Making discoveries for a better life vs. bringing fruits to the national treasury: Davy, Babbage, Brewster and the (ongoing) struggle for the soul of science

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Abstract

In 1830, a heated debate over the "decline of science in England" erupted, in which Charles Babbage and David Brewster had the leading role. Humphry Davy was one of the prime targets of this criticism against the "backwardness" of British science, representing in the eyes of the reformers an outdated research tradition excessively concentrated on the complexities of electricity, at the expense of more pragmatic concerns, and less liable to formalization and precision than the continental analytical mechanics and the analytical chemistry. The contradiction here is between two significations of science. Davy's version of scientific discourse, producing fertile questions instead of profitable answers, retained a philosophical dimension which accentuated the creative, self-valorizing aspect of living labour. The possibility of interaction with other expressions of human creativity, such as poetry, was inherent in his project, while science education was defined principally as self-education, a process which fulfills the Enlightenment ideal of autonomy. On their part, the declinists implicitly introduced new standards, such as the degree of professionalization and state control, for evaluating the status of science, by idealizing the experience of the Napoleonic educational reforms, and positing operability, precision, discipline, and political resilience as the special intellectual virtues which science is meant to exemplify.

Defending science as a critical tradition

"Big science" or "technoscience" is currently, and almost unanimously, viewed as the quintessential type of science: it is the overwhelmingly preferred or recommended way of doing science, to such a degree that even its critics tend to think that to animadvert on "big science" is equivalent to reproving science itself as a way of doing. But only if we turn our back on the temporality of science, on the actual struggles, controversies, or swervings from the normally expected path, that have constituted, and still constitute, this temporality, only then could we identify science as such with late 20th c. big science. Back in 1970, Karl Popper highlighted how imminently dangerous was the rapid growth of big science, signalizing the consolidation of an allegedly "normal" regime of scientific research. Big science threatened to "prevent, or even to destroy [...] great science". The situation, he did not refrain from saying, had already become "tragic if not desperate", and "the present trend in the so-called empirical investigations into the sociology of the natural sciences", as he rightfully predicted, seemed "likely to contribute to the decay of science". The reframing of science education, so as to produce masses of "scientific technicians" –of those specialists, inmates of established paradigms, whom Thomas Kuhn idealized as normal scientists– had the effect that "more and more Ph.D. candidates receive merely technical training in certain techniques of measurement". "They are not initiated into the scientific tradition", which, according to Popper, was but essentially critical: a tradition of posing radical questions, "of being tempted and guided by great and apparently insoluble riddles rather than by the solubility of little puzzles" (Popper 1994, 72).

A century and a half, or so, before, Popper expressed his fears about the advanced decay of science, Humphry Davy, in his last book, under the unexpectedly (as seen from our late modern standpoint) poetic title *Consolations in travel: The last days of a philosopher* (1830), had similar worries to share with his readers. "We may in vain search the aristocracy now for philosophers, and there are very few persons who pursue science with true dignity". Science, instead, "is followed more as connected with objects of profit than those of fame, and there are fifty persons who take out patents for supposed inventions for one who makes a real discovery". Ranked by some of his contemporaries as "one of those meteors, which visit our world at distant intervals" (Olmsted 1830, 217; the authorship attribution is given in Woolsey 1859, 599), or as a compeer of Newton in inventiveness, since "not only did both unlock the choicest casket of nature, but they had the superior merit of planning and constructing the key",[1] Davy was the "most celebrated chemist" during the early 19th c. (Cunningham 1837, VIII.2, 333). He had managed to decompose the fixed alkalis and the alkaline earths and to isolate several new chemical elements, correcting, and even challenging, Lavoisier's theory. He had been the first to successfully

1 Anon. 1830a, 56. This anonymous biographical memoir of Davy was based on a series of articles written by John Ayrton Paris and published in the weekly *Spectator* (see Paris 1831, I, x).

implement the method of electro-chemical decomposition, which later (after his death, by his former assistant, Michael Faraday[2]) came to be called "electrolysis", as a mode of identifying the elementary constituents of chemical compounds, by adapting the voltaic pile to chemical operations. He can be seen as an emblematic figure of what Popper recalls as "great science", and, if nothing else, it's interesting to hear him speak of an impending commodification of knowledge, painting a grim outlook for science, at so early a period.

We know full well, of course, that modern science, from early on, became entangled with profit-making business and state strategies of overseas economic exploitation. The knowledge of why machines work, and why they might not, was a major selling feature for Newtonian-minded experimental philosophers. Industrialization would have been impossible were it not for the new technical literacy nurtured by the scientific lecturers of the 18th c. and steadily spread through the milieus of tradesmen (Jacob and Stewart 2004). The gigantic imperial expansion of the British state, which inflicted the transformation of common lands into private property and the dispossession of indigenous people from their resources in the colonized New World, found some not insignificant ideological justification in the 17th-century natural philosophers' appeals to the restoration of man's prelapsarian empire over the earth, in the sense both of recovering man's original epistemic dominion over nature and of reversing the effects of Adam's Fall on the fertility of the soil through redemptive agrarian labour (Irving 2008). In the geopolitical nexus of state competitions for power and domination over the Atlantic and the Pacific, specific scientific practical and thinking skills, such as planning research activities, observing, collecting specimens, evaluating procedures, performing calculations, analysing, comparing, and inferring, were soon to be regarded as potent factors in creating national comparative advantages, in securing economic gains for the imperial states, and sometimes also in sustaining the viability and the productivity of the slaves' labour power (Brockway 1979, McClellan 1992, Miller and Reill 1996, Schiebinger and Swan 2005, Delbourgo and Dew 2008). By the second half of the 18th c., international scientific expeditions had become instruments for promoting and entrenching colonial power, and occasions, as well, for forging bonds between the intellectual and commercial elites. As Mary Louise Pratt has suggested, the travel narratives contributing to the global project of cataloguing, systematising and controlling nature should be seen also as narratives "in which the naturalist naturalizes the bourgeois European's own global presence and authority" (Pratt 2008, 26). The slave trade and the plantation system were an integral part of the same social fabric wherein Enlightenment taxonomic and analytical scholarship flourished.

Once we take seriously the polycentricity of the networks connecting the various imperial actors, the hybridity of colonial knowledge, and the complexity of interactions between European officials or men of science, local intermediaries, and indigenous people (MacLeod

2 In his "Experimental Researches in Electricity", see Faraday 1834, 78-79.

2000, Baber 2001, Bennett and Hodge 2011, Boomgaard 2013), then it becomes even more clear that modern science was not just a tool which was every so often misused. Rather, it was co-produced with European commercial empires. It advanced "because it focused on describing and explaining those aspects of nature's regularities that permitted certain classes of Europeans to multiply and thrive, especially through the prospering of their expansionist projects" (Harding 1992, 313). One of the most famous and well-studied instances epitomising this interlocking dependency between science and empire is the career of Joseph Banks (1743-1820), who made only a few original scientific contributions as a botanist, explorer and collector, but was Britain's most well-connected patron of science and the longest serving president of the Royal Society of London, holding this position for 41years.

Setting up an expansive circle of contacts and mustering a wide range of financial and institutional resources to support scientific research, Banks did not act as a politically disinterested expert or supervisor of other experts. He conceived scientific literacy to be a means of increasing the wealth of his country and of the bloc of social classes which dominated British political life. But however eagerly he sought to conscript science into the service of the British state he could not avoid being caught up in a tension between the conception of science as a servant of British imperial interests and the conception of science as a cosmopolitan movement for the improvement of the human condition (Gascoigne 1994, 1998, Fulford et al. 2004, 33-148). It is here that the flip side of the coin comes up: modern science emerged not only in relation to the global competition between the European imperial states, but also in relation to the domestic struggles against the prevailing social order in the Western world. The tension traversing the life of Banks adds up to the contradiction between science as an enterprise stimulated by confidence in the present state of things and science as an enterprise inspiring the hope for a different and better life, for the transformation of what-is or the rediscovery of what-was-once and now has been lost. This discontent with existing reality, in quest of lost, or hitherto unexplored, Arcadian states of existence, usually passes under the retrospective historical rubric of 'Romanticism'.

Richard Holmes, for example, places Banks' voyage to Tahiti (1768-1771) under the command of James Cook, on board HMS Bark *the Endeavour*, at the beginning of his narrative on Romantic science (Holmes 2008, 1-59). And, indeed, wasn't the respected voice of Baron Cuvier who had described Banks' voyage as a realisation of those "amusantes féeries de l'Odyssée, qui ont fait le charme de tant de nations et de tant de siècles" (Cuvier 1821, 60)[3]? Wasn't Banks himself who, in one of his letters, speaking about

3 In an anonymous "popular biography" of Banks, published in 1844, this passage is translated in a way that is better suited to Holmes' periodisation: " [...] everything seems to realize the romantic wonders of the Odyssey, which have charmed so many nations during so many ages" (quoted in Holmes 2008, 57).

the women of Tahiti, had idealized the unfettered nature in this island, which produces "forms as exist here [in Europe] only in marble or canvas" (quoted in Holmes 2008, 45)? And wasn't he who at times had freely expressed his disdain for the commercial ethos, the spirit that pervaded his own society (Gascoigne 1994, 18)? Anyway, when Banks sailed to the South Pacific, the term "romantic" had not yet gained currency as a technical term denoting a specific cultural movement. In 18th-century English literature, it still stood for a group of qualities, such as wilderness, seclusion, fertility and mystery, that could associate natural sceneries with sentiments derived from the free constructive activity of imagination (Immerwahr 1972, 17-53). This kind of usage occurs also in the *Endeavour* Journal of Banks.[4] Even well into the 19th c., and in spite of a preceding gradual cultural re-evaluation and rehabilitation of the tradition of Gothic romance, the new intellectual orientation towards the subjective experience, and the ambivalences in the relationship between the self and the world, that was consummated in the philosophy and poetry of Coleridge, Wordsworth, Byron, Keats and Shelley, did not crystallize around the sense of belonging to a common cultural trend, much less to a movement identified by friends or foes as "romantic" (Whalley 1972).

The only reliable options for holding on to this nebulous retrospective characterization is to detach romanticism from the context of the early 19th -century German literary criticism, wherein the adjective "romantisch" was first used as a culturally meaningful term, and to define it either as a sceptical project, which involved a variety of actors, to make modernity reflexive, by undermining modern foundationalist claims, and vocalizing the implications of the social, moral, political and philosophical crises that constituted modern history (Lacoue-Labarthe and Nancy 1978, Peter 1987, Cunningham and Jardine 1990, Frank 1997, Beiser 2003, Millán-Zaibert 2007, Frischmann and Millán-Zaibert 2009), or as that particular tendency in modern culture which represents a revolt against industrial capitalist civilization, but "from the standpoint of a value system –with reference to an ideal– drawn from the past" (Löwy and Sayre 2001, 28). But even then, we should be cautious not to fix our attention exclusively on the differences between romanticism and mainstream modernity, shutting thus out of our visual field the deep embroilment of Romantic critique in that which is criticized. If such a clause is applied in the case of science, the manifestations of romanticism in science should be looked upon as examples of an immanent critique aimed not only at transient facets, but also at possible tendencies and core elements of modern science.

Joseph Banks' scientific legacy is ambiguous and contradictory, but the general tenor of his work as scientist and administrator does not betray many signs of a reflexive mentality. Things stand differently with Davy, Banks' successor as President of the Royal Society.

4 So Banks wrote the following, in his journal entry for March 10, 1770: "We stood in with the shore which provd very high and had a most romantick appearance from the immence steepness of the hills". Cf. also his entry for November 12, 1769. Beaglehole 1962, I, 432, 472.

His denunciation of his profit-seeking colleagues may serve us as a good starting point in trying to re-activate some key aspects of his own controversial conception of science, usually designated in hindsight as Romantic.

Chemistry as philosophy

But is Davy's aphorism, that science tends to be "followed more as connected with objects of profit than those of fame", not an overstatement, inexcusably made for the sake of emphasis? The passage quoted above, one may plausibly contend, is obtained from a text that has very little to do with science, at least with the typology of scientific literature we are used to encountering. Davy's *Consolations* were certainly a curious piece of writing. It was composed not long before its author's death, and what's more, in a period of physical hardship. He had just resigned, due to "a severe and long continued illness",[5] the presidency of the Royal Society, and had quitted England in order to pass the last days of his life traveling across continental Europe, for he had realized that his death was looming near. Overall, he felt like "wearing away the winter", as "a ruin among ruins" or as a "ruin of what he was".[6]

The book itself is written in the form of dialogues between fictional characters, wandering here and there, experiencing apocalyptic reveries, and incessantly discussing on theology, history and science. Rather roughly, one could classify it as a "philosophical romance" (Davy 1830, 139). Its tone betrays a somehow melancholic temper and a depth of contemplating vision. After five dialogues, installed in a pattern of escalating questioning, where the debate revolves around wide-ranging topics such as the history of civilization, the genesis of the earth, the organization of animated nature, the unity of the self, the immortality of the soul, the possibility of scientific knowledge, and the very possibility of living, in the sixth and concluding dialogue the notion of time itself is posited as a problem. Rather than pursuing a trifling amusement while recovering from pain, Davy sets forth a consolation for his singular existence that blossoms and fades out, covering a real distance, carving its own path in life, subject to "the laws of the inevitable destruction of material forms". What is most deeply at stake throughout the whole construction is to establish the validity of hope as a renovating principle, "as that evening star of light in the horizon of life, which, we are sure, is to become in another season a morning star, and it throws its radiance through the gloom and shadow of death" (Davy 1830, 222, 227).

5 Letter to Davies Gilbert, Saltzburgh, July 1, 1827, published in his biography by Paris 1831, II, 301-302 – the quotation on p. 301.

6 The first two phrases appear in Davy's letter to Thomas Poole, Rome, Feb. 6, 1829, in Paris 1831, II, 349-352 – the quotation on p. 349, and republished in J. Davy 1836, II, 339-342 – the quotation on p. 339. The third is to be found in a letter of Poole to John Davy, Nether Stowey, Feb. 1, 1830, published in J. Davy 1836, II, 402-409 – the quotation is on p. 407.

In each chapter, poetic images of this sort are hardly rare. But what is most noteworthy about the way they function is that they creep up on a textual surface covered by detailed realistic descriptions, or even causal explanations, pertaining to theories current at that time in several branches of scientific learning: from ichthyology and geology to general physics and chemistry. Poetic language and scientific language coexist in the same space and interact with eachother. The outcome, however, is a discourse the enunciation of which is attributed to a philosopher ("Philalethes"), and the protagonist within which is also a philosopher. The main character in the dialogic scenes, a rather phantasmatic figure called "the Unknown", who apparently personifies Davy's own ideal self, is a "chemical philosopher", a thinking experimenter and an experimenting thinker, competent enough to rival "the modern geometricians in the greatness of his views and the profoundness of his researches, and the ancient alchemists in industry and piety" (Davy 1830, 254): neither just a skillful manufacturer of useful things nor a mere contemplator, a vector of fleshless spirituality.

