

Making the Connection: Successful Cross Campus Collaboration among Students

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Abstract— In fall 2015, a senior capstone course (CIS 457 Senior Design Lab 1) of multidisciplinary groups from the majors of computer science, information systems, and software engineering aligned with a senior-level entrepreneurship class (ENTR 410 New Venture Creation) consisting of entrepreneurship majors and minors within the school of business to successfully form teams collaborating towards a common project vision. All of the students, in the College of Engineering and Business, have not had a shared experience even though the college was initiated in 2009 and even though efforts to combine a senior-level class have been discussed since 2009.

The approach described in the paper enabled the two, relatively small, classes to connect like-minded, commonly-interested students into functioning groups. The approach enabled several notable achievements: (1) A variety of academic, logistic, and structural hurdles were managed through the approach; (2) Teams were voluntarily formed in a duration of four class periods from each course within the first two weeks of a fall semester, and (3) Joined teams have a market perspective driving the resulting technical innovation.

Each of these achievement areas is discussed. The planning and scripting of the sessions drove the successful approach. In order for other small-sized programs to benefit from the experience, the plans and general structure are shared, and the value of each component is described as a driver to the process. Finally the projects' achievement and validation are discussed.

Keywords— *entrepreneurship; engineering education*

I. BUILDING THE PATH TO THE CROSSROADS OF ENGINEERING AND BUSINESS

In spring 2016, a cross-discipline, entrepreneurial, student team consisting of a combination of Entrepreneurship (ENTR) and Computer and Information Science (CIS) majors, won the Technology Business Accelerator, hosted by the Erie

Technology Incubator at Gannon University [1]. The winning team receives “a grant for \$10,000; six months of residency, coaching and strategic mentoring from the Erie Technology Incubator at Gannon University; legal assistance from MacDonald Illig and MMI Intellectual Property; and one year of e-commerce training provided by Ben Franklin Technology Partners' eMarketing Learning Center” [2]. All in all, what began as two teams, seven students, seeking projects, became a start-up comprised of a subset of the original seven. What began as a hopeful cross-pollination of ideas, interests, and goals became a cohesive, like-minded, mutually-respectful group of enthusiastic seniors.

Each fall, the senior class of the Department of Computer and Information Science (CIS) begins a two-semester senior-design sequence, CIS 457 Senior Design I (fall) and CIS 458 Senior Design II Lab (spring). The students span the majors of computer science, information systems, and software engineering. For three years, the students have been developing their expertise within their discipline. For senior-projects, however, the senior sets are merged together, reflecting the interdisciplinary nature of reality-based projects. The students are allowed to brainstorm and envision projects suiting their majors, interests, and career aspirations. The course allows students to self-define their projects, teams, and development approach. The students not only practice the full-development and management of a project, but also experience the ambiguity of an idea coming into a deployed reality.

Each fall, senior-level business students pursuing an entrepreneurship (ENTR) major or minor take ENTR 410 New Venture Creation. This course is the final entrepreneurship-specific course in their program. For three years, the students have been developing a strong business foundation as well as developing their expertise in entrepreneurship – from idea generation, to customer validation and experimentation, to concept feasibility. Within ENTR 410, the students form

teams to pull all of their learning into a final, comprehensive business plan addressing all of the areas (e.g., detailed product description, market analysis, operational plan and financial plan) needed to pursue the entrepreneurial endeavor. As in the CIS Senior Design courses, the course allows students to pick their own team, projects and approaches, allowing them to move from a beginning idea to hopefully an actionable business opportunity.

Even though the CIS and ENTR majors reside in the same college at Gannon University, (Erie, PA), the College of Engineering and Business (CEB), getting past curriculum and interaction silos of education is difficult. For three years, the professors of CIS 457 and ENTR 410, sought to connect the students' and their projects to gain the benefit of a technologically creative idea improved by business acumen and awareness. The professors recognized the value of the shared perspectives, but sought an approach successfully to foster the connection. After an initial, "good-hearted" approach failed to produce a successful collaboration in fall 2014, an improved, but still organic approach was followed in fall 2015, leading to the 2016 winning effort. While the administrative distance between the programs may seem minimal, in actuality, a gulf of awareness, acceptance, understanding and association separated the students. Not only traditional "functional discipline silos" challenged the business and technology students (i.e., a lack of effective understanding of each group's disciplines), but also conceptual priorities divided the Engineering and Business organizations within the CEB. "Creating a cooperative environment both inside and outside of the classroom was notable in finally achieving a connection between these two academic programs which had previously remained elusive since the combination of engineering and business into one college in 2009 as well as leading to two successful student-project collaborations in the fall 2015 semester."

