Entry Pathways, Academic Performance, and Persistence of Nontraditional Students in Engineering by Transfer Status

Jacqueline C. McNeil
Department of Engineering Fundamentals
University of Louisville
Louisville, Kentucky, USA
j.mcneil@louisville.edu

Matthew W. Ohland, Russell A. Long
School of Engineering Education
Purdue University
West Lafayette, Indiana, USA
ohland@purdue.edu, ralong@purdue.edu

Abstract*—This study uses longitudinal, student record level data from eleven public research universities in the United States over a period of twenty-eight years to investigate nontraditional and traditional undergraduate students who ever declared engineering as a major. A nontraditional student is defined as a person who is older than 24 years of age or attends college part-time for at least part of the academic year. A traditional student is defined as a student who matriculates into a baccalaureate degree program in the summer or fall after high school graduation, is younger than 25 years of age, and pursues college on a continuous, full-time basis during the academic year. The research questions addressed in this paper are: How do nontraditional students enter the engineering curriculum? Are there differences with traditional students' entry into engineering by transfer status? Are there differences in precollege academic preparation? Is the collegiate academic performance of nontraditional students different than traditional students by transfer status? Is there a difference in the graduation or withdrawal rates between nontraditional and traditional students by transfer status? Nontraditional students are very similar to traditional students. Once students choose engineering as a major, there are no differences in mean engineering grade point average (GPA) or final cumulative GPA between nontraditional and traditional students. Nontraditional and traditional students have similar SAT scores, similar high school GPAs, choose an engineering major in similar patterns, and have similar six-year graduation rates. Being a transfer student plays a larger role than being a nontraditional student.

***Keywords*— nontraditional, adult students, post-traditional students, higher education, transfer, engineering**

I. Defining Nontraditional Students

It is easier to define nontraditional students by defining traditional students and concluding who nontraditional students are from the definition of traditional students. A traditional student is defined as a student who matriculates into a baccalaureate degree program in the summer or fall after high school graduation, is younger than 25 years of age, and pursues college on a continuous, full-time basis during the academic year [1]. So, students are considered nontraditional by having the following characteristics: delaying enrollment in higher education, attending part-time for at least part of the academic year, working full-time while enrolled, being financially independent for financial aid purposes, having non-spousal dependents, being a single parent, and not having a traditional high school diploma [1,2,3,4]. About 74 percent of all 2011-12 undergraduates had at least one nontraditional characteristic. This percentage is consistent over time, with at least 70 percent of undergraduates since 1995/96 possessing at least one nontraditional characteristic [5]. Age is often used to define nontraditional students [6,7,8,9,10,11,12]. Indeed, the characteristics listed above are all correlated with age [5]. For this study, we define a nontraditional student as a person who is 25 years of age or older, or a person who, on average, attends college part-time for at least part of the academic year (excluding summer terms).

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II. Introduction

Undergraduate engineering programs in the United States have been urged to increase the number of graduates. Both *The Science and Engineering Workforce/ Realizing America's Potential* [13] and *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* [14] predict that there are not enough graduates with engineering degrees to fill the demand created by an increasing global economy. This demand could potentially be filled by nontraditional students.

Although enrollments of nontraditional students have increased, research on nontraditional students has not kept pace. Because transfer students are more likely to have nontraditional backgrounds [15,16], we will examine the entry pathways, academic performance, and persistence on nontraditional students through the intersectionality with transfer status.

A. Nontraditional Students

Researchers have explored the social and economic forces that have led to the increased participation of nontraditional students in higher education, though little literature is centered on engineering students. As early as 1971, Student Affairs professionals were beginning to bring attention to a changing student demographic: more students were older and delaying entry to college by at least one year following high school.

Cross [17,18,19] first used the term "nontraditional" for those students and developed two conceptual frameworks that describe how they learned.

Opinions of nontraditional students were not always positive. Hopper and Osborne claimed that nontraditional students were underachievers [20]. Faculty thought that nontraditional students' prior experiences are not relevant because the students didn't approach the experience as a learner. Most institutions of higher education recognize students as learners only, because learning is supposed to be their sole focus while attending a university, and nontraditional students have lives beyond the classroom and university, which can make learning more difficult [21]. This negative stereotype of nontraditional students affects everybody, even nontraditional students, because they start to have the same opinions about themselves as faculty, other traditional students, and the institution [22, 23,24].

