RGSTC, Mumbai and DST, New Delhi

Biomedical Engineering and Technology Innovation Centre

BRIEF CUMULATIVE PROGRESS REPORT

(Feb 2014 – Jan 2021)

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Executive Summary

BETIC – Biomedical Engineering & Technology Innovation Centre was established at IIT Bombay in 2014, followed by satellite centers at VNIT Nagpur and COE Pune in 2015. These were funded by RGSTC, Govt. of Maharashtra, Mumbai, and DST, Govt. of India, New Delhi to catalyse indigenous medical device innovation.

The faculty team comprises 14 investigators and associates at the three institutes. More than 110 researchers, project managers and students (PhD, Masters and B. Tech) worked in BETIC. Many of them incubated their startup companies, joined healthcare industry or pursued higher studies. About 50 clinicians and many industry professionals are closely associated as mentors, facilitators or resource persons.

BETIC evolved a 'define-develop-deliver-deploy' model involving doctors, researchers, entrepreneurs and investors for effectively traversing the 'valleys of death' between idea, invention, innovation and impact. The lead-time from bedside to bench (engineering) to business to bedside is less than two years for low or medium-risk devices.

The model was adopted by BETIC cells at four other engineering colleges (KJSCE Mumbai, MIT-ADT Pune, SIU Pune, GHRCE Nagpur) and six medical institutes (GMC & JJH Mumbai, HITRT Mumbai, MGMIHS Sanpada, BJMC Pune, DMIMS Wardha, BKLWRH Dervan). The AP Med Tech Zone and Gujarat Technological University signed collaboration MoUs.

During the last five years, BETIC centers and cells gathered over 400 unmet clinical needs, developed proof-of-concepts of 240 different devices, and filed over 50 patents (as well as 10 PCT applications). Of these, 16 products have been licensed to start-up companies created by the researchers. Another 14 products were licensed to or being developed for local industry partners. These products fall into different categories as follows.

Diagnosis, screening & monitoring (6): smart stethoscope, diaBETIC foot screener, biopsy gun, glaucoma screener, endotracheal blockage detector, centric jaw recorder.

Surgical instruments & software (12): orthopaedic surgery planner, laparoscopy instrument, nasal osteotomy forceps, skin spray gun, artificial temporal bone, mandible surgery guides, auto suturing device, dental burr, electro-chemo therapy device, dental IOS, modular recording system, RF ablation device.

Assistive devices & implants (12): above-knee prosthetic leg, knee ankle foot orthosis, hybrid plaster splint, silicone (nasal) implants, menstrual cup, portable sterile enclosure, patient-specific implants, clubfoot brace monitor, cooling cap, auto CPAP, oxygen concentrator, drug nanosol device.

The BETIC products were exhibited in 35 events, spreading awareness and establishing partnerships. It includes BETIC Medical Device Expo (MEDEX) at BKLW Rural Hospital, Dervan (2015) followed by COE Pune (2016) and IIT Bombay (2017, 2018, 2019). Other events include Global Business Forum (Goa, 2015), India International Science Festival (Delhi 2015 and 2016, Chennai 2017, Lucknow 2018, Kolkata 2019), Make in India Expo (Mumbai, 2016), India Medical Device Expo (Bangalore 2017), Magnetic Maharashtra (Mumbai, 2018) and Tech-Connect (IIT Bombay, 2015-2020).

BETIC startups won BIRAC Biotechnology Ignition Grant 15 times, each funding about Rs. 50 lakh to the respective company. Team members also won 40 other awards including Gandhian Young Technological Award, DST India Innovation Growth Programme Medal (thrice), Google Impact Challenge, Emerging Startup of the Year, American Bazaar Start-Up Competition, Young Entrepreneur, Indo-Swiss AIT, SICOT Research, SKB Seva Samaj, Maharashtra Startup Week, AI Innovation Challenge, NCPEDP-Mphasis Universal Design, IET IOT Challenge-Healthcare, Infosys Aarohan Social Innovation award, DST Cawach, Millenium Alliance, NIDHI-Prayas, MeitY TIDE, BIRAC Fast Track and BIPP.