CEB is unique in its structural merging of engineering and technical disciplines with the pragmatic, opportunity-attuned specialties of business. Located in the industrial, downtown region of Erie, PA, CEB seeks to build the capacity of skills and collaborations the US economy will need to embrace in order to create organizations able to function constructively as the third millennium begins. All the majors within CEB reflect the need of society to create products and services desired by the current and future generations of a technically-savvy, youthful, population.

In the 2013-2014 academic year a team from CIS had successfully developed a project consisting of a high-altitude balloon, carrying a payload throughout its flight including a Raspberry Pi mini-computer featuring a GPS, a digital camera, a digital video camera, various sensors, and a parachute. While the project was challenging and rewarding, the effort did not reflect any market need for its conclusion. In the fall of the same academic year, a team in the ENTR 410 class developed a business plan for a higher-education learning company to provide middle school STEM teachers with the opportunity to bring science into action through a combination of the company's customizable "plug-and-play" STEM curriculum linked to experiential, high-altitude balloon science experiments.

This anecdote typifies the short-comings of both courses' projects – even successful ones. The projects were executed within the silo of their individual disciplines and were lacking the justification of market need and were lacking the constraints of deployable technology, respectively. These projects became the catalyst driving the course professors to coordinate and to break the silos. As with many situations, it was the serendipitous event of the ENTR 410 professor being invited to the CIS senior-design project final presentations – which included the high-altitude balloon project – that formed the impetus to work on a way to provide an opportunity for students in both classes to create a synergistic benefit of a strong technology solution driven by a verified market-driven need.

II. 2009 – 2013: AN UNFULFILLED DESIRE FOR DEEPER CROSS-DISCIPLINE COLLABORATION

Although CEB had been constituted in 2009 and the mission to promote engineered-ready, business-vetted projects was defined, student-blended experiences were less common. The CEB mission was manifested in ancillary units connected with the college, namely the Erie Technology Incubator and the Small Business Development Center. These units and their activities foster and support business development within the local community. Building a student perspective embracing the mission of the college is not part of their roles.

Many institutions realize the value of having a senior-capstone course as the vehicle for building the perspective of the CEB mission [3-5]. Typically, the perspective has an engineering bias, i.e., the engineers will be taught entrepreneurial thinking and will exhibit entrepreneurial skills; entrepreneurial skills are tacked-on in the course of the senior design experience. In [3], the traditional capstone learning elements are compared to entrepreneurial learning elements. Thus the type of knowledge engineering students bring to senior design, traditionally, is complemented by the type of knowledge an entrepreneur should bring. Capstone efforts realizing this strategy are documented in [4] and [5].

For several years, faculty sought to connect senior-level courses with a strong design element by scheduling the offerings at congruent times. While the solution seemed straight-forward, the implementation of it faced various logistical challenges. First, the college and its academic units had a change in the administration. As one set of strategic plans and aspirations faded and another rose to overshadow prior efforts, aspects such as coordinating class times were often relegated to an afterthought, occurring too late to be implemented. Second, the leadership of the courses and the academic departments varied from year-to-year. Since building the CEB perspective into the students was not an outcome of the course or of the college, attention to its creation was marginalized. Third, the ideal courses for such mergers had different structures. Each had its own set of outcomes. The CIS course was also a core-education (general education) course of the university with additional learning outcomes coming from the core-education committee. The CIS course was much more of a development experience with a strong emphasis on project management and team processes. The capstone within the school of business was BCOR 480 –

Business Policy, also a core-education course driven partially by outcomes coming from the core-education committee, which had a much broader group of students (e.g., accounting, finance, risk management, entrepreneurship, marketing, advertising & communications, etc.) with a much broader set of outcomes than the specific, opportunity-focused outcomes of ENTR 410. The BCOR 480 course focused on getting students to develop a “large-corporate” holistic view by understanding how the various business disciplines are integrated into a single strategic view of existing companies as well as undertaking community projects helping non-profits deliver on their missions.