Chemical philosophy is not a philosophy *for* chemistry, a mode of explicating the meaning of chemical procedures, formulas or statements. It is a mode of philosophizing, pondering over the possibility of things, which takes its departure from a particular, fertile and highly cultivated, field of experimental work: the most well-developed branch of philosophia experimentalis. Although clearly demarcated, the territory of chemistry is not an exclusive, specialized locus of valid knowledge. The other way round: trustworthy and admissible as content of knowledge is only what points beyond the limits of the inherited forms of knowledge, keeping "alive that inextinguishable thirst after knowledge, which is one of the greatest characteristics of our nature". Every new genuine discovery in chemistry, showing how imperfect our theories are, and strengthening our awareness "that the greater the circle of light, the greater the boundary of darkness by which it is surrounded", is a challenge to increase our efforts for acquiring "a higher kind of wisdom, and a state in which truth is fully and brightly revealed" (Davy 1830, 246). The knowledge of the temporal dimension of being induces human reason to ascertain and transcend its own limitations, opening up a border zone between objective knowledge and subjective faith, experience and revelation, wherein the hope for a world-to-come resurfaces as the most valuable anchor human beings may get hold of in their struggle against their destiny of decay. After all, "the sun appears to sink in the ocean in darkness, but it rises in another hemisphere" (Davy 1830, 281). The "true chemical philosopher" does not dissolve the sinking sun into abstract entities, furnished with measurable properties, seeking to reduce reality to controllable variables and repressing thus the variable temporal density of life. By contrast, he is actively engaged in the restless interplay between the actuality of powerlessness and the power of the possible:

> "He sees man an atom amidst atoms fixed upon a point in space; and yet modifying the laws that are around him by understanding them; and gaining, as it were, a kind of dominion over time, and an empire in material space,

> and exerting on a scale infinitely small a power seeming a sort of shadow or reflection of a creative energy and which entitles him to the distinction of being made in the image of God and animated by a spark of the divine mind". (Davy 1830, 245)

Lying at a considerable distance from the commonplaces of ordinary, either lay or scholarly, discourse, the text of the *Consolations* is illustrative of an oneiric, philosophical and at the same stroke poetical, discourse, which a present-day specialist puzzle-solver might only disregard as a joke or a failed sample of literary amateurism, intermingling several different genres, and speculating unguardedly about states of affairs, otherwise quite amenable to scientific control. Even so, this oddity turned out to be the most successful, in terms of its sales output, its endurance in time, and the breadth of its distribution, writing Davy ever offered to an audience wider than that which attended his lectures at the Royal Institution: by 1869 it had reached its 7th English edition, in 1870 its second American imprint was published, it was translated into German, Swedish, Spanish, and French (see the detailed description given by Fullmer 1969, 98-100), the latter translation going through 9 editions. It was also included among the 214 classical works of English literature that Cassell Company Ltd published in New York, London, and Melbourne, between 1886 and 1890 in low-priced weekly issues.

That poetry occupied a prominent role in the early life of Davy is something that both his brother, John, and his first biographer, John Ayrton Paris, were eager to attest (J. Davy 1836, I, 15, Paris 1831, I, 6-7). One of his first publications, while he still resided in Bristol, working as an assistant in Thomas Beddoes' Pneumatic Institution, was a series of five poems which were included in the first volume of Robert Southey's *Annual anthology* (1799). But his poetic proclivity was not a feature of his character which he retained only as long as his naive youth lasted. He never stopped writing poems. And even though he did not publish any collection of them, his occasional pieces of poetry, scattered throughout his notebooks, mirror his intellectual pursuits, commitments or obsessions (Fullmer 1960). He was a friend of the poet and philosopher Samuel Taylor Coleridge, and he left his imprint on the latter's thought, as well as on some aspects of William Wordsworth's philosophical project, especially with regard to the debate on the relations between poetry and natural philosophy (Sharrock 1962, Harré 1983, Levere 1989, Lefebure 1990, Ross 2003, Hindle 2012). His work, and particularly this "vein of philosophical contemplation" (Paris 1831, I, 24) running through the composition both of his poems and of the texts of his lectures at the Royal Institution, from 1802 onwards, have been proved to be influential to poets and writers such as John Keats (Sperry Jr. 1970), Percy Bysshe Shelley (Grabo 1930, 139-178, Kipperman 1998, Peterfreund 2003, Ruston 2005, 95-101), and Edgar Alan Poe (Hall 1968, Brody 1990). The acceptance of his ideas was not always favourable: his "Introductory discourse to a course of lectures on chemistry" of 1802 was probably

a source for Mary Shelley's *Frankenstein*.[7]

But for Davy poetry could be placed on a par with science, not on account of the fact that they both evince an unrestrained power to control and to transform nature, but because they both stir up an unstable middle ground between actuality and reality, between the triviality of a definite, temporally and spatially bounded, self and the sublimity of the elusive flux of a common, universal life. Science is poetical to the extent that it transforms the subject of the act of knowing as much as its object: by experimenting with natural phenomena, the chemist transcends his own self, and thus he experiences both a deepening of his sensibility, his feeling of being, and an intensification of his reflexivity, his ability to ponder over being. Truth is not the effect of abstraction or detachment from the reality of life. Truth is the participation, or rather, the passionate involvement in the flowing wholeness that life is. Or, to quote Davy's own words, from a short essay drawing "parallels between science and art" he anonymously published in 1807:

> "The contemplation of the laws of the universe is connected with an immediate tranquil exaltation of mind, and pure mental enjoyment. The perception of truth is almost as simple a feeling, as the perception of beauty: and the genius of Newton, of Shakespeare, of Michael Angelo, and of Handel, are not very remote in character from each other. Imagination, as well as reason, is necessary to perfection, in the philosophical mind. A rapidity of combination, a power of perceiving analogies, and of comparing them by facts is the creative source of discovery. Discrimination and delicacy of sensation, so important in physical research, are other words for taste; and the love of nature is the same passion, as the love of the magnificent, the sublime, and the beautiful". (Davy 1807, 196-197)

More than twenty years later, in his *Consolations*, Davy insists on giving the same meaning to his actions, writing that just as poetry cannot be judged with the standard of "absolute utility" because it "gives pleasure, refines, and exalts the mind", so

> "philosophic pursuits have likewise a noble and independent use of this kind; and there is a double reason offered for pursuing them, for, whilst in their sublime speculations they reach to the heavens, in their application they belong to the earth; whilst they exalt the intellect, they provide food for our common wants and likewise minister to the noblest appetites and most exalted views belonging to our nature". (Davy 1830, 243)

7 Crouch 1978; Mellor 1988, 91-95. Richard Holmes thinks it more likely that Shelley was indirectly inspired by the experimental work of the German physiologist Johann Wilhelm Ritter (2008, 328-330).

Chemical philosophy and self-education

With that being said, we cannot ignore that if Davy during his lifetime enjoyed extraordinary fame this was the result of the discoveries he made as an experimenter. Owing to his scientific work, he attracted admiration from many and different sections of the British society. His lectures at the Royal Institution were attended by crowds. They were inspiring not only for "gentlemen", middle-class male spectators, or for some possible wealthy admirers and sponsors, but also for women (Foote 1952), who crowded the halls of the Royal Institution in order to hear what Davy had to say about the hidden powers of nature, and to see what experimental arrangements and novelties he had to exhibit.

Jane Halimand Marcet (1769-1858) in 1806, inspired by Davy's chemical philosophy, published anonymously a two-volume work, under the heading of *Conversations on chemistry*, in which a series of discussions between the fictional educator "Mrs. B." and her two female students, Emily and Caroline, is used as a dramatic vehicle for the familiarization of young women with chemistry. Previous women science writers, such as Priscilla Wakefield (*Introduction to botany*, London 1796) and Maria Jacson (*Botanical dialogues: Between Hortensia and her four children*, London 1797), had already opted for the epistolary or the conversational format, therefore relocating science from the laboratory or the lecture hall to the intimate sphere of family life. The idealization of the maternal figure –who fulfills with devotion the duties of nurturing– notwithstanding, this "familiar style of science writing" facilitated access to scientific knowledge by young women otherwise irreparably confined to traditional feminine roles within their domestic space (Shteir 1990, 312-313). The *Conversations* are both skillfully composed and theoretically informed. The aim is not to give female readers some idea of how scientific research is being performed within the enclosed space of the chemical laboratory. Marcet, instead, makes it plain that the whyfor of chemistry does not consist in solving riddles after executing protocols (as we could say in a late modern idiom), but in obtaining knowledge of the "intimate nature of bodies" after thinking deeper and beyond the immediacy of actual experience, after destabilizing the quotidian world and instilling or re-invigorating a sense of wonder for the qualities of even the most familiar objects (Keene 2013). Chemistry is less practical and more philosophical than usually assumed:

> "without entering into the minute details of practical chemistry, a woman may obtain such a knowledge of the science as will not only throw an interest on the common occurrences of life, but will enlarge the sphere of her ideas, and render the contemplation of nature a source of delightful instruction". (Marcet 1820, 26-28)

What a young woman should learn is to raise interesting, radical questions, drifting beyond the limits of her ordinary individual experience, and the social context of her subjectivation. Her chemical education is not primarily intended to help her handle technical details, so as

to apply bits of knowledge to bits of reality. Emily and Caroline let themselves be surprised by the unfamiliar intricacies of the experimental knowledge, relinquish their faith in the direct, intuitive acquaintance with things, and by questioning what they are told they become capable of comprehending such disputable and ambiguous chemical conceptions as those of heat, light, and electricity (by and large, as developed by Davy). On that score, the *Conversations*, which, when compared with later chemical textbooks, may appear to represent an outdated "union of dogma and elegance",[8] resonate strongly with some of the most liberating aspects of the Enlightenment, as a historical movement towards the realization of human autonomy.

Relatively to other contemporary books on science targeting women, such as Louis Aimé Martin's *Lettres à Sophie sur la physique, la chimie et l'histoire naturelle* (Paris 1810), Marcet's book is far more oriented towards fostering scientific understanding and productivity (cf. Pigeard 2000, 314). As David Knight observes: "there were no concessions to 'femininity' in these dialogues. They are not based upon cookery or needlework, but got the science across accessibly as a part of high culture" (Knight 2004, 175). The subjective import borne by the ideal type of the woman of science, whom "Mrs. B." exemplifies, is appreciably richer than that of the fashionable classically educated woman, which was scornfully dubbed "bluestocking" (cf. Tolley 2003, 63). The speaking subject, here, is much more akin to the universal, autonomous human subject upheld by the most radical currents of the Enlightenment. Accordingly, not only the non-specialized female audience did take advantage of the *Conversations*: the book was also sometimes recommended as an introductory reading for young medical apprentices (Crellin 1979, 459), and it reportedly kindled Michael Faraday's interest in chemistry, back in 1809, when he was still working as a bookbinder apprentice.[9] It went through 16 editions in Britain and 23 impressions in North America, where it became the most widely used chemical textbook over a period of almost fifty years (Lindee 1991). But even more significant is the fact that it triggered a kind of international movement, outside the academic space, promoting the chemical education of women as a form of self-education through creative, critical thinking. A number of translations, adaptations or imitations of the *Conversations* appeared in France,[10] North America,[11] and Germany.[12] In each new edition the book was updated, including information about recent advances in chemistry, whereas in each adaptation the author felt free to step upon Marcet's plan, without strict adherence to the letter,

8 See the remarks of Knight 1986.

9 See his Letter 3519, in James 1991-2011, V, 453.

10 *Conversations sur la chimie* [trans. M. de Végobre], Geneva 1809; Anon., *Entretiens sur la chimie après les méthodes of MM. Thenard et Davy,* Paris 1826; Anselme Payen, *La chimie enseignée en vingt-six leçons,* Paris 1826.

11 Thomas Jones, *New conversations on chemistry,* Philadelphia 1831.

12 *Unterhaltungen über die Chemie,* trans. F.F. Runge, Berlin 1839.

though being faithful to the spirit of her book. This type of science literature, relying on conversational style, emerged as the educational shadow of Davy's chemical philosophy. It exploited the allure of the new, so much promising, field of knowledge that Davy had labeled as "electrochemistry". But it also played an active part in the process of signifying the latter, in generating social meaning for that mode of doing chemistry which Davy personified, as a prolific conjunction of experimentation with philosophical contemplation.

Redefining the exception and the rule

Andrew Ure, in his highly popular *Dictionary of chemistry*, had voiced his admiration for Davy's outstanding experimental track record with the following apostrophe:

> "Of the discoveries made by Sir H. Davy, in voltaic electricity, and in chemistry, by the sagacious application of his unlimited powers, it is difficult to speak in the cold language of philosophy. They probably surpass in importance, as they do in splendour, the united discoveries of preceding chemists; and when the breath of contemporary envy shall be condensed in the cold grave, they will shine forth on the diadem of English science, companion gems, to the diamond of Newton". (1821, entry for "Electricity", no pagination, col. 19)

It was not the first time that the name of Davy had been matched with that of Newton. In the December 1816 issue of the *Annals of Philosophy*, a scholarly journal edited by Thomas Thomson, the mineralogist John B. Longmire, amidst the heated controversy over the reliability of the safety lamp for coal-miners that Davy had just designed (Knight 1992, 205-220, James 2005), had also described him as the "Newton of chemistry" (Longmire 1816, 427), though with a bitterly ironic tone this time. Davy was exceptional, this was something to which everybody around him was willing to subscribe, at least during the 1810s, when he was at the high peak of his career. But to be admirable, as an exception sometimes might be, is not the same as to be credible, so much credible as an exemplar to follow normally ought to be. And some of Davy's contemporaries treated him, and his chemical philosophy, as an exception that should not affect, much less become, the rule.