BETIC team organized 10 Medical Device Hackathon (MEDHA) in different institutes in Mumbai, Pune, Nagpur, Wardha and Kolhapur during weekends of June-August in 2017, 2018 and 2019, training about 400 students. Most of these institutes set up BETIC cells. About 300 teachers, doctors, innovation managers, industry professionals and students were trained in five 5-day Medical Device Innovation Camp (MEDIC) at IIT Bombay (2015, 2018, 2019), VNIT Nagpur (2016) and COE Pune (2017). Other events organized by COE Pune and MGMHIS Sanpada benefited another 200 participants.

The book '*The Essence of Medical Device Innovation*' (Crossword, Mumbai, 2017) captures the medical device innovation process of BETIC. Over 2000 copies are in circulation. The Medical Devices Quality Management System of BETIC received ISO 13485 certification in 2018, easing the path for regulatory approvals.

Project investigators and researchers shared their experience through 65 technical papers in journals and conference proceedings as well as 150 invited talks in various institutes and workshops. Many distinguished scientists, clinicians, heads of institutions, government officials, business leaders and alumni visited BETIC centers. Team members also visited and established close contacts with many medical institutes and innovation centers in India, and a few overseas as well.

The project has met or exceeded the original targets in all objectives. Complementary projects funded by DST, BIRAC, DBT and ICMR have been initiated or in the pipeline, to sustain and scale up the activities. BETIC processes, pipeline, products and people are contributing to the medical device innovation ecosystem in the country, leading to healthcare innovation and high-value entrepreneurship.

1. Goal & Objectives

Originally titled "Biomedical Engineering & Technology Centre Incubation", the project is an inter-disciplinary multi-institution initiative supported by the RG S&T Commission of Maharashtra to catalyse indigenous medical device innovation. The long-term goal is to evolve an inclusive, scalable and sustainable model for developing novel medical devices that are affordable, reliable and suitable for the local population.

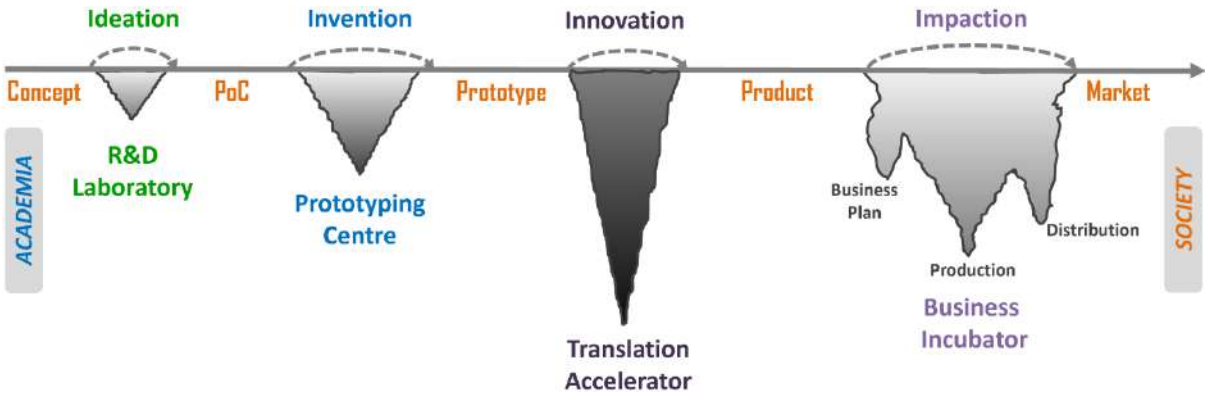
Major objectives as per the original proposal include:
(a) establishing an integrated facility for medical device innovation,
(b) developing selected medical devices for unmet clinical needs,
(c) manufacturing and testing the devices in collaboration with industrial partners,
(d) facilitating clinical trials, IPR filing and technology licensing, and
(e) training and supporting medical device innovators.

