

Walter Robert Jung (1926-2011): An Appreciation¹

Walter Jung, an influential German physics educator, died in May 2011 at age 85 years. He was born on February 6th 1926 in Darmstadt, Germany and died of natural causes on 29th May 2011 during travel abroad pursuing his interest in the cultural history of the Orient. He was planning to visit the Hittite fortress Gavur Kalesi in Turkey, where excavations have been carried out since 1930, to photograph stone reliefs of several thousand years of age.



Unfortunately his work and accomplishments are little known outside of his native Germany; hopefully this

note might give belated but deserved international exposure to his achievements in education.

Jung's Connection to the IHPST Group

Apart from Jung's many national honours and achievements, his passing warrants notice by the International History, Philosophy and Science Teaching Group because in the late 1980s he played an important 'go-between' role in the formation of the IHPST Group: he brought the small European HPS&ST research community into contact with the nascent Australasian/North American/Anglo HPS&ST community. The result of this 'marriage' was the First International History, Philosophy and Science Teaching conference held in Tallahassee in November 1989, at which the IHPST group was formed, and from which two years later the Kluwer-published journal *Science & Education* was founded. Walter Jung contributed to the intellectual culture of the IHPST group through two early publications in the journal - one on cognitive science and physics teaching (1993) and the other on history of physics and physics teaching (1994)).

In belated recognition of his passing and in order to give the international community some sense of Jung's scholarship and of his educational philosophy and commitments, a hitherto unpublished long paper of his on 'Philosophy of Science and Education' will be published in *Science & Education* Vol.21 No.8 (August 2012) and is currently available in Springer Online at:

<http://www.springerlink.com/content/1276k58866166110/?MUD=MP>

¹¹¹ Information for this obituary comes from four sources: first, a one-page biographical statement sent to me by Walter Jung on 12 June 1992; second, an obituary written by Jung's colleagues Hartmut Wiesner, Hannelore Schwedes, and Rita Wodzinski published in *Aufsätze zur Didaktik der Physik* (2011, vol.10, nos.8-9); third, correspondence with his son Thomas Jung during May 2012; fourth, an account of Jung's life and achievements written by Fritz Siemsen his successor in the Chair of Physics Didactics at Frankfurt University.

In 1987 while I was on leave in the Philosophy Department at Florida State University, I attended the huge Washington AAAS symposium celebrating the tri-centenary of the publication of Newton's *Principia*. On my return, after commenting to Jaakko Hintikka that it was a pity that science teachers and science educators did not often attend such meetings, he suggested I guest edit a special issue of *Synthese* journal on the topic of HPS&ST. This one issue grew into seven special issues of different education and HPS journals (*Educational Philosophy and Theory* vol.20 no.2, 1988, *Synthese* vol.80 no.1, 1989; *Interchange* vol.20 no.2, 1989; *Studies in Philosophy and Education* vol.10, no.1, 1990; *Science Education* vol.75 no.1, 1991). With these journal submissions, a research conference on 'History, Philosophy and Science Teaching' was suggested by the late FSU philosophy professor David Gruender. He, with the newly appointed FSU science education professor, Ken Tobin, arranged local and National Science Foundation support for a conference to occur in Tallahassee in November 1989. My role was to edit the journal issues that would provide the core of the conference programme; and to try, by writing 'pyramid scheme' letters (web and email usage were in the distant future) to identify scholars doing research or teaching in HPS&ST who might wish to contribute to the conference programme. In this context someone gave me Walter Jung's name and details, mentioning him as a German scholar who might be interested.

I wrote to Jung on 19 March 1989 inviting him to contribute to the conference. Two months later he replied saying that an illness prevented his attendance but highly recommending that I inform Professor Fabio Bevilacqua of the Physics Department of Pavia University who, he said, for some while had been organising small European meetings on HPS&ST themes. Two years later (22.8.1991) Jung would write: 'My ailment which prevented me from partaking in the Tallahassee Conference had one good consequence, bringing Fabio into the game. I am very glad to see that he is so actively participating in the field'.

It was this lead that put the hitherto Australasian/North American/Anglo group into contact with the older and established European community of HPS&ST researchers. Both then came together for what would be the First International History, Philosophy and Science Teaching Conference in November 1989. The IHPST Group was formed at that conference. And based on the success of the conference, the diverse journal special issues, and the group's printed and mailed newsletter, in 1992 Kluwer Academic Publishers, on the initiative of their Education Editor Peter de Liefde, commenced publication of the journal *Science & Education: Contributions from History, Philosophy and Sociology of Science* which twenty years later is still associated with the IHPST group.

