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Grinter Got it Right: Seventy Years of the Grinter Report

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Abstract
Anniversaries are fitting times for reflection, so it seems appropriate on the 70th anniversary of the Grinter Report to revisit that document and consider its continuing influence on the course of engineering education. By many accounts, the Grinter Report achieved an impact that is seldom the result of committee reports, for it seems to have been the catalyst for a transformation of engineering education from practical and hands-on to the scientific education which is ubiquitous to this day. This has led to the identification of the Grinter Report with these changes and the perception that it recommended a one-size-fits-all curriculum that was impractical and inflexible. This paper will reexamine the report and show how it considers many of the same problems we are still debating today. A case for reconsidering the Grinter Report will be made through three points. 1) The current engineering curriculum is at most superficially related to the Grinter Report. It will be argued that curricular changes rarely coincided with the intentions of the report and were rather motivated by other factors. 2) The Grinter Report focuses on principles of engineering education, not a particular curriculum. It will be shown that these principles are built on a long tradition of liberal education. 3) While the Grinter Report is often critiqued as advocating an impersonal, one-size-fits-all education, the report emphasizes the great need to recognize the personal needs of both faculty and students. This appeal aligns well with the aspirations of many for an engineering education that is both true intellectually, and good for the person.

Introduction

As Cheville and his coauthors observed, "the desire to change something is a driving factor for many individuals' engagement with engineering education"[1]. This desire for change in part explains why the last century has seen so many evaluations of engineering education. These include the Mann Report (1918), the Wickenden Study (1923), the Hammond Report (1940), the Goals of Engineering Education (1968), Engineering Education and Practice in the United States (1985), and The Engineer of 2020 (2004). Despite this desire for change, engineering education remains relatively stable. The education engineering students receive today, comprised of math, science, engineering science and design on the periphery, is largely the same as that received by the generations of their parents and their grandparents; however, this model of engineering education has not always been the norm. The Grinter Report, named after its committee chairman and published in 1955, is widely cited as a catalyst for change across engineering education.

The Grinter Report came out at a crucial moment in the development of technology. World War II was still in recent memory and the Cold War was in full swing. The prevailing opinion was that success in the Cold War meant maintaining technological superiority at all costs. A committee of leading engineering educators was assembled to assess the readiness of engineering programs in the United States for the technological challenges of the coming decades. The committee's work lasted over three years, beginning in 1952. A preliminary report was issued in 1953 which went to all accredited engineering programs and the committee received feedback reports from 122 institutional committees. Based on this feedback, an interim report was issued in 1954 and sent not only to engineering educators, but also to various industries. Further revisions were made, and the final report was issued in 1955. This history demonstrates that the conclusions of this report were not developed in an off-hand way, nor were they merely the opinions of a select few. The extensive cycle of dissemination and review by diverse stakeholders lends strong face validity to the report.

In a recent article titled *Stuck in 1955, Engineering Education Needs a Revolution* a group of prominent ASEE leaders including past president Sheryl Sorby identify the Grinter Report as a key barrier to needed change in Engineering Education. They describe how the report "brought about a sea change in the training of engineers and became a foundational document for engineering education that still has a significant influence on engineering curricula at the undergraduate and graduate levels. After Grinter, theory replaced practical hands-on work. And this approach has changed little in the intervening decades" [2]. As the title of that article indicates, many engineering educators believe we are stuck in 1955. Many believe that while the changes attributed to the Grinter Report may have served the needs of engineering education in its day, its influence is now counter-productive in many ways to the goal of preparing students for current and future realities. They argue that "engineering education needs a revolution" [2].

Given the high value engineering educators place on change, the question arises: why revisit a seventy-year-old report? After all, the world itself has changed, and engineering education has had seven decades of development. John Whinnery answered this question during the last major review of the Grinter Report thirty years ago in the Journal of Engineering Education [3]. Whinnery makes the following claim:

> Although I have been critical of persons who plan major educational experiments without reviewing past experiments or studies, I must confess that I'd nearly forgotten the monumental Grinter study... In rereading the report after nearly forty years, I'm amazed to find it so thorough and so current. The ten points in the summary are timeless principles that could stand as a tablet of ten commandments for engineering education. These are broad principles, but even the detail of the report, with a few exceptions, could have been written this week [3, p. 72].

