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Engineering in Reformed Perspective

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Dordt College is in the process of expanding its pre-engineering program to a full, four-year bachelor degree program offering majors in mechanical engineering, electrical engineering, and engineering science. Such a move makes Dordt one of a very small number of liberal arts colleges offering degree programs in engineering, and one of an even smaller number of Christian colleges that do so. It also gives occasion to a number of questions, some of which probe at the very meaning and purpose of reformed liberal arts higher education. It is the purpose of this article to review some of those questions and briefly to suggest directions in which one might profitably go in trying to answer them.

Why Engineering Now?

The first question one might raise when considering the development of engineering education at a Christian college is, very simply, "Why?" After all, Christian colleges have traditionally limited their curricula to the liberal arts subjects, which have popularly been understood to be the humanities: literature, philosophy, theology, etc. Natural science has rarely been a strong point, and, excepting teacher training, what might be called "vocational" fields

of study until only recently have been all but ignored. The explanation for this one-sided state of affairs is multi-faceted, having roots reaching back to the earliest points in the historical and intellectual development of Western civilization, and certainly beyond the scope of a paper such as this. Suffice it to say that the development of engineering education at a Christian college runs counter to historical trends, and therefore makes appropriate the question, "Why now?"

The Cultural Mandate

The primary basis and impetus for establishing an engineering program at a Christian college must be the awareness we have of our calling as God's covenant people, standing in the tradition of the Reformation, to bring every area of life under the lordship of Christ. In opposition to any dualistic view of reality which might separate "sacred" from "secular," "nature" from "grace," or "value-laden humanities" from "neutral science," the Biblical motivating principle of creation, fall, and redemption requires that man recognize God's stamp of ownership on *everything* that exists. This implies that all creatures—from the most transient sub-atomic particle to distant galaxies, from the tiniest microorganism to man, from the muscle-straining work of a man's hands to his most imaginative dreams—are claimed by God for His service. There is no object in creation whose continued existence cannot be characterized as potential service to the Lord. And there is no human activity in which directing creation for service to the Lord is not involved. This unique role that man plays in the creation, directing it to the service of its Creator, characterizes his very existence and is the "calling" he has by virtue of being created in God's image. Historically this has come to be known as the cultural mandate.

Stated most generally, the implication for man of the cultural mandate is that "all of life is religion." That is to say, ". . . whether you eat or drink or whatever you do, do it all for the glory of God" (I Corinthians 10:31). Every thought, word, and deed constitutes service to the Lord—service that is done either in obedience or disobedience to His will.

In its statement of purpose Dordt College recognizes the cultural mandate and begins to spell out its implications for higher education:

> To understand the nature of education, we must see it against the background of God's mandate to subdue the earth. God called man to the task of dressing and keeping the garden; that is, man must develop and conserve the created order. Moreover, as God's image-bearer, man is capable of fulfilling this mandate, because God, in calling man to his task, also equips him. Education, in its broadest sense, is an essential element in the development and exercise of that capability.[1]
>
> Dordt College must strive to transmit the kind of insight that will enable Christians to discern the will of the Lord for any situation and to develop the capacity to implement it. Serviceable insight, therefore, prepares for Kingdom citizenship. And Dordt, as a Christian college, aims to train Kingdom citizens aware of the demands of the cultural mandate, equipped to take their place and carry out their tasks within the community of believers, able to discern the spiritual direction

> of our civilization, and prepared to advance, in loving service, the claims of Christ over all areas of life.[2]

An understanding of the cultural mandate may call into question certain aspects of the distinction that has traditionally been made at Christian colleges between "vocationally oriented" curricula and "liberal arts" curricula. Particularly vulnerable is the onesidedness with which most Christian colleges have favored the liberal arts curricula. The very nature of the term "calling" implies vocation. In fact, vocation may be defined as the work or calling for which one has a special fitness. If education in its broadest sense is seen in terms of developing the special fitness that one has for his calling, then surely Christian education must concern itself at least equally with vocationally-oriented curricula as with liberal arts curricula (if such a distinction is even justifiable in the first place). Dordt's statement of purpose is very clear on this point:

> One goal of the College is to identify those occupational areas where serviceable insight is increasingly needed. In principle no legitimate profession, occupation, vocation, or station in life can be precluded from Dordt's educational concern. Wherever insight is required, there Dordt College is called to supply it.[3]

