Austrian citizenship. Nevertheless, he decided he had to leave. When the University of Manchester, the most distinguished of the red brick English universities, offered him a position as head of Physical Chemistry, he gladly accepted the post. Six months later, after much to-do with finishing research, shipping laboratory apparatus, and settling personal affairs (all but the laundry which was somehow left behind) the Polanyi family arrived in Manchester at the beginning of September, 1933.

The University warmly welcomed the four Polanyis and installed them in a large house in the Didsbury section, befitting Polanyi's status as a professor. Magda set about the work of purchasing furniture, hiring servants, and arranging for the children's needs. She and Michael agreed on the Quaker Boarding School in Bootham as the right place for eleven-year old George, and they found a daily playmate for four-year old John. Little John spoke not a word to his young friend until he had learned enough English to overcome his shyness. Then he rapidly and permanently switched to the language of the land.

Despite the black fog and the loss of cherished Berlin colleagues, Polanyi found Manchester a good place to be. It was his home base for the next 25 years, a period when his many-sided gifts and interests moved in the fields of physical chemistry, then economics and social theory, and finally philosophy.

In the Manchester lab, Polanyi boldly entered a new phase of research in reaction rates, using as a tool "heavy water," which had been discovered in New York only two years before and was useful for the study of proton transfer reactions. He wanted to study proton transfers in biological compounds but they were generally too unstable for experimental purposes. However, he seized on a stable compound, phthalocyanine, just discovered in a London laboratory, and put his American post-doctoral student Melvin Calvin to work on that compound.

At the Berkeley Centennial Celebration last month (May, 1991) Calvin—now a Nobel Laureate and professor emeritus of the University of California—shared memories of his two years in Manchester with Polanyi. Calvin's own lab was in the basement but he often came upstairs to Polanyi's office, sometimes as often as once a day. What did they talk about? "Anything," Calvin remembered, and then he repeated emphatically, "just *anything*." Calvin also described Polanyi's special gift to him: learning to be "fearless" in following his

own intuition and inspiration.

Others in the Manchester team continued work on the flame experiments and on modifications of the rate theory, both along new lines—with Polanyi, there were always new lines! As his own interests continued to shift toward fundamental economic and political problems, Polanyi was pleased to see his younger colleagues publishing a series of papers on their own ongoing experiments—he called these applications "hatching ducklings."

During these early years in England, Polanyi's lifelong interest in the problems of the world drove him to study the mechanisms of the economic system. He was convinced the woes of periodic unemployment under capitalism helped to engender the passionate revolutionary ideologies of the time. He believed his job was to ask the two technical, not moral, questions. First, what is the mechanism that generates depressions and what can we do to alter it? Second, is a planned economy a workable alternative to capitalism?

Three major projects came out of his explorations in economics. The first project was the book *USSR Economics*, (1935), which was based both on Polanyi's readings and on his four trips to the Soviet Union in the period 1928-35. He made it evident that planned economy was not working. He was pleased that Walter Lippman praised this factual account of difficulties in Soviet production as the work of "an exceptionally gifted observer."

The second project, an original, animated film on the money cycle, was an effort to teach the public how the normally invisible capitalist economy actually functions. The film, titled "Unemployment and Money", came out of five years of work begun on a beach in Yugoslavia and finished in London in the spring of 1940, when wartime concerns overshadowed its importance. Alongside the film project, Polanyi came upon the essence of Keynesian insights on the relation between deficit spending and unemployment, but did not get this relation into the film script. The film was not a success for Polanyi, only being seen by relatively few audiences.

The third project, a scholarly book entitled *Full Employment and Free Trade* (1945) was suggested to Michael by his son George. Polanyi interpreted Keynesian theory by working out a plan for a workable free enterprise system modified to prevent serious depressions and unemployment. The fundamental idea was using deficit spending through newly created money in a way that does not require the burden of heavy interest payments. The book was widely and positively reviewed but later ignored in the plethora of studies by professional economists. Polanyi took the failure of both film and book with wry humor, writing to Mausi "My main point is to say *my say*, so that at least nobody will be able to reproach *me* if the world goes down in the next economic collapse."

At Eastertime, 1935, while he was in Moscow to deliver a paper, Polanyi met the chief Soviet theoretician N. I. Bukharin. Bukharin shocked Polanyi by his statement that Marxists have no need for the "bourgeois" conception of science as motivated by the pure love of truth. Rather, Bukharin explained, science should serve the practical needs of the people as determined by the Party. The Soviet denial of truth in science aroused Polanyi and the zoologist J. R. Baker to the creation of the Society for Freedom in Science and a long literary campaign against the Soviet claims and those of their British supporters.