The attack against the kind of chemistry he advocated was launched a little soon before his death, and it is interesting enough the fact that despite being the main target of the attack, the debt owed to the "Newton of chemistry", as for the development of scientific knowledge, was never publicly repudiated. The first blow was struck in 1829, when Thomas Thomson published in the *Edinburgh Review* a brief historical outline of chemistry, under the guise of a review of two chemical textbooks (the one of Berzelius and the other of Boswell Reid). In his narrative, chemistry is depicted as a newfangled science, the history of which does not extend beyond the middle of the 18th c. Compared to other fields of knowledge, chemical research does not promise much philosophical

profundity or gratification to the mind. The ideal chemist of Thomson is not motivated by the "inextinguishable thirst after knowledge", as the ideal chemist of Davy solemny does profess to be. He is not inspired by the zeal, the melancholy or the frenzy of the philosophers. He would gladly settle for less: the scope of chemistry is no broader than the isolation and effective control of agents, classes of entities, constituent parts of bodies. Chemistry is a clearly defined discipline, the intellectual growth of which hinges on the development of functional concepts, tools to assist with the manipulation, through quantitative analysis, of the simple substances and the definite compounds that are the objects of chemical knowledge, and the unbounded progress it has, as such, undegone allows Thomson to envision what the near future seems to reserve:

> "the time may come when sugar, starch, and gum, and many similar substances, may be manufactured by uniting their constituents, as soap is made at present. Even fat, wax, albumen, and glue, may, hereafter, be made artificially". (Thomson 1829, 275; the attribution is given in Houghton 1966-1989, I, ER 1273)

The science of artificially producing useful things should evolve into a productive force, an embodied knowledge of producing commodities. There is a transition going on from the chemical laboratory to the chemical "manufactory". "Every chemical manufactory consists merely in the formation or decomposition of definite compounds". The more we come to know of these definite compounds, the more we increase the efficiency in these novel, potentially prosperous, sites of industrialised production (Thomson 1829, 275-276). And to such a goal a new form of science education does unmistakably correspond.

French and German chemists, and some of their Scottish colleagues too, are already moving in this new direction. British chemistry, on the other side, is in a state of "retrogradation", facing the danger to "descent from her eminence". The reason is no other than the persistence of a philosophical version of chemical science, with serious implications in science education: the fault "must be ascribed to the way in which the science has been hitherto taught in this country, namely, by lectures only, with illustrative experiments". Although avoiding at this point any explicit mention of Davy, Thomson gives a public thumbs-down to the kind of chemical education Davy had for long practised at the Royal Institution, which is surreptitiouslty caricatured here as being little more than a theatrical performance of individual genius. "In order to form chemists, something more is necessary", and this has been already appreciated by some of the British universities, id est, by the University of Edinburgh and that of Glasgow, where "Classes for instruction in Practical Chemistry have been lately instituted". The students of chemistry must "have the means of practical instruction in the details of analysis, and all the operations in the Laboratory; [...] must have the means of acquiring the art of experimental chemistry by regulated practice". Whatever the significance of the theoretical contributions made by British chemists in the recent past, the advent of atomic theory has altered the nature of chemistry itself: "the minute accuracy now necessary for experimenting is so great, that

genius alone, without practical skill, cannot be expected to succeed" (Thomson 1829, 276). The renovated setting of the post-Daltonian chemistry is no longer welcoming for the "showman in the other corner".[13] Thomson exaggerated the importance of the practical teaching of chemistry in the early 19th-century educational landscape of the Scottish university cities. Both in Edinburgh and in Glasgow, the belief that the courses in practical chemistry, "if properly supported and conducted", could yield "the most beneficial results" (Thomson 1829, 276) was championed by only a small minority of scholars. The success of his own laboratory class, at Glasgow University, was exceptional, in the literal sense of the word, and it did not last long. The conservative College professors, the dominant professorial group in the University retained their firm grasp on higher educational affairs, and Thomson's reforming zeal was repeatedly thwarted (see Morrell 1969a). A similar pattern was demonstrated in the University of Edinburgh. The first courses in practical chemistry (and pharmacy) were launched in 1823 under the superindendence of John Wilson Anderson (1803-1835) and George Dixon Longstaff (1799-1892), who were then assistants to Thomas Charles Hope. Class attendance was not compulsory for the University medical students, whereas, additionally, the lecturers did not have access to the University equipment. The practical class ran from 1823 to 1828 (in 1824 by Anderson and between 1825-1828 by Longstaff alone) but did not attract much notice. Neither did it find actual support by Hope himself, who despite his being the nominal supervisor did not share the view that laboratory teaching was an essential part of chemical education. He seems to have regarded the practical class as an optional extra, which had little or no bearing upon his own lectures. Things changed considerably in 1828, when David Boswell Reid (1805-1863) was appointed as Hope's assistant and took over the task of directing the class. His courses were more popular than those of his predecessors, and his assiduous work was aided by the fortunate circumstance that, in early 1829, the Royal College of Surgeons of Edinburgh adopted new licensing rules requiring each candidate for a certificate of competency to have attended a three-months' course in practical chemistry. Since Reid then lacked the necessary academic credentials, that could render his courses eligible to provide that prerequisite training, the name of Hope was added to the ticket for the practical class. That arrangement lasted until 1832 but, in reality, Hope's involvement was minimal and restricted to an introductory lecture which he delivered in 1829. Reid, in 1832, resigned and in the following year he proposed to the Town Council of Edinburgh the introduction of an independent chair of practical chemistry in the University. His proposal was rejected and he turned to private teaching (Morrell 1969b; 1972, 53-55). Thomson certainly overestimated the prospects for change. But his exaggeration was not

13 This is how the professor of natural philosophy in the University of Edinburgh, John Leslie, described his colleague, professor of chemistry and medicine in the Faculty of Medicine of the same university from 1799 to 1843, Thomas Charles Hope (1766-1844), according to the testimony of the chemist Thomas Graham, who had studied and worked for some time (1826-1828) under Hope (Smith 1884, 9).

unfounded. Practical chemistry, centered on analytical investigations, had not become the rule. The rule, however, could be redefined.

In May 1830, the baton passed to Charles Babbage, who published a tract called *Reflections on the decline of science in England and on some of its causes*. Resolute and polemical[14] in tenor, the diagnosis he provided was far more detailed, running across a wide array of traceable shortcomings: defects in the system of education, lack of a distinctly professional impulse for committing oneself to science, insufficient encouragement afforded by the state, bad management and misrule by leading "parties" or "coteries" in the learned societies, most notably in the Royal Society of London itself. Babbage urged his readers to "look at the prospects of a young man at his entrance into life, who, impelled by an almost irresistible desire to devote himself to the abstruser sciences, or who, confident in the energy of youthful power, feels that the career of science is that in which his mental faculties are most fitted to achieve the reputation for which he pants":

> "What are his prospects? Can even the glowing pencil of enthusiasm add colour to the blank before him? There are no situations in the state; there is no position in society to which hope can point, to cheer him in his laborious path. If, indeed, he belong to one of our universities, there are some few chairs in his *own* Alma Mater to which he may at some distant day pretend; but these are not numerous; and whilst the salaries attached are seldom sufficient for the sole support of the individual, they are very rarely enough for that of a family. What then can he reply to the entreaties of his friends, to betake himself to some business in which perhaps they have power to assist him, or to choose some profession in which his talents may produce for him their fair reward? If he have no fortune, the choice is taken away: he *must* give up that line of life in which his habits of thought and his ambition qualify him to succeed eminently, and he *must* choose the bar, or some other profession, in which, among so many competitors, in spite of his great talents, he can be but moderately successful. The loss to him is great, but to the country it is greater. We thus, by a destructive misapplication of talent which our institutions create, exchange a profound philosopher for but a tolerable lawyer". (Babbage 1989, VII, 18-19, emphasis in original)

So, if we take for granted Babbage's assertions of fact, in early 19th-century Britain, science did not promise much for the prosperity of an individual, which is to say, for his successful integration into the labour market and his profitable career as a distinguished and useful cell within the national torso. The suggested remedy was both to dilute the

14 Babbage's intention was clearly to run a campaign: at least 204 copies of his book were distributed free, 53 to the Continent and 8 to the United States (Cannon 1978, 186).

aristocratic grip on the existing scientific institutions and to professionalize science, to differentiate it as a separate vocation, the pursuit of which should be safeguarded by the state, as an investment. In other countries, and most markedly in France, under Napoleon, during whose reign the national triumphs scored were "as eminent in Science as they were splendid in arms", it was already admitted "that a knowledge of science is a recommendation to public appointments" (Babbage 1989, VII, 13). Britain had to traverse the same road.

Babbage recognized that both the elaboration of new principles in science, through contemplative theoretical activity, and the application of abstract truths to particular problems, through puzzle-solving practical activity, are equally important aspects of science, which merit state encouragement and support (Babbage 1989, VII, 8-10). But this does not imply that, generally, doing science is, or at least necessitates, philosophizing. At the conclusion of his book, paying his homage to William Hyde Wollaston and Davy, those two, recently deceased, "bright ornaments" of England, Babbage sets the "minute chemistry" professed by the one, his "perfect attention which he could command, and the minute precision with which he examined every object", against the philosophical chemistry propounded by the other: "in associating with Wollaston, you perceived that the predominant principle was to avoid error; in the society of Davy, you saw that it was the desire to see and to make known truth". The one was not, and he never could have been, a poet. The other "might have been a great one" (Babbage 1989, VII, 105-109). The same statements, slightly modified, were repeated by John Paris (1831, II, 402-403), and later, Paris' variation, in its turn, was quoted by John Barrow, in his own biographical sketch of Davy (Barrow 1849, 94-95). But also Babbage himself could not claim originality for putting these two portraits side by side. He echoed, in a much abbreviated and sharpened form, William Henry's discussion of the relative merits of Davy versus Wollaston in the Preface to the 11th edition of his *Elements of experimental chemistry*:

> "To those high gifts of nature, which are the characteristics of genius, and which constitute its very essence, both these eminent men united an unwearied industry and zeal in research, and habits of accurate reasoning, without which even the energies of genius are inadequate to the achievement of great scientific designs. With these excellencies, common to both, they were nevertheless distinguishable by marked intellectual peculiarities. Bold, ardent, and enthusiastic, Davy soared to greater heights; he commanded a wider horizon; and his keen vision penetrated to its utmost boundaries. His imagination, in the highest degree fertile and inventive, took a rapid and extensive range in pursuit of conjectural analogies, which he submitted to close and patient comparison with known facts, and tried by an appeal to ingenious and conclusive experiments. He was imbued with the spirit, and was a master in the practice, of the inductive logic; and he has left us some of the noblest examples of the efficacy of that great instrument of human reason in

the discovery of truth. He applied it, not only to connect classes of facts of more limited extent and importance, but to develop great and comprehensive laws, which embrace phenomena, that are almost universal to the natural world. In explaining those laws, he cast upon them the illumination of his own clear and vivid conceptions; – he felt an intense admiration of the beauty, order, and harmony, which are conspicuous in the perfect CHEMISTRY OF NATURE; – and he expressed those feelings with a force of eloquence, which could issue only from a mind of the highest powers, and of the finest sensibilities. With much less enthusiasm from temperament, Dr. Wollaston was endowed with bodily senses of extraordinary acuteness and accuracy, and with great general vigour of understanding. Trained in the discipline of the exact sciences, he had acquired a powerful command over his attention, and had habituated himself to the most rigid correctness, both of thought and of language. He was sufficiently provided with the resources of the mathematics, to be enabled to pursue, with success, profound inquiries in mechanical and optical philosophy, the results of which enabled him to unfold the causes of phenomena, not before understood, and to enrich the arts, connected with those sciences, by the invention of ingenious and valuable instruments. In CHEMISTRY, he was distinguished by the extreme nicety and delicacy of his observations; by the quickness and precision, with which he marked resemblances and discriminated differences; the sagacity, with which he devised experiments, and anticipated their results; and the skill, with which he executed the analysis of fragments of new substances, often so minute as to be scarcely perceptible by ordinary eyes. He was remarkable, too, for the caution, with which advanced from facts to general conclusions; a caution which, if it sometimes prevented him from reaching at once to the most sublime truths, yet rendered every step of his ascent a secure station, from which it was easy to rise to higher and more enlarged inductions. Thus these illustrious men, though differing essentially in their natural powers and acquired habits, and moving, independently of each other, in different paths, contributed to accomplish the same great ends – the evolving new elements; the combining matter into new forms; the increase of human happiness by the improvement of the arts of civilized life; and the establishment of general laws, that will serve to guide other philosophers onwards, through vast and unexplored regions of scientific discovery".[15]

15 We quote from the American imprint of the 1829 London edition: Henry 1831, viii-x. Henry's eulogy for Wollaston and Davy was verbatim reproduced in several scholarly journals, such as the *Philosophical Magazine* (1830, 7(39): 228-229), the *Edinburgh Journal of Science* (1830, new series 3(6): 349-350), the *London Medical Gazette* (March 27, 1830: 829), and the *American Journal of Science and Arts* (1831, 20: 90-91). It can also be found in Paris 1831, II, 405-407, and in many short biographies of Wollaston, e.g. that which was included in the

In echoing Henry, Babbage reformulated the relationship between Davy and Wollaston in a new key. The shift in tone is easily detectable. Henry compares two different work-styles and personalities, which ultimately coalesce into a single common inductive enterprise; Babbage arrives at two opposing chemistries. Henry construes Wollaston's capacity for precision as a quality of an individual mental and bodily idiosyncracy; Babbage credits the same capacity to a careful channeling of attention and a methodical training in seeing and recording details (see Musselman 2006, 120-121): to an adjustment of the mind to the objects under observation, without experimental wavering, poetical wandering or philosophical wondering. There is a clear-cut disjunction underlying what is being said. Wollaston is an exemplary practitioner of science as a mode of steering clear of error. Davy's science is a mode for accessing truth. Two distinct significations of science, and two different routes to choose from: to be precise or to be insightful?

What are the implications of this dilemma for the social role of science? Let us open a brief parenthesis here. In 1832, Babbage published a treatise under the title *On the Economy of Machinery and Manufactures* disclosing the prospective outcome on which the wager was really laid: the implementation of "a division of mental labour" enabling the owners of the means of social production "to purchase and apply to each process precisely that quantity of skill and knowledge which is required for it", so as to "avoid employing any part of the time of a man who can get eight or ten shillings a day by his skill in tempering needles, in turning a wheel, which can be done for sixpence a day", and to "equally avoid the loss arising from the employment of an accomplished mathematician in performing the lowest processes of arithmetic" (Babbage 1989, VIII, 141). It is commonly held that Babbage was ahead of his time in recognizing the potential of scientific planning in the direct production process. But he was not so far ahead as to seem an eccentric dreamer or as though he was a visionary utopian. Now we are in a position to see that the application of science to the production of commodities was a long, complicated, and painful process which meant a lot more than the utilization of knowledge objectified in machines. Science played also an important part in the organizational changes that were necessary for the enactment and the normativization of the time-oriented work discipline, the functional dissection of tasks, and the intensification of labour within the workplace (Braverman 1998, 49-126). It was through the use of scientific expertise in the factories that the manufacturing division of labour became an irresistible tool for labour exploitation. Yes, it is true that only at the turn of the 20th century "scientific management" began to be generalized. Only after Frederick Winslow Taylor codified his experience as a foreman at the Midvale Steel Company, and propagated it through his management consulting services, science

Annual Biography and Obituary (1830, XIV, 266-277 – the passage is on pp. 276-277), that in the *Gallery of Portraits* published under the "superintendence of the Society for the Diffusion of Useful Knowledge" (1833, II, 121-125 – the passage is on p. 125), and that in Cunningham 1837, VIII.2, 362-366 – the passage in on pp. 365-366.

could be effectively mobilized in factory settings, placing at the disposal of the production supervisors and planners a set of standardizable practices for performing calculations involving amounts of abstract human labour, "quantities of skill and knowledge" that could be purchased and allocated with precision to definite segments of the production process. Taylor proved that Babbage had right: science could indeed lead to industrial success, not only by procuring capital equipment, whose use would increase, and even expand, productive capacity, but also by handing out to the capital owners the know-how of workforce control. Productivity could not be raised unless the introduction of machinery were coupled with "a more careful regulation of the economy of the factory" (Babbage 1989, VIII, 253), i.e., the reorganization of the labour process itself. And adapting itself to the social context of the factory, science should be defined anew, through the selective stressing of its own value as an effectively regulated way of working. In the new economy of knowledge production, the attribute of scientific activity to which the highest value should be attached was its susceptibility to strict time control and planning concerned with quantitative inputs and outputs.