Redeeming Technology

Since the explosion of the atomic bomb over Hiroshima in 1945, it has become increasingly clear that the fields of science and technology and the profession of engineering constitute an area of life where serviceable insight is sorely needed. The ecological and energy crises of the past decade, which can be seen as different manifestations of the same basic problem, point to the fact that our technological developments have not been carried out in obedience to the will of the Lord, or in recognition of His creational norms for technology. The Biblical motivating principle of creation, fall, and redemption enables us to see the problems of technology in light of the radical fall into sin. The fall, having its origin in the heart of man, affects every area of creation because of man's calling as God's vicegerent. In his self-centered turning away from God, man rejected his covenantal responsibility of stewardship of the creation and

> . . . began to treat the creation not as the Kingdom of God, but as an object of exploitation for his own glory. Having rejected the source of true fellowship and harmony, man abandoned himself and the creation to division and strife, misery and death.[4]

And so those of us who have new life in Christ, and who in particular have been given a "special fitness" for working with technology, have a very specific calling today in the 1980s, here in North America, the heartland of modern technology. We are called to bring the demands and the redemptive healing of the Gospel to bear on this critical area of modern life. Technology must not be abandoned to the curse which it brings upon itself. Instead we must act from the conviction that the Lord Jesus Christ not only created this world, not only upholds it, but also is in the process of redeeming it.[5] Unfortunately this idea of the redemption of the creation, while integral to the Biblical motivating principle of creation, fall, and redemption, has not been clearly understood, even among reform-

ed Christians. And the notions of redeeming technology and our role as agents in that redemptive process will remain foreign to us until we grasp the significance of Christ's atoning work for the whole cosmos. Abraham Kuyper pointed to the problem when he wrote in 1898:

> [T]he object of the work of redemption is not limited to the salvation of individual sinners, but extends itself to the redemption *of the world*, and to the organic reunion of all things in heaven and on earth under Christ as their original head. Christ himself does not speak only of the regeneration of the earth, but also of a regeneration of the cosmos (Matt. 19:28). Paul declares: "The whole creation groaneth waiting for the bursting forth of the glory of the children of God." And when John on Patmos listened to the hymns of the Cherubim and the Redeemed, all honor, praise and thanks were given to God, "Who has created the heaven and the earth." The Apocalypse returns to the starting-point of Gen. 1:1 —"In the beginning God created the heaven and *the earth*." In keeping with this, the final outcome of the future, foreshadowed in the Holy Scriptures, is not the merely spiritual existence of saved souls, but *the restoration of the entire cosmos*, when God will be all in all under the renewed heaven on the renewed earth.[6]

This is clearly spelled out in the Dordt statement of purpose:

> We must clearly see that Christ redeemed not only man, but the cosmos as well. Even though the effects of the fall continue to be present, Christ has broken the dominion of Satan, rescued the creation from the curse of sin and reigns as King over all. From this position of power, He summons the redeemed members of the new humanity to work for the expression of His Kingdom everywhere. As agents of reconciliation, they are called to labor together as one body in fulfilling the original mandate according to the claims of Christ.[7]

Technological problems such as the energy crisis stand today not only as signs to us of the calling we have as the Lord's agents of reconciliation, but also as opportunities for building models of the Kingdom. Such models would be witnesses in this world that are not restricted or encumbered by the pietistic baggage that too often accompanies Christian action.

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Technology and engineering in particular need reform. Truly reformed engineering is that which brings healing to a broken world. When we recognize, unfold, and work out the creational norms for technology, they will be very far from the kind of sterile technicism which brought us, as a society, to the

point of questioning technological progress in general.

Our Historical Situation

Accepting our failure in the past as Christian academic communities to reform technology, we still have the question, "Why now?" Is it just by chance that some Christian institutions are beginning to consider the establishment or expansion of programs in engineering? Or is there something characteristic of our time that leads us to see that the time is ripe?

There are good historical explanations for why reformed Christians have not been in the vanguard of movements to establish engineering schools during the last one hundred and fifty years. For our purposes it will be sufficient to examine the academic climate of the last thirty years.