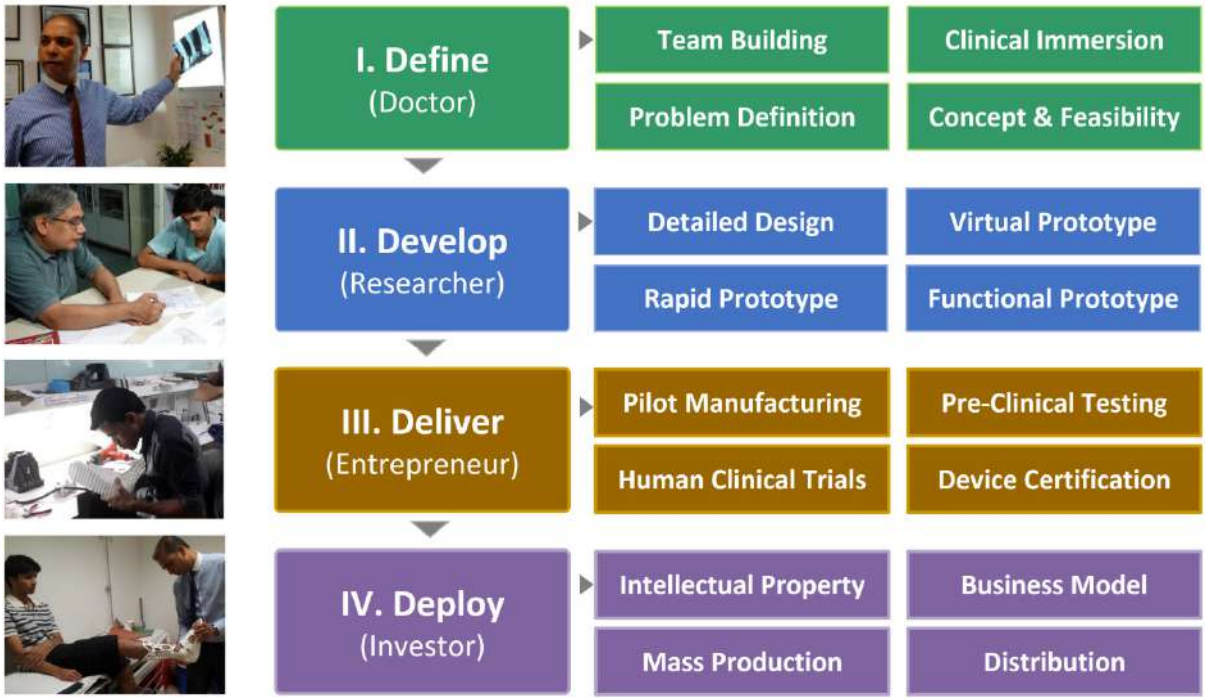
Scope and focus include medical devices that meet the following criteria:
(a) clear established local need (market) for the device,
(b) availability of related R&D expertise and facilities,
(c) involvement of experienced clinicians for feedback and testing,
(d) potential for innovation (patenting) and cost reduction, and
(e) readiness of domestic manufactures to produce and commercialize.