Whinnery reminds us that we greatly increase our chances of success in future changes by considering what has been done in the past. He also reminds us of another important truth about change. Any alteration involves things that change and things that stay the same. The Grinter Report was a monumental achievement in engineering education because it does not get mired with the preoccupations of its time, but identifies the "timeless principles," to use Whinnery's phrase, upon which a firm tradition of engineering education can be built. Understanding the principles of the Grinter Report will allow this generation of engineering educators to make wise decisions as we consider how to create an education that leads to intellectual growth, creative development, and personal flourishing.

This paper will reframe the Grinter Report around its main educational philosophy, which is an invaluable guide to our current debates. The case will be made along three main points: 1) The current engineering curriculum is at most superficially related to the Grinter Report. It will be argued that curricular changes rarely coincided with the intentions of the report and were rather motivated by other factors. 2) The Grinter Report focuses on principles of engineering education, not a particular curriculum. It will be shown that these principles are built on a long tradition of liberal education. 3) While the Grinter Report is often critiqued as advocating an impersonal, one-size-fits-all education, the report emphasizes the critical importance of recognizing the personal needs of both faculty and students. This appeal aligns well with the aspirations of many for an engineering education that is both true intellectually, and good for the person. This paper makes extensive use of quotations from both the Grinter Report and other sources. Given the importance of the Grinter Report as a source, quotations from that report are set in italics.

Curricular Changes and the Grinter Report

In contrast to Whinnery's claim above that the Grinter Report contains "timeless principles," it is sometimes claimed instead that the Grinter Report was reactionary to its historical moment. For example, Miller claims that the major technological developments attributed to scientists rather than engineers during World War II were the impetus for the committee's report. He states that "when it came to the origination of big, new ideas, it seemed to many, including Grinter's committee, that engineering was in danger of being left behind"[4, p. 53]. He goes on to say that the adoption of the Grinter Report's curriculum was driven by the launch of Sputnik: "Although some initially resisted this course change, Russia's launch of Sputnik in 1957 turned the tide firmly in favor of those advocating a more mathematically and scientifically rigorous engineering education"[4, p. 53]. While it is true that the Grinter Report urged a greater focus on math and science in engineering education, and that engineering curricula did change in this direction around the time of the report's publication, it is not clear that the reports publication caused these changes. This causal link is made doubtful by investigating changes in engineering education attributed to the report and comparing them to the contents of the report itself.

The Grinter Report has achieved an almost legendary status in engineering education. References to the report found throughout the literature emphasize the shift from practical studies to engineering science as described above. It will be argued that much of the "damage" of the Grinter Report is based on changes that were not recommended by the report. This section will examine critiques of the Grinter Report and will show that the report almost always anticipates these objections and, in fact, proposes almost the same solutions as its critics.

Basic Math and Science

Sorby speaks for many in engineering who feel that the emphasis on the calculus sequence is out of proportion to the needs of engineering:

> We need to examine and discard some of the canonical ideas in engineering education. Instead of forcing our students to memorize the intricacies of the chain rule in taking derivatives, would it not be better to teach them to use mathematics to model physical phenomena, to question numbers that magically appear on their calculator readout, or to know when to apply the chain rule and where to look it up when needed? Some professors have advocated breaking calculus' grip on the engineering curriculum. (In current curricula, it is often faculty in the mathematics department who determine who gets to be an engineer) [2].

The Grinter Report essentially agrees, stating:

> *Engineering judgment is more and more often guided by mathematical analysis, and such analysis is rapidly expanding the demands it places upon advanced areas of mathematics. At the undergraduate level, competence is the theory and use of simple, ordinary differential equations and their application to the solution of physical problems lies close to the boundary of minimum acceptability of mathematics in any satisfactory engineering curriculum* [3, p. 80].