According to Samuel C. Florman, one of the most eloquent of modern spokesmen for the profession of engineering, the downfall of the engineer (and, one may surmise, of modern technology) began on "January 31, 1950, the day President Truman announced that work would begin on the development of a hydrogen bomb."[8] A few days later, in a style that sounds strikingly modern, Albert Einstein wrote,

> Radioactive poisoning of the atmosphere and hence annihilation of any life on earth has been brought within the range of technical possibilities. . . . In the end, there beckons more and more clearly general annihilation.[9]

During the next decade the decline of the engineer was checked by such factors as increased economic growth (and the consequent demand for engineers), various technological developments, and the national effort to explore space and land a man on the moon. By the mid sixties, however, these factors were unable to counteract the negative atmosphere beginning to surround engineering and technology as they increasingly became associated with the Vietnam war effort. By 1968, possibly the nadir of technology's popularity, the environmental crisis arose and demanded a scapegoat. Technology, staggered by its alliance with the war effort, was the appropriate candidate. The engineer was cast in the role of a twentieth century Dr. Faustus, albeit without his philosophising personality. The economic recession of the early 1970s served to confirm this less-than-admirable image of the profession as many engineers (particularly in the aerospace industry) found themselves without jobs. A consequence of all this was the general decline in enrollment at engineering schools which took place during the seventies. But American culture, despite its disaffection with technology in the abstract, continued its increasing dependency on the products of technology. The energy crisis, which first manifested itself during the seventies, has done little to reduce this dependency. Paradoxically, it has served to increase the dependency on technology by forcing society to renew its faith in technology's presumed saving power.

Today, at the beginning of the eighties, the situation is very different from a decade ago. The student activists of the late sixties have for the most part mellowed into respectable middle class members of society. The young people of today do not remember the role that technology played in the turmoil of twelve years ago. And a society which has maintained its dependency on technology but failed for a decade to educate a sufficient number of engineers finds itself in the

position of having a shortage of trained people to address the continuing technological problems that arise.

This is indeed a situation well suited or, perhaps better said, begging for the development of Christ-centered engineering programs. Not only does the shortage of engineers give a promise that graduates will find employment, but society is desperately looking for answers to its technological problems. There exists a recognition of our societal need for new directions in technology. Into this situation the reformed academic community is called to bring the Word of God with its healing and redirection. We have a responsibility to our covenant community, an increasing number of whose young people are recognizing their God-given technical talents and are turning to technology as a vocation. We have a responsibility as well to our culture: to meet the demand for engineers with people who have genuine insight into the meaning of technology and are sensitive to the creational norms which give it structure.

Coherence and Interrelatedness

In terms of the overall curriculum at most Christian colleges, engineering, if carefully developed, would not only prove compatible with but would also complement many of the existing programs. Most Christian colleges now include such fields as physics, chemistry, and mathematics among the programs in their curricula. While the advantageous relationship which would exist between these fields and engineering is perhaps obvious, some of the less obvious relationships may prove the most fruitful. Many engineering students will elect or be required to take courses in economics, political science, business administration, agriculture, or computer science. Their presence in such courses would add a new dimension to those programs and would increase their potential for development.

But these are relationships that have traditionally proved advantageous in engineering education. The unique contribution that a Christian college can make is in developing non-traditional relationships—interdependencies between technological programs and what have classically been called the humanities. For out of the Biblical motivating principle of creation, fall, and redemption we can truly begin to appreciate the coherence and interrelation of the various aspects of reality. An understanding of the nature of this coherence and interrelatedness, as well as the ability to display it even in the intricacies of one's specialized discipline, must be seen as normative goals in both the development of overall curriculum and the structuring of individual courses. Therefore courses in literature, history, political science, philosophy, and the fine arts will be important to the engineering student and must be integral with his other, more technical courses.