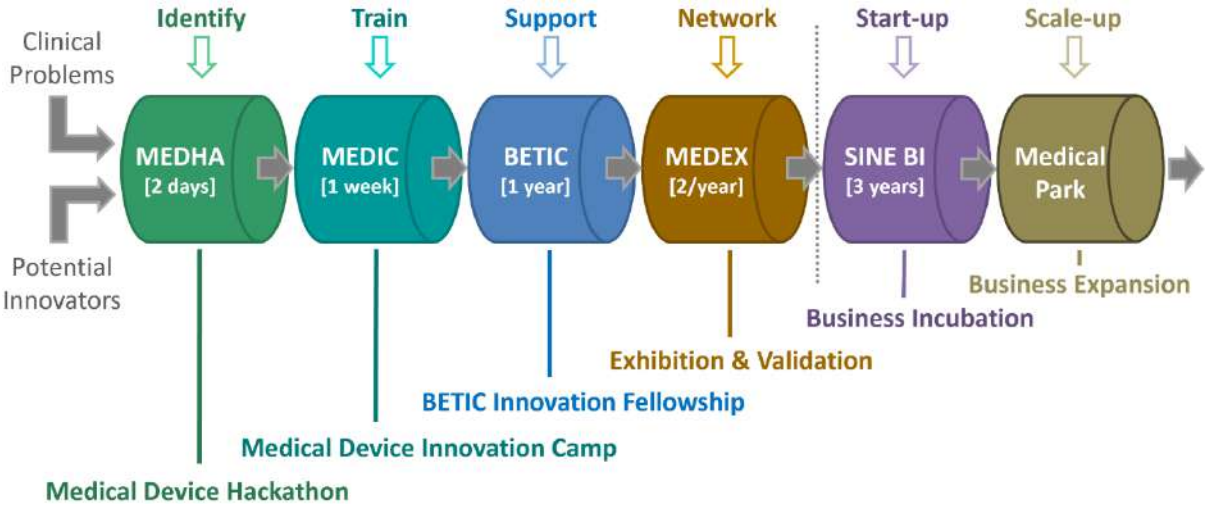
Methodology and activities in line with the above objectives are as follows:
(a) identifying and networking a team of researchers, clinicians and domain experts,
(b) establishing the Centre and sub-centres with equipment and other facilities,
(c) identifying the set of devices to be developed, in consultation with clinicians,
(d) medical device specifications, concept, design and rapid prototyping,
(e) device manufacture, quality inspection and tissue engineering,
(f) biocompatibility, functionality and safety evaluation of the devices,
(g) device documentation, intellectual property rights filing and clinical trials,
(h) technology licensing / transfer to domestic industry for commercialization,
(i) documenting the device development methodology along with case studies, and
(j) training and guiding other interested groups in medical device innovation.

Performance parameters include the following over the project duration:
(a) Number of clinicians interacting with BETC: one new one every quarter.
(b) Number of medical devices designed and prototyped: total 13
(c) Number of patents filed: 4-5 in India, and at least one overseas.
(d) Number of young engineers trained in medical innovation: 50
(e) Economic impact by high quality coupled with significantly lower cost.

The following chapters briefly describe the progress achieved so far.







'Valleys of death', BETIC process and pipeline for medical device innovators

2. Project Team Members

The project is led by principal investigator Prof. B. Ravi at IIT Bombay, along with Prof. A.M. Kuthe and Prof. B.B. Ahuja at VNIT Nagpur and COE Pune, respectively. Ten co-opted faculty members at the three centers help in planning the facilities, selecting researchers, reviewing device projects, equipment purchase, and other major decisions. Many more are involved in 11 BETIC Cells at engineering and medical partner institutes.

Senior Executive Officer Dr. Rupesh Ghyar coordinates all activities at BETIC-IITB. He is assisted by five project managers in charge of design, electronics, manufacturing, vendors and quality. BETIC VNIT and COEP have project managers to coordinate their activities. Full-time project assistants and researchers (master's and PhD students) associated with BETIC take one of the two responsibilities: (i) operating and maintaining the equipment for a specific facility, such as rapid prototyping, or (ii) developing and testing a particular medical device. All are required to keep 20% of their time for helping others. At present, the three centers have about 30 project staff and researchers. The total number of project staff associated with BETIC over the last five years is 57. In addition, 58 students (PhD, master's, B.Tech and interns) have worked at BETIC.

The BETIC team has established contact with more than 110 expert clinicians (physicians and surgeons), and about 50 of them are closely associated with the device projects. They define the clinical need, provide feedback on the designs, test the prototypes and promote the product in their network. They are named in the patents and royalty sharing agreement with product licensees. The team maintains close links with the technology business incubators in the respective institutes as well as others in the region, for their researchers to incubate startup companies.

Each device project has a dedicated team led by a full-time project assistant or researcher, who is supported by others in charge of various facilities. They are guided by one or more expert clinicians. The progress is reviewed every week by project managers and about once a month by the faculty. This has enabled good and continuous progress.

The PIs meet typically meet once every quarter to plan the targets and events, review the progress, exchange the best practices and streamline any bottlenecks. The Steering and Monitoring Committee comprising the directors of the three partner institutes, as well as other institutes (engineering and medical) and government representatives, meets once every year (typically in May) to review the overall progress.

