

A 31-Year Record of CS Enrollment at a Single Urban Public Institution

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Abstract- *We present a 31-year record of undergraduate and Master's-level Computer Science enrollment at Brooklyn College, a comprehensive, urban institution in New York City. Data is presented for overall enrollment, separate undergraduate and Master's level enrollment, enrollment in CS0 and CS1, and in a course in computer applications. A number of "noise" factors (changes in the nature of courses, in enrollment policies, in course requirements and in technological developments) are also identified in the interpretation of the raw data.*

Keywords: computer science, enrollment, history,

1. Brooklyn College

Brooklyn College is a comprehensive unit of the City University of New York. The University consists of 19 constituent colleges within the City of New York, and is funded by the State of New York and tuition revenues. The University is the largest system of higher education in the country in terms of enrollment [1] and contains community colleges, 4-year colleges, comprehensive colleges, a law school and other specialty schools. The University has a Ph.D. Program in computer science, which is a consortial program among the various constituent colleges, headquartered at the University Graduate Center. The individual colleges of the University

offer Associate, Bachelor, and/or Master's degrees in computer science and in associated computing disciplines.

Located in the borough of Brooklyn, Brooklyn College has had, over the 30-year period documented by this paper, between 14,500 and 17,500 students, of which approximately 2,000-3,000 were Master's students. The demographics of the student body are 32% White, 18% non-Hispanic Black, 12% Hispanic, 14% Asian, and 24% Other and Unidentified. The largest two undergraduate majors are Accounting and Business. Computing, in all its forms, represents the 7th largest number of majors in the College, after Business, Accounting, Education, Psychology, Health Science and TV Radio.

The College grants Bachelor and Masters degrees in Computer Science and in Information Systems, and a Bachelor's degree in Multimedia Computing and in Computational Mathematics. Table 1 indicates the date that each of these programs began, any departments whose courses constitute over a third of the program, and the current number of majors in each program. The Department of CIS consists of 26 full-time faculty, 15 adjunct faculty, and 3 graduate fellows. Full-time faculty members of CIS are also active in the University Ph.D. Program in Computer Science.

Table 1: Brooklyn College Programs in Computing

Program	Year Begun	Departments	# of Majors (Feb. 2014)
Bachelor's in Computer Science	1974	CIS	289
Bachelor's in Computational Mathematics	1972	CIS / Mathematics	9
Bachelor's in Information Systems	2006	CIS / Business	82
Bachelor's in Multimedia Computing	2006	CIS	43
Master's in Computer Science	1977	CIS	61
Master's in Information Systems	1989	CIS	66

2. Data Collection

Professor Frank Beckman was Chair of CIS in the period 1972-1985, and may be credited with establishing the department, putting it on a firm academic footing and making its offerings attractive to students. Professor Aaron Tenenbaum (one of the authors) was Chair during the period 1985-2009 and began collection of this data. When he became Chair, he retrieved enrollment figures for the previous three years, 1982-85. From that time on, he updated a table each semester with that semester's enrollment figures in order to report one facet of the state of the department to the faculty on a regular basis. Professor Yedidiah Langsam (the other author of this paper) continued this practice when he became Chair in 2009 until the present date.

Generally, the data was taken on the day that regular student registration for the semester ended, and may not account for drop-outs and late registrations after that date. However, since the data was taken at the same relative date each semester, the trends it displays are valid. No conclusions should be drawn from the absolute numbers, but only from comparisons (in terms of percentage increases and decreases) between different semesters and years and the trends they produce.

A student undergraduate FTE represents 15 credit-hours, while a graduate FTE represents 12 credit-

hours. All charts are in terms of student FTEs, whether graduate, undergraduate, or a blend of both, as appropriate.

