RESTORATIVE DENTISTRY PROGRAM AT CITY TECH AND DIGITAL DENTISTRY

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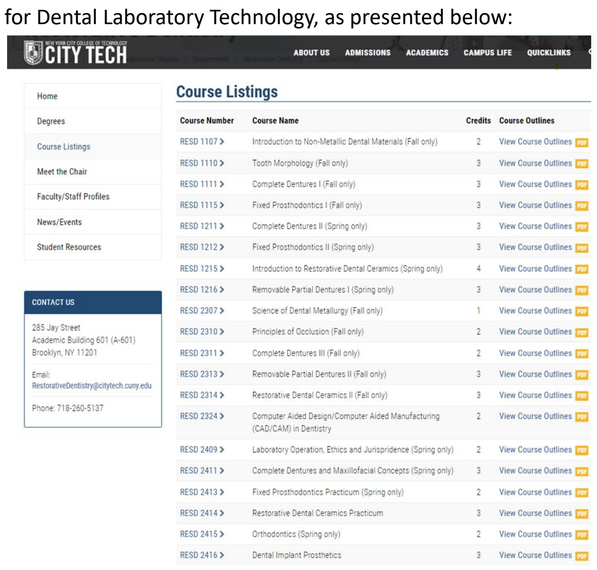
THE CITY UNIVERSITY OF NEW YORK, NEW YORK CITY COLLEGE OF TECHNOLOGY

Introduction: About City Tech's Restorative Dentistry Program

The Restorative Dentistry program at City Tech is the largest and oldest Dental Laboratory Technology program in the nation and the only accredited program in the area covering over 1,000 dental laboratories, offering an Associate in Applied Science degree. Currently, the program is in a new state-of the-art facility, having three new laboratory classrooms and a lecture room equipped for teaching Computer Assisted Design/Computer Assisted Manufacture or CAD/CAM technology. The department's personnel consist of 5 full-time and 13 part-time faculty members, 1 full-time and 3 adjunct College Laboratory Technicians, and 1 administrative assistant serving annually, in average approximately 90 students. The program's curriculum is designed to teach students all aspects of dental laboratory specialties, such as fixed and removable dental prostheses and appliances, in addition to the Laboratory Operation, Ethics and Jurisprudence course and prepares students for taking the Recognized Graduate examination, as part of becoming certified dental technicians and it is administered by the National Board of Certification for Dental Laboratory Technology, as presented below:



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Course Listings

Course Number	Course Name	Credits	Course Outlines
RESD 1107	Introduction to Non-Metallic Dental Materials (Fall only)	2	View Course Outlines
RESD 1110	Tooth Morphology (Fall only)	3	View Course Outlines
RESD 1111	Complete Dentures I (Fall only)	3	View Course Outlines
RESD 1115	Fixed Prosthodontics I (Fall only)	3	View Course Outlines
RESD 1211	Complete Dentures II (Spring only)	3	View Course Outlines
RESD 1212	Fixed Prosthodontics II (Spring only)	3	View Course Outlines
RESD 1215	Introduction to Restorative Dental Ceramics (Spring only)	4	View Course Outlines
RESD 1216	Removable Partial Dentures I (Spring only)	3	View Course Outlines
RESD 2307	Science of Dental Metallurgy (Fall only)	1	View Course Outlines
RESD 2310	Principles of Occlusion (Fall only)	2	View Course Outlines
RESD 2311	Complete Dentures III (Fall only)	2	View Course Outlines
RESD 2313	Removable Partial Dentures II (Fall only)	3	View Course Outlines
RESD 2314	Restorative Dental Ceramics II (Fall only)	3	View Course Outlines
RESD 2324	Computer Aided Design/Computer Aided Manufacturing (CAD/CAM) in Dentistry	2	View Course Outlines
RESD 2409	Laboratory Operation, Ethics and Jurisprudence (Spring only)	2	View Course Outlines
RESD 2411	Complete Dentures and Maxillofacial Concepts (Spring only)	3	View Course Outlines
RESD 2413	Fixed Prosthodontics Practicum (Spring only)	2	View Course Outlines
RESD 2414	Restorative Dental Ceramics Practicum	3	View Course Outlines
RESD 2415	Orthodontics (Spring only)	2	View Course Outlines
RESD 2416	Dental Implant Prosthetics	3	View Course Outlines