But let's continue with our story. Yet one actor in the controversy over the status of British science was David Brewster. Taking his stand on the side of the decline alarmists, by writing a supportive review of Babbage's *Reflections*, he went so far as to put theoretical scientific activity in stark opposition to applied, or applicable, research. "Discoveries in abstract science, however rich and ample may be their blossom, do not at once bring their fruits into the national treasury". Over against the protracted "winter" that intervenes between the spring of theoretical achievements "and their harvest", "the inventions of mechanical genius, and the processes in agriculture and the useful arts, advance into immediate maturity, and while they add to the comforts and luxuries of the people, they, in the same proportion, contribute to the resources of the state". Mechanical and chemical arts are "the basis of our manufacturing and commercial wealth". And what is the best path to the top, provided, of course, that the state indeed has the will to encourage the cultivation of these "useful arts"? Brewster consumes a lot of pages to express himself in detail: the abolition of patent fees ... (1830, 332-342; the attribution is given in Houghton 1966-1989, I, QR 243). Some pages ago, he had tried to recruit Davy himself for the cause of British science reform. Davy's "long residence in foreign countries enabled him to draw the painful contrast [with the state of science in England] which wounded his pride and roused his indignation", and intending to "draw the public attention" to the problem the British chemist began to write an essay in order to point out its extent, "which he unfortunately did not live to complete". The evidence Brewster offers in support of his allegation is a passage from the *Consolations*, where Davy notes with a sorrowful mood that "there are very few persons [in England] who pursue science with true dignity", meaning that the dominant tendency, which should be arrested and reversed, is to do science "more as connected with objects of profit than those of fame": it is the passage that we have quoted above, comparing Popper's fears with those of Davy (Brewster 1830, 306-307; cf. Davy 1830, 226). Reprehended here is the subsumption of scientific inquiry

under pragmatic considerations and professional ambition: exactly what the partisans of British science reform strived to promote! Davy evaluates as negative what Brewster evaluates as positive, but because the name of the former is prestigious, the latter is obliged to quote his words, and the sheer effect of vibrating together, side by side in the same text, broaching the same crisis of orientation, makes both voices seem consonant. Were we to resort to the findings of political communication research, this phenomenon would be described as follows:

> "semantic features linked to one object may be transferred to another simply through their co-occurrence. [...] The semantic frame attempts to influence judgments by simply putting two things within the same frame, that is, establishing semantic interrelationships through co-occurrence". (Biocca 1991, 67)

To tell the truth, this trick was first performed by Babbage, who had used the same excerpt from the *Consolations*, as well as the same allegation that Davy was about to write an essay perfectly concordant with his own castigation of the existing state of affairs in British science. Without burying former enmities in oblivion,[16] he wished this essay would see the light of day as soon as possible: "It is to be hoped that it may be allowed by his friends to convey his opinions to posterity, and that the writings of the philosopher may enable his contemporaries to forget some of the deeds of the President of the Royal Society" (Babbage 1989, VII, viii). We can quickly appraise the success of Babbage's cheerless appropriation of Davy's laurels by seeing how frequently Davy is enlisted, by later historians, on the side of the "declinists", although no tract on the decline of science in Britain, written by his hand, was ever found among his papers, and although it was only once that he used the word "decline", when referring to science, in his inaugural address on taking the chair of the Royal Society, back in 1820, where he spurred his colleagues on to "labour together", against complacency, "and steadily endeavour to gain [...] acquisitions which may be useful to our fellow-creatures", or put differently, "practical applications in science, not, however, forgetting the dignity of their pursuit, the noblest end of which is, to exalt the powers of the human mind, and to increase the sphere of intellectual enjoyment, by enlarging our views of nature, and of the power, wisdom, and goodness of the Author of nature" (Davy 1839-1840, VII, 14-15).

Brewster did not let the rhetorical advantage gained go to waste: he converted the tale of the concurrent discomfort with British science into a founding myth for the British Association for the Advancement of Science, the new learned society, founded soon after the publication of Babbage's book and the subsequent turmoil, in 1831, as an incarnation of the exclusive unity of the practitioners of science. When the calendar had turned over

16 For Babbage's conflicts with Davy, during the latter's presidency of the Royal Society, see Gleason 1991, 105-117.

to the year 1835, in reviewing, anonymously as it was usual in the scholarly journals of the time, the reports of the first three meetings of the British Association, he looked back with satisfaction on the "controversial discussion" around the state of British science which "four English philosophers, Sir Humphry Davy, Sir John Herschel, Mr Babbage, and Sir David Brewster [sic], under a deep concern for the honour of England" had opened, by investigating "the causes by which so fatal a change had been produced" and suggesting "the means by which the sciences might be fostered and revived". The impetus to create a separate body representing the men of science originates from these days of conflict. And undoubtedly the end was happy: "the public had judged calmly, and decided justly; and ministers, in power and out of power, had pledged themselves to a more generous patronage of science" (Brewster 1835, 370; the attribution is given in Houghton 1966-1989, I, ER 1513). That same year, Dionysius Lardner, a prolific popular science writer, lecturer and publishing entrepreneur, who was also one of the correspondents of Babbage (discussing with him the question whether the language and operations of mathematical analysis should be applied to political economy, see Henderson 1996, 16-19), and a collaborator with Brewster on various publishing projects, in his own anonymous review of the official reports of the first three meetings of the British Association, counted Davy among the limited number of those belonging to the "party" which in the early 1830s held and propagated the view that "the societies established for [science's] encouragement and advancement had fallen into inactivity and decrepitude". Shown to act in concert with Babbage and Brewster, Davy appears to have espoused one very distinctive formulation of the problem: "that scientific men were not placed in that position in society, to which their intellectual endowments entitled them: that, on the other hand, they were a marked caste, stigmatised by exclusion from offices and honours, to which members of the liberal professions and others were eligible; that, more specifically, they were, by custom and prescription, disqualified from filling the offices of state, and from taking any direct share in the political administration of the country; that, supposing (but not admitting) that their talents would be most beneficially employed, if exclusively devoted to the prosecution of science, still no public provision was made to enable them to attain that object; that scientific men, like other human beings, must be clothed and fed, and must live under a roof; that the means of doing this, much less of obtaining a position in society, were not afforded them; that University professorships (the only offices compatible with those objects) were notoriously restricted by conditions, which would render them inaccessible to the great bulk of the scientific community; but that, even were they otherwise, their number was utterly insufficient for such an object". The plan for redeeming the "stigmatised caste" by crafting an instrument whereby the unity of "scientific men" could be politically effective was put forward by that small party, which laid the cornerstone of such an association, modeled after the "Versammlung deutscher Naturforscher und Aerzte" that Lorenz Oken had founded in 1822 at Leipzig, and had the tactical ingenuity to sacrifice for some period, during the fragile state of the British Association's infancy, the clarity of its objectives on the altar of achieving broad consensus (Lardner 1835, 364-366; the attribution is given in Houghton 1966-1989, III, BGFR 16).

The story about the unfinished Davy's "work with this specific title [i.e. the decline of English science], full of feeling and eloquence, which his executors have not deemed it proper to publish" was rehearsed once again by Brewster, in 1850, when he recounted the origins and the growth of the British Association, celebrating the harvest of the first twenty years since its inaugural meeting in York. Nothing unforeseen interfered, strengthening the factual basis for his claim. The only difference is that the extract from the *Consolations*, containing the same passage which we have already seen Babbage invoking, is much more extensive this time (Brewster 1850, 238-239; the attribution is given in Houghton 1966-1989, I, NBR 221). Davy's role as signal-giver for the attack of the declinists finally became part of the "institutional hagiography" (the term has been used by Roy MacLeod 1981, 3) which glorified the founding fathers of the British Association. Margaret Fison, in her *Handbook of the British Association for the Advancement of Science*, published in 1859, "inscribed by permission" to the geologist Roderick Murchison, one of the founding members and former General Secretary (from 1836 to 1845) of the British Association, retells the same primordial scene: "Sir Humphry Davy, Sir John Herschel, Sir David Brewster, Professor Playfair, and many others, had all expressed their deliberate opinion of the superiority of foreign to British scientific institutions, and their strong feeling, with regard to the national discouragement given to scientific men in England. These opinions were held by persons engaged in the pursuit of different branches of science, who had no connexion with each other" (Fison 1859, 84). Is it then any wonder that when Babbage, in 1864, openly implicated Davy in the corruption prevailing among the top echelons of the Royal Society, during the pre-1830 era,[17] many of his own

17 In his *Passages from the Life of a Philosopher*, Babbage accused Davy of having "contrived to transfer between three and four hundred pounds from the funds of the Royal Society into his own pocket". What had happened was that Davy had sold the copyright of his *Six Discourses, Delivered before the Royal Society at their Anniversary Meetings, on the Award of the Royal and Copley Medals*, published at the request of the Council of the Royal Society, to the publisher John Murray, for 500 guineas (525 pounds). The Council decided (Babbage claimed that this provision was part of the deal between Davy and Murray, as an inducement for the latter to publish the book) to purchase in advance 500 copies of the book ordering a payment of 381 pounds and 5 shillings to Murray. Had the Council resolved to print 500 copies of Davy's *Discourses* on its own, "allowing a very high price for composing, printing, and paper", the cost would have been approximately 150 pounds (Babbage 1989, XI, 139-140). Vulnerable to the whims of its president, the Royal Society, as it seems, spent 381-150=231 pounds that could have been saved, and helped Davy get a reward of 525 pounds. But even if we accept to the letter what Babbage says, evidently all this does not amount to the accusation that Davy transferred hundreds of pounds "from *the funds of the Royal Society* into his own pocket" (our emphasis). Davy's brother, John, in a letter published in the *Philosophical Magazine*, protested against the charge, by presenting evidence which showed that, given the total cost paid by Murray for the publication, if he had managed to have the whole of the

contemporaries were prone to remember the supposed unfinished last writing of the philosopher and to forget the supposed deeds of the President of the Royal Society, just as Babbage himself had predicted? The origin myth, so often recited, remained intact. That Davy "began a book upon the subject but died before completing it" is what we are told also in another historical narrative about the British Association, of a much later date and of an indisputably official character, published in 1922 and written by Osbern John Radcliffe Howarth, who at that time held the post of the Secretary of the British Association (Howarth 1922, 3).

But to those who could read between the lines of Babbage's *Reflections* the message was loud and clear from the outset. Immediately preceding the sentences borrowed from Davy, Babbage quotes from the entry on "Chemistry" in the *Encyclopaedia Metropolitana* (published in 1830) a passage wherein analytical chemistry is counterposed over against electrochemistry. Chemistry "has suffered some degree of neglect" in consequence of the electro-magnetic researches and discoveries: "at least, we remark that, during this period, good chemical analyses and researches have been rare in England". Author of the entry cited was Francis Lunn, and although he only mentions Hans Christian Oersted "and his followers", as representatives of this, rather obstructive for the growth of chemistry, line of inquiry, it is not difficult to hear the bell tolling also for Davy and Faraday (Babbage 1989, VII, viii; cf. Lunn 1830, 596). Lunn was a friend to Babbage, but not the only one called here to testify. To the quotations from Lunn and Davy a comment of John Herschel had been added, gleaned from the "Treatise on Sound" (published in the same volume of the *Encyclopaedia Metropolitana* as Lunn's entry), mostly concerning the inadequacy of British scientific journals, as for the communication of recent scientific developments from abroad, in comparison with the journals published in continental Europe (Babbage 1989, VII, viii; cf. Herschel 1830, note on p. 810). When Herschel read the draft of the *Reflections*, handed to him by Babbage before publication, his first reaction was to exhort his friend to "burn it or rewrite it": "If I were near you and could do it without hurting you and thought you would not return it with interest I would give you a good slap in the face" (letter of Herschel to Babbage n.d. [5-18 Mar. 1830] quoted in Morrell and Thackray 1981, 48). A decade earlier, at the time when Davy was a candidate for the Royal Society presidency, both Babbage and Herschel, along with Lunn and George Peacock, all of them key players in that "loose convergence of scientists, historians, dons, and other scholars, with a common acceptance of accuracy, intelligence and novelty" which Walter Cannon

impression sold at trade price, he would have lost 94 pounds or so (in fact, he sold less and his loss was greater). This is an indication that there had been no need for him to be "induced": Murray was willing to give a large sum of money for the copyright because he expected "that the demand for the 'Discourses' would have been so great as to require more than one edition, so as to remunerate him for his outlay" (J. Davy 1864, 482-483).

called the "Cambridge Network" (Cannon 1964, 66), had struggled in common to build support for Wollaston, as the most reliable challenger to Davy.[18] In 1826, Herschel shared Babbage's disappointment both with Royal Society's decision to award the first Royal Medals, for recent original contributions in science, to John Dalton and James Ivory, and with Davy's personal choice to name John George Children to the Secretaryship of the Royal Society, in either case discarding Babbage as a candidate (MacLeod 1971, 84, Miller 1983, 38-39). Later on in the same year when Herschel threatened to slap Babbage, the latter was the leading supporter of the former in the contest for the chair of the Royal Society, against Augustus Frederick, Duke of Sussex, who eventually won this race (Williams 1961, 229-230). They were of the same camp, but the way they assessed the current situation, as well as their preferred tactics in responding to the challenge, were different. Letting Herschel's call for caution go,[19] Babbage and Brewster proceeded with their campaign and by making use of the names of two lionized scholars maintaining an authoritative grip (Davy and Herschel) they tried to divert the possible criticism of existing scientific practices to the particular direction of reforms they themselves were proposing.

