BILDUNG, AND "HOW TO THINK" LIKE AN ENGINEER

Karl Palmås

PREPRINT – DRAFT CHAPTER, JULY 2023

Abstract: Starting from the proposition that higher education is a matter of "learning how to think", this chapter investigates the meaning of *Bildung* in the context of engineering education. In the context of recent calls for a re-evaluation of classical *Bildung* – more specifically calls for a turn to a more politically-oriented critical-reflexive *Bildung* – the chapter studies one earlier instance of a re-evaluation of the notion of classical *Bildung*. By exploring how Erik Gustaf Geijer and Carl Jonas Love Almqvist challenged dominant conceptions of *Bildung* in Sweden during the 1830s and 1840s, the text argues that the classical *Bildung* ideal of forming original human beings who can think for themselves remains a valid objective of higher education. As such, the chapter suggests that recent, more politically-oriented versions of *Bildung* jeopardizes the classical *Bildung* ideal of intellectual autonomy – an ideal which holds particular value in engineering education.

Keywords: Liberal education; classical *Bildung*, David Foster Wallace, Erik Gustaf Geijer, Carl Jonas Love Almqvist

1. Introduction: Learning "how to think"

It is sometimes held that higher education is about teaching students "how to think". Indeed, engineering education is sometimes described in those very terms: I remember hearing this repeated to me when I was an engineering student, having ploughed through the initial maths-intensive phase of the program. Doing engineering, a teacher told me, is not so much about learning to solve this or that equation. Rather, it is about learning to think in a specific manner. As such, each particular, specific solution of a mathematical problem is a drill exercise that hones one's skills in more general problem-solving. As such, engineering education is really about instilling a habit of mind; about teaching students to engage with the world in a specific problem-solving manner. The same *modus operandum*, over and over: Breaking large and complicated problems into manageable components, solving each lower-level problem one by one, thus deriving a higher-level solution.

This description of engineering education is hardly unique: In his recent monograph about *Bildung* in engineering education, Jacobsson (2019: 44) suggests that the problem-solving trope constitutes the most pervasive notion of what it means to think like an engineer. Similarly, when the UK Royal Academy of Engineering describes what it means to "think like an engineer", problem-finding and problem-solving are promoted as key "engineering habits of mind". (Royal Academy of Engineering, 2014) Again, from this perspective, engineering education is a matter of teaching students to think in such problem-solving terms.

However, the proposition that higher education is about teaching students "how to think" is not confined to engineering education. The idea is as prevalent in the Anglo-American tradition of liberal arts education. Due to the fact that they do not – like technical universities – present their *raison d'être* in terms of educating for a specific profession, liberal arts institutions are

more strongly wedded to the abstract purpose of "learning how to think". (Harford, 2022; Schwartz, 2015) As such,

> the goal of liberal education cannot simply be the acquisition of content knowledge, but the development of thinking skills, and more specifically the skills of thinking insightfully, critically and creatively. (Hadzigeorgiou, 2015: 263)

American novelist David Foster Wallace comments on this proposition in his famous 2005 commencement speech to the graduating class at the prestigious liberal arts institution Kenyon College. In the meditation subsequently published as "This is water", he even suggests that the idea of teaching students how to think is the "single most pervasive cliché" in the liberal arts commencement speech genre. (Foster Wallace, 2009) For him, the problem is not only that it is a hackneyed trope: It is also somewhat insulting to students. The young minds that he is addressing were already capable thinkers before they arrived at the highly selective Ohio-based college.

Nevertheless, Foster Wallace concludes, the cliché of learning "how to think" actually does contain an element of truth, but this truth requires some qualification. Granted, a liberal arts education does offer the student a distinct set of tools with which to understand the world. This includes what Foster Wallace calls the "standard liberal arts analysis", which prompts the student to accept that "the exact same experience can mean two totally different things to two different people, given those people's two different belief templates and two different ways of constructing meaning from experience". This understanding of the world breeds tolerance, and an appreciation of diversity of belief – two virtues that are key to liberal education. When Schwartz (2015) seeks to demystify the notion of learning how to think in liberal arts terms, he spells out a series of intellectual virtues that should be fostered by a such education. These include honesty about one's failings;

fair-mindedness; humility and willingness to seek help; good listening; perspective-taking and empathy. Schwartz are keen to bill them precisely as virtues – a term that implies moral imperatives – which are distinct from cognitive skills such as quantitative abilities, conceptual flexibility, analytical acumen and expressive clarity. Similarly, when the American Association for the Advancement of Science promotes liberal education in the sciences, it describes it in the following terms:

> Ideally, a liberal education produces persons who are open-minded and free from provincialism, dogma, preconception, and ideology; conscious of their opinions and judgments; reflective of their actions; and aware of their place in the social and natural worlds. (AAAS, 1990: xi)

Still, Foster Wallace refrains from positing that this "standard" liberal education habit of mind is the be-all and end-all of liberal education. The value of such studies cannot be reduced to individuals learning how to think in tolerant and open-minded ways. "Learning how to think", he tells the graduating class, really means "learning how to exercise some control" over what to think about. It is about learning to *choose* what you think about, as you find yourself in the "day-to-day trenches of adult existence".

For him, then, the value of a liberal education is deeply personal, as it may assist in coping with the emptiness of contemporary life. Through the liberal arts, students may escape feelings of boredom and loneliness – major themes of Foster Wallace's novels – but only through exercising control over their thoughts. Actively choosing how to think about the world is crucial, especially as the standard "socially-conscious" liberal arts criticality may sometimes increase one's sense of emptiness. In short, Foster Wallace seems to suggest that the virtues and habits of thought cultivated by a liberal education are noble pursuits – but ultimately students must be capable of *trans-*

cending “standard” procedures, “standard” habits of thoughts, and become autonomous subjects.

This reading of Foster Wallace’s argument – one that emphasizes the cultivating of individuals capable of thinking for themselves – places it squarely within a long-standing discussion on *Bildung*, as conceived in the continental European setting as well as Anglo-American liberal education tradition. This idea will reoccur throughout this chapter, which will argue that this aspect of classical *Bildung* should remain central in current discussion on how to interpret the notion of *Bildung* in contemporary engineering education.

The argument runs as follows. The next section will review central themes in the literature on *Bildung* in engineering education, focusing on the five different conceptions of *Bildung* outlined by Sjöström et.al. (2017), as well as the kind of updated, politically-oriented critical-reflexive *Bildung* that they themselves promote. It will also introduce Erik Gustaf Geijer and Carl Jonas Love Almqvist, whose work was central to how the notion of *Bildung* was introduced and re-interpreted in the Swedish educational setting during the 19th century. Neither Geijer nor Almqvist were associated with technical universities, but their concerns – what is the place of classical *Bildung* in the context of new social challenges? – overlaps with the issues at stake in this argument.

The subsequent section (3) goes into the specifics of Geijer and Almqvist’s understanding of the place of classical *Bildung* in a modernizing society, emphasizing their point of not lapsing into static modes of reading that merely mimics the classics. The section then transposes their work into the issue of teaching engineering students: In contrast to the close readings associated with the humanities, the context of the engineering education requires creative readings that make the problems inherited from the classics come alive in the context of present concerns. More generally, Geijer and Almqvist’s work underscores the importance of promoting creativity rather

than fidelity in engaging with the classics. This imperative is somewhat at odds with recent interpretations of a critical-reflexive *Bildung* that suggest that STEM education should be aligned with social critique and the agendas of societal challenges. Much like liberal education is about more than repeating the "standard liberal arts analysis", *Bildung* in engineering education cannot be reduced to teaching students "standard" procedures for social critiques of engineering, or standard critiques of technology in general.

The chapter ends with a concluding discussion (5.4) that joins the threads of the argument. Combining the arguments of Foster Wallace, Geijer, Almqvist and others, the argument ends with an attempt to describe and name that "excess" faculty that we seek to promote when fostering *Bildung* among engineering students.

2. Shifting Conceptions of *Bildung*

Thus far in this chapter, two versions of *Bildung* have been discussed: The classical *Bildung* tradition of continental Europe, and the liberal education tradition of the Anglosphere. In a useful systematic review of the international literature on the concept, Sjöström et.al. (2017) list three further versions of *Bildung*: The Scandinavian folk-*Bildung* tradition, the United States-based tradition of democratic education, and the more recent critical-hermeneutic version of *Bildung*. This section will describe these in further detail, and then briefly describe where the work of Geijer and Almqvist fit into this taxonomy.