Let me choose just one of these areas—the fine arts—to emphasize this point and to suggest the importance of its interrelationship with technology. Unfortunately, this is an area that has been all but ignored by most students of technology. Engineering schools have at best provided, by means of one or two humanities electives, the opportunity for students to "sample" art or music or poetry. But never have these areas been integrated into the engineering curriculum. As a result, men like Frank Lloyd Wright, Jacob Bronowski, and Samuel Florman are very few and far between. Educators have recognized the importance of creativity in engineering design, but for the most part have failed to see its relationship to

aesthetic sensitivity, harmony, symbolism, and other elements of the fine arts. It has been assumed that if students are merely "exposed" to the arts they will become more "well-rounded" and any latent potentialities towards creativity will be given opportunity to flower. But as C.P. Snow so well pointed out, the vast majority of technologists and artists cannot communicate with each other except on superficial levels because they have developed into "two cultures." Any competent artist or poet who attempts to teach in an engineering school does so at the risk of enormous

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frustration. It is not much different for the engineering student who "braves" a course in art or poetry. The coherence between the aesthetic and logical aspects of reality has been lost. One result in our culture is the ugliness, both in appearance and function, of many of our modern technological products. A mind sensitive to aesthetic norms would not easily design a human transportation vehicle that necessitates the acceleration and deceleration of three thousand pounds of its own mass just to take one to the grocery store for a gallon of milk.

What is required is an understanding of the interrelation between aesthetics and technology. That this interrelatedness exists is not only evidenced by the unity in creation itself, but is alluded to even in the Scriptures. In Proverbs 8 the Word of God (who was with God in the beginning [John 1:1-3]) speaks as wisdom personified and portrays a context that is clearly technical: the "master craftsman" bringing about the structures of the creation. And yet the message is one of aesthetic appreciation and playfulness:

> Yahweh created me when his purpose first unfolded, before the oldest of his works.
> From everlasting I was firmly set, from the beginning, before earth came into being.
> The deep was not, when I was born, there were no springs to gush with water.
> Before the mountains were settled, before the hills, I came to birth;
> before he made the earth, the countryside, or the first grains of the world's dust.
> When he fixed the heavens firm, I was there, when he drew a ring on the surface of the deep,
> when he thickened the clouds above, when he fixed fast the springs of the deep,
> when he assigned the sea its boundaries—and the waters will not invade the shore—when he laid down the foundations of the earth,
> I was by his side, a master craftsman, delighting him day after day, ever at play in his presence,
> at play everywhere in his world, delighting to be with the sons of men.
> (Proverbs 8:22-31, The Jerusalem Bible)

An engineering program in a Christian college can provide opportunity for the working out of the curricular norms of coherence and interrelatedness. It will do that in two ways: first, in the engineering program itself, in the design of curricular and course content; and secondly, by requiring the non-technical departments of the college to become sensitive to the issues of technology and to the need for communicating with engineering staff and students. Of course this can be achieved only when the college is a true community operating from one foundation and articulating the normative principles growing out of that foundation. At Dordt College this articulation takes the form of its statement of purpose, and it speaks clearly to the norms of coherence and interrelatedness:

> Since . . . truly serviceable insight involves theoretical comprehension, practical ability, and proper motivation, the curriculum of Dordt College aims at coherence and interrelatedness. Education at Dordt is not a concatenation of unrelated facts or isolated bits of information; nor does the curriculum consist of dissociated academic subjects and unconnected skill courses. Rather, the various areas of the curriculum, whether they involve academic disciplines, creative activity, or skills, are to be interrelated within the unifying framework of a Biblical perspective.[10]

A question that might legitimately be asked at this point is this: Can an engineering program be *truly* responsive to the curricular norms of coherence and interrelatedness *in its own curricular structure*? Or is the very nature of an engineering program antithetical to those norms because of its necessarily high degree of technicality and structure? Needless to say, I believe the answer to the first question is yes. A high degree of technicality and structure in an academic program does not necessarily exclude coherence and interrelatedness. That this has been the case in traditional engineering programs is due to the elevation of the norm of economy (efficiency) above those of coherence and interrelatedness along with the pervasive influence of positivism (maximization of factual content). A Biblically directed approach to engineering education, while maintaining technical integrity, will be far more able to achieve the proper harmonization of curricular norms because its starting point is the Word of God rather than an elevated aspect of creation, and its aim is Kingdom service rather than efficiency.

While the actual working out of the norms of coherence and interrelatedness in an engineering program will be admittedly a long and difficult process, there are some encouraging indicators that it is not an impossible task.