Sorby emphasizes judgment, and modeling physical phenomena; the Grinter Report agrees. The claim that engineering students need at least competence in theory and use of simple ordinary differential equations is modest compared to all the material presented in the calculus sequence at most institutions.

Engineering Science
The six core engineering sciences recommended by the Grinter Report are not usually criticized in the literature. If any objection is made, it deals with the question of how much engineering science is needed for all engineers verses what is needed for particular fields. Whinnery gives voice to this perspective:

> My main criticism of the (Grinter Report) curriculum discussion when I was department chairperson had to do with the list of six engineering sciences. After making the point in the first paragraph that engineering sciences stem from two basic areas, mechanical phenomena and electrical phenomena, it was disturbing to find that the first four relate to the former area and only one to the latter. The report makes clear that the list is not complete, encourages experimentation, and mentions information theory as a possible addition, but some accrediting teams did expect to find a course for each listed item [3, p. 72].

Whinnery observes that one concrete way the Grinter Report affected engineering curricula is through accreditation. As he notes, the report makes clear that its recommendations are not to be used in this way.

While most current engineering programs contain courses with the names of the six engineering sciences listed in the report (i.e. mechanics of solids, thermodynamic), these current courses may not reflect the authors' intentions. Following the list of engineering sciences, the Grinter Report gives the following caveat: "*It is not necessary that this material be treated as separate courses. Experimentation should be encouraged to find the best way of achieving, with the available staff, the desired goal in a specific environment*" [3, p. 81]. It is often assumed that the Grinter Report required too much material to be taught effectively in four years, but in fact the question of how much of each engineering science students need to know is left to the discretion of each program.

Engineering Design
Eder associates a reduction in emphasis on engineering design with the Grinter Report, and also expresses the view that the report's recommendations have been made superseded by later scholarship in engineering education:

> For several years it has been recognized that the curriculum changes introduced in the 1960's, as a result of the Grinter Report, were in some ways counter-productive… The Grinter report was written before any serious start had been made on studying procedures, systematic methods and methodologies, modeling tools and theories of designing -- a verb describing the necessary and possible activities and processes… Too much emphasis was (and is) placed on engineering science, especially on solving the mathematical models, and not enough on other aspects of engineering [5, pp. 1–2].

Eder acknowledges "an integrated study of engineering analysis, design, and engineering systems" [3, p. 74] is a primary recommendation of the report, but this focus on design was not widely adopted. In fact, the report takes great interest in the importance of engineering design:

> *Education directed toward the creative and practical phases of economic design, involving analysis, synthesis, development, and engineering research is the most distinctive feature of engineering curricula. Such education intrinsically stems from the case method of approach, rather than from an orderly exploration of a given subject-matter field. Some experience in this "design" function should be carried in an integrated manner through each semester of the last two years and may be begun earlier if practicable* [3, p. 81].

While the implementation of the Grinter Report may have given too little emphasis to design as Eder notes, the Grinter Report assigns roughly equal time to the three areas of basic math and science, engineering science, and engineering design. The report recommends roughly a quarter of the curriculum for each category, leaving a quarter of the time for general education, laboratories and other courses.

Engineering Laboratories

Feisel and Rosa summarize the Grinter Report's effect on laboratories as follows:

> To save dollars with reduced enrollments, some schools elected to minimize laboratory courses, citing the Grinter Report's conclusion that knowing theory was paramount and that engineering practicum appeared to be of secondary importance. Many engineering schools began graduating engineers who were steeped in theory but poor in practice [6, p. 122].

Feisel and Rosa acknowledge that monetary factors often drove changes which were attributed to the Grinter Report. This dynamic will be revisited below.