2.1 Five versions of Bildung

Classical *Bildung* has its roots in continental Europe, and tends to be associated with Vilhelm von Humboldt. In this original statement of the term, *Bildung* is 'a process of individualization where humans develop their personality through studies and reflections in a diverse, harmonious and unique way, and thus become a human original rather than a copy of others' (Burman, 2014: 127, cited in Sjöström et.al., 2017: 169). Thus, the term emphasizes a process which is about personal development, which serves a purpose that transcends any professional or instrumental ends. This sentiment is inherited from German romanticism. There is value in seeking knowledge for knowledge's own sake, because the final end of *Bildung* is self-realization. Not only does this end transcend professional imperatives – it also trumps ends like the common good, or the unity of the state. (Beiser, 2003: 91) This is why autonomy is crucial: The Humboldtian university should be autonomous – free from outside interference – and the final end of the education is the autonomous, fully developed human being.

The tradition of classical *Bildung* also inherits another sentiment from German romanticism – the primacy of the humanities and fine arts. For one, there is Humboldt's own preoccupation with language. For him, *Bildung* is about overcoming a fundamental alienation from the external world (von Humboldt, 2000: 59), and thus about establishing a connection between the self and the world. This connection can only ever be structured as language, ranging from everyday speech to the adoption of alternative worldviews through the learning of foreign languages. (von Humboldt, 1963) However, there is also the influence of the German romantics' focus on *Bildung* through art, not least through Friedrich Schiller's aesthetic education. This idea emerged in response to what the romantics saw as a failed enlightenment: The thinkers of the enlightenment had sought to explain (*aufklären*) the world though reason, but by spreading their ready-made concepts to the public they had contributed to revolutionary chaos. Their approach was flawed, Schiller suggested, because it did not inspire the member of the public to engage in thinking for oneself, or in thinking spontaneously, since the enlightenment thinkers had already done the thinking for them. The public had become passive recipients of knowledge, not autonomous individuals, and could not translate the philosophers' ideals into reasoned action. (Beiser, 2003: 94) Schiller thus proposed that aesthetic experience of the beautiful could develop sensibilities that compel the individual to act in reasoned ways. The inspirational power of art would fill the moral void left after the enlightenment's demolishing of religious authority. In this way, aesthetic education serves as a higher order mode of learning – rather than building formal knowledge, it shapes the character of autonomous human beings.

As hinted in the previous section, the Anglo-American tradition of liberal education is shares many of the traits of classical *Bildung*. It too emphasizes the formation of individuals who can think for themselves, and the idea of seeking knowledge for its own sake. However, given that its ties are not as strong to the romantic tradition of continental Europe, it has traditionally not

placed as strong of a focus on the humanities. Rather, liberal educational programs are generalist in nature, encompassing the sciences as well as the humanities and social sciences. In studying a broad range of fields – mathematics, science, literature, fine arts, history, and philosophy – liberal arts students are attuned to different "forms of knowledge". (Hirst, 1972) As such, the liberal education "trains the seeing of connections" (Kallenberg, 2015: 133) across such knowledge domains.

Aside from the above, there are two versions of *Bildung* that are more directly oriented towards the education of all citizens. In Scandinavia, there is the folk-*Bildung* tradition, which emerges in the late nineteenth century. As a part of the social-democrat ambition to build an inclusive society, it is an endeavor to provide education for the whole people, outside of the confines of academia. In the United States, the democratic education – which is associated with pragmatist philosopher John Dewey – represents a similar ambition.

Finally, Sjöström et.al. (2017) traces a critical-hermeneutic *Bildung* tradition, that starts with Hans-Georg Gadamer (1900–2002) and Paul Ricœur (1913–2005), runs via Wolfgang Klafki (1927–2016), and on to present-day thinkers. As a continuation of this tradition, they propose a critical-reflexive *Bildung*, updated for the present time. This involves a stronger socio-political orientation, enabling it to "function as a bridge between traditional liberal education and activism-oriented education", promoting "constructive participation in society, and solidarity towards persons limited in the competence of self-determination and participation". (Sjöström et.al., 2017: 180)

This more politicized version of *Bildung* is deemed useful in today's "latemodern risk society with all its socio-scientific and technological challenges". The present time is indeed one that places demands on educational institutions, and one may wonder how the ideals of classical *Bildung* fare in the context of such challenges. Let us now turn to an earlier time in history –

to the 1830s and 1840s – when similar anxieties about social challenges prompted similar re-evaluations of classical *Bildung*.

2.2 Geijer and Almqvist's challenge to classical Bildung

By European standards, Sweden was a late bloomer in terms of democratization and modernization. Major advances in political participation and socio-economic welfare set in a few decades into the 20th century. However, in the early to mid-19th century, Swedish intellectuals were closely monitoring the onset of modernity that was raging on the European continent.