III. FALL 2014 – A VALIANT EFFORT

In fall 2014, even though all these logistical and administrative issues remained, an effort to build connections between the CIS Senior Design (CIS 457 and CIS 458) and New Venture Creation (ENTR 410) classes was attempted in an effort to allow the students from both the engineering and business disciplines to benefit from interacting with each other and to avoid the missed opportunity uncovered the previous academic year with two independent teams working on a high-altitude ballooning project unbeknownst to either team or either course instructor.

The professors agreed on a few working principles:

- Cross-collaboration between the CIS and ENTR classes would be valuable to both sets of students, not only in the classroom setting, but in their future careers.
- The faculty should not force student team partnerships, but instead should encourage and support these partnerships.

In the third week of the fall 2014 semester, the instructors led a joint classroom session to facilitate a single brainstorming session with the goal of generating possible partnering opportunities and to allow the students to begin forming interpersonal relationships leading to collaboration between the student groups. While there was a moderate level of interaction and idea generation, the interest in collaboration quickly dissipated. At the end of the fall 2014 semester, the instructors met to assess the attempt at cross-course collaboration and identified the following issues and recommendations:

- *Issue:* The initial meeting was too late in the semester and the students felt that forming teams seemed “rushed” and would also delay the start of their respective projects.
 - *Recommendation:* Meet earlier and more often especially at the beginning of the semester. Specifically, start the first week of the semester and meet multiple times to allow students to engage more fully and form stronger relationships.
- *Issue:* While the two groups of students showed initial interest in collaborating, they felt the relationships were not formalized and therefore were not solid enough to depend on each other.
 - *Recommendation:* While the formation of the groups should continue to be organic with students agreeing

(or not agreeing) to “opt in” to a team, once the teams were formed the students should formally agree to remain part of the cross-course team throughout the duration of the fall semester.

- *Issue:* Not enough incentives, either formalized or not, were perceived by the student groups to find a benefit in the “pain” of collaboration.
 - *Recommendations:*
 - Explicitly address the benefits of cross-collaboration for CIS students (e.g., coalesce as a business-tech team on a “creative” or “cool” idea rather than a technology proof-of-concept, the enhanced ability to perform a stronger business/customer analysis on their project as this is a component of their final project grade, the need to learn how to effectively communicate with “business” people in their future careers);
 - Explicitly address the benefits of cross-collaboration for ENTR students (e.g., coalesce as a business-tech team on a possible viable business opportunity rather than “making up” a basic business idea for a class project, the opportunity to earn a higher grade if they partner with a technology team, the need to learn how to effectively communicate with “technology” people in their future careers);
 - Explain the improved opportunities of competing as a team in both collegiate-level and professional-level elevator pitch and business plan competitions for both the experience and the chance to win resources (e.g., money, mentorship) to help them pursue their identified opportunity.

IV. FALL 2015 – SUCCESSFULLY ADAPTING OUR APPROACH

Working with knowledge from previous years’ attempts and the results of the fall 2014 post-course assessment, the two CIS and ENTR course instructors held a coordination meeting to spearhead the goal of facilitating interaction opportunities for the students. For both, a project should not only be technically strong, but also be centered on a market-driven need. For both, student bonding could not be forced, but had to be an emergent property of interpersonal dynamics. For both, students can be idea powerhouses, but the development of their ideas into a mission requires coaching. Finally, for both, cultural change occurs by building safe environments for open exchanges.

With these shared perspectives, a sequence of eight class interactions was planned, spanning the first 15 days of the semester. Both courses were essentially suspended so that focus could be placed on project and team formation. The professors set a two-week limit for teams to be formed and initial project ideas to be addressed at a high-level. By promoting the willingness of the instructors to support the perspective before the “usual grind” of classes was underway,

traditional alliances were not immediately formed among the student groups.