Jung's English Publications

Fabio Bevilacqua gave me copies of proceedings of a 1983 conference held in Pavia - *Using History of Physics in Innovative Physics Education* (F. Bevilacqua & P.J. Kennedy, eds) - and also of a 1986 conference held in Munich - *Science Education and the History of Physics* (P.V. Thomsen, ed.). The volumes were of limited distribution (80 participants in Pavia, 40 in Munich) and printed by Gestener machine, but they contained wonderful papers by competent scholars, among them being Gerd Buchdahl, David Edge, John Heilbron, A.P. French, Jürgen Teichmann, Harry Collins, Stephen Shapin, Hans Niedderer, Danielle Fauque and Helge Kragh. As Foundation Editor of *Science & Education*, a number of these papers struck me as warranting publication in the new journal, in particular two papers by Walter Jung. Thus his 1983 Pavia paper on 'History of Physics and Physics Teaching' was

published in 1994, and his 1986 Munich paper on 'Cognitive Science and History of Science' was published in 1993.

HISTORY OF PHYSICS AND PHYSICS TEACHING

Jung's 'History' paper contains his characteristically comprehensive survey of literature and educational issues. There are 90 references, and listing just some of the better-known authors indicates the range of his intellectual engagement: Achinstein, Böhme, Brush, Bunge, Duhem, Elkana, Forman, Goethe, Hanson, Heisenberg, Holton, Needham, Pais, Putnam, Quine, Sjhapere, Toulmin, Whitehead and Ziman. The paper contends that:

..in physics teaching our aim cannot solely be to teach physics, I mean a well-founded, stable, applicable knowledge of phenomena, concepts, theories, and methods of physics. By teaching physics we also have to teach a lot *about* physics.

And that:

..it seems to me quite obvious that the decisive element of an inclusion of the history of physics into physics teaching is a philosophical frame of mind, a 'science observed' attitude which may be acquired best by historical studies.

Such teaching:

..may have a doubly beneficial effect on the student: he may lose an exaggerated confidence in authority, and be encouraged to think for himself.

COGNITIVE SCIENCE AND HISTORY OF SCIENCE

The 'Cognitive Science' paper has the same pattern of immersion in quality literature and thoughtful engagement with its pedagogical implications. Among the cited authors are: Bloor, Collins, Elkana, Hesse, Husserl, Kuhn, Lakoff, Larkin, Nersessian, Polanyi, Resnick, Simon, Whitehead and Strauss. He outlines the pedagogical utility of two chief 'discoveries' of cognitive science: Production Systems and Cognitive Schema; and asks 'How can we impart the schemes of physics to students?' The paper utilises his own detailed studies of the history and teaching of Optics, and points to a more comprehensive learning outcome:

By discussions of this sort, using properly selected historical passages ...we may in fact convey to them the insight that physicalism, the conception that everything can be explained by the schemes of physics, is questionable to say the least. And in any case physicalism as a meta-lesson, often a by-product of physics teaching, can be drawn into the open and discussed as something open.

Among three lessons he draws about the usage of cognitive science, one is especially apt and cautionary:

..cognitive science tends to make the what of learning science to be a rather static, finished issue in the vein of 'now we know'. [whereas] history provides the learner with an idea of science in the making.

PHILOSOPHY OF SCIENCE AND EDUCATION

Along with his May 1989 'unable to attend' letter, Walter Jung enclosed a long (18,000 words) unpublished manuscript on 'Philosophy of Science and Education' that had earlier been given to a meeting in Sicily. It had its origins in a 1979 collection of essays on the topic: *Aufsätze zur Didaktik der Physik und Wissenschaftstheorie* ('Essays on the Didactics of Physics and Philosophy of Science'). In the general rush of events leading up to the 1989 Tallahassee conference, this paper was put aside, and it lay unattended till belated notice of his death sent me back to my filing-cabinet drawers of 20+ years ago. The paper will be published in *Science & Education* vol.21 no.8 and is available on Springer's 'Online First' site at:

The paper is a remarkable and comprehensive treatment of core issues in both philosophy of science and philosophy of education. It establishes the claim that, as well as knowledge of their discipline, science teachers should have interests and competences in history and philosophy of science. Jung writes:

What can a physics/science teacher do with philosophy of science? First of all, I think he must know a lot of it. This may appear implausible given the disagreement [among philosophers]. But it is important that he knows that there is this disagreement, and knows what the disagreement is about; that is, that he has background knowledge. Otherwise he will sell to students his unenlightened tacit philosophy as a meta-lesson. This frequently happens. Also he should have knowledge of different positions such that he can argue for his own in case he is married to one. I do not think he should teach philosophy explicitly, except in the college range. But the more important is good background knowledge in order to become aware of what one really says.

The Reference list contains 100 entries, and the range of his philosophical engagement can be gleaned from listing-some of the authors mentioned: Achinstein, Brown, Buchwald, Colondy, Elkana, van Fraassen, Goodman, Hanson, Heisenberg, Hesse, Kuhn, Lakatos, Laudan, Polanyi, Sellars, Siegel, Shapere, Tillich, Whitehead, and Ziman. And as the force of good philosophical argument and the value of proper conceptual distinctions are not readily lost, out-dated or overturned, the belated publication of Jung's manuscript will be a considerable contribution to current discussion and research in the field.