Erik Gustaf Geijer – historian, poet, statesman and Rector at Uppsala University – was one of those who saw the modern groundswell coming, and adjusted his political orientation accordingly. He had spent the early 1800s as a conservative intellectual, championing a position that only nobility and clerics were to learn how to think. Here, he was heavily influenced by the German romantic idea of *Bildung*, and its concomitant focus on the humanities. (Geijer, 1928 [1810]; Landquist, 1924) In the late 1830s, he would then reject this position, announcing his defection from conservatism to liberalism, and spearheading an educational reform that saw the state assuming responsibility for offering *Bildung* to the broader citizenry of the emerging middle class. (Geijer, 1928 [1838]) This would later pave the way for the development of the Swedish folk-*Bildung* tradition. Crucially, his departure from his previous views also represented a departure from the idea that the humanities should hold a privileged position when cultivating *Bildung*.

Geijer's experience is emblematic of a specific period in history, in which a conservative, feudal state of affairs was crushed by a modernity that – paraphrasing Marshall Berman – not only brought "adventure, power, joy, growth, transformation of ourselves and the world" but also threatened "to destroy everything we have, everything we know, everything we are". (Berman, 1982) Not only does Geijer personify the shift from conservatism to

liberalism – he also embodies an abandonment of a specific reading of *Bildung*, and a shift towards a new one.

The liberal reform of the educational system that Geijer promoted was also supported by the novelist and educationalist Carl Jonas Love Almqvist. Their joint engagement on the issue constituted a challenge to what classical *Bildung* had become. In the next section, this chapter will explore the specifics of this challenge to classical *Bildung*. At this point in the argument, however, it is worth noting two things. First: Our moment in history – the "late-modern risk society with all its socio-scientific and technological challenges" (Sjöström et.al., 2017: 180) – is not unique in generating calls for a revision of what *Bildung* entails. Second: Then, as now, classical *Bildung* was challenged by progressives who suggested that new times call for new interpretations of the term. However, as we shall see in the next section, their proposed revision of the term differed significantly from today's calls for a more activist- and societal participation-oriented interpretation of *Bildung*.

3. Learning from Geijer and Almqvist

This section will first explore the specifics of Geijer and Almqvist's critique of what classical *Bildung* had become in the 1830s. It will then transpose some of their points to current concerns with how to cultivate *Bildung* in contemporary engineering education, focusing specifically on how to read classics, and how to inherit the legacy of classical *Bildung* today.

3.1 From Romanticism to Realism

As hinted above, Geijer defected from conservatism to liberalism, and this shift also amounted to a new interpretation of *Bildung*. This transformation can be described as a shift from romanticism to realism, and this shift affected not only Geijer. In the intellectual circles of Stockholm and Uppsala of the 1830s and 1840s, romanticism was in decline, and there was a "realist urge to get away from empty abstractions". (Norberg, 1944: 67) Realism is, however, a particularly apt description of Geijer's position. His turn to liberalism can be understood as emerging from an experience of being a conservative "mugged by reality".[1] In light of the new social, economic and technical realities he observed in Europe, he realized that the feudal structures (and the conservative views that defended them) were about to crumble. This caused him some concern – he feared that modernity may spell doom – but he nevertheless felt compelled to face what he saw as new facts about the world. His defection from conservatism to liberalism caused an outcry, and there is no coincidence that it was announced in the context of a debate on education.

[1] This is a paraphrase – a near-reversal of Irving Kristol's famous saying that a neoconservative is a liberal mugged by reality.

Both Geijer and Almqvist concluded that they were living in a time when the affirmation of the individual was inevitable. This understanding was, in part, a result of a reading of the social circumstances, but it was equally a reflection of their inspiration from classical *Bildung*; the celebration of self-actualization. They both referred to the "personality principle" – a phrase coined by Geijer that implied that we become fully formed individuals in the meeting with others. Such meetings must, however, be meetings among equals. Thus, Geijer – like Tocqueville, his major source of inspiration – held that the gravitation towards equality was both desirable and inevitable. The personality principle contained both political and pedagogical dimensions. First, the primacy of the individual and the inevitability of equality implied that the remnants of the feudal system of government had to be abolished. However, the personality principle connected the question of rights – *one person, one vote* – with the question of *Bildung – education for all*. (Ullman, 2014: 46)