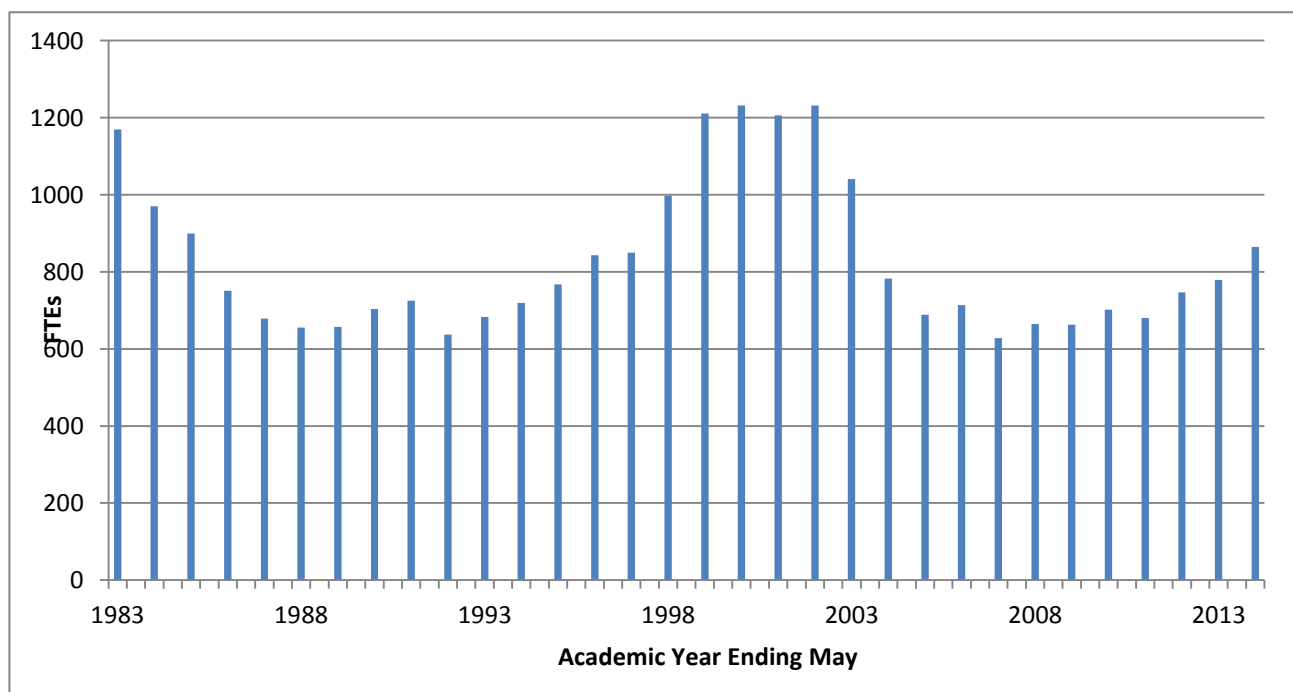
3. Total Undergraduate CS Enrollment

Chart 1 shows total annual Undergraduate Computer Science FTE enrollment at Brooklyn College from 1982-83 through 2013-14 (Fall plus following Spring). This does not include enrollment in CS0, which is part of the College Core Curriculum and is not required for the major. Information on CS0 will be presented later in the paper.

This chart is very similar to a chart that appears in a report from the Georgetown University Center on Education and the Workforce [2]. That chart was taken from NSF data on the percentage of Computer Science degrees among all bachelor's degrees granted and the percentage of CS majors in a UCLA survey of freshmen shifted forward by 4 years. This supports the notion that the Brooklyn data is a reflection of the national picture.

The lowest value on this chart (636.9 in 1992) is approximately 48% below the highest value (1232.0 in 2000), affirming wide swings in demand for computer science education. The chart also suggests that these swings are cyclical.

Chart 1: Undergraduate Computer Science FTEs



3.1 Causes for the Wide Swings

Many computer science departments were excoriated by their administrations in the mid-decade 2001-2010 for dropping enrollments, with the assumption that, somehow, the departments were to blame.

The fact that the trend was nationwide, which is well documented [3], indicates that the drop more likely was due to societal shifts: the national economy and job market, and the shift in the nature of computer skills that became necessary at that time (the end of the Y2K crisis, the advent of more user-oriented computing tools, and the change in programming and computing methodologies and modalities). We recall that high-school counselors were actively discouraging their students from seeking to major in computer science at that time. Another factor that may have caused this was the well-publicized forced retirements of experienced information systems workers [4] that occurred at that time as the workstation and server replaced the mainframe as the chief engine of commercial computing.