Importantly Jung was interested both in HPS-informed teaching, and in student learning. He was engaged by cognitive science and by classroom research on effective teaching. He was concerned with how his pedagogical ideas worked out in classrooms.

STUDENTS' UNDERSTANDING OF OPTICS

This classroom engagement is signalled by the title of the fourth of Jung's English publications: 'Understanding Students' Understanding: The Case of Elementary Optics' which was a paper given at the *Second International Seminar on Misconceptions and Educational Strategies in Science and Mathematics* held at Cornell University in 1987. He concludes with an appeal to education researchers that 'apart from putting teaching-learning in an anthropological context, I should like to urge investigators to take serious the phenomenological understanding [of students]'. Another paper given at the conference was by the late Martin Eger, who was also an important contributor to the early volumes of *Science & Education*, writing a series of articles on 'Hermeneutics in Science and in Science Education' (vol.1(4), vol.2(1), (4), vol.4(2)). Eger's Cornell paper was: 'Philosophy of Science in Teacher Education'. As it happens, my own first science education presentation

was at this meeting - 'Experiment as the Objectification of Theory: Galileo's Revolution'. But the conference was so big that our paths never crossed.

These huge 'Misconceptions' conferences - at the second there were 177 papers and 367 participants from 26 countries - were guided by Professor Joseph Novak whose own paper 'Human Constructivism: Toward a Unity of Psychological and Epistemological Meaning Making' captured the spirit and enthusiasm of the majority of participants. In the Introduction to the three volumes of conference proceedings, Novak wrote: 'There was strong endorsement of "constructivist" epistemology both for clarifying the nature of knowledge and knowledge production, and as an underpinning for lesson planning and pedagogical practices'. This was close to the high-water mark of constructivist influence in science and mathematics education.

In the Cornell paper, Jung utilised a research methodology of in-depth student interviews following classroom lessons and experiments. Jung recognised with constructivists that 'you cannot [just] show students the relevant experiment and expect that they will grasp the physics'. And although Jung recognised, as constructivists do, 'that it is not easy for a physicist to understand students' talk, because a physicist is used to understanding within the "meaning province" of the theories of physics' - he nevertheless opposed the philosophical lessons being drawn by many of the constructivists at the Cornell meeting. Later he would write in his 'Philosophy of Science' essay that: 'I am sceptical concerning "constructivism" now fashionable with didacticians in different countries'. This scepticism was focussed on the idealist ontologies being advanced by constructivists and the sceptical and relativist epistemologies also being advanced. In his 'Philosophy of Science' paper Jung quotes with approval the physicist George Zweig saying:

Most of my family perished in the war, probably in concentration camps. I learned at a very early age from the example of my father, who was wise enough to see the situation in Germany for what it really was, that it is very important to understand reality. Reality is the bottom line. Science deals with reality ...

The Contribution of Philosophy to Jung's Early Intellectual Formation

Beyond attention to the arguments and analyses of his published papers, the international HPS&ST community can learn a great deal from the example of Walter Jung's own life and the trajectory of his own intellectual formation. He is an example for those scholars and teachers who believe that teaching a discipline necessarily involves grappling with serious questions raised by the history and philosophy of the discipline, and questions raised by the discipline's social and cultural engagement. And this is so whether the discipline be mathematics, theology, economics, history, art or anything else in the curriculum.

Jung was raised in a Social Democrat and Christian family, and was six years old in 1933 when Hitler proclaimed the Third German Reich. At school he loved mathematics, and as with many students at the time he devoured the popular mathematics book of Colerus - *Vom Einmaleins zum Integral* ('From the Basics to the Integral' 1934).

At age 18, along with nearly all other German youth of the same age, he was drafted into the Wehrmacht and after a few weeks of improvised basic training was placed in a motorised artillery unit and sent, in the spring of 1944, to the French city of Calais. With the Allied Normandy landings in June his unit quickly became 'un-motorised' and it joined the general retreat of the German army out of France during the autumn and winter of 1944-45.

Understandably much of the war experience disturbed and scared him, but he did later recount at least one moral act that impressed him: when his battery was ordered to fire on a village, his commander directed them to fire not at but alongside the village. This was a small act in the scheme of things, but evidence for Jung that moral choices could and should be made in life even in the most constrained circumstances. The lesson impressed itself on him. Later, Jung and two other soldiers on a field-telephone cable-laying mission were cut off and elected to surrender to advancing American infantry. For Jung the war was over. He spent time in Allied prisoner of war camps being released in August 1945 aged 19 years.