In terms of the role of the laboratory, Feisel and Rosa seem to miss an opportunity to learn from the Grinter Report. They claim that "As history has shown, there has not been general agreement on the objectives of engineering instructional laboratories nor any real efforts to define a comprehensive set until now" [6, p. 126]. While their claim may rely on a particular definition of "objectives" for a course, the Grinter Report does exactly what they say has not been done:

> *The laboratory is the means of teaching the experimental method. It should give the student the opportunity to observe phenomena and seek explanations, to test theories and note contradictions, to devise experiments which will yield essential data, and to interpret results. Therefore, laboratories should be used where and only where these aims are being sought. The value of a set number of stereotyped experiments is questionable. The development of a smaller number of appropriate experimental problems by the students themselves under effective guidance will have much greater educational value* [3, p. 82].

The aims laid out here are significantly aligned with the thirteen objectives reported in Feisel and Rosa. While the section on laboratories is brief compared to other areas of the curriculum, the report assigned a crucial role to laboratories that could hardly be used to justify their removal. It is true that the report does not assign a percentage of the curricular time to laboratories, but this was likely because these courses, even when well represented, are not a significant percentage of the credit hours of a program.

Of particular importance is the Grinter Report's claim of the dubious value of "stereotyped experiments" which remain common in engineering to this day. While many doubt the value of "stereotyped experiments," experience shows that the kind of experimentation recommended in the Grinter Report is much harder to explain to students and to grade. What is true in laboratories seems to be true with all the recommendations of the Grinter Report. What the report recommends was seen as impractical; what was thought to be more feasible, and thus actually implemented by educators, was not satisfactory.

Career Preparation

Although not specifically tied to one part of the curriculum, many are concerned that engineering education as it exists today does not do enough to prepare students for their careers. Sorby expresses this goal of engineering education as follows: "It is time that we as educators take a long, critical look at our values and curricula to ensure that we are preparing students for careers that exist today and for future careers" [2]. Sorby is aligned with many who believe that less emphasis on theory and more emphasis on specific tools and problem-solving strategies would be more beneficial for career readiness.

The Grinter Report should be commended for its willingness to ask difficult questions of its recommendations including the question of career readiness. When considering the broad curriculum it recommends, the authors ask themselves: "*would the employer be pleased with graduates of such programs or would he prefer men able to earn their salary immediately upon graduation without special job training*"[3, p. 84]. No engineering educator can ignore this question, but it is a difficult question to answer and the answer may depend on the economic conditions at the time. There is significant evidence that employers expect more skills of employees when the economy is weak than when it is strong [7], so in that way perhaps the education of the Grinter Report was better suited to its time of strong economic growth. On the other hand, employers have always been capable of training their employees and will do so if it benefits them.

At the time of the Grinter Report, employers felt that a broad, scientific training was best for engineers generally. The report says "*the industrial representatives who were present concluded that they would prefer nearly all of their engineers to be trained in scientifically oriented curricula*" [3, p. 85]. Perhaps employers today would prefer certain skills in place of scientifically trained engineers, but this does not seem to be entirely established. During the era of the Grinter Report employers were mainly focused on the need to improve non-technical skills. The report states that "*comments which were received, particularly from industry, place great emphasis upon the inability of engineers to express themselves in clear, concise, effective, and interesting language. Stress was also placed upon the importance to engineers of an acquaintance with the humanities and social sciences*"[3, p. 75]. Perhaps employers today would not voice their concerns in exactly the same way; nevertheless, the desire for engineers to engage with the humanities and social sciences may be based on the reality that employers deal with the long-term effects of engineering education. They may have a vision for shortcomings that are not always apparent or deemed important within the four years of undergraduate education.

Curricular Conclusions

As the analysis above has shown, many curricular changes associated with the Grinter Report were, in fact, advised against in that report. If the report's actual recommendations are not widely known by engineering educators today, that is because they were never widely implemented. In the JEE review of the report thirty years ago, Irene Peden stated her view that "the (Grinter) committee did not foresee the selectivity the academic community would apply in implementing the goals articulated in the report" [3, p. 71]. As Feisel and Rosa claim in the section on laboratories above, this selectivity may have had more to do with justifying decisions than with making decisions in the first place.

While the Grinter Report can be linked to curricular changes through accreditation requirements as Whinnery claims in the section on engineering science above, many other curricular changes at the time were due to changing priorities in engineering education which coincided with the publication of the Grinter Report.