Now, however, there is a strong demand for computing skills again, much greater than the supply

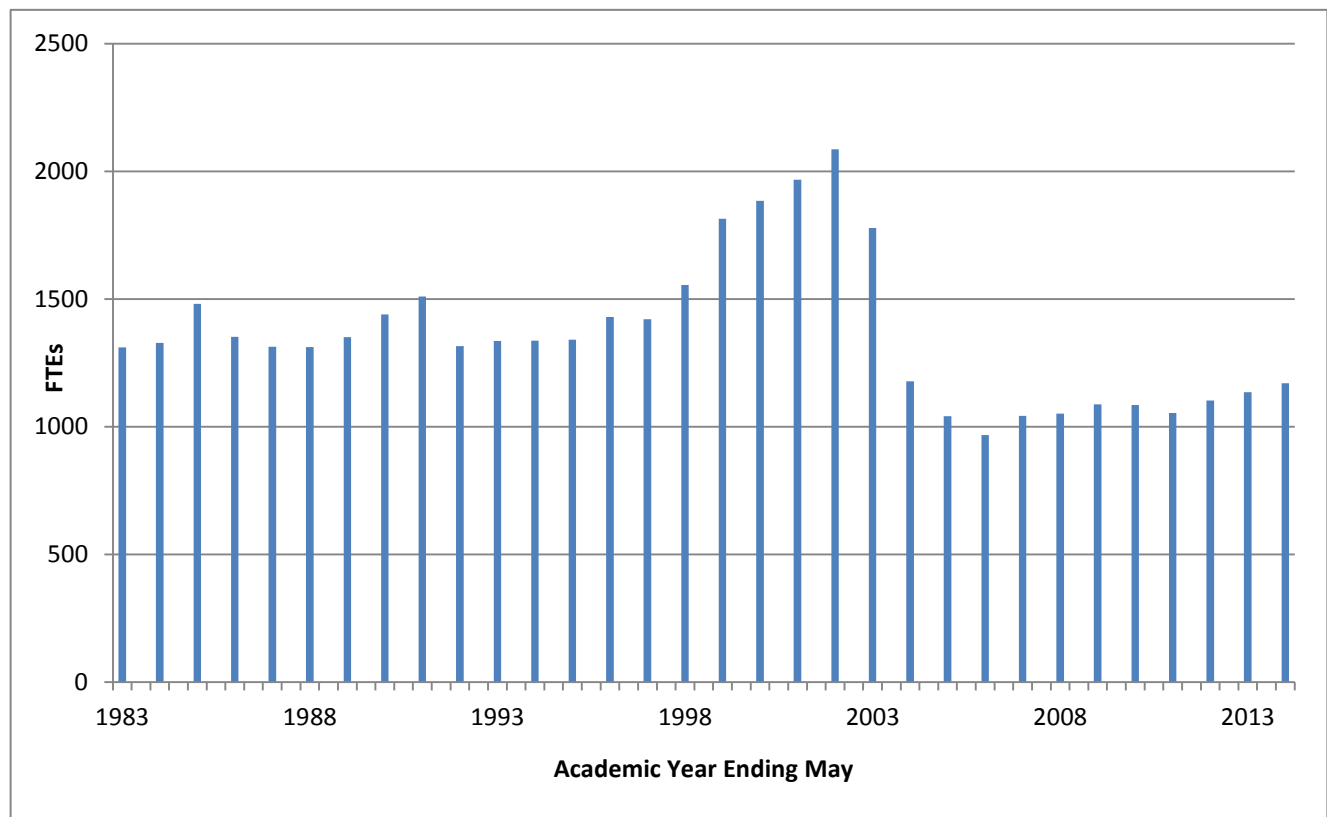
[5]. So the graph is again turning upwards as this fact becomes more generally known. A study of the precise factors involved in both the drops and the recoveries would be quite useful so that the future can be shaped (or at least predicted) based on the mistakes and events of the past.

3.2 Parachute and Free-Fall: The 1983-92 Reduction vs. the 2003-07 Reduction

The two troughs in Chart 1 appear very similar. The reduction in Computer Science FTEs from 1983 to 1992 was 31.6%. The decline is even greater when one realizes that 1983 itself was not a maximum compared to the previous years. The 2003-07 reduction was 48.4%. Yet, the loss was far more severe in 2003-07 than in 1983-92.

The reason for this is apparent in Chart 2. Here, not only targeted Computer Science undergraduate enrollment is portrayed, but total departmental enrollment including CS0 and graduate (Master's) courses as well. The 1983-92 trough essentially disappears.