Jung returned to his parent's home, both of whom had survived the war and had moved temporarily to the Göttingen area in the north of Germany. When Johann Wolfgang Goethe University reopened in Frankfurt am Main in 1946 he moved there to do his matriculation exams and to begin studies of mathematics, physics and philosophy with the goal of becoming a Gymnasium physics teacher. Jung was among the first students at the Faculty of Natural Sciences. His first semester professors were Marianus Czerny, who taught Experimental Physics, the mathematician and topologist Wolfgang Franz, and Erwin Madelung who lectured on Electrodynamics. During his studies he received his first award, a prize for a work on combinatory topology.

In philosophy the three central professors who Jung acknowledged as influential in his intellectual formation while at Frankfurt were the philosophical sociologist Theodor Wiesengrund-Adorno (1903-1969), the Heidegger-influenced hermeneutist Hans-Georg Gadamer (1900-2002), and the American metaphysician and process philosopher Charles Hartshorne (1897-2000) who was a visiting professor at the university.

Adorno was a significant member of the pre-war 'Frankfurt School' of neo-Marxist social, cultural and intellectual critics, all of who belonged to the University's Institute of Social Research. Other members were Max Horkheimer, Herbert Marcuse, Walter Benjamin and much later Jürgen Habermas. With the rise of Nazism the Institute relocated to America, but Adorno returned to Frankfurt immediately after the war at the same time as Jung enrolled at the university. In his final university years Jung worked for Adorno in preparing a German edition of the latter's 1950 *The Authoritarian Personality* (or *Studies in Prejudice*). This exposed him to Else Fraenkel-Brunswick's work in the field and to her use of statistical analysis combined with qualitative analysis. This early exposure to combined qualitative and quantitative research method would inform his later research in physics didactics.

It is reasonable to surmise that Jung was-attracted by the arguments of Adorno's *Dialektik der Aufklärung* (1944) that had been published in New York (in German) just two years before the 20 year-old student and 43 year-old teacher arrived in Frankfurt (English translation as *Dialectic of Enlightenment* 1972. The German publication was part of Jung's library, along with Adorno's *Minima Moralia: Reflections From Damaged Life* (1951)).

The *Dialectic* (written with Max Horkheimer) was an attempt to discern the relationship between the European Enlightenment tradition, which had its roots in the new science of the seventeenth century and the writings of the eighteenth century philosophical defenders of science and reason, and the twentieth-century catastrophes of Nazism, Fascism and Communism. Did the Enlightenment tradition support, oppose or remain aloof from these latter ideologies and social movements? These were important questions because science education and the cultivation of a scientific outlook among all citizens, 'Science for All', was central to the Enlightenment project. Jung surely would appreciate that Adorno's critique of

the Enlightenment did not support a return to nineteenth-century Romanticism, but was an effort to ascertain 'what is living and what is dead' in the Enlightenment project. That Jung continued to pursue science education as a career, or indeed life-calling, meant that he did not share the Romantic reaction against science and modern technology.

Gadamer, afflicted with polio, lived in Germany through the war, and took a professorship in Frankfurt at war's end. It's reasonable to assume that the lectures that Jung attended would have been on themes that occupied Gadamer's later books which were translated as *Truth and Method* and *Reason in the Age of Science*. The opening chapter of *Reason in the Age of Science* is entitled 'On the Philosophic Element in the Sciences and the Scientific Character of Philosophy'. This is a commitment found throughout Jung's writings, and that permeates his philosophy, or theory, of science teacher education. Gadamer's emphasis on the processes and conditions for *understanding* written texts impressed itself on Jung and bore subsequent fruit in his commitment to understanding students' writing, communications and examination answers. The *Science & Education* papers on Hermeneutics and Education of Martin Eger, a contributor to the 1987 Cornell conference attended by Jung, develop this theme that Jung embraced.

Jung later cited Berger's book *Historische Psychologie des Neuen Testaments* ("Historical Psychology of the New Testament", 1991). Saying that: 'It is the aim of the book to find ways of reconstructing the experience of early Christians.' And then adding: '... we try to find ways of reconstruction of the experiences of students, which certainly implies more and something different than just the "hunt for wrong concepts.'

Adorno and Gadamer separately invited Jung to become their scientific assistant but he declined both offers in order to continue the practical component of his teacher training programme, namely placement in a school for 'practice teaching'.

The philosopher who Jung describes as having the most significant direct influence on his early intellectual development was Charles Hartshorne, the Harvard-educated American metaphysician and process philosopher who had been in Germany before the war studying with Edmund Husserl and Martin Heidegger and who had a visiting professorship at the Frankfurt University while Jung was a student. Hartshorne was the last assistant to Alfred North Whitehead and was an expositor of the philosophy of the pragmatist Charles Sanders Peirce and editor of the latter's *Collected Papers*. Before Hartshorne's arrival in Frankfurt Jung, while studying physics and mathematics, had read and been engaged by the writings of Plato, Aristotle, Leibnitz and Kant but he acknowledged his gratitude to Hartshorne for introducing him to the work and arguments of Peirce and Whitehead, especially to the educational writings of the latter (*The Aims of Education and Other Essays*, 1916). Like Whitehead, for Jung the goal of education was the development of one's own style, morality and aesthetic value. Jung's own early philosophical papers on Whitehead and Peirce were published in *Philosophia Naturalis*, *Zeitschrift für philosophische Forschung*, and *Philosophische Rundschau*.