In the first day of the CIS 457 class, the ENTR professor promoted the “customer-focused, engineered-ready, business-vetted” perspective for projects. Similarly, the perspective was marketed to the ENTR 410 students in their first day of class. It was during these initial meetings that the importance of being able to “bridge” the chasm between business and technology was addressed. As silos have long been a hurdle in the corporate world, restricting innovation and business development, bridging techniques are a valuable skillset for both business and technical specialists to develop. As such, numerous examples were given about the value the marketplace gives to individuals who were able to excel in their own discipline (i.e., CIS majors in their respective technical disciplines and ENTR in their respective business disciplines), but who were also able to effectively communicate with people in their “partner” disciplines (i.e., CIS majors with business people and ENTR majors with technical people). Further discussions centered on how the development of this critical skill set --the ability for an individual to be a “bridge” between both disciplines -- could not only be developed in a cross-course project, but also how it could be further improved by competing in business plan competitions as a team.

This general introduction was immediately followed by a series of face-to-face meetings between the CIS and ENTR students. These meetings were initially facilitated by the course instructors and then progressed to moving the responsibility of continuing the conversation directly to the students.

For the third encounter, the ENTR students attended the second CIS class for a brainstorming session. The ENTR students and professor came to the CIS environment only because of timing barriers; ENTR 410 was offered at a time precluding CIS students’ attendance. Available CIS students were invited to the second ENTR class (the fourth encounter), but due to schedule conflicts, none were able to attend. Rather the ENTR class reflected on the conversations held during the third encounter and presented an alternative approach to the brainstorming. Then, during the fifth encounter, the alternative brainstorming approach was used. Sensing a convergence of ideas among the students, facing the Labor Day hiatus, and wanting to keep the momentum on-going, the professors added an opportunity for any interested students from either class to meet during the university’s regularly scheduled Common Hour (i.e., a time from 11:00 am – Noon on Tuesdays and Thursdays when no classes are scheduled at Gannon). By the next class time for both courses, teams and project ideas were due. Salient points of the planned sessions are highlighted in Table I.

TABLE I. CLASS ACTIVITY SYNOPSIS

Encounter	Class, Day of Semester	Date	Activity
1	CIS 457,	8/26/15	ENTR professor addresses the benefits of cross-course

Encounter	Class, Day of Semester	Date	Activity
	Day 1		collaboration identified from the fall 2014 post-course assessment. <u>KEY TAKEAWAY:</u> By relating personal successful experiences in industrial start-ups, ENTR professor marketed the value of engineering-business bridges. It is important to get the CIS students to understand the numerous, and sometimes longer-timeframe, benefits of cross collaboration with business personnel so they have an incentive to collaborate.
2	ENTR 410, Day 1	8/27/15	ENTR professor addresses the benefits of cross-course collaboration identified from the fall 2014 post-course assessment. <u>KEY TAKEAWAY:</u> ENTR students needed to have a marketing aspect made to them also to reduce the strangeness of working with technical personnel. Hence, it is important to get the ENTR students to understand the numerous, and sometimes longer-timeframe, benefits of cross collaboration with technical personnel so they have an incentive to collaborate.
3	CIS 457, Day 2	8/31/15	ENTR students visit the CIS class. The combined class was led through a more traditional, structured, open-ended brainstorming activity facilitated by the ENTR instructor. Small groups of each class rotated with each other in a speed-dating format. The objective was for the students to identify any “pains” to be addressed with a technology solution (i.e., a customer-centric approach). <u>KEY TAKEAWAY:</u> The ENTR students were welcomed into the CIS class where the CIS instructor provided food and beverages for all students to share. The creation of an open and inviting atmosphere where the students could “break bread” together was important as it set the stage for a more open and interactive brainstorming session. Also, creating a structured brainstorming process allowed the students to get a chance to meet, interact and begin forming relationships with multiple possible partners while starting the process of idea generation and sharing. Finally, it was observed that the brainstorming session, with its focus on identifying customer