The years following World War II saw a tremendous increase in federal funding of academic research. Seely describes the magnitude of this change:

> An avalanche of federal money, primarily from the military and the Atomic Energy Commission, displaced the smaller industrial research projects that had been conducted by a few engineering colleges before 1940. Trade associations had been the key research supporters in the 1930s, and a few thousand dollars a year constituted a large project.

> After 1945, however, federal grants worth hundreds of thousands or even millions of dollars a year supported not just researchers but entire graduate programs with marvelous new facilities and expensive equipment [8, p. 289].

This increase in research funding had profound effects on undergraduate education in two primary ways. First, the demands of these new research projects changed the dynamics of faculty searches. Before this research paradigm, faculty qualifications would be primarily based on motivation and aptitude for teaching as is recommended in the Grinter Report. After the era identified by Seely, the focus shifted towards securing grants and performing scientific research. Faculty with the scientific background needed to compete for these grants would likely tend to favor a more theoretical approach to courses. In addition to changing faculty motivation, research duties competed with teaching for faculty time, and theory is often more efficient to teach and assess than applications. Sorby notes that time pressures still dictate many of the problems we are willing to assign:

> Instead of assigning messy problems that would require the synthesis of concepts from multiple disciplines, applying logical boundary conditions, and examining outcomes to make sure they are reasonable, we assign problems that could be solved with a slide rule. These are easier to grade and explain, but they are not all that realistic or inspiring. And they are not really representative of the type of problems engineers may encounter in their working careers [2].

This section has shown that, although criticisms of contemporary engineering education are often linked to the Grinter Report, current educational practices rarely reflect the recommendations it put forward. The next section will go further, illustrating how a closer examination of the educational principles in the Grinter Report reveals an even wider divide between the tradition it promoted and the realities of present-day engineering education.

Building a Tradition of Engineering Education

Calls for curricular change in engineering education are often motivated by the basic need for engineering education to keep pace with the times. Every major engineering report identifies the challenge of societal and technological change as the impetus for curricular change. For example, the Wickenden study says "the problem of engineering education is to determine and to meet the progressive demands of a rapidly changing civilization" [9, p. 8]. Almost a century later, Sorby et al. said almost the same thing: "our system of engineering education needs to address the needs of today's digital, diverse, global, and rapidly changing society" [2]. The Grinter Report recognizes the same challenge, stating that "*engineering is far from static*" [3, p. 75]. The question is: what education best prepares students for a rapidly changing world?

One solution to the problem of rapid technological change and growth of knowledge would be to make every effort to keep the engineering curriculum up to date with current practice; however, the Grinter Report proposes that such a curriculum will always be inadequate. The authors formulate their argument as follows:

> *After facing many questions regarding the future of engineering practice, one is likely to conclude that the teaching of practice, as it exists today, will always be of limited use because the graduate is certain to find practice changing from year to year. And, as a matter of fact, the engineering art taught in colleges will normally reflect practice that is already obsolete in part, since the teacher's knowledge of practice becomes rapidly outdated* [3, p. 84].

This is a strong argument, and it does not seem that any changes since the publication of the report have invalidated its conclusion. This rapid obsolescence of practical knowledge, and uncertainty about what knowledge will be most useful in the future are the main reasons why the Grinter Report recommends a broad education focused on theory in early years and transitioning to engineering design in later years.

In the face of rapid change, the Grinter Report claims that "*fortunately, some things do not change*" [3, p. 84]. Fundamental scientific principles will always be at play in the design of any real device. As the authors say of math, science, and engineering science, "*these studies encompass the solid, unshifting foundation of engineering science upon which the engineering curriculum can be built with assurance and conviction*" [3, p. 84]. Assurance and conviction are desirable traits in higher education as elsewhere, assuming they are rightly placed. Without fixed guideposts, it is impossible for faculty to work together towards shared goals. Lack of assurance and conviction will also erode student confidence in the value of their education. Theory provides one key element of the engineering tradition advocated for in the Grinter Report, but it should not be confused for the entire tradition.