Jung's Educational Career

In 1951 at age 25, Jung passed the final university examination for his physics teaching degree. The examination was in two parts, written and oral, and he received his degree with a 'summa cum laude' grade. The subject of his thesis was "Die Materie bei Leibniz und in der modernen Physik" (*The Concept of Matter in the Works of Leibniz and in Modern Physics*).

The thesis topic folds together physics, philosophy and history – a melding that characterised much of Jung’s subsequent scholarly endeavour. That this was a thesis for completion of a physics teacher-education programme was not as noteworthy then as it might now seem when so much of teacher training is altogether bereft of philosophy and dominated by-learning theory, teaching technique and classroom technology and management. Indeed increasingly any university study is minimised in favour of ‘on the job’, apprenticeship-like training. But in the tradition of German, and more generally continental, physics education there is nothing especially noteworthy about Jung’s thesis topic.

All the major German and European physicists did their science in tandem with philosophy and wrote major books on the interplay between philosophy and physics. For instance: Planck *The Philosophy of Physics* (1936), Schrödinger *Science and the Human Temperament* (1935), Heisenberg *The Physical Principles of the Quantum Theory* (1930) and *Physics and Philosophy* (1962), Bohr *Atomic Physics and Human Knowledge* (1958), Boltzmann *Theoretical Physics and Philosophical Problems* (1905), von Helmholtz *Science and Culture: Popular and Philosophical Essays* (1853-1892), Born *The Restless Universe* (1951), Einstein and Infeld *The Evolution of Physics* (1938), and von Weizsäcker *The Relevance of Science* (1964) and *The Unity of Nature* (1971). Many others could be listed. This tradition was represented in England by the two prominent physicists and popularisers of science: James Jeans (*Physics and Philosophy*, 1943) and Arthur Eddington (*The Philosophy of Physical Science*, 1939) along with numerous others. In France this philosophical-physics tradition was most prominently represented by Henri Poincaré (*Science and Hypothesis* 1905) and Pierre Duhem (*The Aim and Structure of Physical Theory* 1906).

And of course it needs be remembered that the bulk of ‘progressive’, ‘modern’ or ‘advanced’ European philosophy in the inter-war and post-war period was conducted in dialogue with science. The Vienna Circle group and the wider positivist traditions all took the methodology and results of natural science as their philosophical yardstick. The works of Rudolf Carnap (*The Logical Structure of the World* 1928, *The Unity of Science* 1934), Hans Reichenbach (*Experience and Prediction* 1938, *Philosophic Foundations of Quantum Mechanics* 1944), Philipp Frank (*Modern Science and Its Philosophy* 1950) were staples for most serious philosophers. Frank quotes the French historian and philosopher Abel Rey: ‘the spirit of positivism and the spirit of science have become synonymous in current speech’ (p.5). This positivist tradition had a currency and relevance that other inter-war traditions (scholasticism, phenomenism, Personalism, Marxism, existentialism and different idealisms) simply did not have, especially for a serious student engaged by science and mathematics.

So for Jung, who was an undergraduate student engaged by both physics and philosophy, it was natural that the two disciplines would be pursued in tandem, not in isolation. And he would also affirm that physics education needed to be done in conjunction with philosophy: physics classes can open up philosophical questions for students if physics teachers are able to identify these questions in their curriculum, textbooks and lessons.

The fount of this continental philosophical physics tradition was the great positivist historian, philosopher and physicist Ernst Mach whose *The Science of Mechanics* was published in 1883 and who wrote numerous philosophically-informed physics textbooks, and who asserted that physics and philosophy had to be learnt together. Einstein remarked that ‘German physicists absorbed Mach with their mother’s milk,’ and later said that ‘a physicist was just a philosopher in workingman’s clothes’. There was a spread of philosophies that informed the physicists: Positivism, Kantianism, National Socialism, Marxism, Thomism,

Phenomenology, Idealism and others. But most serious physicists and philosophers worked in the positivist tradition that, of course, itself evolved in the light of philosophical and scientific debates (most famously occasioned by debates over Mechanism, Realism and Instrumentalism).

At the present time, especially in Education circles Positivism conjures up images akin to that conjured up in the popular mind by Terrorism. But it is worth being reminded that this is an altogether distorted and corrupted rendering of the Positivist tradition. Peter Bergmann, who in 1933 was an 18 year-old refugee from Berlin and a physics student in Vienna, recalled the lectures of Philipp Frank the great physicist and founding member of the Vienna Circle Group:

In this overheated and jittery atmosphere there was one fatherly figure who represented all that was best at the University, Philipp Frank. ... He would encourage all of us students, and he gave us the feeling of a wide-open intellectual window, open to things that happened in and out of physics, and open to things that happened outside of the country as well. Philipp Frank saw to it that there was close contact with philosophy of science ... with experimental physics ... and with pure mathematics.