Encounter	Class, Day of Semester	Date	Activity
			"pains", was likely too open-ended and ambiguous for the CIS students who are less accustomed to such a starting point.
4	ENTR 410, Day 2	9/1/15	When a planned visit from CIS students to visit the ENTR class failed to materialize because of schedule conflicts, the ENTR students were taken through a reflection of the current progress and process. The ENTR students came up with several suggestions on how to improve idea generation in future events. <u>KEY TAKEAWAY:</u> An interim "regrouping" meeting in each individual class (i.e., CIS class meets with CIS instructor, ENTR class meets with ENTR instructor) is valuable in getting more open feedback on the process. This also allows the ability to gather feedback mid-process so that adjustments can be made.
5	CIS 457, Day 3	9/2/15	ENTR students visit the CIS class. The combined class was led through a modified, less structured, more focused brainstorming activity facilitated by the ENTR students. The objective was to start with solutions the CIS students had been considering and then try to identify what customer "pains" might exist for those solutions (i.e., a solution-centric approach). <u>KEY TAKEAWAY:</u> The alteration in the brainstorming process, as well as allowing the ENTR students to do the facilitation, was a very effective adjustment. The CIS students were much more comfortable discussing their ideas and passions (i.e., the solutions the CIS had been already considering) which were much more "concrete". Also, putting the students in charge of running the meeting started the transition from an "instructor-oversight" to "student-driven" process.
6	Thursday, Common Hour	9/3/15	Students from both classes "self-select" to meet and openly discuss partnering opportunities. These meetings were completely facilitated by students and instructors were not present. <u>KEY TAKEAWAY:</u> While it is important to formally identify a time for the students to meet outside of the classroom without instructors present, it is equally

Encounter	Class, Day of Semester	Date	Activity
			important to allow each student to choose whether or not to participate. This continues the transition to the students "owning" the collaboration.
7	Labor Day Weekend	9/5/15 – 9/7/15	As the ENTR and CIS students who chose to pursue a collaboration started to coalesce around a project idea, they decided to continue to meet independently over the long weekend to solidify their idea and the cross-course partnership. <u>KEY TAKEAWAY:</u> It is essential for the students to continue to meet independently so both project and team momentum are maintained and relationships between team members continue to strengthen.
8	CIS 457, Day 4	9/9/15	CIS students had to formally commit to a project idea and, where applicable, their intention to partner with ENTR students. <u>KEY TAKEAWAY:</u> While the formation of cross-course teams was voluntary, and not every CIS student chose to enter into one, it was important for the students who chose to partner to formally commit to their project teams for the entire fall semester.
9	ENTR 410, Day 4	9/10/15	ENTR students had to formally commit to a project idea and, where applicable, their intention to partner with CIS students. <u>KEY TAKEAWAY:</u> While the formation of cross-course teams was voluntary, and not every ENTR student chose to enter into one, it was important for the students who chose to partner to formally commit to their project teams for the entire fall semester.

V. SUCCESSFUL FOLLOW-THROUGH

"Anything that won't sell, I don't want to invent. Its sale is proof of utility, and utility is success."

--- Thomas A. Edison, Inventor

The lessons learned from the initial fall 2014 attempt at cross-course collaboration between the CIS 457 and ENTR 410 students led to the successful efforts in the fall 2015 semester. Two teams were formed out of the fall 2015 efforts. Those students worked throughout the semester to create two viable business opportunities; opportunities rooted in the application of relevant technology to existing customers problems. While the results of the collaborations were clearly evident in the increased quality of the teams' end-of-semester deliverables (i.e., both in the CIS 457 and ENTR 410 classes), the efforts

also received external validation of the benefits of cross-discipline collaboration through both teams' improved ability to gain entrance into business accelerator programs and collegiate business plan/pitch competitions. (Accelerator programs are start-up "boot camps" where participants receive advice, guidance and support for businesses in the startup phase and often have a chance to compete for seed funding. and collegiate business plan/pitch competitions.)

The first team's project centered on a specific need owned by the Resident Hall Director at Gannon University. He had the problem of renting vacant dormitory rooms to individuals who participate in Erie's annual "Roar on the Shore" -- a world-class motorcycle rally held each July with the purpose of attracting approximately 165,000 visitors to Erie, Pennsylvania, to raise money for charity while encouraging motorcycle riding, safety and fellowship. What started as a "point solution" for a single problem and customer, developed over the semester into a comprehensive software platform solution called InnCampus.

The concept of InnCampus is to become "Airbnb for vacant, underutilized dorm rooms across the United States". The team went on to be accepted into a professional-level accelerator program with fourteen other companies and became one of four companies reaching the finals of the accelerator's business pitch competition. The team also competed as a finalist in an Ohio/Pennsylvania collegiate business plan competition, a first for any Gannon team. The team is currently considering forming a company to pursue the opportunity.