This is where the critique of classical *Bildung* surfaced. First of all, this critique was directed at the problem of what constitutes proper education for political representatives. On this matter, Almqvist provided a scathing critique, stating that some of the elements of classical Bildung – such as knowledge in Greek or Latin – was as useless as knowledge in heraldry. (Almqvist, 1995 [1844-1845]: 393) Instead, the new times required knowledge in governance, relating to military matters, as well as fundamentals of finance and economics. (394) In particular, Almqvist railed against how the nobility and clergy referred to classical *Bildung* when legitimating their power – especially as their *Bildung* constituted a shallow one. The only thing that distinguished the rulers from the ruled was the fact that the rulers could use French, German, English or Latin to say what the ruled could say in Swedish. The nobility and clergy made use of hackneyed sayings that "sound more than they contain", yet held little relevance for the political

matters at hand. Their modes of thought were convoluted, and they lacked the capacity to continue a train of thought to their logical end. (395)

The outcome of Almqvist and Geijer's efforts was the establishment of a public school system for all, whose role it was to educate citizens into self-government as well as self-actualization. This development also implied a toppling of the hegemonic status of Latin course of study (consisting of classical languages) as the education for the ruling classes. Latin was thus complemented by a new course of study – fittingly titled *Real* – which focused on mathematics and natural sciences. However, for the purposes of this chapter, it is worth examining Almqvist's critique of how the Latin course of study had failed the original ideals of classical *Bildung*. In his critique of the supposedly "learned" ruling classes, one can trace his animosity towards how the study of classical languages had been reduced to an empty mimicking, devoid of creativity. This ran counter to the imperatives of forming autonomous human beings who could think for themselves. According to the personality principle, the point of education must always be for individuals to seek their own originality. When engaging with the classics, he suggested, the challenge is to avoid shallow repetition of dead sayings, and instead probe the deeper meanings that such classics contain. Indeed, as Ullman (2014: 53-54) suggests, his position is in alignment with the more recent suggestion by Donald Broady (1984) – that classical *Bildung* cannot be inherited through mere "aping". The only way to inherit it is through constructive engagement with the experiences and ideas of the classics. The chapter will now move on to examine what import these historical developments may have on contemporary engineering education.

3.2 Inheriting the ideals of classical Bildung today

As suggested above, the debate on classical *Bildung* in early- to mid-19th century Sweden is illuminating when placed alongside contemporary discussion on how to inherit the ideals of such *Bildung* in engineering education. Then, like now, a sense of societal dislocation provides the impetus for a re-evaluation of what *Bildung* really means. Beyond these similarities, there are however further things to take away from Geijer and Almqvist. One concerns the specific question of how to read the classics, another the broader question of how to foster constructive participation for engineering students in society.

In the North American context, there are recent attempts to formulate what a "liberal studies in engineering" program would look like. (Bucciarelli and Drew, 2015) For instance, this could imply adding a broader understanding of the socio-political context of engineering, through "schooling in certain 'fundamentals' […] in political philosophy and social theory, for example, Plato, Aristotle, Machiavelli, Hobbes, Locke, Rousseau, Marx, and Tocqueville". (Bucciarelli and Drew, 2015: 117) In response to this proposal, Donna Riley (2015) warns against shallow appropriations of the liberal arts approach, where it becomes reduced to "a haphazard smattering of superficial exposures". She describes such cringe-worthy practices in the following manner:

> Add an element of history here, a writing assignment there, an ethics case study every blue moon and presto! Liberal education. The most dangerous aspect is that engineering faculty dilettantes can mischaracterize or reduce entire genres of knowledge, damn the consequences. (Riley, 2015: 139)

This is, of course, a valid concern. It is wise for faculty of technical universities not to overstep the mark and mislabel their approaches. Labels like "technology and society" and similar are perhaps more useful for describing the teaching activities that seek to instil *Bildung* in engineering curricula – which, after all, are more instrumentalist in nature than either liberal education or the humanities. Still, it is worth remembering that such activities at technical universities are not *meant* to act as torchbearers of the liberal education or classical *Bildung* traditions.

Furthermore, as suggested by Almqvist, one must resist the tendency for classical *Bildung* to gravitate towards non-creative repetition; towards the shallow mimicking of dead sentences. This constitutes a betrayal of the ideals of classical *Bildung*. Again, the challenge when reading classic texts – be it Plato, Machiavelli, or Hobbes – is to move from shallow repetition to the deeper meanings. In the end, the timeless character of such texts – their capacity to speak to people across ages and contexts – is precisely what makes them classics. This implies that they can indeed speak to today's engineering students, provided the reading of them is a creative one. Such readings require that the teacher manages to convey some deeper meaning of the text that remains valid in the context of the students' future life. The means by which this meaning is acquired are, nevertheless, of a lesser importance: As compared to the humanities, there is less need for back-to-back readings of complete works, or for readings in original language.