Bergmann's Vienna educational experience seems not too far removed from Jung's Frankfurt experience of positivism some fifteen years later.

In the immediate post-war years in Germany the question of the relationships between science and philosophy, and more generally science and society, were not merely academic; the war gravely disturbed all hitherto comfortable and ingrained assumptions about the 'goodness' or benefit of scientific progress.

Famously, at the beginning of the First War, 93 prominent German scientists, including current and future Nobel laureates Haber, Planck, Fischer, Ehrlich, Ostwald, signed the *Fulda Manifesto* declaring academic and scientific support for Germany's war aims, and affirming that science should be at the service of the fatherland. Einstein took a contrary position and organised a less-publicised counter-manifesto signed by scientists and other prominent intellectuals. With Hitler's ascension to power in 1933 scientists, including again Nobel laureates such as Haber, Lenard and Stark flocked to the Nazi banner and advanced Third Reich weapons and industrial research. Those that did not flock to the banner, looked the other way, resisted, or fled the country. Max Planck's painful situation and choices regarding the relationship of physics to philosophy and politics encapsulates the 'Dilemmas of an Upright Man', to use the title of John Heilbron's biography of Planck.

The Enlightenment assumption that teaching and learning science, and developing a citizenry with a scientific outlook would lead to a liberal, democratic, and anti-authoritarian society and state, was severely shaken by the Second War and what preceded it. Joseph Priestley in the 18th century wrote of the spread of science as being like laying 'gunpowder' under authoritarian, closed ecclesiastical and government regimes. For Priestley, science was a 'subversive activity', to use the title of Postman and Weingartner's 1976 book. Long before Popper, he outlined an epistemological argument for an Open Society: science seeks truth, finding truth requires open and public debate, hence truth seeking societies need to be liberal and non-authoritarian. If the Stalinist USSR experience had not demolished this faith, the Hitlerian German experience surely would: In both cases there was science aplenty, but it did not abate the rise of absolutism. So these matters of science, philosophy, ethics and social responsibility all loomed large for science educators in the immediate post-war period.

Professors preparing science teachers needed to have a deep appreciation of the responsibility or otherwise of science in the creation and utilisation of weapons of mass destruction.

In 1942 the great English life-long champion of science and science teaching, Fredrick W. Westaway, wrote:

I fear that, during my professional career, I advocated the claims of science teaching much too strongly, and I am now quite sure that the time often devoted by young boys to laboratory practice, and to the purely mathematical side of science, more especially chemistry and physics, was far too great.

At the moment, science is devoting itself to forging new weapons of destruction. The war once over, will there not be an urgent need for men to beat their swords into ploughshares – to abandon the manufacture of murder's weapons and instead to construct implements and instruments which will contribute to the world's happiness and help to foster mutual human affection? (*Science in the Dock* 1942, p.v)

Jung's education, his own war experience, and his eye-witness observation of a destroyed Germany meant that he would have entertained comparable questions and misgivings to those articulated by Westaway.

On completion of his teacher education degree, and after turning down offers to stay at university and work as an assistant with both Adorno and Gadamer, Jung began his school placement working as a student-teacher in autumn 1951 in his hometown of Darmstadt in central Germany. His supervisor was Martin Wagenschein who is still of great influence in German science education. Wagenschein influenced Jung's way of thinking with his comprehensive humanistic education. Wagenschein in his educational autobiography "Reminder for Tomorrow" wrote: 'The most clever among my trainees was Walter Jung. We had many stimulating conversations. After the time at the seminar, we continued to work together for several years in Traisa, the school village *Bergstrasse* and on curriculum committees.'

In the following years Walter Jung worked at the Schuldorf Bergstraße – one of the most famous reform-oriented schools in Germany. *Schuldorf* literally 'school village', was an American inspired project and one of the first, if not first post-war education project integrating the entire range, from Kindergarten to Gymnasium (the pre-University stage, after 13 years). Schuldorf also featured a boarding school segment, a school for the handicapped, and a vocational training school, large sports facilities inclusive of football fields and running tracks, a general assembly hall and a little amphitheatre - all on a spacious campus built into a pine tree forest. Jung was part of the founding faculty staff from 1954 onwards, taking high school classes to the final university entry qualification exams, the *Abitur*. During this time he cooperated with Wagenschein and published his first didactic works in the field of mathematics. Despite the mutual admiration they shared, Jung promoted physics didactics as an empirical science, while Wagenschein saw didactics more as a poetic, literary or philosophical undertaking.