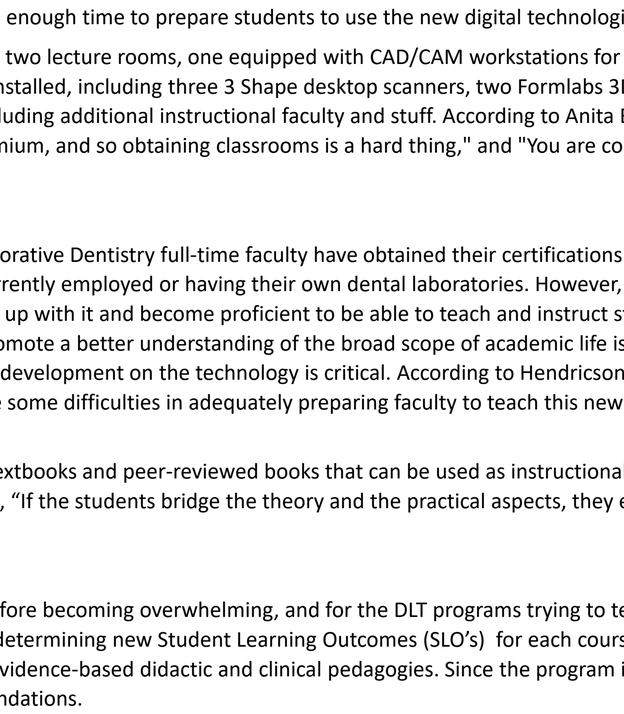
Industry's Trends and Needs

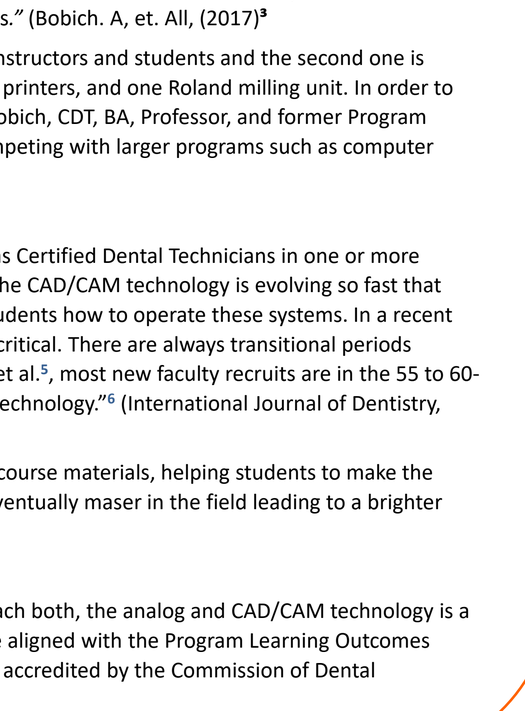
Based on the projected market growth of 38% for North America, from which a large portion is attributed to United States, the industry's demand for educated dental technicians will increase, therefore the allied dental higher education programs must develop course curriculums and set the Student Learning Outcomes which includes CAD/CAM system/technology training and projects.

In addition, the Dental Laboratory Technology higher education programs feel the pressure from the dental schools' programs, which already implemented CAD/CAM systems and technology in their didactic and clinical curriculums, to prepare DLT students to be proficient in using dental digital technology. In an article published in the Journal of Dental Education, the authors state that:

"Currently, the preclinical fixed prosthodontics courses at Southern Illinois University School of Dental Medicine require that students manually design crowns using a conventional wax-added technique and virtually design crowns using CAD techniques."2 (Douglas, R.D, et all, 2014).[1]

Technavio is a leading market research company with global coverage, and according to their latest report published by Yahoo news, in the near future, the "Dental CAD-CAM Market size to grow by USD 422.68 Million".[2]





Challenges for the Program to Implement Digital Dentistry

1. Financial: Higher Education institutions such as City Tech were financially hard hit by the COVID pandemic, and many programs, such as Restorative Dentistry, having clinical course sections had to make provisions for maintaining safety and provide additional protective gear and supplies for faculty, staff, and students. Therefore, a good portion of the department's budget was invested to comply with the school's guidance and policies regarding the safety protocols for COVID 19. As a result, the implementation of the CAD/CAM technology in course curriculums and projects was delayed. In addition, given the large number of students (annual student enrollment average is between 90-100) and the high costs of implementing and maintaining both, analog and digital (CAD/CAM) learning systems, the department found itself in short supply of the necessary the equipment and materials.