The Grinter Report repeatedly emphasizes the need for engineers to receive a broad education. It claims that an engineering course "*can be taught either as a narrow specialty or as a liberal subject in a professional curriculum*" and that wise engineering educators "*should strive for the latter*" [3, p. 76]. This liberal approach to learning will inspire "*students toward creative endeavor and intellectual development not only while they are in college but also throughout their careers*"[3, p. 76]. For the Grinter Report, this creative and intellectual development comes through integration of knowledge. Students must understand how general principles learned in earlier courses are applied and developed in later courses. When describing the engineering science sequence, the ideal of integration is stated as follows:

> *In the study of engineering science, full use should be made of the mathematics, physics, and chemistry described in the section on Basic sciences… Perhaps nowhere else can the qualities of a scholarly engineering faculty be employed so effectively as in the presentation of the engineering sciences with an appropriate mathematical understanding* [3, p. 81].

Again, when discussing engineering analysis and design courses, the report states "*It is important again to stress the necessity of utilizing fully in such studies the basic and engineering science training at the level which this report outlines*" [3, p. 81]. Integration of knowledge in broader education courses was stressed as much as it was for other areas of the curriculum:

> *To the attainment of these objectives both the technological and the humanistic divisions of the curriculum should contribute as integral parts of one total program. It is a mistake to look upon technology alone as the productive component of the student's development and on the humanities as providing only the liberalizing elements in his pattern of growth. On the contrary, all of his courses of study, whatever their specific objectives in knowledge or skill, should be so designed and taught as to contribute toward the student's development as a truly educated man whose convictions, understandings, manner, and speech are intimately related components in the fibre of his life* [3, p. 82].

The engineering tradition developed by the Grinter Report consisting of fundamental theory integrated throughout many contexts is not an innovation; it rests on a long-standing tradition of liberal education. This will be illustrated through the seminal work of liberal education by John Henry Newman, called *The Idea of a University,* or, the *Idea* for short.

Newman devotes an entire chapter in the *Idea* to the relationship between true knowledge of the kind that universities should develop on the one hand and what he calls mere learning on the other hand. True knowledge goes beyond memorization of facts or procedures. Newman says "there is no enlargement, unless there be a comparison of ideas with one another… and a systematizing of them" [10, p. 134]. He concludes:

> That only is true enlargement of mind which is the power of viewing many things at once as one whole, of referring them severally to their place in the universal system, of understanding their respective values, and determining their mutual dependence [10, pp. 136–137].

This cultivation of the ability to see how general principles apply in new situations is crucial in preparing students for a rapidly-changing world. Newman claims that "a truly great intellect…such as the intellect of Aristotle, or of St. Thomas, or of Newton… is one which takes a connected view of old and new, past and present… and which has an insight into the influence of all these on one another" [10, p. 134]. This is the true value that the Grinter Report assigns to its curricular recommendations. It is not only that basic theory does not change; it is the value of basic theory in developing the intellect of a student through grasping connections, and generalizations. Development of this kind allows students to see the power of ideas, as well as their limitations.

The kinds of integration described in the Grinter Report did not become common practice. Faulkner [11] investigated the integration calculus concepts in engineering courses and found that such integration was minimal. Where concepts were utilized, they typically were the most basic ideas, like the integration of polynomials. Likewise, Robinson [12] investigated historical trends in introductory engineering circuits textbooks and found that use of basic electricity and magnetism theory decreased over time. Texts published before the Grinter Report integrated much more scientific theory while more recent texts approach problem solving from a more pragmatic perspective of performing basic calculations.

Integration of the type recommended in the Grinter Report is, in the report's words, a "*difficult and challenging job, but a very necessary one*" [3, p. 81]. Experience shows that students often do not retain even the basic ideas from previous courses, making meaningful integration essentially impossible without extensive review which rarely seems justified. If Newman and the Grinter Report are correct about the benefits of an integrated view of knowledge, this situation deserves serious consideration.