Bean and Metzner [12] modeled nontraditional student attrition and proposed four sets of variables affecting student dropout rates: academic performance, intent, defining variables, and non-institutional environmental variables. Defining variables include age, race, and sex. Non-institutional environmental variables are finances, family support, and employment. Their research found that grade point average and institutional commitment impacted students leaving the institution. Pascarella [25] found that nontraditional student persistence is influenced by grade point average, intellectual development, and faculty interaction. Farabaugh-Dorkins [26] tested a modified version of Bean and Metzner's model and the results revealed that the intent to leave and grade point average were the most important variables in explaining why students left the institution.

Using data from the National Longitudinal Survey of Youth, Taniguchi and Kaufman [4] found that nontraditional students have lower dropout rates when compared to traditional students. Yet, using face-to-face interviews conducted with 10 nontraditional students at a small private college in New Jersey, Goncalves & Trunk [27] found that high drop-out rates plague nontraditional students.

Nontraditional students have been shown to be more intrinsically interested in learning [28,29]. Older students have more "stick-to-itiveness" in their choice of major [30,31]. Franklin [32] found that nontraditional students have higher persistence than traditional students. They have higher GPAs and are more decisive [33]. Spitzer also compared female nontraditional students with traditional aged female students and found that nontraditional females were better able to cope with the psychological stress associated with college life [34].

B. Transfer Students

There is conflict in the higher education literature on the effect that attending a community college has on a student's future options. Some researchers contend that the initial choice to attend a two-year institution lowers the possibility that the student will acquire a bachelor's degree and lengthens time-to-degree [35,36,37,38]. Among researchers who study negative outcomes for transfers, a cause commonly discussed is "transfer shock" in the first term at 4-year institutions resulting from academic, psychological, sociocultural, informational, financial, and other barriers [39, 40]. Summarized by Cuseo [41], this shock is a response to an institutional culture described as: less nurturing [42], with less faculty attention and concern, a lack of a centralized source of information about academic requirements, and a tendency to marginalize transfer students [43]. Engineering students who transfer to a four-year university face unique challenges in adjusting, including rigid prerequisite requirements [44], inadequate preparation for upper division courses, and self-initiated advising [45]. Transfer shock is worse at research universities [46] and more intense for technical students than others [47].

Some research suggests that transfer students are less likely to achieve their educational goals than students who begin at a 4-year institution [48]. Native students are better prepared to graduate than transfer students and these differences are particularly noticeable among STEM transfer students, who are less prepared to graduate than students in other disciplines [49]. Some research indicates that engineering transfer students are more likely to experience a drop in GPA after entering the four-year institution, compared to transfers in other majors [50]. A study of articulation in Florida found that a greater percentage of native students graduated and a greater percentage of transfer students dropped out [51]. Yet, the same study revealed transfer students performed just as well academically as native students in terms of GPA. Also, the successful may take longer to complete their degree than native students, which could depend on the number of hours transferred in and a student's first term GPA [52].

Some studies portray a more positive view [53,54,55,56] including research indicating that although the shock may cause an initial drop in transfer student GPA, their grades rebound, even to exceed those of native students [55]. Some have found that minorities and lower socioeconomic students (SES) benefit from attending two-year institutions to set goals and gain confidence [57,58]. Other research indicates that the low-SES community college students who transfer to elite institutions are more likely to graduate than those low-SES students with similar characteristics who started at four-year universities [59]. Brainerd [60] found that engineering transfer students earn better grades and graduate at higher rates than their native counterparts.

In the past several years, more studies on transfer students have focused on engineering students and found that: students who transfer into engineering programs are adjusting well to the new university environment [61], the performance gap of engineering and final cumulative GPA between transfer and FTIC students is negligible in engineering GPA and small in final cumulative GPA [62], the literature on engineering transfer students may disproportionally represent transfers from community colleges and ignore students who transfer from an institution of a similar type to the new institution [63], and, there are apparent differences between FTIC and transfer students in academic preparation, performance, and success [64].

This paper will resolve the conflicting findings of some studies on academic performance and completion of nontraditional students with disaggregation by transfer status –

at least as those findings relate to the students in the study population.

III. Research Questions

- How do nontraditional students enter the engineering curriculum?
- Are there differences with traditional students' entry into engineering by transfer status?
- Are there differences in precollege academic preparation?
- Is the academic performance of nontraditional students different than traditional students by transfer status?
- Is there a difference in the graduation or withdrawal rates between nontraditional and traditional students by transfer status?

IV. Definitions and the Study Population

In research on student populations it is important to have clear definitions because certain terms are either used differently in literature or in common usage.