First, in the development of its curriculum, an engineering program must respect and integrate the general education requirements into its own program. This body of courses which every student must study in order to graduate can be no less important for the engineering student. In fact, because of the necessarily technical aspect of the majority of other courses in the engineering curriculum, the general education courses take on added significance. They cannot be treated as mere "opportunities for exposure" to the humanities. Rather, they must be foundational to the engineering curriculum, and future courses, technical or otherwise, must build on them. An engineer without an under-

standing of history and philosophy is just as rootless and impaired in his life and calling as other persons who lack that understanding, regardless of their profession. Without the ability to read widely or communicate meaningfully in speaking and writing, or without an aesthetic sensitivity, an engineer is reduced to little more than a calculating machine.

Secondly, an engineering program can maintain continuity between the general education courses and the more technical engineering courses by developing its own "directional" courses which specifically address the engineering student and the field of technology in their interrelated wholeness with the rest of creation. A primary goal of these courses would be the development of a Christian perspective on engineering and technology. Perhaps a minimum effort in this direction would include two courses: one offered early in the program (no later than the sophomore year) which would introduce the student to the field of engineering, its methods, history, and relationship to other fields, and a second course, offered in the senior year, which would attempt to complete the focusing of what the engineer has learned into a cohesive whole. It would also provide opportunity for a study of the philosophy and sociology of technology, developing a systematic Christian approach to these subjects as well as critiquing the various predominant schools of thought. The point is that these courses would be the most comprehensive in terms of curricular integration. Students would find themselves writing essays as well as calculating solutions to problems, and reading aesthetically qualified literature as well as technical articles.

A third way of working out the norms of coherence and interrelatedness must be by reforming the traditional, technical engineering courses so that they reflect the coherence of the program as a whole. No single course may be taught as if it were independent from the rest. This is perhaps the most difficult task facing engineering departments at Christian colleges because of the very definitive nature of most engineering courses (e.g. mechanics, thermodynamics, etc.) and the heavy dependency that is normally placed on the textbook in such courses. Nevertheless, it is imperative that a unified effort be made in this direction. Thermodynamics must remain thermodynamics in terms of the conceptual understanding and computational skills that a student derives from the course. But the context of the course must make clear its interdependency with and relationship to other areas of study.

A fourth and, for the purposes of this article, last direction in which an engineering program can move to achieve coherence and interrelatedness is with a strong dependency on non-curricular forms of education. Traditionally this means the organization of clubs, the scheduling of special conferences and lectures, and attendance at various professional meetings that are appropriate to both students and faculty. Other forms of non-curricular education might take advantage of the developing insight and skills of engineering students and the needs of the college or surrounding community. For example, if the college is geographically well-situated and maintains a healthy relationship with its constituency and/or surrounding community, and if, in addition, the community has municipally owned utilities and the desire to conserve energy, then the opportunities for a mechanical engineering department are many. Assessing the potential for achieving community energy independence via solar and/or wind energy, and perhaps

actually working toward that goal, are not projects to be dismissed lightly. They can provide a real opportunity for the engineering department to serve the community as well as provide, in this extra-curricular way, integrative education of a most valuable sort for its students.

In a Liberal Arts Context?

Another basic question which any effort to develop engineering at a Christian college must face is how to justify a heavily technical and highly structured curricular program in a liberal arts context. For example, a forty-course program including a typical liberal arts major may specify ten to twelve general education courses, ten to fifteen courses in the major area, and thereby leave thirteen to twenty courses as free electives. On the other hand, a responsible mechanical engineering curriculum may require in addition to the twelve general education courses twenty-six courses in engineering, science, mathematics, and related fields. This would leave only two courses as free electives. Can such a program really be considered "liberal arts" education?

What are the liberal arts? It is generally assumed that when we use the term "liberal arts" we are all pretty much in agreement as to what it means. One writer puts it this way,

> Through the years a liberal arts education has come to comprise all those studies which are not technical or vocational by nature, those which are not "useful arts."[11]

But this is more of a definition by default, and really does not tell us much about what the liberal arts *are*. That same author, perhaps recognizing the inadequacy of the above definition, suggests that liberal learning

> . . . concerns itself with the eternal quest for truth, goodness, and beauty. It grapples with such ultimate concerns as the meaning of justice, liberty, virtue, honor, love, and happiness. . . . All agree that the ultimate goal of liberal learning is wisdom and a reverence for beauty.[12]

What the former definition lacked in terms of positive assertions, this definition lacks in specificity. We are left with a rather nebulous idea of what

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the liberal arts are and only a slightly less nebulous idea of what they are not.