Jung remarks in his 'Philosophy of Science' essay that Wagenschein was influenced by the educational philosophers Litt and Lipps, and by Ernst Mach, in developing his position of 'paradigmatic teaching of physics'. As Jung explains, 'Paradigmatic teaching' means to teach selected portions of physics, as everybody does, but to select the portions so that the student is not only able to learn about physics but also is lead to philosophical reflection. In Wagenschein's words:

All I propose is to teach the child to really understand, even understand understanding.
(1960, p.84)

Mach in 1895 in his essay 'On Instruction in the Classics and the Sciences' expressed this view as follows:

I know nothing more terrible than the poor creatures who have learned too much. What they have acquired is a spider's web of thoughts too weak to furnish sure supports, but complicated enough to produce confusion.

Wagenschein's exemplary principle had a liberating effect on Jung. But unlike Wagenschein's *Wandervogel* idealism with the physics lessons held at the idyllic village pond, Jung felt himself as 'asphalt man' with responsibility for students in difficult urban situations, such as around the city railway station.

In 1961 Jung became head of the Institute of Teacher's Education in Frankfurt/Main which was the central institution for the continuing scientific education of teachers in the federal state of Hessen. He was responsible for the organizational and conceptual design of reforms, mainly of mathematical education. He published in the field of teaching methodology and philosophy.

In 1968, Students for a Democratic Society (SDS) people stormed the Rectorate of the University of Frankfurt. Jung commented: "They do not understand anything, but they claim to know-it-all." Nevertheless he did not shy away from discussions with Marxists from Marburg and elsewhere. As a result of the 1968 student upheavals, physics didactics was integrated into the Department of Physics. Jung vehemently opposed this integration, albeit to no avail. The university-oriented physics didactics tended to topics, such as quantum theory, which he considered unimportant for physics teaching, except maybe for the higher grades of the gymnasium. The real problems of science learning, according to Jung, are instead located in the lower and middle grades.

In 1970 he was appointed Professor für Didaktik der Physik at the University of Frankfurt. He was Dean of the faculty for two terms, and a member of numerous university committees and a member of the Advisory Board of the Leibniz-Institute for Science Education (IPN) at the University of Kiel. From 1978-1991 he was editor of the journal *Physica Didactica*, and between 1995-1999 he edited *Zeitschrift für Didaktik der Naturwissenschaften*. Jung conducted research and published over 150 articles and books in the field of mathematics and physics teaching. He also participated in the writing of physics curricula and regularly contributed to in-service teacher education programmes and workshops.

Until 1969 he spent periods as a researcher at the Berlin Max Planck Institute for Educational Research, whose former director, Prof. Saul B. Robinsohn wrote, that 'all who worked with Professor Jung on the job admired the combination of great loyalty and unconditional objectivity with which he performed.'

Jung had a strong interest in the Anglo-Saxon didactics. He studied the Nuffield reforms of mathematics and physics teaching in England. Jung regretted that the very competent research accompanying the Harvard Project Physics was insufficiently received in Europe.

In 1991 on his retirement he was appointed an emeritus professor of Johann Wolfgang Goethe University, Frankfurt am Main.

Jung kept his broad intellectual horizons. Alongside his considerable physics and mathematics didactics research and despite his increasing university administrative responsibilities he maintained engagement with subjects and topics not often associated with physics and mathematics. In his letter to me of 2nd May 1989 he wrote:

We just had a Wittgenstein-Heidegger Symposium in Frankfurt, both centenarians this year. Both had no close relations to science, but they gain considerable influence in education. I suppose I was the sole member of the physics department attending the symposium.

Education as a Discipline

Jung believed that there was an independent scholarly field of didactics, and that his research contributed to that field. In his 1986 'Cognitive Science' paper he writes:

I am neither a cognitive scientist nor a historian of physics, but a didactician, which means organizing interdisciplinary research.

This 'organizing' of other disciplines into something which is itself a scientific discipline is a demanding task and one easier said than done. But Jung brought to it his competence in the foundation disciplines to which he was introduced as a student in Frankfurt, and with which he was continually engaged. Without this competent engagement in the foundation disciplines – psychology, philosophy, sociology, and more marginally economics, anthropology and history - university Didactics, or Education departments in the Anglo tradition, too easily become places where mere 'slogan-like borrowing from philosophy and psychology occur' as Peter Fensham has depressingly written (*Defining an Identity: The Evolution of Science Education as a Field of Research*, 2004). When this happens it is to the detriment of everyone, and certainly to the academic reputation of Education departments. In this situation the discipline of Education becomes akin to how C. D. Broad described the discipline of Psychology in the 1930s: 'a great deal of Psychology consists mainly of muddle, twaddle and quacksalving, trying to impose itself as a science by the elaborateness of its technical terminology and the confidence of its assertions' (*Examination of McTaggart's Philosophy*, 1933, p.270).