The list of BETIC centers & cells; project staff (current & previous); and expert clinicians associated with BETIC are given in Appendix 1, 2 and 3, respectively.

BETIC partner institutes

Project investigators at BETIC, IIT Bombay

BETIC project researchers and students

3. Facilities and Processes

The project was kick-started from existing labs at the three partners institutes, who gradually added more space to accommodate the equipment, personnel and activities.

BETIC-IITB operates from five locations inside the Institute: (i) OrthoCAD Lab for medical modelling and rapid prototyping, (iii) E-Foundry lab at the back, which was refurbished for electronics prototyping, (iii) Idea room created in the front for concept design & POC, (iv) Porta cabin (two-level) created on the side for pilot manufacturing of parts in metal, (iv) Room in SAIF building for metal rapid prototyping, and (v) Room in Mechanical Engineering AMTF lab for testing equipment. All these provide a working space of about 2500 sq.ft (232 sq.m). In addition, a Gait Lab was created at MGM Institute of Health Sciences, Navi Mumbai, who provided about 1500 sq.ft. space, complementary equipment and medical staff to manage and maintain the facility.

BETIC-VNIT is operating from the CAD/CAM Lab of Mechanical Engineering department, which has about 2000 sq.ft space for the project. BETIC-COEP started operating from the Rapid Prototyping & Fab Labs, and have recently moved into new space created for the project, which is about 2000 sq.ft.

The facilities allow the project team to create medical CAD models, simulate and optimize their performance, fabricate proof-of-concepts, rapid prototypes in plastic, functional prototypes in metal, embedded electronics, and basic inspection and testing. The team has developed a network of local vendors for specialized fabrication work, advanced testing and packaging of medical devices.

BETIC evolved a systematic process for medical device innovation. It involves defining an unmet clinical need, developing a novel solution, delivering a tested device, and deploying it in clinical practice. This is referred to as bedside-bench-business-bedside. BETIC also evolved a pipeline to train the innovators and create a continuous steam of products. It starts from a medical device hackathon (MEDHA) and proceeds through medical device innovation clinic (MEDIC), product development at BETIC, medical device exhibition (MEDEX), and licensing the technology to startup or industry partner.

The innovation process was codified into a quality management system with 21 SOPs and 53 forms. This received ISO 13485 certification in July 2018, which was reconfirmed in 2019 and 2020. It helped systematic documentation (for future reference and retrieval), training of new team members, regulatory approvals (by hospital institutional ethics committees and government bodies like CDSCO), and enhanced credibility.

The list of major equipment at the three partner institutes is given in Appendix 4.

Medical device innovation facilities at BETIC, IIT Bombay

3D Bioplotter at VNIT Nagpur and Gait Lab at MGMIHS Navi Mumbai

4. Products & Startups

Medical devices developed at BETIC originate from clinical needs articulated by expert clinicians and validated by market research. They represent different medical specialties (like ophthalmology and orthopedics) and risk classes – low, medium and high.

Till date, more than 400 medical problems have been collected from over 100 doctors in different hospitals. These were curated by the BETIC team and 200 problems were given to the participants of medical device hackathons and camps, as well as the collaborative (medical device) engineering course at IIT Bombay. These yielded about 250 different proof-of-concepts. Full-time researchers who joined BETIC took their ideas forward, developed the products, and filed more than 50 patents in India (plus 10 PCT).

Total 16 products were licensed to the startup companies created by the researchers. Another 14 products were licensed to or being developed for local industry partners who approached BETIC. These products fall into different categories as follows.