A. Definitions

Age is calculated in years from the student's birth to the time of first matriculation.

Average years of attendance for a first-time in college student is the number of years attended from first matriculation at the MIDFIELD institution until graduation or withdrawal from the MIDFIELD institution. Years of attendance for transfer students is calculated by starting with the matriculation date at the MIDFIELD institution and adding time by examining where a transfer student starts in the engineering curriculum, hours transferred into the major, and specific engineering courses the student takes in the first term of enrollment in an engineering discipline.

Engineering Courses include all science, mathematics, and engineering courses required to earn a baccalaureate degree in engineering.

First discipline is defined using the first two digits of the Classification of Instructional Programs (CIP) [65]. CIP was originally developed by the U.S. Department of Education's National Center for Education Statistics (NCES) in 1980, with revisions occurring in 1985, 1990, 2000, and 2010.

First engineering major is defined using the six-digit CIP.

Full-time/part-time status is determined by dividing the total number of credit hours attempted by the number of terms attended (excluding summer terms). Students having an average of fewer than 12 attempted credit hours per term are classified as part-time, and students having an average of 12 or more attempted credit hours per term are classified as full-time.

A first-time in college (FTIC) student has graduated from high school or completed a GED and has earned no transferrable college credit after high school – excluding advanced placement.

Grade Point Average (GPA) is a standard way of measuring academic achievement. It is the average of the grade point values earned for all courses attempted. MIDFIELD grade point values range from 0.00 (F grade) to 4.00 (A grade).

Graduation is defined as having graduated with a baccalaureate degree in any discipline by the sixth year from matriculation, following a standard of reporting by the Integrated Postsecondary Education Data System (IPEDS).

A transfer student is defined as a student who attended and earned at least 15 semester credit hours from at least one regionally-accredited college or university after high school or GED completion and before undergraduate matriculation at a MIDFIELD institution.

Withdrawal is defined as leaving the institution for any reason other than graduation. Students who remain enrolled at a MIDFIELD institution, have not graduated, and do not have six years of data in MIDFIELD are excluded from this study.

B. The Study Population

This research explores The Multiple-Institution Database for Investigating Engineering Longitudinal Development (MIDFIELD). MIDFIELD is a multi-institution, longitudinal, student record level dataset that is used to answer many research questions about how undergraduate students maneuver through required engineering curriculum and what courses or policies stand in their way toward graduation. MIDFIELD includes demographic, enrollment, course performance, and graduation data on 1,023,237 undergraduate students at 11 large public research universities. For this study we examine 142,781 students who ever declared engineering as a major - including students who matriculated in engineering, those who migrated into engineering from other majors, students who came to engineering as transfer students, and part-time engineering students.

MIDFIELD institutions include 7 of the 50 largest U.S. engineering programs in terms of engineering bachelor's degrees awarded, resulting in a population that includes 10% of all engineering graduates of U.S. engineering programs. MIDFIELD includes 22% female engineering students, which aligns with national averages of 20% to 25% percent from 1999 to 2013. African-American students are significantly overrepresented in the MIDFIELD dataset—partner schools graduate 15% of all US African-American engineering B.S. degree recipients each year, because the MIDFIELD participants include six of the top twenty producers of African-American engineering graduates, including two HBCUs. The graduation percentage of Hispanics (regardless of gender) is not representative of other U.S. programs. Three percent of MIDFIELD engineering bachelor's degrees are awarded to Hispanics while 9% of engineering bachelor's degrees in the nation are awarded to Hispanics. Hispanic students are particularly concentrated at two institutions in the database, Georgia Tech and the University of Florida. Together they account for 65 percent of the Hispanic population in our database. All other ethnic populations are representative of a national sample [66]. Even with limitation, MIDFIELD is large enough to support disaggregated analyses. In this way, we avoid constructing synthetic cohorts and the limited information that can be gathered through cross-sectional data.

V. HOW DO NONTRADITIONAL STUDENTS ENTER THE ENGINEERING PATHWAY?

Of the 142,781 students studied, 56,592 (39.6%) are nontraditional. Table I shows the population used in this study. Transfer students are equally likely to be traditional or nontraditional. But FTIC students are twice as likely to be traditional as nontraditional. A full third of FTIC are nontraditional. This number corresponds well with the literature that shows 35% of students in higher education are nontraditional – even though that number is for all students – not just engineering.