Chart 2: Total Departmental FTEs (Undergrad+Grad+CS0)



What accounts for the smoothing seen at Brooklyn College over the 1983-92 period? Primarily the introduction of the Brooklyn College Core Curriculum that included a Math/Computing course (CS0, if you will) that was required of all students in the College. This requirement added students to the department's responsibilities and maintained the overall teaching load of the department. Additionally, the department's graduate enrollment was increasing during this period. More about this, later.

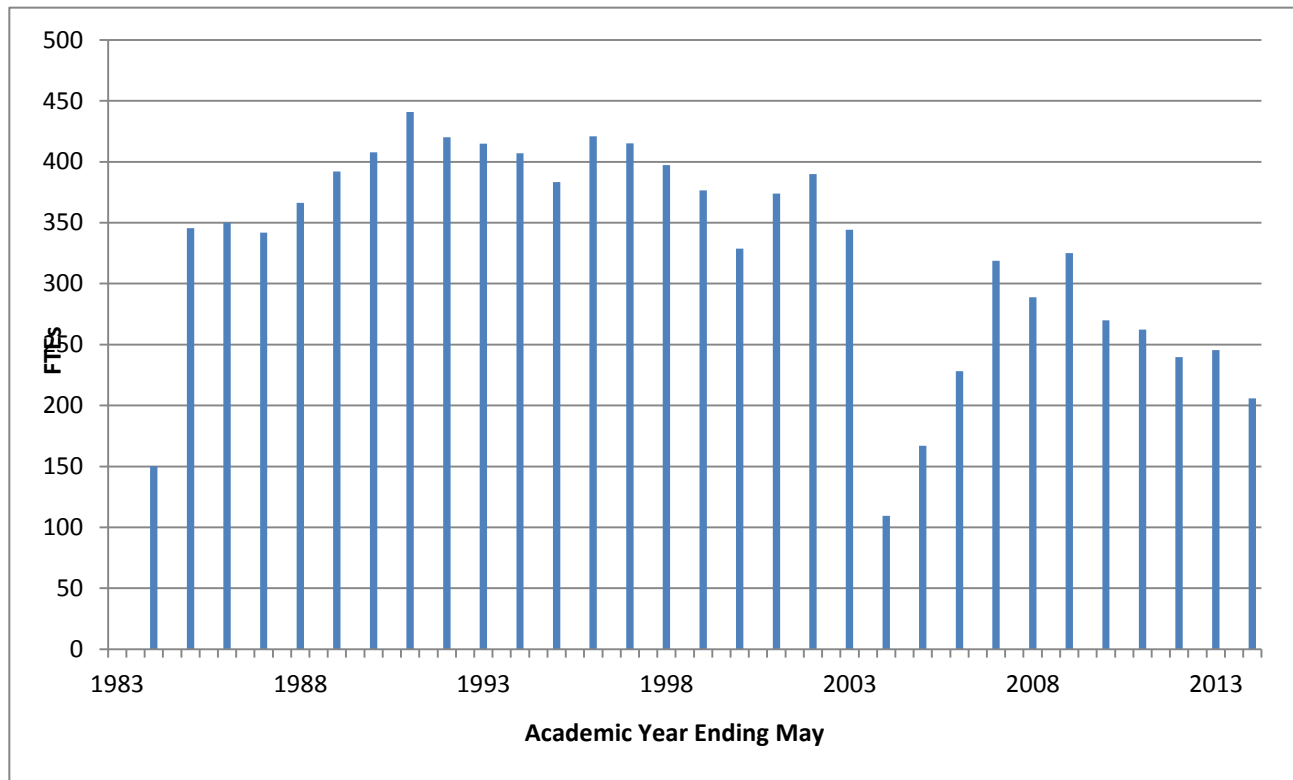
By contrast, the 2003-07 period was a time when more students in the City University were placed initially in community colleges, so a large portion of the College population was transfer students who often transferred in credit for CS0 and no longer took it at the College. As a result, not only did the department suffer the general nationwide disinterest in computer science courses, but also suffered a reduction in enrollment in the "required" computing course, CS0.