The only significant attempt, from the ranks of the scholarly community, to counterbalance this attack was made, anonymously at first, in 1831 by a letter of Gerard Moll, a chemist, inhabitant of Utrecht, who argued against the devaluation of English experimenters. Michael Faraday, the recipient of Moll's letter, published it as a pamphlet, under the telling signature of "a foreigner", adding his own one-page comment as an afterword. Self-taught experimenter himself, as Davy, his mentor, had been, and champion of the same kind of science, Faraday eschewed touching upon the crux of the matter, i.e. the question of science as a profession. All he had to say was that "it is an extraordinary circumstance for English character to be attacked by natives and defended by foreigners" (Faraday 1831). The debate took a new, different twist, being reframed as a controversy over national character and national accomplishments. This new framing made less semantically important some of the salient points initially stressed by Moll, and in particular those regarding the impact on science both of the growing division of labor and of centralized state control.

"In England", Moll writes, "men of science take a more general interest in branches unconnected with the object of their immediate research". This is not the case in France, where "the principle of the division of labour is more acted upon": here "a mathematician

18 See the extracts from Herschel's diary in Gilbert 1955, 258-263. Wollaston decided to withdraw his candidacy and till his death, in 1828, remained a friend and supporter of Davy.

19 Soon after the *Reflexions* were published, Herschel himself changed his mind and told Babbage that he now thinks that the book will do good and "would have done much more had it been less bitterly sarcastic" (letter to Babbage, May 22, 1830, quoted in Boas Hall 1984, 50).

understands mathematics, and nothing else; a mineralogist may be very ignorant of every other branch of science; and they actually had an astronomer of great renown, whose mathematical knowledge did not extend beyond the rules of arithmetic" (Moll 1831, 14-15). More specialization means less scientific creativity. If Herschel and Babbage had the luck to live in France, they "would have selected some particular department in which they would have concentrated all their powers, but they never would have thought of ranging, as chance or opportunity directed, through the fields of optics, mineralogy, mechanics, and astronomy". Operating within a cultural milieu marked by segmentation, Babbage, now so notoriously ingenious, restless and versatile, "might have written a standard book on mechanics, but he could never have thought of inventing that wonderful calculating engine which it must be the wish of every lover of science to see him bring into use and perfection" (Moll 1831, 15). And is really Napoleonic science a seductive example, so that other countries to import its know-how? Yes is the answer of Moll, but only in the sense of seducing philosophers into their corruption, into the abandonment of any principled conduct. The men dedicated to science are, and should remain, philosophers, and philosophers are not, and should not aspire to become, state functionaries, occupying high positions in state hierarchy. Sometimes it happens that a marquis, a baron, a minister selects the path of becoming a philosopher, but "it is not the philosopher who, on account of his philosophy, is raised to the rank of an ambassador, or a count, or a baron, or a minister". These functions are certainly profitable. Yet, they are not necessarily honorable, all the more so when the political regime in question is that of a tyranny, as the Napoleonic Empire essentially was: "in our opinion, the humble dwelling where Mr. Ivory resides, and where he enjoys what Galileo's friend named *la monarchia de se stesso*, is a place far more deserving of our respect than the splendid residence of La Place in the palace of that senate whose business and servility taught Napoleon to despise the human race" (Moll 1831, 19, 21).

Unpacking these nuances of Moll's argumentation, we can plainly see that at stake was something far more important than a cross-national comparison. The real contradiction was between two significations of science, two different conceptions of doing science. Davy and Faraday in the eyes of the declinists represented an outdated research tradition excessively concentrated on how to find ways out of the theoretical labyrinth of electricity, at the expense of other fields of research, congruent with a type of scientific practice growingly specialized, and subordinate to state control.[20] Continental analytical mechanics and analytical chemistry posed as viable alternatives to the philosophical chemistry still being expounded in London (cf. Bud and Roberts 41-42). Not because of their being less abstract. Exactly the opposite holds true. They were more detached from the domain of lived experience. But they were more befitting to that type of scientific

20 This is not to say that the declinists did not find electricity an interesting topic. Babbage, for example, alongside with Herschel, had repeated and modified Arago's electromagnetic experiments (Schwarz 2002, 371-372).

practice, then still an exceptional condition, inside Western societies, though not in the colonial territories, which was afterwards to become the rule: whereupon the capitalist state "regiments the production of science in such a way that it becomes, a state science locked into the mechanisms of power", whereupon the intellectual labour is structured by this state "through a whole series of circuits and networks thanks to which it has taken the place of the Church"; whereupon "intellectuals have been constituted as specialized professional corps through their reduction to functionaries or mercenaries of the modern State"; whereupon "in the universities, institutes, academies and societies of learning, these bearers of knowledge-science have become state functionaries through the same mechanisms that made intellectuals of this State's functionaries" (Poulantzas 2000, 57). Babbage and Brewster rode the wave they had seen coming and instigated a battle "about efficiency and the proper division of labor in science" (Morus 2005, 37).

Science under measurement

Not rarely, in historical accounts of the origins of Victorian culture, or more specifically of Victorian science, the debate over the decline of science in Britain is alluded to briefly or discussed in detail. But what most historians tend to overlook is that Babbage and Brewster, while weighing British scientific achievement, introduced new standards of evaluation, or rather they tacitly used new requirements as the only pertinent factors in calibrating their scale. Up to then, both state patronage and the professionalization of science were far from having been commonly identified with the most desirable avenues for the future of science, or straightforwardly championed as valid indicators for its current vigour.

Besides Moll, Jean-Baptiste Biot, in his own review of Babbage's pamphlet, also admonishes his colleagues against considering honorary titles granted by the state as an unobjectionable index of intellectual ranking. The reason why "a spirit so much abstract as Babbage's is" believes that they must be so perhaps has to do with the exalted leverage that the distinction of ranks has had and still retains in British society.[21] At variance with that sense of social status, the most gratifying privilege a "savan" may enjoy is to be ranked on the basis of the judgment of his peers, who are "distributed across the whole surface of the civilized world" (Biot 1831, 45 – our translation). Even more importantly, Biot rejects Babbage's explanation of the rapid advancement of science in France. If impressive scientific deeds have been brought forth in French society, this must be attributed to two complementary

21 "Or, c'est assurément un effet moral bien remarquable de cette distinction des rangs si fortement prononcée et si continuellement sentie en Angleterre, que de voir un esprit aussi abstrait que M. Babbage, amené à admettre des titres honorifiques comme l'expression acceptable des rangs intellectuels", Biot 1831, 45.

causes. The one is the public character that the highest education has acquired through a variety of public lectures offered independently both of state intervention and of any private contributions. Since they received a basic salary from the state, the lecturers could focus their energies with undistracted attention on a thorough examination of the fields of knowledge they were surveying, without being absorbed by the imperative to attract crowds who could afford to pay. The courses delivered in the Collége de France, the Jardin des Plantes, or the Bibliothèque Royale fall into this category. The second cause is the foundation of novel educational institutions out of the highly promising political and moral climate which existed in the immediate wake of the overthrow of the Jacobin revolutionary dictatorship in 1794, thanks to the diligence of certain highly esteemed scholars, who were also active in the public sphere, such as Monge, Berthollet, Fourcroy, Guyton de Morveau. The École Normale, providing teacher education, and the École Polytechnique, covering the entire range of the natural, mathematical and military sciences, those two higher education centers, adjoined with a system of free public secondary schools across all of the country's departments, became the new scenes of action, not only for the circulation but also for the production of knowledge.[22] "Strange assemblies of the sciences" were held therein: philosophical discussions where curious students, such as for example the young Joseph Fourier, could put new questions or express their doubts to lecturers, such as Lagrange and Laplace, "who never could have been heard freely exposing their ideas to public debate, had this revolution not occurred" and "whose genius had been hitherto confined to address itself, only generally, to Europe" (Biot 1831, 46-47). Science advanced because a system of free public education has been developed, where professors, though poorly paid, could work independently and occupy themselves only with teaching, discussing and researching: not with prolonging their career as state functionaries, but with practicing science as truth seekers. Biot, however, asserts that this cause of advancement did not last for long. The secondary schools of the departments soon ceased to exist. The Polytechnic School has taken another direction, towards an education which is "less elevated and less general" (Biot 1831, 47); it has been reduced into a military academy. Centralized state control of education inhibits scientific creativity, which presupposes freedom of inquiry and the ability to work without any external imposition of priorities. In England, at the bare minimum, "despite the fact that scholars have been left abandoned by the government, or perhaps by reason of the fact that they are so abandoned, the mere randomness by which they are scattered throughout the kingdom gives a character of solitary and independent originality to their scientific researches, which is rarely to be found in the same degree among the productions of the scholarly associations, and which is not one of their less

22 Cf. what Maurice Crosland (1975, 43-44) notes: "the revolutionary situation in France enabled institutions to be established where teaching was at the level of research [...] It was as a teacher that a scientist was most exposed to the public, and the scientist was probably thought of as much as a lecturer as a research worker".

salient merits".[23] Now it is French society that must arrest the impending decline in science: even apropos of the higher mathematics, "unless prompt remedies be applied, in a very short time from now English scholars will be quite justified in no longer saying that they have hopelessly stepped out of the arena" (Biot 1831, 47).

Both during the Republic and during the Empire, state patronage was afforded to the men of science, creating the material conditions for their unification, demarcation and reproduction as a distinct social group, which could be incorporated, as such, into the social category responsible for "setting the institutions of the political power into operation" (Poulantzas 1973, 332): the salaried and hierarchical bureaucracy of the rising capitalist state. As Maurice Crosland has showed, from the days of the revolution and the war, science in France had been differentiated out, as a "culture" separate from that passing under the name of belles-lettres, as a particular modality for reconstructing realities and doing things (notably, for the benefit of the army's arsenal) which ought to be cherished and protected, if not for its own sake, then at least in its functional peculiarity. After 1794, a new educational framework was built which gave science scholars the opportunity to earn their living by their scientific work, and rendered formal science training a stage of a possible career path (Crosland 1975). Biot's own professional life epitomizes the repercussions of these institutional novelties: he graduated from the École Polytechnique in 1796, he was appointed as professor of mathematics at the École Centrale d'Oise in 1797, then he became professor of mathematical physics at the Collège de France in 1800, and at the age of 29 he was elected to the First Class of the Institut de France in 1803. He did not need to come out with any outstanding new discovery in his hand (and indeed, his early work was not exceptional). Neither did he need to find a private patron, apart from the mathematician Sylvester-François Lacroix, who became his mentor, commissioning him to edit, or to write on his own, elementary treatises, introducing him to other scholars, and advising him about career choices to be made (Frankel 1978). But in 1831, Biot knew that there was a grave difference between the science education agenda carried forward under revolutionary democracy and that carried forward under Bonapartist despotism. During Napoleon's rule, the public provision of universal free education was substituted by the state provision of educational services adapted to meet the pre-defined political target of securing social stability and conformity. The social experiment of an educational system intended to promote the ideal of "a rational society in which laws were formulated for the good of all and in which the equality and liberty of men were recognized as fundamental and natural rights" (Williams 1953, 318) was terminated. The militarized,

23 "C'est ainsi qu'en Angleterre, par exemple, malgré l'abandon où les savans sont laissés par le gouvernement, et peut-être à cause de cet abandon même, le hasard qui les disperse sur toute la surface du royaume, donne à leur recherches scientifiques un caractère d'originalité solitaire et indépendante qui se rencontre rarement au même degré dans les productions des compagnies savantes, et qui n'est pas un des leurs mérites les moins saillans", Biot 1831, 48.

disciplined lucées replaced the "chaotic" liberal écoles centrales. The state did not any longer guarantee, through public education, the buildup of its citizens' autonomy, their ability to judge and to legislate for themselves. Education was not any more defined as an incitement to self-education, or as itself, at the very core of its meaning, a systemized form of self-education. "To the Napoleonic government, such aims were but the vaporings of metaphysicians who knew nothing about the realities of the world in which they lived. The scheme of the *Idéologues* was dismissed by [the famous chemist, and councilor of the state, at that time] Chaptal with the words "It is impossible to teach the art of law-making" [in his *Mémoire sur l'instruction publique adressée aux Consuls*, 1800]. The Napoleonic state was based on the proposition that one man –Napoleon– was to bear the entire burden of government, and that citizens in the ideological sense of the word, were not only superfluous but dangerous. Napoleon desired obedience, not criticism or discussion. The function of education in this state was correspondingly redefined" (Williams 1956, 370-371). To be educated henceforth meant to learn how to be loyal to the political regime, respectful of the established social order, and how to prove oneself, as well, efficient and skillful in performing the tasks of the state bureaucrat (cf. Grab 2003, 56).

Public education, as envisaged by the republican group of Parisian philosophers known as the Idéologues, and in the form in which it began to be materialized during the period of the Directory, was not identical with, neither should it be taken as a necessary harbinger of, what later became entrenched as state education. The Napoleonic experience altered both the meaning of the word "education" and the meaning of the word "state". The contradictory dynamics of the revolution, the friction between the new real possibilities opened through the collective plebeian struggles for political liberation and the concrete actuality of a state apparatus, which, under the absolute monarchy, had already been augmented and intricately structured, quite enough to serve both as an aggressive war machine and as an adjustable organizational structure for shielding political class domination from any potential opposition or radical criticism, was surmounted by the consolidation of the state's role in controlling, stratifying, and imposing enclosures upon public life. The Bourbon Restoration did by no means entail a slowdown of this process: "every *common* interest was immediately detached from society, opposed to it as a higher, *general* interest, torn away from the self-activity of the individual members of society and made a subject for governmental activity, whether it was a bridge, a schoolhouse, the communal property of a village community, or the railways, the national wealth and the national university of France" (Marx 1973, 237-238; emphasis in original).