As with other areas of the engineering curriculum, courses taken outside of engineering have likewise failed to be integrated, perhaps to a much greater extent. Much of a student's broader education comes from their institutions' general education requirements, which are rarely designed to address the particular needs of engineers. This is a situation that the Grinter Report considers a great defect:

> *This Committee believes that no effort to enhance the value of the humanities and social studies will yield greater returns than that devoted to bringing about a genuine community of interest, better understanding, and more meaningful cooperation between teachers of engineering and those in the liberal arts* [3, p. 83].

Anyone who has attempted this interdisciplinary work knows that it can be very difficult and fraught with misunderstandings; however, those of us who agree with the Grinter Report must find ways to advance this crucial objective.

The Relational Aspects of Engineering Education

For many, the legacy of the Grinter Report is associated with its science-based engineering curriculum. Sorby et al. speak to the desire to see a change in this curriculum when they say:

> The (Grinter Report) moved the pendulum from hands-on, practical training to the side of theoretical and science-based engineering. We believe it is time to move the pendulum in an entirely new direction—toward a more humanistic approach to engineering. By focusing on the students themselves, we can graduate more balanced engineers who are prepared for the world as it is today and for the future [2].

Perhaps it would be surprising for some to find out that the Grinter Report contains passages like this:

> *Students need a close bond of mutual interest and friendship with members of the faculty. They need objective guidance and encouragement in their intellectual growth; they need sympathetic understanding of their personal problems; but above all, they need the realization that they are being treated as individuals* [3, p. 76].

In fact, the development of both students and faculty as individuals is one of the major themes of the Grinter Report. The authors insist that engineering education must:

> *Help the student to arrive at a satisfying personal philosophy rather than to provide him merely with immediately useful technical knowledge and skill (and) provide the individual with an enlightened background that will give him the means and the inspiration to grow on his own initiative before and after graduation* [3, p. 76].

These are not isolated quotations; in fact, the Grinter Report begins by stating its belief that engineering curricula must always "*be based upon the obligations of the engineering profession to society and upon the importance of the development of the student as an individual*" [3, p. 75]. Humanistic engineering education was very much on the minds of the report's authors. They insist that "*the student, not the curriculum, is the primary concern*" [3, p. 79]. The Grinter Report sees the personal development of the student as the primary concern, but it also recognizes that this will only happen if the faculty are also given an environment where they can flourish. The report extensively describes faculty development and places the chief importance on the university environment:

> *The academic and professional development of an engineering faculty can proceed only in a favorable environment. More important than physical surroundings is the intellectual atmosphere; that is, the attitudes and ideas of the people who comprise the university. A common inner urge to know and to understand is basic to this atmosphere and leads to unity of purpose—the mutual selection of common goals and coordination of effort toward their achievement. There must be encouragement of intellectual growth and opportunity for professional development such as is involved in the teaching of graduate courses. Teaching loads must be kept at reasonable levels to allow time for scholarly or creative activities. The development of such a favorable academic atmosphere should be the concern of all faculty members, particularly those in senior administrative posts* [3, p. 76].

The preceding quote highlights the importance of strong relationships between faculty members. The authors claim that a common urge to know and understand is essential if faculty are to work effectively together rather than as individual actors.

Conclusion: Is the Tradition of the Grinter Report Still Valuable?

This paper has shown that the common view of the Grinter Report as advocating a lifeless and impractical scientific engineering education is not accurate. That interpretation stems more from contemporaneous shifts in engineering education than from the report's actual recommendations. Nonetheless, considering that the Grinter Report reflects ideas from seventy years ago, one might ask whether it still holds relevance today. We argue that it does.

Far from being opposed to current proposals for change in engineering education, the Grinter Report anticipates these developments, and encourages them. Engineering educators want a curriculum that develops students' intellectual potential; the Grinter Report tells them how to achieve their goal. Engineering educators want a curriculum that nurtures students' creative capabilities; the Grinter Report points the way. Engineering educators want programs that lead to personal flourishing; the Grinter Report affirms this goal as both necessary and good. Engineering educators want to foster collegial relations and common goals with other faculty; the Grinter Report provides a tradition which can direct these efforts. If the Grinter Report anticipates these aims, which must always be present in engineering education, then it also anticipates the challenges which the years after the report would bring to the implementation of these aims.