Such readings must not be confused with the *close* readings that is the mainstay of the humanities. They remain crucial for safeguarding our collective ability to inherit from classic texts. Riley (2015) is correct in arguing that engineering faculty members may be well served with a bit of humility towards the rich tradition that they are poaching from. Nevertheless, that should not stop them from persisting in their attempts to assign classic texts to their students. After all, in doing so, they breathe new life into such texts.

The question of how to inherit the ideals of classical *Bildung* is also at stake in the recent proposition by Sjöström et.al. (2017) that *Bildung* today should prompt students to engage in "constructive participation in society". Again, one may compare this re-evaluation of the meaning of *Bildung* to that of Geijer and Almqvist. While both of these proposals for re-evaluation point to an urgency created by social circumstances, there are clear differences between the two.

Sjöström et.al. (2017) – along with other scholars – point to the need for a critical-reflexive form of *Bildung* that forms "a bridge between traditional liberal education and activism-oriented education", tying the *Bildung* agenda to specific political challenges, notably social and ecological justice. (Sjöström et.al., 2017: 182) This position also includes the fostering of critical literacy, in which reflection breeds action. In this view, critical *consciousness* is invariably tied to critical *agency* (Ebenezer, 2013): Critical literacy implies a disruption of the commonplace, an interrogation of multiple viewpoints, a focus on socio-political issues, tied to political action and promoting social justice. (Lewinson, Flint, and Van Sluys, 2002) The kind of citizenship that is at stake is a critical one, and this includes the fostering of political emotions. For Ruitenberg (2009: 277, cited in Sjöström et.al., 2017: 180) this may – in accordance with the political theory of Chantal Mouffe – imply "the ability to feel anger on behalf of injustices committed against those in less powerful social positions".

In contrast, Geijer and Almqvist's re-evaluation of classical *Bildung* concerned the domain of knowledges that are to be privileged: Away from a sole focus on classical languages, to more focus on social sciences and natural sciences. It also concerned the methods of engaging with the classics, with a focus on deep understanding rather than shallow regurgitation. The objective of these revisions was, however, to stay true to the original ideals of classical *Bildung*, as inherited from the romantics – the cultivation of unique human beings, which possess the capacity to think for themselves. This was, in turn,

into their view of citizenship: The very point of democracy is to release the originality of each singular individual.

Here, the position of Geijer and Almqvist is at odds with the more recent formulation of a critical-reflexive *Bildung*. In short, the highly prescriptive orientation of the latter approach leaves little room for autonomous individuals who are to think for themselves. There is a risk that critical-reflexive *Bildung* – at least when operationalized into everyday teaching – moves beyond the idea of teaching students *how* to think, instead prescribing *what* to think. There is also a risk that students call teachers out for prescribing what to think *about*, as well as how to *act* and *feel*. What to think about? Social and ecological justice. How to act? In accordance with such justice movements. How to feel? Anger.

Indeed, much of Almqvist's critique of the shallow Latin-based *Bildung* of his time could be directed toward such prescriptive tendencies of contemporary critical-reflexive *Bildung*. True – for Geijer and Almqvist, the issue of cultivating responsible citizens was at stake, but this process could not be traded off against the process of forging individuals' ability to think for themselves. After all, shallow regurgitation was precisely what Almqvist objected against.

These propositions may be transposed onto *Bildung*-oriented teaching in contemporary engineering education contexts. When studying classics like Plato, Machiavelli, or Hobbes, there is ample space *not* to prescribe what students must take-away from the class. The teacher may encourage a particular way of understanding the text – for instance, that one of the concerns of Plato is the place of expertise in decision-making. However, the question of what to think about Plato or his critics, what to feel about such views, or whether the discussions in class should prompt political action is best left to the students themselves. Yet, as stated before, classics are classics by virtue of their ability to invite new thoughts and feelings – to suggest new potential waypoints for student's continued travels. In the end, it is up to them which

waypoints to follow as they develop their own original character. An all too prescriptive approach places teachers in a position perilously close to the false impression that *Bildung* is a readymade bundle of ideas, rather than a process of personal formation.