4. CS0 Enrollment

Chart 3 shows the department's enrollment in Core computing courses over the 30-year period. The entire Core and the Core computing course(s) underwent significant changes over the 30 years represented by Chart 3. The Core was first introduced in 1980 at the College. The required computing course was actually a combined Math/CS course that taught rudimentary programming in BASIC and mathematics in the form of number theory or probability. Programming was used primarily to illustrate or demonstrate the mathematics. Half the courses were taught by appointees of the Mathematics Department, and half by appointees of the Department of Computer and Information Science. Half the number of students and half the student FTEs were credited to each department.

The CS department chafed over this course, feeling that its computer content was not modern and perhaps that Mathematics was "driving the bus." Professor David Arnow, after much effort, succeeded in partitioning the subject matter of the course into a math version and a computing version. The computing course became a low level mathematical

Chart 3: Core Computing FTE Enrollment



logic and programming logic course using the Pascal language. A text was produced by Arnow and Naomi Bushman [6] in 1995 specifically for this version of the course, and the curriculum and text were used for CS sections of the course through 2003.

There was some dissatisfaction by a number of pedagogues in the College that a single course was used to teach two different subjects, and a number of proposals were put forward. This included leaving the course alone; restoration of the original version of the course, using BASIC, for all sections; and formally creating two different courses. Eventually, two separate courses were formally created beginning in Spring 2003, and students chose which one they wanted. However, certain areas of the College, such as the School of Education, insisted on its students taking the Mathematics version.

The computing course (now designated as Core Curriculum 1312) also morphed into *The Nature, Power and Limits of Computing* [7], a course in algorithmic thinking, elementary programming, the Internet and the Web. Javascript was used as the language.

For reasons that are unclear, the enrollment in CS0 core courses dropped sharply as soon as this happened, but recovered somewhat in the ensuing years. One external factor in the lower level of Core students across the College was the sharp rise in transfer students who received credit for many Core courses upon transferring in to Brooklyn.

In Fall 2006, the nature of the college-wide Core was changed significantly. The Core was broken up into a lower tier and an upper tier. The lower-tier consisted of 9 required courses (with the same limited choices as before for 3 of the 9). The choice of mathematics or computer science was preserved in the lower tier and the CS0 course we were teaching evolved somewhat, but was not modified significantly at this time.

The upper tier was a wide choice of topical courses, without prerequisites, that departments proposed and retired based on teaching availability, topicality and societal and academic trends. Examples of such courses are Forensic Chemistry; *The Silk Road*; *Oil, Water and Population*. Computer Science taught two such courses: *Introduction to Robotics*, and *Paradoxes and the Limits of Knowledge* [8] (the latter with the Department of Philosophy and using a text written by a member of the Department). The CS upper-tier courses are among the most popular of the entire upper tier.

Transfer students, who now represent the majority of the college's student population, are often exempt from the lower tier, but still must take two upper-tier courses. Chart 3 includes both lower- and upper-tier Core courses. At the present time, lower tier CS0 enrolls 45 FTEs, while the two upper-tier CS courses together enroll 76.

A new administration at the College, beginning in 2009, sharply reduced the number of adjuncts and other part-time faculty throughout the College. For example, the number of part-time CS instructors dropped from approximately 40 to approximately 15. In addition, the number of full-time CS faculty dropped slowly, from 31 to 26. Class sizes grew from 20-30 to 45 and CS1 was constrained in its enrollment.

4.1 Pathways

As this is being written, the City University, of which Brooklyn College is one constituent, is implementing a University-wide framework, called Pathways, for all general education. The number of gen-ed courses to be required is lower than what Brooklyn College required traditionally. Courses in a number of "course buckets" (such as "Our Scientific World," "Mathematics and Problem Solving," "Creative Expression," "The Individual and Society") were required. The individual colleges of the University had leeway in the courses they could choose to meet the requirements of buckets. A Mathematics and Quantitative Reasoning course was mandated by the University, and Computer Science did not qualify in that course bucket.

As of now, the Brooklyn College administration has chosen not to include computing in the "Our Scientific World" bucket either, and to omit CS0 entirely as a course meeting the lower-tier general education requirement at the school, despite the fact that the department had prepared four possible CS syllabi and approved three for use as CS0. All upper-tier courses (including the two CS courses), however, will remain as choices for Brooklyn College students in a "college-option" portion of the Pathways framework. The faculty is working on yet another version of general education requirements and it is unknown how Computer Science will fare in the re-organization.