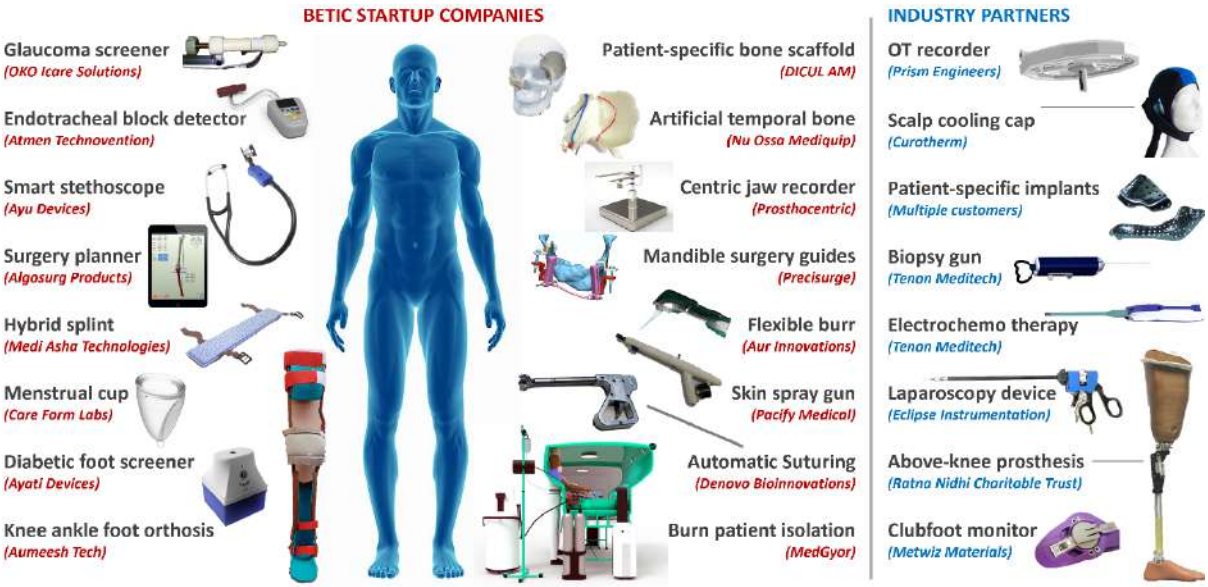
Diagnosis, screening & monitoring (6): smart stethoscope, diaBETIC foot screener, biopsy gun, glaucoma screener, endotracheal blockage detector, centric jaw recorder.

Surgical instruments & software (12): orthopaedic surgery planner, laparoscopy instrument, nasal osteotomy forceps, skin spray gun, artificial temporal bone, mandible surgery guides, auto suturing device, dental burr, electro-chemo therapy device, dental IOS, modular recording system, RF ablation device.

Assistive devices & implants (12): above-knee prosthetic leg, knee ankle foot orthosis, hybrid plaster splint, silicone (nasal) implants, menstrual cup, portable sterile enclosure, patient-specific implants, clubfoot brace monitor, cooling cap, auto CPAP, oxygen concentrator, drug nanosol device.

Another 20 medical products developed at BETIC are ready for licensing to interested partners. These include stroke detection, wireless ECG patch, pulse-based diagnostics, obstructive lung disease devices, hemoglobin quantifier, x-ray based diagnostics, heart valve template, endo retractor, monopolar hook, endoscope insertion & fixation, cleft palate impression tray, suture anchor, bicondylar compression screw, smart acupressure glove, dialysis cuff, wearable module for knee joint, hand splint for burn patients, hand rehabilitation device and ICU ventilator. BETIC team also provided several custom medical devices to support various orthopedic surgeries.

The above devices and company names (where applicable) are listed in Appendix 5.



BETIC products, startups (red) and industry partners (blue)

Team members working with clinicians

BETIC team at Medical Device Expo in IIT Bombay

5. Knowledge Dissemination

An implicit goal of the project has been to codify the knowledge, experience and best practices gained at BETIC, and share it with the larger community for contributing to the overall ecosystem for medical device innovation. This is achieved through publications, talks, training events, exhibitions, media coverage and exchange visits.

Patents and copyrights: BETIC team members filed 51 patents in India and 10 PCT (Patent Cooperation Treaty) applications; a few devices like smart stethoscope module have been patented in multiple countries. The name of the expert clinician who assisted in the product development is included as an inventor in the patent filing as well as in the revenue sharing agreement, when the technology is licensed for commercialization. A few copyrights and design registrations have also been filed. These are listed in Appendix 6.