2. Time: This is a two-year program for which the curriculum is developed to teach students all aspects of dental laboratory technology (as presented above), including Laboratory Operations, Ethics and Jurisprudence and preparing students for Registered Graduate Exam, which is the first step in becoming Certified Dental Technicians, and it is organized and administered by the National Board of Certification of Dental Laboratory Technology. Therefore, it is difficult to find enough time in the classrooms to cover both analog and digital dental technology, especially allowing students to practice both during the courses' laboratory sessions. This concern is expressed in an article published in the Journal of Dental Education, where the authors mention it as a weakness, because "… the traditional two-year restorative dental technologist educational program may not provide enough time to prepare students to use the new digital technologies." (Bobich. A, et. All, (2017)[3]

3. Logistics: The Restorative Dentistry Department has the main office, 3 state-of-the art laboratories, designed for 15 students, and two lecture rooms, one equipped with CAD/CAM workstations for instructors and students and the second one is shared with the Nursing Department. In terms of the CAD/CAM equipment and technology, the department has 3 Shape software installed, including three 3 Shape desktop scanners, two Formlabs 3D printers, and one Roland milling unit. In order to allow students to practice out of their scheduled classes, the program will need another laboratory, designated for this purpose, including additional instructional faculty and stuff. According to Anita Bobich, CDT, BA, Professor, and former Program Administrator for the Restorative Dental Technology Program at Pasadena City College "Real estate on college campuses is very premium, and so obtaining classrooms is a hard thing," and "You are competing with larger programs such as computer technology, music, mathematics, etc." (IDT, 2022)[4]

4. Faculty and instructor training:

In addition to the academic requirements of having graduated from a Doctoral, Graduate or Doctoral equivalency program, the Restorative Dentistry full-time faculty have obtained their certifications as Certified Dental Technicians in one or more specializations. The part-time or adjunct lecturer faculty are also, certified dental technicians in one or more specializations, and currently employed or having their own dental laboratories. However, the CAD/CAM technology is evolving so fast that sometimes is hard to keep up with all the available innovations and systems, therefore the faculty must find time to constantly keep up with it and become proficient to be able to teach and instruct students how to operate these systems. In a recent article, Ishida at al., states that "The shortage of faculty is an unresolved problem in dental education, and a continuous effort to promote a better understanding of the broad scope of academic life is critical. There are always transitional periods associated with introducing new technologies due to financial constraints, workforce, and curricular time. Thus, appropriate faculty development on the technology is critical. According to Hendricson et al.[5], most new faculty recruits are in the 55 to 60-year age range and are changing their career paths from private practice, military service, or public health positions. This could pose some difficulties in adequately preparing faculty to teach this new technology."[6] (International Journal of Dentistry, 2022).

5. Textbooks and instructional course materials: Another challenge for the DLT programs, regarding digital dentistry is the limited textbooks and peer-reviewed books that can be used as instructional course materials, helping students to make the connection between the theory behind CAD/CAM technologies and their practical applications, as mentioned by Venugopalan et al., "If the students bridge the theory and the practical aspects, they eventually maser in the field leading to a brighter CADCAM future."[7] (IOSR Journal of Dental and Medical Sciences, 2014).

6. Curriculum development, SLOs and PLOs in accordance with CODA:

There is a fine line in achieving a balance in how much information and knowledge students can gain from a course or a program before becoming overwhelming, and for the DLT programs trying to teach both, the analog and CAD/CAM technology is a challenge. The implementation of CAD/CAM technology into course curriculum from didactic and educational perspectives involve determining new Student Learning Outcomes (SLO's) for each course aligned with the Program Learning Outcomes (PLO's). Each course curriculum must clearly present the course objective and establish students' academic progress by employing evidence-based didactic and clinical pedagogies. Since the program is accredited by the Commission of Dental Accreditation (CODA), it is important to maintain its standards and guidance by implementing pedagogies based on these recommendations.