The major divide in the Anglo-world has been between those on the one hand who share Jung's position that Educational theory and theorising is comparable to scientific theory and theorising, meaning at least that both empirical evidence and rational assessment are germane to assessment of educational theory (see for example, D.J. O'Connor *Introduction to the Philosophy of Education*, 1957 and D.C. Phillips *Philosophy, Science and Social Inquiry* 1987); and on the other hand those who regard educational theory and educational theorising as inherently impossible to bring within the scientific tent because educational theory is intrinsically tied to evaluative, normative or ideological considerations; it is concerned with what *should* be done, not only with what is being done in schools and classrooms (for example, Paul Hirst 'Educational Theory' 1966; Kieran Egan *Education and Psychology* 1983). One advocate of this latter position has claimed that not empirical evidence but 'emotionality, personal responsibility, an ethic of caring, political praxis, multivoiced texts...' provide the kinds of evidence relevant to appraisal of educational theory (Denzin & Lincoln *The Landscape of Qualitative Research* 1998, p.10).

Sometimes this divide maps onto the quantitative versus qualitative division in educational research methodology. These are important debates on which a great deal hinge, not least the

multi-million dollars in government research support money – witness recent US government directives to fund only ‘scientific’ research in education. And they are debates that require historical and philosophically informed contributions.

Sadly it is a moot point as to how much the kind of foundational training that Jung had in Frankfurt after the war, and that he continued to pursue while teaching is any longer possible for university Education faculty. The twin regimes of ‘publish or perish’ and ‘be seen to be doing things’ militates against the wide and thoughtful reading that is so evident in Jung’s work. When my own university was established out of a former Technical College in 1949 its foundation motto was *Scientia Manu et Mente* (‘Knowledge by Hand and Mind’). In 2010 its corporate governors and marketing department changed the motto to the more modern and thought-to-be apt ‘Never Stand Still’. They did not appreciate that it is hard to read and think while standing, let alone while constantly running.

Colleagues’ Estimation

In an obituary for Jung published in *Aufsätze zur Didaktik der Physik* (2011, vol.10, nos.8-9), Hartmut Wiesner who was one of his Frankfurt University collaborators and a co-author of the ‘Learning Optics’ paper given at the 1987 ‘Misconceptions’ conference, along with Hannelore Schwedes and Rita Wodzinski, wrote that two of his research fields should particularly be emphasized:

First, Jung was a principal initiator of research on students’ conceptions and learning difficulties, which has been the subject of intense research activities on an international level to this day. The starting point was his experience as a teacher that many students do not understand physical concepts the way it is intended. With different, complementary methods he was able to generate relevant and reliable knowledge on typical learning difficulties in physics which covered practically all areas of physics taught at schools. Being aware of the limitations of statistical methods, he always combined them with qualitative techniques. His first project with substantial external funding on the learning of mechanics is a particularly good example for this.

His research on the way of students’ thinking in physical contexts has always been accompanied by the development and evaluation of teaching materials. His suggestions for improvement of the learning success based on the knowledge of students’ conceptions have been further developed by his co-workers for the fields of optics, electricity, mechanics, energy and quantum physics, and their benefits have been proven empirically. Many of the issues that are discussed today in the framework of theories on conceptual development and conceptual change can already be found in his works.

A second main area of research comprises his analyses of the philosophy of science which also entered the discussion about the objectives of physics education. Here, the dialectical argumentation in his monograph *Aufsätze zur Didaktik der Physik und Wissenschaftstheorie* (Essays on physics education and the philosophy of science) published 1979 demonstrated how to avoid simple, one-dimensional solutions for science education that are occasionally considered ‘fashionable’ in didactic discussion.

The breadth and depth of his knowledge was extraordinary. Whether it was about general pedagogical questions, socio-scientific or economic aspects, or questions on the interpretation of quantum theory in view of its philosophical background – he always had something substantial to say.

The great appreciation of Walter Jung's scientific work was reflected in numerous invitations to international conferences to give plenary talks on the history of physics or the didactics of physics. He was awarded the title of an honorary doctor by the University of Hamburg in 1992 and by the Pedagogical University of Ludwigsburg in 2003. In 2009 he received the honorary medal of the Society for Didactics of Chemistry and Physics (GDPC).

Surely the science education research community has lost a scientific pioneer of extraordinary intellect who has left his mark on didactic research in Germany like no one else, and transferred didactics of physics into a recognized scientific discipline. We are deeply indebted to him."

Family Opinion

In a personal communication responding to my request for biographical information, Thomas Jung, one of Walter's three sons wrote:

'He was one of the most modest, if not self-forgetting humans I've ever met, and certainly would have preferred his writings to be the focal point, not his biography,

Essentials suffice, I guess would sum up his view in that regard. He was very much a follower of *say your piece efficiency* - express what you intend to bring across without ado, let the work speak for itself, and that's that.'



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