Many of these intellectuals found resonance with Bukharin's view of science and saw collectivism as the wave of the future for the West as well as the East. As the threat of war grew, Polanyi became concerned that no matter which side won, the great ideals of the free, liberal state would be lost. He saw no movement on the horizon toward formulating an adequate defense of these ideals.

In 1937, in anticipation of his later philosophy, Polanyi wrote down some thoughts about truth, reason, belief, and values: "Truth is a miraculous part of life, for we are always drawing conclusions and entrusting ourselves to our convictions." He continued with several insights that became incorporated later in his book *Personal Knowledge*: perception is active, not passive, and belief is an organ of perception. The reference frame of belief cannot be established by reason though reason can clarify it. Our historic martyrs did not examine both sides of basic values. Instead they chose their beliefs and died for reason and liberty.

When war broke out in September, 1939, Polanyi wanted to devote his scientific talents to allied military needs but was not allowed to. He resolved to take on as his own particular war duty, the preparation of the intellectual defense of liberalism. Since supervising the work at the University of Manchester laboratories took little of his time, he was free for other concerns.

Although Michael and Magda suffered very little from physical damage in the war, it brought them increasing inconveniences in food, heating and communication along with severe emotional strain. Michael volunteered as fire watcher during the bombing raids and Magda worked with an agency assisting bombed-out people—they were both impressed with the calm sturdiness of the bombed-out British.

As the war heated up and fears of invasion grew, the Polanyis soberly shipped eleven-year old John off to Toronto where he spent the next three years with the family of Dr. Michael Cameron under a government program to move children out of danger. In the fall of 1940, George became a student of history in Oxford while undergoing military training there. He joined the Royal Artillery in the fall of 1942 and left for Normandy June 1944. He had the good fortune of being attached to headquarters. The hardest tragedy for the Polanyis to bear was the Nazis taking Sofie's husband Egon from Austria, then Sofie herself and her youngest child Karl. They all died in concentration camps.

In 1944, Michael Polanyi was inducted into the Royal Society in recognition of his creative contributions to physical chemistry, just 27 years before John also became a Fellow. Impressed by a piece of Polanyi's theological writing, Joseph Oldham invited him to join The Moot, a wide-ranging discussion group that met twice a year to hear a paper on some aspect of Christianity. Polanyi expressed his own outlook in a letter to Moot member Karl Mannheim: "In the midst of rising and falling convictions in the general populace, there remains fixed a deeper, secret pivot of faith around which we keep revolving, a code of duty of which we are so unconscious that we cannot formulate even one syllable."

The deepest expression of Polanyi's early Christian outlook was based on St. Paul. He said of his belief: "Fundamental is the fact that from the beginning of my enquiries in the early years of the war I was guided by a conviction that the Pauline scheme of redemption is the paradigm of the process of scientific discovery. It demands us to undertake a task for which our explicit faculties are clearly insufficient, trusting that our labours will be granted success by powers over which we have no command."

Throughout the war period Polanyi pursued his self-assigned duty, composing many articles, speeches and book-length drafts on various aspects of liberty. His thought followed many lines and as usual his mind was filled with more ideas of world scope than he could put together in any one of his book-length projects. It frequently took an invitation to lecture or to publish to provide him with a coherent focus, and the prospect of an attentive audience to stir him into action. Karl Mannheim invited Polanyi to publish a volume in his series on sociology and social reconstruction, on the subject of the structures of a free and creative society. It was published as a collection of essays in 1950 under the title *The Logic of Liberty*. A more immediate invitation came in May 1945, to give a series of lectures that turned into the book *Science, Faith and Society*. These two works satisfied Polanyi's self-set wartime duty and opened the way for the future. However, his writing thus far did not provide fundamental philosophical justification for his claims. He needed to go deeper. Now he turned to what he called his "true vocation: the pursuit of a new philosophy to meet the needs of our age."

The crucial invitation for Polanyi's philosophic direction came in 1947 when the University of Aberdeen asked him to give the Gifford Lectures on science and religion. He accepted with gusto, pouring himself into voluminous reading and intense writing and rewriting at home in Manchester and in country guest houses. The University kindly arranged change in his status from Professor of Physical Chemistry to Professor of Social Studies.