Solutions: Measures taken by Restorative Dentistry Program to Implement Digital Dentistry

1. Financial: In addition to the allocated budget from the college, the department relies on grants through the Foundation for Dental Laboratory Technology, such as: Keystone, Sterngold etc., financial donations through the CUNY RD Giving Tuesday campaign, and equipment and materials donations from industry leaders and manufacturing companies, such as Straumann and from local dental practices and laboratories. Also, for each semester, the students are required to pay for their tools, uniforms, and books, as presented below:

Approximate Additional Costs

All dental technology students are required to purchase tools, uniforms and books, which are used during the four semesters.

First Semester	
Uniform	$30.00
Tools and Supplies	$650.00
Books	$220.00
Second Semester	
Tools and Supplies	$250.00
Books	$140.00
Third Semester	
Tools and Supplies	$50.00
Books	$70.00
Fourth Semester	
Tools and Supplies[1]	$350.00
R.G. Examination[2]	$210.00

1 May vary according to specialization chosen in fourth semester.
2 Recognized Graduate Examination National Board for Certification.

2. Time: The faculty is dedicated to teaching students CAD/CAM technology by introducing lecture presentations, handouts of articles published in specialized peer-reviewed journals, encourage students to attend courses and symposiums, such as LMT East Day in Chicago. Also, the department facilitates workshops and presentations from dentists and professional organizations, such as Straumann and other dental laboratories engaged in promoting this technology. One successful way of best utilizing classroom time is the introduction of laboratory projects where the students must use both analog and CAD/CAM to complete them, such is the case for the RESD 2416 Dental Implant Prosthetics course, where some of the laboratory projects involve the analog fabrication of a screw-retained restoration for tooth # 14 and the digital design of a screw-retained restoration for tooth #3. Moreover, the Restorative Dentistry Department in collaboration with City Tech is working to develop the curriculum for a Bachelor of Technology program, which will allow for much needed framework for expanding teaching CAD/CAM technology.

3. Logistics: To maximize the laboratories space and efficiency, the department is working on installing computers at workbenches allowing students to use the CAD/CAM systems in combination with the analog methods of fabricating different dental protheses and appliances. The CAD/CAM system currently used is 3 Shape which is an open architecture system allowing the integration of other software components such as 3D printing and milling.

4. Faculty and instructors training: The department organized and facilitated training sessions with 3 Shape educational team, encourage its faculty to attend continuing education courses, workshops, and symposiums, either in person or virtual and to practice using the CAD/CAM technology that is already installed. In addition, the faculty can apply for educational grants through the Foundation for Dental Laboratory Technology, such as Spear Education Academy, The Dawson Academy, etc. One great initiative supported by the department is the Complete Denture Workshop, where every year, the faculty meets for one day to discuss the complete denture courses curricula, laboratory projects and the implementation of CAD/CAM technology for complete dentures. In addition, at the end of each academic year, during the last departmental meeting, the faculty meets and discusses in detail the overall achievements and the methods to improve teaching including different pedagogies for implementing the CAD/CAM technology in most of the program's courses.

5. Textbooks and instructional course materials: Even though there are limited numbers of textbooks about CAD/CAM technology, there are other plentiful resources that the faculty can use to instruct and teach students, such as: published works, video tutorials and demonstrations.

6. Curriculum development, SLOs and PLOs in accordance with CODA: The Restorative Dentistry Program is accredited by the Commission of Dental Accreditation (CODA), and therefore must adhere to its guidance and standards. Under General Laboratory Techniques Standards section 2-14 of CODA, "students must demonstrate competence in general laboratory techniques, including subpoints: "g) Utilizing various methods of fabrication (i.e., analog and/or digital) and i) Digital workflow (i.e., didactic and/or laboratory procedures). Intent: Dental technology curriculum content includes various methods of fabrication; students should be exposed to new technologies and processes." Accreditation Standards for Dental Laboratory Technology Education Programs, January 2022, pg. 26-27[8]. This provides the framework for the development of course curricula, creating obtainable Student Learning Outcomes (SLO's) and enhancing Program Learning Outcomes (PLO'S), which are reflected in course instructional materials including assignments and students' evaluations, and student learning experiences through class CAD/CAM demonstrations, CAD/CAM laboratory projects. In addition, the Summer Externship, which is a place-based program allows second-year students to observe and/or practice, from experienced technicians, CAD/CAM technology directly in dental laboratories all around the New York City and Tristate areas.

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