This restructuring of power relations, and of education too, had profound ramifications for science: the way its progress, or its decline, could be imagined, sensed and sized up changed to a degree which we can hardly overestimate. Arnold Thackray once opined that if we want to measure how healthy science is, at a given period, then we need to construct proper indicators, and the best strategy for doing so is to ask questions likely to elicit explanations which bring into play the weight of ongoing major social changes upon science as a mode

of culture, the variation in the collective representations of science, and the different types of socialization processes operating in different ways of knowledge transmission (formal science education or informal popularization of science). It's not an easy exercise, and strictly speaking it cannot be broken down into operations of quantitative measurement: to assess the contemporary state of science is to problematize both science itself and the social settings in which science is grounded and embedded. The failure to acknowledge this complexity has repeatedly led to verdicts which were very soon found false. Likewise, the preoccupation with the most obvious and familiar traits in a given historical reality, the acquiescence to the seemingly irresistible trends that pervade society in a conjuncture of time, yields no better results. Babbage's campaign against the decline of science in England is probably the most notorious example. 1830, Thackray reminds us, was the year when "Charles Lyell was bringing to fruition his *Principles of Geology*, Charles Darwin was moving at increasing pace toward the *Beagle voyage*, and Michael Faraday stood on the brink of discovering electromagnetic induction". Babbage and Moll disagreed over the standards to be used, and the significations to be attributed to certain contemporary events. They both also neglected a whole range of parameters, whose pertinence as indicators pointing to dynamism, rather than decline, we are now, in hindsight, able to affirm: "the rate of formation of metropolitan discipline societies, of provincial 'literary and philosophical' associations, of natural history clubs, of statistical and agricultural societies, and of mechanics' institutes", as well as "the tremendous growth in textbook and encyclopedia publishing, the emergence of a popular journal literature of science, and the dramatic expansion of teaching and learning opportunities through the activities of itinerant lecturers, mathematical practitioners, instrument-makers, and medical entrepreneurs" (Thackray 1977, 24-27). Only an elaborate, sociologically informed analysis may bring out this emerging cultural landscape, then still faintly discernible, the confluence of a variety of local movements from below which came to form a counter-current running against the sweeping tide of statalization and professionalization of science.

But precluding, in advance, any further critical reflection, or even any normative evaluation, that might raise the issue of what should science *not be*, what actual state of science intercepts or tends to abrogate its reality as a critical tradition, is not without cost. For this is precisely the issue that set Moll and Biot at odds with Babbage and Brewster. The latter nominated Napoleonic science, or state-controlled, and abstracted from human lived experience, science, as an exemplary state of science. They did not incite their compatriots to emulate the approach to public education adopted by Fichte or Humboldt, where autonomy and community interweave in the fabric of a national universal education, aimed at the moral preparation of citizens to regain, exercise, and reciprocally limit their natural freedom. They spoke mostly of career possibilities, ranks, pensions, and patents. Over universality and synthetic thinking they favoured specialization and analytical skills. The declinists did not merely describe a situation: to emphasize potential achievement in deploying analytical mathematical methods and to downplay the significance of the theoretical work done in the experimental sciences, to prioritize the professionalization

of science at the expense of the moral independence of the men of science, is to make tacit normative assumptions about what science is and what should it become. Moll's and Biot's qualitative judgments were not of "different things", as Nathan Reingold maintains, echoing an argument made by Babbage, indicative of his general rhetorical strategy of abstaining from any discussion over the premises of his criticism, and presenting his statements not as normative, but chiefly as statements about facts.[24] Thackray keeps himself away from that snag, yet without probing further into the question of what ideal type of science did Moll and Biot vindicate, and how might such a vindication be relevant to current debates about the nature of science. The more we repress the normative facet of the matter in disagreement, the less accurate, symmetrical,[25] and meaningful (to us, today) our historical reconstructions will be: against Babbage and Brewster, both Moll and Biot saw in Napoleonic science the negation of science as a critical tradition developed in tandem with the free circulation of knowledge, through public education, and the assertion and realization of human autonomy, through the diffusion of political power. And they were not alone. It was for similar reasons that Alexander von Humboldt scoffed at Babbage's "liking for the Princes whom he calls grand lords",[26] and William Wordsworth characterized Brewster's review of the *Reflections* as "foolish", a "poor compliment" to science, the hill of which "it seems, in the opinion of the writer, cannot be ascended unless the pilgrim be 'stuck o'er with titles, and hung round with strings', and have the pockets laden with cash" (Wordsworth 1939, 546).

A mirror that reflects

To be "stuck o'er with titles, and hung round with strings": it is somewhat strange to see this verse from Alexander Pope's *Essay on Man* cited here, among words of reprimand against Brewster. A line, meant to further illustrate that "honour and shame from no Condition rise" and that "worth makes the man" (Pope 1996, 542, lines 193, 203, 205), written by a Tory poet, who nonetheless, had created for himself, and left behind as a legacy, the idealized image of the "professional", independent of aristocratic patronage, writer (Griffin 1996, 123-154), is directed by Wordsworth against a Whig natural philosopher. But there

24 See the extract from a letter to Quetelet, December 24, 1831, published by Reingold 1968, 58-59 – for Reingold's own treatment of the differences between Babbage and Moll see pp. 59-61.

25 If we take the requirement for employing the same type of explanations for both sides of the controversy to mean a call to "restructure our curiosity", and to overcome the tendency to adapt to our own background conditions (Bloor 1991, 175-176), in our case: the proclivity to reproduce, justify and protect the image of science dominant in our own cultural logic.

26 Letter to François Arago, Postdam, July 10, 1830 in Hamy 1908, 87-94 – the quotation on p. 92.

is still more. Apart from being "a consistent though moderate Liberal" throughout his life (Gordon 1870, 149), Brewster, by rushing forward as a front-line partisan of Babbage's cause, had aligned himself with the "reform alliance" forged within the metropolitan scientific milieu against the administrative regime of Joseph Banks, who was blamed for conferring a much too preponderant role upon aristocratic amateurism. Babbage and Herschel were prominent figures in this alliance, which was clustered around the Cambridge Network and crystallized when Banks was about to retire and Davy stood ready to succeed him. In the decade to follow, the reforming party was alerted to stand by for attack (Miller 1983, 30-40; Boas Hall 1984, 16-32), but also flexible enough to be able to garner, at crucial moments, broader support among those who were generally favorable to reforms that might boost scientific literacy and expertise, albeit endorsing a different set of priorities or guiding ideas.

The leading Cambridge academic William Whewell, for instance, sided with Herschel's backers in the 1830 election for the presidency of the Royal Society, even though he had reacted with hostility to Babbage's and Brewster's plea for the reform of British science, criticizing their insistence on juxtaposing the habit of original research to that of "academic instruction", and defending, before the conservative audience of the *British Critic* (a theological journal which reflected the views of the High Church Tories), the reputation of the traditional universities of Cambridge and Oxford against all "those who sneer, and rail, and propose the re-modelling or subversion of these institutions".[27] So adequately moderate as to look like "a Whig among Tories and a Tory among Whigs" (thus says the neoconservative political historian Maurice Cowling 2001, 218), to stand up for the intellectual efficacy of science in the face of Anglican conservatism and to preach reverence for the dominant beliefs and practices in the face of educational liberalism or philosophical radicalism (Yeo 1993, 209-230, Wilkes 2001, 47-50), Whewell was to play a more influential role in the formation and evolution of the British Association than did Babbage, or even Brewster himself, who deservedly gets the credit for being the first to put such an idea on the table, being so little satisfied at the prospect of reforming the existing scientific institutions as "Lenin would have been, with Kerensky's regime, had it worked" (Cannon 1978, 219).[28] As a matter of fact, political moderation was a quality

27 Whewell 1831, 72, 89; the attribution is given in Todhunter 1876, I, 49. Cf. the analysis of Richard Yeo (Yeo 1993, 90-92). Before the publication of the *Reflexions*, Whewell maintained a friendly communication with Brewster, but their disagreement over the value of Babbage's book was the occasion "if not the cause of a deep breach between them" (Morrell and Thackray 1981, 49).

28 Babbage, in 1828, had attended the annual meeting of the Versammlung deutscher Naturforscher und Aerzte in Berlin. He wrote a report for Brewster's *Edinburgh Journal of Science* and in his private correspondence suggested the creation of a European gathering of men of science. James Finlay Weir Johnston, in 1831, publishing, in the same journal, his own report of

shared by both the anti-aristocratic opposition which was active, during the 1820s, inside the Royal Society, and the "gentlemen of science", as Jack Morrell and Arnold Thackray (Morrell and Thackray 1981, 23-29) called the managing coterie of the British Association, which became the hegemonic group within the rising scientific intelligentsia of the British Isles, the head of the national church of knowledge. Confidence in the direction things were taking in society, barring any serious and potentially disastrous political turmoil, was yet another element the two groups had in common.

The difference and analytical engines that Babbage designed, and which have handed down his name to posterity (since they are hailed as precursors to the modern computer), were embodiments of the sense that the factory system, the inner core of the new industrialized social reality, was not only irresistible, but also a necessary step in the normal, progressive course of human affairs, perfectly in tune with the natural order of the world. They reflected the deluging wave of machine production and simultaneously they displayed a mirror fit to reflect what was happening in the factories as something natural. The actuality as the best of all possible realities: in Babbage's project "the mechanization of reason went in hand with the rationalization of mechanism" (Schaffer 2003, 282). Machinofacture made evident how intelligent reason operates, how it could be technically reproduced, and how it could be rendered productive, because intelligence itself was redefined so as to replicate the formidable power wielded by the "labour discipline within a system of division and coordination producing geometrical precision out of mere manual skill in despite of proletarian resistance" (Schaffer 1994, 222). But if we may agree with Bruce Berman that "computers were conceived in the image of a particular historical world", whose central features, as transmuted into the work of Babbage, were "the dominance of instrumental rationality, the development of bureaucratic organization, and the struggle to control the labour process" (Berman 1989, 15), we also should admit that the political neutrality assigned to science by the "gentlemen of science" obeys precisely the same rule.

One of the far-reaching novelties introduced by the founders and the spokesmen of the British Association was the articulation of an ideology of science, according to which the

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the 1830 meeting of the Versammlung in Hamburg, asked himself whether it was possible a similar institution to be founded in Britain. But it was Brewster who first explicitly articulated the idea of organizing an association, at the national level, "for the purpose of protecting and promoting the *secular* interests of science", in a letter to Babbage, dated February 24, 1830 (emphasis in original). One year later, in another letter to Babbage, Brewster speaking about Johnston's account took the occasion to make specific plans for staging the first national meeting of British men of science in York. See Morrell and Thackray 1981, 46-47, 59, Orange 1972, 156-157. For the part played by Brewster during the early days of the British Association, in comparison with the growing authority assumed by Whewell, see Morrell 1984.

appeal to nature, through science, and regardless of whether actually existing forms of political repression and class exploitation do condition both the nature and the scope of human agency, could furnish the means of constructing incompatible value-free and impersonal judgments about everyday problems and conflicts. Once again, what-is is being rationalized and reason instrumentalized: "to the politician and theologian science became a means of bolstering those of their claims which could be understood in terms of the natural or ordained place of man. To the manufacturer and engineer, science became the rhetorical guarantor of the rightness of their chosen courses. To the prosperous citizen, science became not only a private pleasure but a civic duty. To the Gentlemen of Science themselves, and those who aspired to join them, science as a vastly extended intellectual quest and as a conveyor of moral purpose was soon translated into science as a lobby of Government; science as an argument for prestige and position; science as a means of career enhancement; science as a subject of grants, reports and research programmes; and science as a socially irreproachable means of ego aggrandisement" (Morrell and Thackray 1981, 33). What had already happened in the colonized parts of the world, where scientific research was subsumed under the demands of the expanding imperial states, now was to be re-enacted inside the societies of the West. Knowing was to be severed from the responsibility to *become* a subject, to judge and act autonomously, even against the odds, by striving to transform both the self and the actual conditions of selfhood. Science could now be turned into an intellectual capital and a potential force of capitalist production: a faithful mirror of our world as it stands frozen, naturalized and ostensibly eternal, before our eyes, the eyes of the Ego that wills and represents its own normalized, efficiently aggressive and competitive self as the best possible world. Science could mature into "big science", the type of science to which we are now accustomed.

Amphibious life, adaptable fragments

Reaching the end of our narrative, we must return to where we started: to Davy. Sure enough, it would be a grave misrepresentation to portray him as the "good guy" in that episode. Having being for seven years president of the Royal Society, he personified what Babbage, not without good reasons, abhorred: elitism and private patronage. He could easily pretend to despise money-making from science, because he had already made money from lecturing under the auspices of wealthy, aristocratic patrons, such as Count Rumford, the founder of the Royal Institution. Whereas Lavoisier, to cite but a single example, three decades earlier, had been earning his living as a tax collector, and had pursued chemistry as a hobby, Davy was one of the first professional and well paid experimenters (just before his marriage in 1812, his annual income, taken altogether, was about £1000, see Knight 2002, 114). When he decided to stop giving lectures at the Royal Institution, he had already secured a comfortable life for the rest of his years due to his marriage with Jane Kerr, widow of Shuckburgh Aprecee, eldest son of a baronet, and heiress of a wealthy Scottish merchant, who had taken "the *blue* line" establishing

herself as a "leader of literary fashion" (Scott 1890, I, 107, emphasis in original).[29] Son of an artisan and an apprentice apothecary himself, Davy ended up being the first practitioner of science to receive a knighthood from the Regency (in 1812) since Isaac Newton. In 1819 he was awarded a baronetcy too.

If Babbage applauded the tyranny of Napoleon, Davy was content to go along with the status quo in his own country, bowing before the "sacredness of property" and "social order".[30] He was flattered at being awarded prizes, ready to flatter potential patrons of science, and quite unreluctant to demonstrate his loyalty to the British Crown and his identity with the British interests. During his first continental tour (1813-14), he passed from Paris to collect the 3000-franc Prix Volta founded by Napoleon for breakthrough discoveries in galvanism. He justified his acceptance on the ground that science knows no national borders. France was at war against Britain; the men of science were not –"that would indeed be a *civil war* of the worst sort" (J. Davy 1836, II, 405-406). But immediately after the battle of Waterloo he drafted a letter intended to Lord Liverpool, then Prime Minister of the United Kingdom, in which universalist aspirations were swept away by feelings of aggressive nationalism (and even anti-Semitism): "the French, after their multiplied perjuries and atrocities, ought to consider it a mercy that their cities are not burnt, and their country divided; they ought to consider it a mercy that they do not suffer the fate of that people whom they resemble in so many particulars – the Jews, when Jerusalem was destroyed by Titus, and the name made a reproach amongst nations" (J. Davy 1858, 194). When, in 1810, John Sinclair, President of the Board of Agriculture, was appointed to the Privy Council, Davy wished that this might be "the prelude of an uniform patronage of the public objects of science and useful art, on which the glory and prosperity of the country must ultimately depend" (letter to John Sinclair, December 1809, published in Sinclair 1831, I, 431). He had first-hand experience of his recipient's patronizing generosity: on behalf of the Board of Agriculture, Davy delivered a series of lectures on agricultural chemistry from 1802 to 1812, during which "he derived considerable emolument" and "became acquainted with a number of the most distinguished characters in the kingdom" (as Sinclair himself noted, 1831, I, 431). And he definitely wanted to be uplifted to the social summit populated by those "most distinguished characters", however much he meditated on honours as being but "artificial lights" (from one of his notebook entries quoted in J. Davy 1836, II, 67). After he had embarked to his last continental journey, he confessed to his wife that he felt he had

29 Taking the "blue line" means becoming a 'bluestocking'. It has to be noted here that, the mutual benefits notwithstanding, what brought together Davy and Mrs. Aprecee was love, as the letters they exchanged before and after their wedding prove, see Fullmer 1962, 156, Holmes 2008, 337-343.