TABLE I. STUDY DEMOGRAPHICS

Pathway	Student Type		
	Traditional	***Nontraditional***	***All***
FTIC	71,242 (49.9%)	39,616 (27.7%)	110,858 (77.6%)
Transfer	14,947 (10.5%)	16,976 (11.9%)	31,923 (22.4%)
All	86,189 (60.4%)	56,592 (39.6%)	142,781

A. Are there differences in how nontraditional students select first disciplines and engineering majors?

Table II shows the percentage, by discipline and student type, of students who ever declared engineering as a major. Most students are starting in engineering. Nontraditional FTIC students are more likely to enter engineering from a non-engineering pathway. The increase in entry through non-engineering pathways is uniformly spread over all other pathways. Both nontraditional and traditional students are behaving similarly. Transfer students are more assertive in declaring engineering as a major than FTIC students.

TABLE II. FIRST DISCIPLINE OF STUDENTS WHO EVER DECLARED ENGINEERING AS A MAJOR

Discipline	Student Type			
	Traditional		***Nontraditional***	
	FTIC (%)	***Transfer (%)***	***FTIC (%)***	***Transfer (%)***
Engineering	90.5	92.4	86.4	90.4
Undecided	3.6	2.0	4.5	2.2
Computer Science	1.0	0.8	1.5	1.3
Liberal Arts	0.8	0.8	1.3	0.9
Business	0.6	0.3	1.0	0.6
Physical Sciences	0.7	0.9	1.0	1.3
Biological Sciences	0.5	0.5	1.0	0.6

Three MIDFIELD institutions have First-Year Engineering (FYE) programs and two other institutions have programs that allow students to enter engineering without declaring a major. These students comprise 44.6% (63,694) of the study population. Institutional policy determines requirements when a student may declare an engineering major. If a student does not meet institutional requirements, the student is often forced to switch to another discipline or leave the institution. 39.3% (25,032) of students who start in an FYE program never declare another engineering major and get stuck. Table III shows that nontraditional FTIC students are less likely to be stuck in first-year programs (8.1% to 22.6%). It is better to have fewer students stuck in a first-year program, so they can move into their major and take higher level engineering courses. We would expect all other engineering pathways should increase by a moderate amount when they are able to get through the first year program, as the nontraditional students show in Table III. The increase of percentage in each engineering major is not showing a difference in preference by age. However, transfer students seem to be more focused choice of first engineering major.

TABLE III. FIRST ENGINEERING MAJOR

Major	Student Type			
	Traditional		***Nontraditional***	
	FTIC (%)	***Transfer (%)***	***FTIC (%)***	***Transfer (%)***
Electrical	12.4	19.8	16.8	24.4
Mechanical	13.4	16.3	16.7	18.5
Civil	10.2	13.6	9.9	14.0
Chemical	8.9	8.1	9.9	8.9
First-year	22.6	9.9	8.1	4.3
Industrial	5.2	6.4	8.1	5.8
Aerospace	6.6	5.9	7.7	4.7
Computer	6.7	6.8	7.7	6.6

B. Are there differences in pre-college acheivement?

There does appear to be a moderate difference in high school GPA between FTIC and Transfer students – but the effect is not meaningful between traditional and nontraditional students. Traditional and nontraditional students, on average, have similar high school GPAs. Transfer students do not typically need to report their high school GPA when transferring from one university to another, and from Table IV, you can see how they have found another way to get into their current university without having to report their lower high school GPA.

TABLE IV. AVERAGE HIGH SCHOOL GRADE POINT AVERAGE

Pathway	Student Type		
	Traditional	***Nontraditional***	***All***
FTIC	3.5	3.5	3.5
Transfer	3.3	3.2	3.3
All	3.5	3.4	3.5

On average, nontraditional students perform slightly better on the SAT (see Table V). Two sections of SAT are combined for the score: critical reading and mathematics. Each section receives a score on the scale of 200-800. The maximum score for the two section is 1600. The more significant difference in this table is between FTIC and transfer. Nontraditional students slightly out score traditional students, but the difference is only 21 points. In general, traditional and nontraditional students have similar SAT scores. Transfer students may not need to report their SAT scores through the transfer pathway, and have found a way to get around the higher SAT requirement.