The original meaning of the term "liberal arts" is that they are studies fit for liberated, free men.

> In past ages only a few men were truly free; the vast majority lived as serfs, chained to soil they did not own. So liberal education has an aristocratic tradition. Because it was restricted to the upper classes, it came to serve the purpose of artificially defining the upper classes.[13]

Needless to say this definition of the liberal arts can find no place in

Christian education. But keeping in mind the above quest for definition, what might liberal arts mean in the context of an educational institution guided by the motivating principle of creation, fall into sin, and redemption through Jesus Christ?

Given the principles of unity, coherence, and interrelatedness in creation, the term "liberal arts" may never lead us in the direction of two cultures as described by C.P. Snow. The humanities may never be understood in opposition to the sciences, to the extent that meaningful communication cannot occur between scholars in those two general fields. Art may not be divorced from technics. While admitting and recognizing the diversity in creation, even to the extent of defending the mutual irreducibility of its various modal aspects, we must never lose sight of the interwovenness of creation.

In similar manner an understanding of liberal arts may never give support to any form of a facts-values dichotomy. Recent events in technology are making clear what Christians (should) have known all along: there is no human judgement which is not a "value" judgement. The idea of neutral decisions based only on logic fails to come to grips with man's calling as God's servant and vicegerent and the fact that his every thought, word, and deed are responses, either obedient or disobedient, to the Lord's will. Likewise, an understanding of *facts* as neutral and abstract from values or norms is contradictory to the principles of coherence and interrelatedness.

Referring particularly to Colossians 1:15-20, the Dordt statement of purpose makes this clear in its basis article:

> God upholds and maintains the entire creation by His Son. Therefore, the creation is an integrated totality, a cosmos in which each part is designed to function coherently and meaningfully.[14]

And then later in the section on "content" the Dordt statement of purpose speaks clearly to the effect that those areas of the curriculum which have classically been categorized as liberal arts and technics, though formally distinguishable, are meant to be integrated in the overall curriculum.

> The Dordt graduate must have both a theoretical understanding of a situation and the practical ability and skill to be reformingly busy in response to God's call to service. For that reason, practice or skill is not to be separated from its imbeddedness in the wider structural context to be theoretically understood; nor is the theoretical understanding of God's creation to be divorced from the practical capacity to implement the will of the Lord in everyday situations.[15]

Without pretending to be definitive, I would suggest that liberal arts education viewed from a reformed, Biblical perspective would imply quite the opposite of what is traditionally implied by the liberal arts. Rather than accepting a technical-humanistic dichotomy and clinging absolutistically to the humanities pole, reformed liberal arts would recognize the diversity in creation (and hence the curriculum) without losing sight of the unity, coherence, and interrelatedness and would reflect those in the structure of the curriculum.

Engineering, particularly today, demands a recognition of that kind of unity and coherence. The subject of energy provides a fitting example where just a rudimentary understanding

requires an appreciation for the context of the problem and a recognition that one-sided abstractions only serve to intensify the problem. In this sense, at least, engineering can be seen as appropriate to a liberal arts context.

The question of choice. It may be argued that a liberal arts education provides the student with choice (free electives), allowing him to study in a wide variety of academic areas. This variety is a means of achieving the curricular goals of coherence and interrelatedness. If an engineering education drastically limits this choice by limiting the number of free electives, does it not then run counter to the norms of coherence and interrelatedness? At face value this argument appears to have merit. But some careful thought will reveal many hidden assumptions and presuppositions which can be shown to have very little merit.

One basic assumption is that students, when given the opportunity, will elect courses ranging widely over the curriculum. No doubt some students will do just this. But a number of informal investigations have shown that many students tend to elect courses in a narrow field closely related to their majors. The effect is no different than if those courses were part of the required curriculum of the major.

A point that is often overlooked is that a student enrolled in a highly structured engineering program *has* made a "free choice"; he has in effect elected to major in engineering. Most students make this choice early in their high school years on the basis of very firm evidence: their own aptitude and appreciation for mathematics and science. Very few engineering students begin their undergraduate study unsure of the direction in which they want to move. They usually have very well developed academic and professional aspirations.