30 The words quoted are from a non-dated and unsigned draft letter Davy intended to send (or did send) to Lord Liverpool, and published in J. Davy 1858, 189-196 – the quotation on p. 190.

been honoured somehow rather meagerly: "I ought to have been made a Privy Counsellor [sic] and a Lord of Trade, as my predecessor [i.e. Joseph Banks] was" (extract from a letter to Lady Davy, August 1, 1827, quoted in Knight 1967, 74). "It is not that honours are worth having, but it is painful not to have them" (J. Davy 1836, II, 67): he was mindful of both the discrepancy between moral integrity and professional success and the adjacency between rootedness and assimilation.

In some sense, that should not be underestimated, Davy was part of the problem. And at any rate, there was a deep and widespread need for reform, felt not only inside and around the existing scientific institutions, but in almost every corner of British society. In 1830, the July revolution in France rekindled the political agitation for electoral reform, and the Whigs pushed forward the first Reform Bill: the times demanded, or at least justified, open discussion about the possibility of structural changes. As a rule, any call for reform envelopes a feeling of dissatisfaction with current circumstances, a fear of decline. The originality of the argumentation and the novelty of the standards used by Babbage and Brewster provoked temporarily a buzz of disapproval among some of their colleagues, but this did not hamper seriously their attempt to make out a plausible case, by installing their criticism on a line of continuity with previous warning voices.

Such is the case with three reviews anonymously published in the *Edinburgh Review* by the Scottish mathematician and natural philosopher John Playfair, who was, by the way, a friend of Davy, in company with whom he had undertaken some geological field excursions.[31] Recently, Maurice Crosland in an essay on the question of state patronage in the early Victorian era positioned Playfair as a forerunner of Babbage and Brewster, as far as the urge for reform in British science is concerned (Crosland 2010, 530-532). Up to a certain point, this seems to be a sound inference after a close reading of the relevant texts. Only up to a certain point though. Playfair does talk about the "decline [...] or deficiency in mathematical knowledge" in England (Playfair 1808, 282; the attribution is given in Houghton 1966-1989, I, ER 384), but not about the decline of British science in general. He is explicit in acknowledging that "in a country which has done more for chemistry, than all Europe put together, which has given greater encouragement to the arts –to agriculture and manufactures –to literature and general science –than any nation on the face of the globe – a charge of intellectual inferiority cannot be well founded" (Playfair 1819, 392; the attribution is given in Houghton 1966-1989, I, ER 868). He also repeatedly talks about the "small pensions and great honours, bestowed on a few men for devoting themselves exclusively to works of invention and discovery" (Playfair 1810, 398; the attribution is given in Houghton 1966-1989, I, ER 504), "to deliver them alike from the embarrassments of poverty or the temptations of wealth, to give them a place and station in society the most respectable and independent" (Playfair 1822, II, 217), as a means of

31 Siegfried and Dott 1980, xvii, xxiv. Playfair had also fallen in love with Jane Aprecee, before she married Davy, see Treneer 1963, 120.

advancing the mathematical sciences, successfully used in France, but he does not say anything at all about the need for professionalization, for career opportunities generated by reliance on state patronage and control. He extols at some length the Parisian Royal Academy of Sciences as a site of scientific creativity, along with the École Polytechnique, but only insomuch as to show that the time has come for new public scientific institutions to come into being, shifting thus the center of gravity in science education away from the old universities, and in the curriculum itself away from the traditional disciplines (in the case of Oxford University) or away from the traditional interrogative methods of teaching (in the case of Cambridge University). And lastly, he refers to Napoleon in rather favorable terms, but he does not mean "to plead the cause of those governments where the opinion of the people has no share in determining the conduct of their rulers": "such governments are essentially bad; and the fact we have stated only tends to prove, that there is no evil so pure as not to contain some alloy of what is good" (Playfair 1810, 398). The contradistinctions he makes between the synthetic and the analytic mathematical methods (Playfair 1808, 282, Playfair 1819, 393), between the ample production of textbooks in post-revolutionary France and the zeal to extend the boundaries of science, by exploring new territories, that animated French scholars before 1789 (Playfair 1810, 396-397), between general and particular knowledge, between the gentlemen and the ladies who are "conversant in chemistry, mineralogy, entomology, modern languages, history, politics, and fifty hard-worded studies beside" and the men who choose to devote themselves "almost exclusively to Mathematics" (Playfair 1819, 393) portend perhaps the series of contradistinctions later made by Babbage and Brewster between synthetic and analytic knowing, between theoretical and pragmatically oriented research, between the ability to discover something new and the ability to teach, to reproduce something known, between philosophical insights and specialized efforts or abilities divisible in distinct measurable skills. But such a line of descent is ascertainable only if we reiterate the tactical move Babbage and Brewster made, when they resignified various fragments of earlier worrying comments about the state of science, in British society, holding their own views as a yardstick. It is a matter of perspective, but what we now know –especially in connection with the way they annexed to their signatures the name of Davy, who was one of their shooting targets– does not license us to give preference to their perspective: the impression that Playfair's criticism influenced the declinists does not outweigh, neither does it contradict, the impression that the declinists appropriated and reinterpreted for their own ends, and under their own reform agenda, some of Playfair's recommendations.

Appropriation, re-signification, reframing of the rule (e.g. autonomy of the philosopher), normalization of the exception (science as a career path in the administrative machinery of the state or in private business): here, this seems to be a generally applicable pattern. Babbage and Brewster recast earlier criticisms or discontents into an urgent appeal for reform which was predicated upon a redefinition of the finality in the very process of knowing. Research, knowledge production, was dissociated from education, from knowledge circulation, but both were tied principally to efficiency assessible within given

social contexts, rather than with creativity extending beyond what-is, pointing to the real possibility of a better and rational society (the enlightenment ideal of an autonomous citizen of the world, of a community-to-come). Davy, even against the objective limitations imposed by his own class determination, always defended the second option: his chemical philosophy was poetical, an expression itself of the self-valorizing dimension of living labor, and only as such could it be useful in practice.

He was awake to the need for reform, too. Both in the Royal Institution and in the Royal Society he tried to identify and exploit objective possibilities for reform, but he was unable to build stable alliances and to navigate through the tensions, the heightening animosities, and the mutually hostile parties which were already in place (Fullmer 1980, Miller 1983, P. Unwin and R. Unwin 2009). A manuscript draft of a speech he intended to deliver before the Royal Society or at the Royal Institution, sometime after his resignation in 1827, includes the following telling remark: "in every part of the metropolis people are crying out for knowledge, they are searching for her even in corners & bye ways & such is their desire for her that they are disposed to seize her by illegitimate means if they cannot obtain her by fair or just ones. This then is the moment to give energy to their efforts & for the legislator to sanction what reason has so long required". The reform project that Davy had in mind was "a radical & fundamental change" in everything related to the British Museum with a view to converting a foundation which seemed to represent "little more than a series of quaint collections in vertu where illustrations of the history of medals & the most exquisite specimens of the bronzes of the Magna Graecia are found in the same room with the sledges & dresses of the Esquimaux, the canoes arms & dresses of the people of Austrailasia & the wildest ornaments invented either by the caprices or diseased fashions of folly in almost every climate & in every age", into an awe-inspiring registry of the sublimity lurking all along within the temporality of human civilization: "the most magnificent collection of the beauties & wonders of nature & art formed from every quarter of the globe containing the most splendid monuments of the glory of the most powerful & the most ancient nations of the earth". Additionally, the libraries of the Museum and the Royal Society should be merged, and a new, "Newtonian College" should be set up (Fullmer 1967, 140-141).

The central objective of the institutional reform suggested by Davy was to open new and wider channels for the circulation of knowledge. It was a response to a cry for knowledge. But who precisely were raising this cry? We already know that it was not the aristocracy. "We may in vain search the aristocracy now for philosophers": this is what Davy said in his *Consolations* (and Babbage and Brewster reinterpreted as a warning of decline). An anonymous reviewer of Babbage's *Reflections*, in the *Edinburgh Literary Journal* added that "we were not aware that this ever was a likely place to look for them; and at all events, a few mathematicians more or less among our Corinthians, is no index of the fluctuations of science among the great body of society" (Anon. 1830b, 106). So, in which "corners and bye ways" of the social topography was this high demand for science stimulated?

If we provisionally lend some credence to the five-class model contrived by Ronald Stanley Neale to depict the social structure of the early 19th-century Britain, then we had better look for the answer among the same social class that was most inclined to embrace the latest versions of philosophical and political radicalism. "Made up of those who were low in the traditional scale of status and privilege, i.e., towards the bottom in relationships of authority and subjection, and those in this position who aspired to rise and could only do so through their own unaided efforts, whether efforts of mind and skill in trade and manufacture, or in the professions", this "middling class" of petit bourgeois, literates and artisans, as Neale defines it,[32] distinctly from the "middle class" composed of senior military and professional men and owners of industrial and commercial property, was both the most mercurial and dynamic element in the rapidly changing early Victorian society and the most combat-ready bearer of Enlightenment ideals (Neale 1968, 13-21, 23). The class consciousness of the middling class was not a "proletarian" one, viz., consciousness of an irreconcilable class antagonism sustained by structural relations of exploitation. At the porous borderline between the skilled upper fractions of the working class and the lower, politically unrepresented, levels of the middle class, the creed of self-help and the logic of communal solidarity, the sense of alienation or self-exilement and the sense of craft pride, the practices of class collaboration and the spirit of class independence and collective resistance, all these contradictory strains did, more often than not, intercross (indicatively see Tyrrell 1970, Koditschek 1990, Rodrick 2004, 1-132). But the self-awareness articulated through the local social skirmishes and the broader political battles waged by the middling class encompassed the experience of the industrial working class, by enunciating its need to protect itself against the insecurities concomitant with the very conditions of industrialized production and to break, as well, the monopoly granted to capital owners, the gentry (the lesser landowning class) and the landed aristocracy on political representation. A whole variety of new coalitions and organizations, either educational or openly political, rendering the increasing puissance of the working class visible resulted from the initiative and the coordinated, more or less independent (from the state and the upper and middle classes), action of self-confident and "non-deferential" middling-class artisans: the London Mechanics' Institute (1823), the British Association for the Promotion of Cooperative Knowledge (1829), the National Association for the Protection of Labour (1830), the National Union of the Working Classes (1831), the National Political Union (1831), and even the Association of Working Men to

32 Neale distinguishes between social stratification, determined by objective criteria (such as the source and size of income, occupation, education level, size of assets, values, social custom, and language), and social classes, which are "really conflict groups arising out of the authority structure of imperatively coordinated associations" (Neale 1968, 9). Thus, the identification of a social class involves both the knowledge of the prevailing patterns of power relations and the study of the social struggles that destabilize these patterns. Cf. Borsay 1999, where Neale's model is criticized for overestimating the role of political conflicts in class formation.

Procure a Cheap and Honest Press (1836), out of which grew the London Working Men's Association that issued the People's Charter (Morrell and Thackray 1981, 10, Neale 1968, 26-32; for a more general overview Thomson 1963, 711-832).

A mirror that transforms

Davy was a middling-class member who succeeded in rising. He even became a "Sir". To what degree did his being a "Sir" affect his chemical philosophy? Jan Golinski has asseverated that Davy packaged chemistry as a public science by giving a conservative twist to the rhetoric of polite knowledge and general enlightenment. And at least in two artisanal printed forums, the *Chemist* and the *Mechanics' Magazine*, he was criticized as being submissive to his bosses, digested by the gentlemanly mainstream, and aloof from the concerns and the struggles of the "labouring classes" (Golinski 1992, 238-245). By playing his new role convincingly, just like a fish which can swim well in different (aristocratic) waters, he re-created both himself and the science he practised after an image adaptable to the new social context in which he worked: that of the disinterested scientist, standing above social conflicts, and of the politically neutralized science, which has plenty of amusing spectacles and useful applications in store, but implies no threats to social order. At his apex, "Sir Humphry Davy" was the tamed descendant of the notorious and exiled Joseph Priestley.

For all its high pertinence value, as regards the question of how communication with a given public audience reshapes science communicated, this approach involves a one-sided accentuation of certain features, which is not always desirable or fruitful. Davy's public discourses contain many scattered passages evincing deep interest in the welfare of the working class. His wordings seem to be in consonance with the tastes or the fears of the upper class and at the same time reminiscent of a commitment to some core republican and egalitarian ideals, which he shared with the friends or mentors of his youth Beddoes, Coleridge, Wordsworth, Poole, and Southey (Ross 2003, 42). He was always sensitive to possible criticism from below, and this made him much more vulnerable, than his other colleagues in the Royal Society were, to attacks of this kind. Not that there was any scarcity of criticism from above. In 1824, in the middle of his presidency of the Royal Society, the scandalous Tory weekly *John Bull Magazine* found a lot of flaws to satirize in Davy's awkward endeavours to imitate the manners of a gentleman (Fullmer 1962, 153-159). This was not uncommon: to the members of the upper class, he looked like an outsider. No perfume could dispel the smell of the apothecary shop which never really left him. The author of the *John Bull Magazine* piece about Davy narrates that one evening he was "particularly superb and dandyish, dressed in a green velvet waistcoat, with gold spangles on it, at Miss Lydia White's, when she observed, that he looked as if he had stepped out of a box. 'A pill-box, by G–, ma'am, then', said Lutterel, 'and I see the powdered licorice has stuck to

his waistcoat'" (Anon. 1824, 89).

But for Davy himself, no spoken or written slander would be more severe than the allegation that he was making money from science. Wollaston had patented the process he had devised for purifying platinum and procuring it in a compact and workable form, and he had made a fortune out of it. He was "fond of amassing money", another chemist, George Wilson, later said, but there is no reason to press charges against "an unpensioned, unplaced chemist like Wollaston": "to manufacture platina may be, in the eyes of the world, a less dignified occupation than practicing medicine, but it left the man of science much more leisure for his studies than physic would have done, and paid him a great deal better" (Wilson 1846, 104-105, the attribution is given in Houghton 1966-1989, IV, BQR 69). Davy censured Wollaston for "applying science to purposes of profit" (Fullmer 1967, 134), and he did not himself patent any of the results of his multifarious research activities, not even his safety lamp. He was hostile to the ethos of commodification, the re-evaluation of the power to work, the power to do and to transcend oneself by doing, as an exchangeable service, a commodity to be purchased or as variable capital, an investment to be made. Was he a traditionalist? No. But he can be seen, indeed, as a romantic in the sense defined above: as articulating a critical stance towards the very same modern culture in which he actively participated. And there is here a significant detail that has gone relatively unnoticed through the historiography of Victorian science: the ethos of commodification was treated with equal hostility by the most energetic and militant parts of the middling class. E.P. Thomson concluded his monumental work on the *Making of the English Working Class* by recalling that something was lost in the failure of the so-called Romantic tradition to intersect with the tradition of artisanal political radicalism. Still, "these years appear at times to display, not a revolutionary challenge, but a resistance movement, in which both the Romantics and the Radical craftsmen opposed the annunciation of the Acquisitive Man" (Thomson 1963, 832). Something is lost too, whenever, in our historical accounts, we obliterate the affinity between these two critical traditions, their shared background, their shared foes, and their shared horizon.