The second team's project originally centered on a peer-to-peer website simplifying the selling of college textbooks between Gannon students. Through several meetings facilitated by the ENTR instructor using techniques including a customer empathy map [6] (i.e., a collaborative tool teams can use to gain a deeper insight into their customers), the team modified their concept into a software solution called DaBull (pronounced "dabble") which utilizes a "friend-finder" algorithm allowing college students to find fellow students who share common interests. The solution is marketed to universities as a way to increase their retention rates. The team went on to be accepted into the same accelerator program as InnCampus and ended up taking first in the business pitch competition winning \$10,000 and six months of residency and mentorship in a technology incubator. The team also went on to win first place in a collegiate student pitch competition, winning \$3,000. Currently, the team is in the process of forming a company and pursuing intellectual property protection on their idea. (See [1], [2], and [7] for public announcements of the winning. To date, neither team has reached a marketable state with a public website for public consumption.)

VI. REFLECTIONS FOR THE FUTURE EFFORTS

The success of the fall 2015 effort correlated with the eight strategies listed in [3] for promoting entrepreneurial learning in engineering capstones:

1. Develop an entrepreneurial mindset
2. Provide necessary curricular content and support scaffolding for entrepreneurial goals and objectives
3. Allow students to generate their own ideas
4. Incorporate authentic deliverables, constraints and feedback into the process
5. Form interdisciplinary student teams
6. Allow students to engage early and to continue post-course
7. Create opportunities for competition and external validation
8. Facilitate student ownership of intellectual property

The manner in which these strategies were realized did not dissolve the disciplines' silos so much as to embrace a divide-and-conquer approach.

While the fall 2015 efforts produced numerous successful results, modifications to the approach are either being implemented or being considered for implementation, in future semesters. These modifications as well as the aspects to continue are offered.

- The primary roadblock to collaboration in the fall 2015 semester was the class schedule as CIS 457 and ENTR 410 were offered on different days and different times. In fall 2016, both courses are being offered on the same day and time.

- The success of the cross-course collaboration has drawn another technical discipline, specifically Biomedical Engineering, into the partnering effort. The senior design course for these students will also be offered on the same time as CIS 457 and ENTR 410 in the fall 2016 semester.

- Since most of the engineering senior design courses are offered over the course of two semesters (i.e., fall and spring semesters of senior year), the entrepreneurship program is considering offering a spring semester follow-on course to ENTR 410 where students would continue to work on a business idea created in the fall semester. This follow-on course will be an elective choice of the students, not a structural required component of either the engineering or the entrepreneurial curriculum, unlike the approach seen in [5].

- The engineering and entrepreneurial courses can continue to maintain their separate workflows and deliverables. Although [5] suggested "broadening" the workflows and deliverables, the Gannon model shows discipline separation allows expertise to be shown to specific specialists, not all students need to produce all the details.

- Entrepreneurial elements as listed by [3] need not be a rigid component of the engineering capstone course. The elements can be introduced like tinder to a fire, and where the essence of the elements take hold, the fire of entrepreneurialism will ignite. Not all the engineering students need to be entrepreneurs. They need to be attuned to entrepreneurial thinking.

- Students wish to exhibit comprehensively and competently the skills they have mastered through the previous years in their senior capstone projects. By coupling entrepreneurial students with engineering students, an

entrepreneurial mindset can be shared, but the skills particular to each discipline need not be mutually learned.

- Degree of entrepreneurial exposure is not dependent upon the engineering faculty's exposure to entrepreneurship as indicated in [3]. Rather, like the students, each faculty expresses their discipline-specific strengths best; entrepreneurship is best voiced by the faculty of ENTR 410.

Furthermore, the bridges built were not solely across disciplines. The members of the teams from both classes represented various nationalities. The students were willing to be open to alternative thinking from a variety of different perspectives. The initial, classical, business-oriented approach used for the brainstorming had the students focus on common, everyday products or situations. They were to express the "pain" everyone tolerates with the product or situation, but would like to eliminate. These discussions were a good way to start building people-to-people awareness: "That is a pain for you?" "Me, too!" -- or not! Then, the ENTR students' suggestions to modify the approach of the discussions showed a tolerance and an awareness of how to connect with the other class.

Overall, the three phase approach of (1) facilitation of focused discussion, (2) fostering student ownership of ideas, and (3) shared execution responsibility, the students were able to address the traditional silos stiling innovation and business development. Now, a roadmap for keeping the cross campus connection active is available.

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