The work was often discouraging. It took four years and several postponements. In February 1949, Michael told Mausi that the task was unfortunately too much for him and he needed to find a compromise. A month later, he wrote to Karl telling of a postponement of the lecture dates, adding "In fact, I was on the point of going down the drain", and in April he confessed to an old friend that he felt as if he was squandering his last years on a "supreme wild-goose chase." But through it all he had support from family and friends, and especially from the vice-chancellor at Aberdeen who patiently put up with Polanyi's delays.

I have not time to discuss the content of the Gifford Lectures which were given in 1951 and 1952 except to remark in general that they formed a substantial part of *Personal Knowledge*, and in particular that the distinction between subsidiary and focal awareness—so fundamental to many of us—was first brought forward in Lecture Seven of Series Two. A small, polite audience of about 50 asked questions but expressed little excitement. After the years of monumental work, Polanyi was disappointed by the little public response.

A book was clearly called for; not just a reprinting but a thorough revision. The preparation of the typescript of *Personal Knowledge* took five years' work, including the publication of about two dozen articles. The American philosopher Marjorie Grene was of considerable assistance, both as critic and as researcher into references. With the help of her children, she constructed a fine topical index, arranging cards all over the table. This book, which is so clearly Polanyi's greatest work and which most of us here have read and benefitted by, went to press in May 1957.

After a short rest, Polanyi was ready to use his still considerable energy for expansion and promulgation of his work, a firm hand on the wheel of the world. After Michael and Magda had a year's combination of travel and living in London, he was invited to a two-year term as Senior Research Fellow at Merton College in Oxford. In due course, he and Magda moved the portrait of Mihaly and their other family treasures to a comfortable house at 22 Upland Park Road, their home base for the remainder of their lives.

Being a resident scholar in an Oxford college did not turn out to be as stimulating as Polanyi had expected. As a new Research Fellow hardly known among British philosophers, he had few dons and students beating a path to his study. It was after he retired from Merton at the age of 70 and was free to spend extended periods of time in the United States that he found his metier to be lecturing in the American academic scene; in every case an enthusiastic and attentive audience gathered to hear him. Even though he continued to feel that England was his home, he certainly had a love affair with America. By 1964, at Duke University, he was able to say to his co-visiting friend Richard Gelwick "I am no longer an invisible man."

Polanyi's work abroad and at home during the next 14 years is known principally through his books: *The Study of Man*, *The Tacit Dimension*, and *Meaning*, the last co-authored with philosopher Harry Prosch. Each of these books was originally given as lectures in one of the ten universities where he spent extended time in interactions with a campus. Less well known is the extent of his speeches and shorter publications during this period. Rather than take my disappearing time to tell you about them, I have included an abbreviated chart showing the places of extended stays, and 35 of the most important papers in five categories. Ten key themes run through all the work which show how much this work was an extension of *PK*: Emergence, Evolution, Culture, Tradition, Creativity, Achievements, Responsibility, Community, Dynamic Society and the need for a New Foundation for Knowledge. This body of work, which one could characterize as putting the person back into the scientific world view, continues Polanyi's great contribution to our time.

In addition to this scholarly work, there were three organizations in which he took an important part. From 1953 until 1967 he was a leader in The Congress for Cultural Freedom, founded by Melvin Lasky in 1950. The second organization where his thought was crucial was the Study Group for the Unity of Knowledge with headquarters at Marjorie Grene's department in the University of California at Davis. A third group was established in connection with conferences of the Consortium of Higher Education Religion Studies in Ohio. Originally called "The Society of Explorers," the group soon changed its name to the Polanyi Society, a sponsor of this meeting. Convivium, the parallel British group, was formed some years later.

By 1970, Polanyi was complaining of feeling his age. He missed his dear long-time correspondents sister Mausi and brother Karl, both no longer alive, but was grateful for the continued life and work of his sons. His charm and curiosity were still a delight to both friends and family. In the upstairs study of the quiet home at Upland Park, he continued his disciplined daily work and carried on his extensive correspondence, confessing that he was exhausted while planning his writing but unhappy when idle. He hoped that one of his younger colleagues would help him complete his latest thoughts. He still wanted to explore further the foundations of religious faith and the domain of human obligations. However, his life was slipping away. "I feel so unbelievably old," he repeated to his friends.

On a visit from Budapest by Erzebet Vezer, Michael Polanyi quoted a line of a poem by Endre Ady in perfect Hungarian: "Tomorrow I'll have run already far, and will weep somewhere." He died peacefully on the 22nd of February, 1976.

In the end, Michael Polanyi found himself unable to carry out all his dreams. But during his nearly 85 years, he fulfilled a remarkable number of them. Did he take his place at the wheel of the world? You will have to judge for yourself.