One rather questionable presupposition seemingly implied in the argument is that coherence and interrelatedness can be achieved only through curricular diversity, as if individual courses are always *expected* to be narrow and abstract. But if an effort is made at reforming the curriculum on the individual course level as well as the program and general education levels, then one need not be concerned that reducing choice will necessarily be counterproductive to achieving coherence and interrelatedness.

Finally, there are at least two presuppositional problems inherent in the process of "counting courses" and reacting to an alleged imbalance between technical requirements and free electives or humanities. First, there is the notion that only the humanities courses or the free electives can be *directional* courses, courses which bring a sense of interrelatedness to the student. But this idea is based on an acceptance of the technical-humanities dichotomy which was refuted earlier. Second, there is a kind of "numerical reductionism" inherent in the idea that if a student is required to study twenty-six of his forty courses in the fields of mathematics, science, and engineering he is being afforded a one-sided education. The *quality* of education is then being seen as mathematically analogous (proportional) to the *quantity* of courses. This is an old problem. Allow me to illustrate it with a classic example from secondary education. One Christian high school was considering the incorporation of "activity periods" into its daily schedule. These would be times when students would engage in "non-curricular" activities such as clubs, councils, or even intramural sports. This suggestion was strongly resisted by the administration, however, when it was calculated that students would then be attending their regular classes for a total time which

amounted to less than two hundred minutes per week. Because of an old (and defunct) state accreditation ruling, two hundred minutes per week in the classroom had become sacrosanct; *quality* education was dependent on the *number* of minutes students attended a formal class. The indefensibility of this is, I trust, obvious. Students often learn far more from informal encounters with teachers and peers than from actual time spent in the classroom. This is not meant to deprecate formal instruction in any way. Rather, the point is that education cannot be *reduced* to the *number* of minutes a student spends in the classroom. Likewise, the quality of a college education cannot be reduced to the numerical proportions of various areas of study within the curriculum. The impression and educational value of a good philosophy course for an engineering student, during a semester when his other four courses are all highly technical, will certainly be greater than one fifth of his educational experience that semester. And in any case it cannot be measured with quantitative glibness. Overlooked as well in this curricular numbers game is the value of extracurricular activities in achieving coherence. In summary, the relative weight of the influence of courses on students is not necessarily proportional to the number of credit hours.

Conclusion

As mentioned at the outset of this article, Dordt College is developing a bachelor degree level engineering program. Much of the strength and uniqueness of that program will rely on its interdisciplinary character and its interdependency with the other academic disciplines. In addition, it is hoped that the engineering program will prove a catalyst to the overall college program, encouraging interrelatedness as it works out its interdependencies.

Doing this will contribute to the promotion of a most important norm for Christian higher education: that of communal scholarship. And this conforms to one of the goals set down in the Dordt statement of purpose:

> In order to implement such an integrated curriculum more effectively, Dordt College strongly encourages and promotes communal scholarship. Faculty members responsible for the various components of the curriculum are to become increasingly aware of each other's work. Dordt's faculty ought to develop into a team of teachers and scholars, competent professionals who are vitally concerned about their teaching effectiveness, their area of academic specialization, and their responsibility to contribute to the overall development of integrated serviceable insight.[16]

Notes

[1] *The Educational Task of Dordt College*, p. 6.
[2] *Educational Task*, p. 10.
[3] *Educational Task*, p. 11.
[4] *Educational Task*, p. 4.
[5] Colossians 1:15-20.
[6] Abraham Kuyper, *Lectures on Calvinism* (Grand Rapids: Wm. B. Eerdmans Publishing Co., 1931), p. 119.
[7] *Educational Task*, p. 5.
[8] Samuel C. Florman, *The Existential Pleasures of Engineering* (New York: St. Martin's Press, 1976), p. 12.
[9] Florman, p. 12.
[10] *Education Task*, p. 15.
[11] Samuel C. Florman, *Engineering and the Liberal Arts* (New York: McGraw-Hill Book Co., 1968), p. 14.
[12] Florman, *Engineering and Liberal Arts*, pp. 13-14.
[13] Florman, *Engineering and Liberal Arts*, p. 14.
[14] *Educational Task*, p. 3.
[15] *Educational Task*, p. 11.
[16] *Educational Task*, p. 15.