The post–World War II era brought significant transformations to higher education, particularly in the field of engineering, largely due to an influx of federal research funding. This funding created new opportunities that, in some respects, benefited undergraduate education. However, it also introduced new challenges, especially increased competition for faculty time. In addition, as teaching loads were reduced, the kind of integrated learning emphasized in the Grinter Report became more difficult to achieve. Faculty came to teach only one or two courses, which limited their perspective on the overall curriculum. The Grinter Report foresaw both developments. It emphasized teaching effectiveness as a primary qualification for faculty and advocated for a cohesive, integrated approach to learning. In doing so, the report anticipated not only changes within engineering education but also broader societal developments that have continued to influence the profession to the present day.

The era of the Grinter Report was a time of significant degradation in public perceptions of technology, and by extension, of the engineering profession. Historian of engineering Samuel Florman cites 1950 as a key turning point. He calls the period from the industrial revolution up to 1950 the "golden age of engineering" saying:

> To be an engineer in 1902, or at any time between 1850 and 1950, was to be a participant in a great adventure, a leader in a great crusade… Every few months, it seemed, some new technological marvel was unveiled and greeted with wild public enthusiasm… In the late 1800s engineers began to appear regularly as heroes in novels and short stories… The conventional wisdom was that technological progress brought with it real progress – good progress – for all of humanity., and that the men responsible for this progress had reason to consider themselves heroes [13, pp. 4–6].

If this passage embarrasses some engineers today, it is because we no longer live in that golden age. Florman cites January 31, 1950 as the end of that age with president Truman announcing the development of the hydrogen bomb. The following epoch was marked by growing technological skepticism that waxed and waned but has never gone away completely. As discussed above, it is sometimes assumed that a desire to keep up with technological accomplishments from scientists was the motivation for the Grinter Report. There is a case to be made that it was not the struggle for technological competence, but for the personal significance of engineering work that was their real motivation. Although historical changes are rarely clear at the time, perhaps the foresight of the report's authors allowed them to correctly see what was coming: although the engineering profession would grow faster than ever, the public perception of engineers was in rapid decline.

After the golden age, engineers would no longer be seen as heroes. As Florman notes "the antitechnologists have characterized (the engineer) as an uptight, inauthentic person who sees with a dead man's eyes. Except for its poetic excess, this is not too different from the generally accepted view" [13, p. 91]. In part, Florman attributes these personality deficiencies to engineering education:

> Part of the problem is surely the stultifying influence of engineering schools. In too many of these institutions, the least bit of imagination, social concern or cultural interest is snuffed out under a crushing load of purely technical subjects [13, p. 92].

It is true that engineering education is just as much in need of change now as ever. Enough has been said here to demonstrate that the Grinter Report did not advocate the kind of education described by Florman. In fact, it does not insist on any particular curriculum at all. The authors repeatedly emphasize that their mission is not to determine the ideal engineering curriculum, because such a curriculum does not exist. They claim that "*the great need of engineering education at this time is for experimentation with, rather than standardization of, curricula*" [3, p. 86]. This call for experimentation is one of their ten recommendations for engineering education and is emphasized at least seven times throughout the report.

Although the Grinter Report doesn't offer direct solutions to today's challenges in engineering education, it does provide a cohesive, grounded, and desirable vision which can be used to direct and evaluate any proposed changes. This is a significant accomplishment which should not be overlooked. Produced after years of rigorous analysis by some of the most respected educators of the time, the report captures a wealth of collective insights and remains a valuable resource for the engineering education community. Since no single individual can define a comprehensive vision for the field, the report's guidance helps guard against well-intentioned changes that may ultimately fall short. By engaging with the Grinter Report's ideas, educators can align around shared objectives and foster meaningful collaboration—if we're open to hearing what it has to offer.

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