As such, classical *Bildung* implies that higher education is meant to produce something more – or perhaps something else – than whatever their teachers convey to students. This problem will be pursued in the concluding discussion.

4. Concluding Discussion: The Excess of Education

This chapter has argued that the current discussion on a re-evaluation of classical *Bildung* may be well served by reviewing one such earlier re-evaluation – the challenge posed by Geijer and Almqvist in the 1830s and 1840s. In particular, the work of Almqvist is useful for thinking about how to engage with classic texts in engineering education, especially in light of recent proposals for a more politicized form of critical-reflexive *Bildung*. It is worth noting that Almqvist's sentiments are not grounds for dismissing critical-reflexive *Bildung* because it challenges some ideal of an "objective" technical education: The political ramifications of engineering practice should indeed be conveyed to students. The point is, rather, that students must use their education to figure out their own political or ethical positions.

This reading of Almqvist partly dovetails with Hadzigeorgiou's (2015) concerns that 'science education as socio-political action' (SEASPA) approaches downplay "the importance of knowledge for its own sake". (Hadzigeorgiou, 2015: 259) However, while Hadzigeorgiou's disquiet is primarily directed towards a neglect of the "personal/aesthetic dimension of science" – encompassing a sense of awe, mystery and wonder – the argument above is not solely relating to personal matters. Given the long history of engineers running errands for the powers that be (Berner, 1981; Riley, 2008), a focus on teaching engineering students to think for themselves can be understood as a safeguard against future abuses of power. Intellectual autonomy not only serves the private human being – it may also serve the wider community. If personal originality of mind is the final objective of education, then the *Bildung* efforts of engineering schools should steer clear of becoming too prescriptive on matters socio-political. If not, the education fosters subservience rather than autonomy.

At this point, we may return to Foster Wallace's meditation on learning how to think – or rather, on how to learn to *choose* what to think about. His

message can be read as one that celebrates the very autonomy described above. Yes, the "standard liberal arts analysis" taught during the education may be useful, but in the end, the true gift is the ability to choose to *transcend* that formal "take-away" from the education. This begs the question of what an education should offer, if its value really resides in that which is *not* formally taught. This paradox goes all the way back to the German romantics. Indeed,

> there was nothing more important to the romantics than *Bildung*, the education of humanity. This was the central theme and goal of their ethics, aesthetics, and politics. But, from a more practical perspective, there seems to be *nothing less important* to the romantics than education. When it comes to concrete suggestions about how to educate humanity—about what specific institutional arrangements are to be made—the romantics fell silent. (Beiser, 2003: 105, italics added)

In his own way, Foster Wallace seems to be making a similar point. So is Swedish educationalist Ellen Kay, who famously argued that *Bildung* is that which remains once you have forgotten what you have learnt. The classical *Bildung* ideal of forging autonomous thought presents something like a reversed version of Bataille's "accursed share": It is not the excess of an education is accursed; it *only* the excess that is *not* subject to disposal. The formal knowledge must be squandered in order for the "formed" human being to come into view.

Another way to approach this paradox is to ask what critical thinking really implies. As Bruno Latour (2004) has suggested, it all too often implies reducing something more to something less, when in fact criticality should be generative. Here, he plays with Alan Turing's discussion on intelligence among humans and computers. Turing suggests that a majority of the minds that one encounters among humans are "sub-critical", which means that an

"idea presented to such a mind will on average give rise to less than one idea in reply". However, a "smallish proportion" of human minds are "supercritical":

> An idea presented to such a mind may give rise to a whole "theory" consisting of secondary, tertiary and more remote ideas. (Turing, 1950: 454)

Turing suggests that animal minds are always sub-critical, but the question is whether "a machine be made to be super-critical?". Turing's analogy is, of course, sourced from the idea of critical mass in fission: A sub-critical mass is not sufficient for setting off a chain reaction – nothing "more" can emerge from the sub-critical. Latour, on his part, is more interested in what the notion of "super-criticality" means for our understanding of the term "critique". What would it mean if by "critical" we always mean a habit of mind that yields something more, not less? A habit of mind that is generative, not reductive? A fostering of that mode of critical thinking among engineering students may be the proper way to inherit the tradition of classical *Bildung*.

References

AAAS (1990). *The Liberal Art of Science: Agenda for Action*. American Association for the Advancement of Science, Washington, DC.

Almqvist, C.J.L. (1995 [1844-1845]). *Monografi*. Stockholm: Svenska Vitterhetssamfundet.