On a more localized scale, the strongest public defense against Babbage's and Brewster's attack was mounted not by senior scholars but by the pens of literate artisans. In 1831, an anonymous contributor to the *Mechanics' Magazine* seized the opportunity, offered by the publication of Brewster's *Treatise on Optics* and Lardner's *Treatise on Hydrostatics and Pneumatics* (both printed in 1831 as volumes 17 and 19 respectively of the *Cabinet Cyclopaedia*, which was edited by Lardner), to rebuke the declinists vehemently for their "grumbling" about the unfair distribution of state patronage and their hankering for "such distinctions as are now awarded to eminence in the camp or in the cabinet – or at least, such as wait upon crown lawyers and lord mayors". Science is not, and should not become, just another way to find a job in one of the various branches, or even the upper levels, of the state administration: "what harvest can those who cultivate science from

such a motive expect to reap? What height in philosophy can he attain to, who would rather be *Sir Isaac, Master of the Mint, and one of his Majesty's most honourable Privy Council* – than Newton?" (Anon. 1831a, 372-373, emphasis in original). From different angles, different conclusions may be drawn for the health of science in the British Isles. And the artisanal perspective, the perspective of the middling class, is different from, if not opposite to, that of Babbage and Brewster, the perspective of the middle class. Within the former, the emphasis is on the diffusion of knowledge, on the autonomous activity of the exploited social classes (self-education), and of course on the existence of public guarantees both for universal education and for freedom of inquiry. Hence, our reviewer exclaims: "it is a consolation [...] to reflect, that what science we do possess, in these degenerate days, is far more extensively diffused than in those times so deeply regretted; and that our falling-off, if any, is only in those departments least intimately connected with the comfort and happiness of the mass of mankind" (Anon. 1831a, 373). Times are "degenerate", and yet science is not in decline, because the means of knowledge production are being reclaimed by the most dynamic and creative forces in the society, the "labouring classes". But even what the literate artisans understand as the reality of science is not coincidental with what the declinists implicitly project as science proper. Here, science is not a mirror that reflects and idealizes things as they stand, but a mirror that transforms, that uncovers latent possibilities. Its tenability hinges on philosophical insightfulness and experimental creativity, not on precision and discipline. To revert to the juxtaposition made by Babbage: on the intellectual virtues of Davy, not on those of Wollaston. We can therefore see why the reviewer remonstrates that Lardner's treatise lacks novelty, while Brewster's textbook is "confined to strict technicality", teeming with "complex calculations" and the "jargon about refrangibility, catoptrics, dioptrics, &c. &c. &c." (Anon. 1831a, 373-374). From different angles, different appraisals do ensue.

Similarly, in the review of Babbage's *Reflections* in the same journal, the degree of knowledge diffusion is posited as the decisive standard for assessing science's vigour. The author denies that there is any decline, since he does not believe that "there is a country in the world in which mathematical knowledge (to which, we apprehend, Mr. Babbage more particularly alludes) is to a certain extent, and with a view to its practical bearings, so widely diffused amongst the middle and the lower, that is, the industrious classes, as it is in England". He concurs with Babbage as to the pernicious effects of wealth, clubs, factions, and Banks' inner chamber, on the Royal Society. "By this and other kindred contrivances did the capacious minded Lincolnshire baronet convert the Royal Society, and many of that class of members, who attended the public meetings, to his own purposes; – purposes as remote from the diffusion of real philosophy, as playing at backgammon, or dancing a hornpipe". Only Davy and Davies Gilbert, who succeeded him, are set aside as exceptions. But the system "had been long in operation" and "both these accomplished philosophers were obliged to yield each in his turn to the 'influence behind the throne'; so that it is difficult to say whether things remain as they were under

the reign of darkness, or whether they are not even yet proceeding with an accelerated progress to a state of more lamentable uselessness and degradation" (Anon. 1831b, 217, 227). The Royal Society, however, even under such a "reign of darkness" is preferable to the militarized Institut de France:

> "philosophers in a uniform, with swords by their sides, and opera-glasses in their hands [...] soldiers, with muskets and fixed bayonets, not only lining all the avenues to the hall, but standing in the very middle of the assembly; such things may very well have suited the meridian of Paris *until July last*; but we have no desire to see such scientific characteristics as these become fashionable in London". (Anon. 1831b, 226, emphasis in original)

If something deserves blame, this is British higher education.

> "What are boys taught at public schools? Answer, 'Latin and Greek'. What are they subsequently taught at Oxford? Answer again, 'Latin and Greek'. What are they taught at Cambridge? Answer again, 'Latin and Greek'. But is that all? 'No; at Cambridge they must lay in a large stock of modern mathematics, if they mean to attain a high degree'. And is that all? 'No; if they are going into the Church, they *must* attend one course of divinity lectures, and any student *may* attend other lectures, *if he please*'" (Anon. 1831b, 228, emphasis in original).

The reviewer had already, earlier in his text, stressed his distrust of higher mathematics, saying that the calculus rests upon principles "repugnant to sound metaphysics" and a "visionary theory, destitute of foundation in the nature of things" (Anon. 1831b, 227-228). Within the artisanal perspective, mathematics is not the ideal form of science.

And what about chemistry? Imprisoned in Dorchester Gaol, the artisan agitator Robert Carlile wrote in 1821[33] that the revolution Davy had made in chemistry excited the horror of the "despots and priests", the "Baals" of Europe. The revolutionized Chemistry is itself a symptom of a general revolutionization of people's mind, and also a means to further this process. But Carlile also deems chemistry to be "the foundation of all other sciences, and in a manner of speaking to comprise all other branches of science". The necessary liberal educational reform will put chemistry right in the center. But proper methods of instruction are needed too. Since its variety of objects is extensive, "it is not without a class simple enough for the comprehension of the children". Teachers should have recourse to everyday experience, to invoke and at once to defamiliarize this experience:

33 I owe this reference to Simon Schaffer, who generously provided me with many valuable suggestions and leads when I had the opportunity to discuss with him certain questions concerning Davy's chemistry and Victorian science.

> "the burning of a candle is a chemical experiment for the production of light – the burning of the fuel which keeps up our fires, is but a chemical experiment for the production of heat; to which a thousand might be added equally simple, a definition of which could not fail to be of the greatest importance in the education of children". (Carlile 1821, 21-22, 34, 35)

Davy would have not joined hands with Carlile, responding in the affirmative to the latter's appeal to the men of science for common struggle against political oppression and religious prejudices. And vice-versa, his own version of natural theology would have seemed repulsive to the "confirmed materialist" Carlile. But we know that in December 1860 and January 1861, Faraday, formerly a protégé of Davy, gave at the Royal Institution a course of lectures before a juvenile audience on *The Chemical History of a Candle*. The course was printed, and it became the most popular science book ever. The candle of philosophical chemistry had not been blown out.

Babbage and Brewster were the winners of the controversy over the decline of British science, and they wrote, indeed, the history of this episode, as victors usually do. The significance of their victory lies far more in the overpowering and disarming of their opponents than in the imposition of their own vision for science reform. In the long run, what they eventually achieved was to render, within the community of the "men of science", philosophizing, and the moral claim of autonomy that accompany philosophizing, impertinent to science: men of science are not philosophers, but employees to be hired or functionaries to be recruited (and if philosophers are to be scientists, they must be also employees or functionaries). Today, Moll's and Biot's arguments appear to be remnants of another, distant culture. And we are not less surprised to see Herschel citing lines from Shakespeare's *As You Like It* as the appropriate way to describe what it means to be a man of science: a "contemplative man" finding "tongues in trees – books in the running brooks – sermons in stones – and good in every thing" (Herschel 1831, 15). We have been long accustomed to read that kind of statements as spasms of a romantic imagination, i.e., of an imagination that is not ours, that belongs to a past which does not belong to us, which is only an object of curiosity for historians whose specialty are the worldviews in currency during the early 19th century. If Napoleon was the first statesman to use science as an instrument of political discipline and national wealth, Babbage and Brewster were the first scholars to make up an ideal for science out of this actual development.

In the short run, the campaign of the declinists set the stage for the organization of the "men of science"' into a separate body of professionals. The British Association for the Advancement of Science did not endorse Babbage's and Brewster's plan for reform. It was a pressure-group, still under the sway of the gentry and the landed aristocracy, clinging firmly to voluntary cooperation, self-help and individual initiative (Morrell 1971). Brewster himself time and again bemoaned the disavowal of the original demand

for state patronage (Orange 1972, 171-176). But it was at the 1833 meeting of the British Association that the word "scientist" was first coined (by Whewell), to denote all those who distinctly profess science. Coleridge, who had already spoken of a "national clerisy", was present, and he gave his consent to this differentiation of "scientists" from "philosophers". At the start, "this was not generally palatable" (Whewell 1834, 59; the attribution is given in Todhunter 1876, I, 92), but anyway scientists became a clerisy. Although not that envisaged by Coleridge: an independent intellectual caste or elite of ministers of culture, endowed by the state and insulated from financial concerns, whose vocation would be to enlarge the knowledge already possessed, to shelter the "treasures of past civilization", to diffuse "through the whole community, and to every native entitled to its laws and rights, that quantity and quality of knowledge which was indispensable both for the understanding of those rights, and for the performance of the duties correspondent", and finally to "secure for the nation, if not a superiority over the neighboring states, yet an equality at least, in that character of general civilization, which equally with, or rather more than, fleets, armies, and revenue, forms the ground of its defensive and offensive power" (Coleridge 1976, 43-44). Those who are defeated, as it is commonly said, do not write history. And Coleridge was also among the defeated, as much as his friend Davy was.

Both of them have come to be known as "Romantics", which is usually an erudite manner of saying that their problematics (of agency, truth, knowledge, creativity, etc.) are irrelevant to us. But they both continue to attract exceptional attention among historians. They were undeniably extraordinary, and they still seem like prodigies, short-lived comets shooting through the sky. They transcended the limits of the social identities attached to them in the social production of their lives, not by brushing those limits aside, but by turning them into experiential interfaces where instabilities grow deeper and tensions remain helplessly unresolved. Was Coleridge a disenchanted egalitarian or a nostalgic reactionary?[34] Was he a lay preacher or a poetic philosopher?

34 John Stuart Mill, for example, judged the theological sentiments of (the later, conservative) Coleridge to be "not the sentiments of a bigot, or of one who is to be dreaded by Liberals, lest he should illiberalize the minds of the rising generation of Tories and High-Churchmen". The danger was, rather, "lest they should find him vastly too liberal" (Mill 1969, 162). And as for his political philosophy and his views on the cultural and political role of the Church, Coleridge "by setting in a clear light what a national-church establishment ought to be, and what by the very fact of its existence, it must held to pretend to be, he has pronounced the severest satire upon what in fact it is" and he has done "more than would have been effected in thrice the time by Dissenters and Radicals to make the Church ashamed of the evil of her ways, and to determine that movement of improvement from within, which has begun where it ought to begin, at the universities and among the younger clergy, and which, if this sect-ridden country is ever to be really taught, must proceed, *pari passu*, with the assault carried on from without"

Was Davy an overrated dandy-chemist or the solemn poet of the *Consolations*? Was he masculine, bold and visionary as any science-hero is fit to be, or feminine, a frivolous, flamboyant, unprofessional salon habitué (Golinski 1999)? Did he "live always in hope, that he might still be useful to others, and his existence was continued for some useful purpose",[35] or did he "become every day more skeptical as to the use of making or endeavouring to make the people philosophers", because "few persons ever attain the Socratic degree of Knowledge to know their own *entire ignorance*, and skepticism and discontent are the usual *unripe fruits* of this tree – *the only fruits* which the people can gather"?[36] Was he a failed reformer or a brilliant social climber? Did he become a Plato when he was dying (Knight 1996, 108) or was he a Plato that became a "ruin of what he was"? We cannot tell.

Perhaps, the most plausible surmise is that both Coleridge and Davy were extravagantly vulnerable rather than adaptive to their working and living conditions. Their vulnerability seems to be proportional to their obsession with the ineffable bond linking the power of being to that of becoming, the "hidden mystery in every form of existence", the "living germ in which the present involves the future, and in the infinite the <in>finite abides potentially" (Coleridge 2002, 216), or "the winged architect, / Whose home is of our flowery spring, / Who rests her light and vagrant wing / Only were the air is free and pure, / And on a work that may endure, / The prophet of the sunny morn / Of generations yet unborn".[37] Experimental selves, amphibious and protean beings always caught and reshaping themselves between crossfire (Golinski 2011, Jackson 2003), and poet-philosophers, "children of tomorrow" (J. Davy 1836, 2, 69), strikingly discordant with the actuality of their world, who only know enough to fight and to hope for "the *individual immortality of the better part of man*"[38]: why should we not ask ourselves whether that weakness which we have to encounter and overcome, that awareness of the humanity which we have to lose in order to be inscribed in social normativity, that hope of a better life emerging through our efforts to meet with the Other in-between, in terms of mutual emancipation, whether that vulnerability of being and becoming

(Mill 1969, 150). Cf. a recent comment made by Joel Harter: "the truth is that Coleridge is both conservative and liberal, and our labels are inadequate and even anachronistic when applied to his complex and often paradoxical thinking" (Harter 2011, 2).

35 Letter to Lady Davy, Rome, November 18, 1828, published in J. Davy 1858, 305-306.

36 Letter to Lady Davy, Lubiana, April 25, 1827, published in J. Davy 1858, 283-284 – the quotation on p. 284; emphasis in original.

37 From some verses written by Davy in Ilam, at Ilam Hall, September 11, 1825, and published in J. Davy 1858, 259-262 – the quotation on pp. 261-262.

38 Extract from a letter of Davy to his friend, chemist William Clayfield, sometime in 1804, published by Paris 1831, I: 198-200 – the quotation on p. 199; emphasis in original.

oneself[39] could not be the true seat of rationality and objectivity, the true precondition of any genuinely critical interaction, of which science is, or it must again become, the most developed form?

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39 One fecund way to relate conceptually self-transcendence to vulnerability would be to try to correct Popper's theory of "World 3" by resorting to some relevant texts of Luce Irigaray (2004) and Judith Butler (2004, 2005).

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