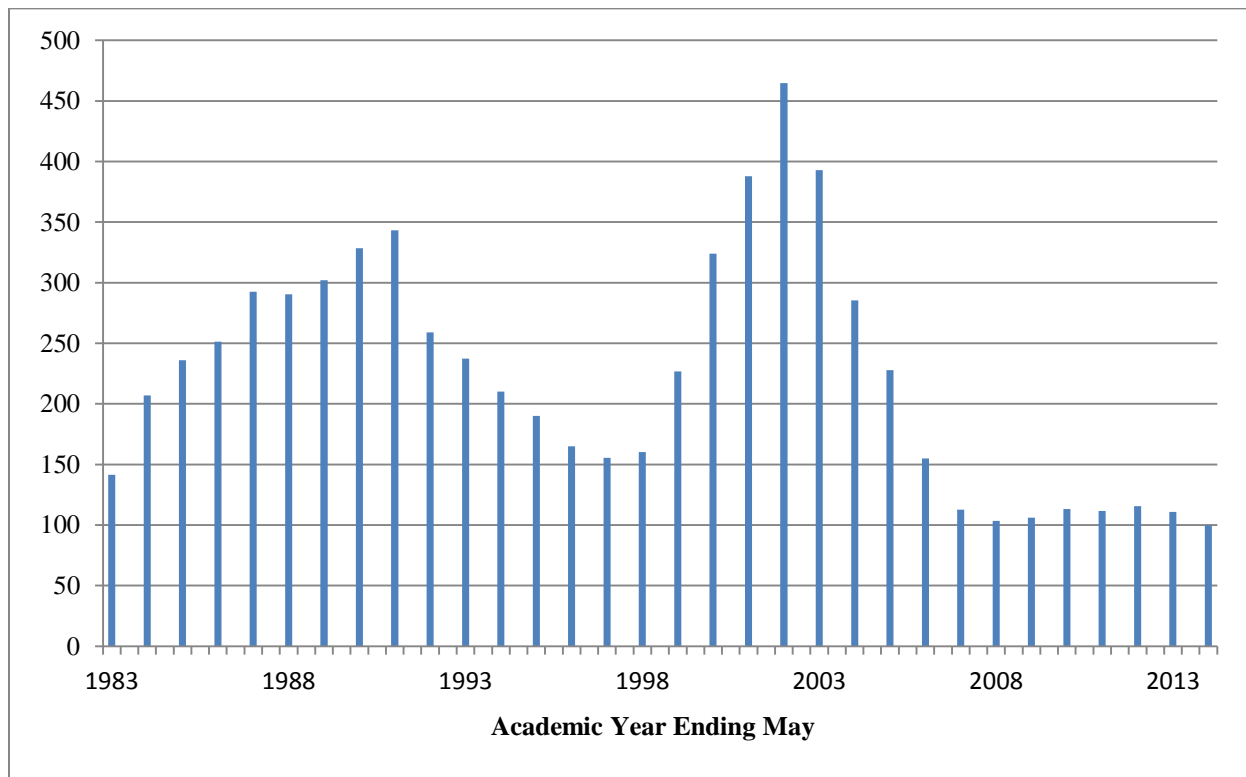
5. Master's Program Enrollment

The Department offers two Master's Programs: in Computer Science and Information Systems. The

Master's in Information Science began in 1987. See Chart 4 for graduate enrollment. The drop from 1991-1997 and the increase from 1998 to 2003 mirrors the change in undergraduate student FTEs, but the graduate enrollment has not recovered since its deep low in 2008, unlike the undergraduate enrollment. Part of the reason for this are Federal administrative rules that make it more difficult for

international students to attend, and College and State regulations that make it more difficult to accept students with degrees in other disciplines on the condition that they make up undergraduate foundational work in computer science. Currently, half the Master's students are CS majors and half are IS majors. Applications are now strong.

Chart 4: Master's Program FTE Enrollment



6. First-Level Course Enrollment: CS1 and the Computer Applications Course

An interesting footnote is the comparison between enrollments in CS1, the Introductory Programming course, and the Introductory Computer Applications (CA) course. The latter course teaches word processing, spreadsheet use, a database system and presentation software.