TABLE V. AVERAGE SAT SCORE

Pathway	Student Type		
	Traditional	***Nontraditional***	***All***
FTIC	1151	1180	1162
Transfer	1056	1035	1047
All	1141	1162	1149

VI. IS THE COLLEGE ACADEMIC PERFORMANCE OF NONTRADITIONAL STUDENTS DIFFERENT THAN TRADITIONAL STUDENTS?

Consistent with earlier research [67,68], for sufficiently large number of students and courses, GPA values tend to converge toward 3.0. On average, there is little difference in academic performance between the groups (see Table VI). *Eng GPA* is engineering GPA and *Final GPA* is final cumulative GPA. Not surprisingly, the students who are withdrawing have, on average, low academic performance. Though transfer students' pre-college assessments (Table IV and Table V) might likely not allow entrance as a FTIC student, transfer students perform academically at about the same level as FTIC students.

TABLE VI. AVERAGE ENGINEERING GPA AND AVERAGE FINAL CUMULATIVE GPA

Pathway	Commit-ment	Grade Point Average (GPA) by Student Type			
		Traditional		***Nontraditional***	
		Eng GPA	***Final GPA***	***Eng GPA***	***Final GPA***
FTIC	Graduated	3.1	3.2	3.0	3.1
	Withdrew	1.8	1.9	1.6	1.8
Transfer	Graduated	3.0	3.1	2.9	3.1
	Withdrew	1.8	1.9	1.5	1.8

VII. IS THERE A DIFFERENCE IN THE GRADUATION OR WITHDRAWAL RATES OF NONTRADITIONAL AND TRADITIONAL STUDENTS?

FTIC nontraditional students take slightly longer to graduate – about 4 months more (see Table VII). All groups of nontraditional students stay at the institution for a longer period of time, than do traditional students, before withdrawing or graduating from the institution. In this paper, we do include part-time students as part of the definition of nontraditional students, and this could be a reason for the delay in withdrawing and taking longer to graduate. For a part-time student that is taking one class at a time, if they fail one course, they could take another course in the next term before getting too discouraged to withdraw. FTIC students take half a year longer and transfer students take almost a year longer to withdraw. Transfer students graduate in less time than FTIC students. However, transfer students persist longer in engineering before withdrawing.

TABLE VII. AVERAGE YEARS TO GRADUATION OR WITHDRAWAL

Pathway	Commit-ment	Years	
		Traditional	***Nontraditional***
FTIC	Graduated	4.6	5.0
	Withdrew	2.3	2.8
Transfer	Graduated	4.2	4.3
	Withdrew	2.5	3.3

Nontraditional students who ever declared engineering as a major are more likely or as likely to graduate in six years as traditional students (Table VIII). The same applies to students who started in an engineering major and graduated in engineering (Table IX). Transfer students graduate at higher rates than FTIC students – but that is to be expected. Transfer students have demonstrated commitment to pursuing a degree by sticking with it and transferring to another institution, while the students who decided to drop out have already done so before attempting to transfer.

TABLE VIII. SIX-YEAR GRADUATION RATES FOR STUDENTS WHO EVER DECLARED ENGINEERING AS A MAJOR AND GRADUATED IN ENGINEERING

Pathway	Graduation Rate Percentage	
	Traditional	***Nontraditional***
FTIC	49.8	51.4
Transfer	59.0	63.4
All	51.4	55.0

TABLE IX. SIX-YEAR GRADUATION RATES FOR STUDENTS WHO STARTED IN ENGINEERING AND GRADUATED IN ENGINEERING

Pathway	Graduation Rate Percentage	
	Traditional	***Nontraditional***
FTIC	66.2	63.2
Transfer	68.9	70.3
All	66.7	65.8

VIII. CONCLUSIONS

Nontraditional students are doing as well or better than traditional students on all measures studied. Institutions seeking to enroll more engineering students should look to this population – both transfer and FTIC pathways. This finding is particularly important because the transfer pathway allows institutions to increase enrollment without increasing the size of first-year classes.

IX. FUTURE WORK

One of the limitations of MIDFIELD is that it is comprised of similar institutions – in size, type and demographic composition. MIDFIELD is growing and has been funded by the National Science Foundation (NSF Award # 1545667, $4,260,978.00, 03/01/16 to 02/28/2021) to increase the number of partner institutions to 113. Students in the expanded MIDFIELD will comprise over half of the undergraduate engineering degrees awarded at U. S. public institutions and approximately two-thirds of the U. S. undergraduate engineering student population each year. The expanded MIDFIELD will contain unit record data for almost 10 million individual students. The expanded MIDFIELD will also contain minority serving institutions, and institutions from a broad range of research classifications. This expansion will make MIDFIELD more generalizable - and will allow us to test our finding on a larger dataset.

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