Bataille, G. (1991). *The Accursed Share: An essay on general economy* (Vol. 1: Consumption). New York, NY.: Zone Books.

Beiser, F.C. (2003). *The Romantic Imperative: The Concept of Early German Romanticism*. Cambridge, MA.: Harvard University Press.

Berman, M. (1982). *All That Is Solid Melts into Air: The Experience of Modernity*. New York, NY.: Simon and Schuster.

Berner, B. (1981). *Teknikens värld: Teknisk förändring och ingenjörsarbete i svensk industri*. Lund: Arkiv förlag.

Broady, D. (1984). Om bildning och konsten att ärva. *Kritisk utbildningstidskrift* VIII, 35-36.

Bucciarelli, L. & Drew, D. (2015). Liberal studies in engineering – a design plan. *Engineering Studies* 7: 2-3, 103-122.

Ebenezer, J. (2013). Social justice pedagogy for all science learners. *Studies in Science Education* 49, 252–264.

Foster Wallace, David. (2009) *This Is Water: Some Thoughts, Delivered on a Significant Occasion, about Living a Compassionate Life*. New York, NY.: Little Brown.

Geijer, Erik Gustaf (1928 [1810]) Om inbillningsgåvan. In *Samlade Skrifter*, vol 1. Stockholm: Norstedt och Söner.

Geijer, Erik Gustaf (1928 [1838]). Tal vid invigning av nya katedralskolehuset i Uppsala d. 21 okt. 1837. In *Samlade Skrifter*, vol 8. Stockholm: Norstedt och Söner.

Hadzigeorgiou, Y. (2015). A Critique of Science Education as Sociopolitical Action from the Perspective of Liberal Education. *Science & Education* 24: April, 259–280.

Harford, T. (2022). Learning how to think well involves hearts as well as minds. *Financial Times*, 10 June.

Hirst, P. (1972). Liberal education and the nature of knowledge. In R. Dearden, P. Hirst, & R. Peters (Eds.), *Education and the development of Reason* (pp. 391–414). London: Routledge & Kegan Paul.

von Humboldt, W. (1963). *Schriften zur Sprachphilosophie*. In *Werke IV*, edited by A. Flitner and K. Giel. Darmstadt: WBG.

von Humboldt, W. (2000). Theory of *Bildung*. In *Teaching as a Reflective Practice: The German Didaktik Tradition*, edited by I. Westbury, S. Hopmann, and K. Riquarts, 57-61. Mahwah, NJ: Erlbaum.

Jacobsson, P. (2019). *Den bildade ingenjören: Bildning, utbildning och teknik*. Lund: Studentlitteratur.

Kallenberg, B. (2015). Liberal Arts is more than 'Perspective'. *Engineering Studies* 7, No. 2-3: 132-134.

Landquist, John (1924) *Erik Gustav Geijer: Hans levnad och verk*. Stockholm: Norstedt och Söner.

Latour, B. (2004). Why has critique run out of steam? From matters of fact to matters of concern. *Critical Inquiry* 30: 2, 225-248

Lewinson, M., Flint, A.S., & Van Sluys, K. (2002). Taking on critical literacy: The journey of newcomers and novices. *Language Arts* 79 , 382–392.

Norberg, E. (1944) *Geijers väg från romantik till realism*. Stockholm: Svenska kyrkans diakonistyrelses bokförlag.

Riley, D. (2008). *Engineering and Social Justice*. San Rafael, CA: Morgan and Claypool.

Riley, D. (2015). Facepalms and cringes: liberal education misapprehended. *Engineering Studies* 7: 2-3, 138-141.

Royal Academy of Engineering (2014). *Thinking like an engineer: implications for the education system*. Report for the Royal Academy of Engineering Standing Committee for Education and Training, May.

Ruitenberg, C.W. (2009). Educating political adversaries: Chantal Mouffe and radical democratic citizenship education. *Studies in Philosophy and Education* 28, 269–281.

Schwartz, B. (2015). What 'learning how to think' really means. *The Chronicle of Higher Education*, June 18.

Sjöström, J. Frerichs, N., Zuin, V.G. & Eilks, I. (2017). Use of the concept of *Bildung* in the international science education literature, its potential, and implications for teaching and learning. *Studies in Science Education*, 53:2, 165-192.

Turing, A.M. (1950). Computing machinery and intelligence. *Mind* LIX: 236, 433–460.

Ullman, A. (2014) Rektor C.J.L. Almqvist och personlighetsprincipen. *Nordic Journal of Educational History* 1: 2.