Before the advent of personal computers, the only introduction to computing was CS1, which was recommended by the Business and Accounting programs. Once the CA course was introduced, there was another “introductory computing” course available, seemingly of much more use to Business students. See Chart 5 for the relative enrollments.

We anticipate, however, that CS department enrollment in the Computer Applications course will shrink as more entrants to Business majors come to the College with a prior knowledge of much of the

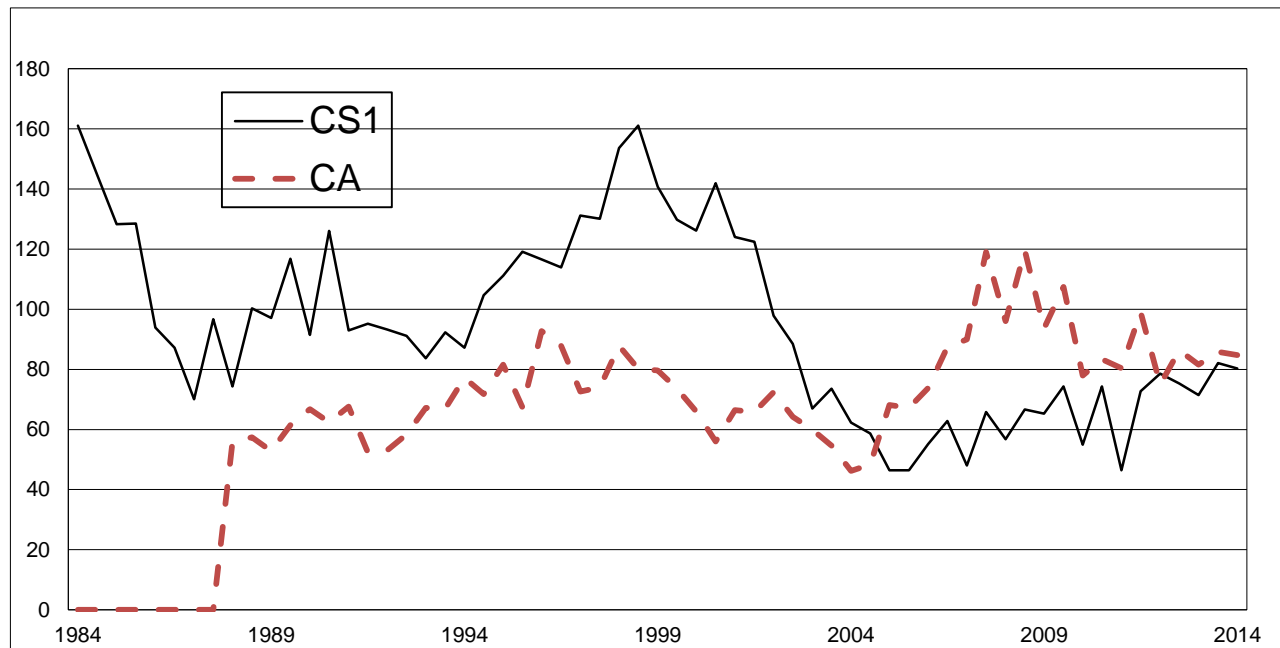
material and as the Business departments incorporate the Applications skills into their own courses.

7. Conclusion

The cyclical nature of computing course enrollments

is demonstrated at one urban institution over a period of 31 years, as an example of general trends. The various components of these enrollments show different patterns, often based on local conditions, technological events, perception and realities of the job market, and changes in the nature of courses.

Chart 5: “Introductory Computing” Course Enrollments



References

- [1] <http://www.cuny.edu/about.html>
- [2] Georgetown University Center on Education and the Workforce, *Best Jobs in America*, Figures 6 and 7 (2012).
- [3] Ibid.
- [4] Marketplace, Why more engineers are losing their jobs, <http://www.marketplace.org/topics/business/fallout-financial-crisis/why-more-engineers-are-losing-jobs> (January 2014).
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- [7] *Computer Science: CORC 1312, Computing: Nature, Power and Limits*, Brooklyn College, Pearson Custom Publishing, 2010, ISBN # 055872820.
- [8] Yanofsky, N., *The Outer Limits of Reason*, The MIT Press, Cambridge MA (2013).