Books, papers and talks: 'The Essence of Medical Device Innovation' authored by B. Ravi and published by The Write Place (Crossword) in 2018 describes the 4-stage x 4-step process of innovation illustrated by stories from BETIC family. B. Ravi or team members also wrote invited chapters in four books: 'Engineering for the Future', Centenary Book of Institution of Engineers (India); Innovation-Venturing and Entrepreneurship in India Network (iVEIN) Report; 3D Printing in Oral Health Science, Springer; and 'Advances in 3D Printing & Additive Manufacturing Technologies,' Springer. The investigators and team members published 37 journal papers, 21 international conference papers and 8 national conference papers. Further, they gave 150 invited talks at various seminars, workshops, faculty development programs and institutions. The publications (journal and conference) and talks are listed in Appendix 7, 8 and 9.

Training workshops: BETIC team organized 10 Medical Device Hackathon (MEDHA) and 5 Medical Device Innovation Camp (MEDIC), Clinical Biomechanics and a few other workshops, training over 800 students and working professionals (Appendix 10).

Exhibitions and media coverage: The products were exhibited at 36 different events including Medical Device Expo (MEDEX) organized by BETIC and other events such as India International Science Festival (IISF), listed in Appendix 11. The products and innovators were featured in Forbes India, Outlook Business, newspapers (mainstream and vernacular), TV channels and All India Radio (Appendix 12).

Exchange visits: Several eminent government officials, foreign ambassadors, institute directors, clinicians, faculty, scientists, industrialists as well as school/college teachers and students visited BETIC. Team members also visited many institutes, industry and innovation/incubation centers to exchange the best practices.

BETIC team members won several innovation awards, listed in Appendix 13.

Book, ISO 13485 certification and website

Medical Device Innovation Camp (MEDIC)

Medical Device Exhibitions

6. Impact & Sustainability

The original and additional performance metrics of BETIC are listed here.

Performance Indicator	IITB	VNIT	COEP	TOTAL
Faculty (core & associate)	8	2	4	**14**
Project managers	15	2	-	**17**
Full-time researchers	26	6	9	**41**
PhD and Masters students	21	3	1	**25**
B. Tech students & interns	10	7	14	**31**
Centers/cells mentored	4	2	4	**10**
Lab space created (sq.m.)	232	84	223	**539**
Collaborating hospitals	21	11	7	**39**
Collaborating clinicians	23	12	13	**48**
Other clinicians visited	34	4	6	**44**
Startups products licensed/mentored	9	3	3	**15**
Industry products licensed/developed	13	1	-	**14**
Ready to license devices	13	12	13	**38**
PoCs by course students	61	10	5	**76**
PoCs by workshop participants	81	42	42	**165**
Indian patents filed	29	11	12	**52**
PCT applications	8	-	2	**10**
Publications – Journal	7	24	6	**37**
Publications – Conference	9	14	5	**28**
Invited talks	112	28	9	**149**
Exhibitions organized/participated	22	11	15	**36**
Medical device hackathons	5	3	3	**11**
Medical device innovation camps	3	1	1	**5**
Other training workshops	4*	1	1	**6**
Participants trained	532	162	173	**867**
Innovation awards	34	9	15	**58**
Innovation awards (Rs. Lakh)	1086	208	215	**1509**
Industry Projects (Rs. Lakh)	185	0	0	**185**
Licensing fees/Services (Rs. Lakh)	41	2	0	**43**

* with MGMIHS, Navi Mumbai

Future Sustainability measures

Right from the beginning of the project, BETIC team devoted considerable thought and effort for strengthening, streamlining, sustaining and scaling up the activities.

A strong network of resources was created through collaboration with engineering and medical institutes, as well as various government agencies and industry. This helped in covering many gaps in knowledge, skillset and facilities needed for taking the concepts to market. The BETIC family comprises about 50 organizations (13 institutes, 16 startups, 10 industry partners and a dozen or so vendors for various services). More than 150 faculty, expert clinicians, full-time researchers and students worked at BETIC. Standard operating procedures, encapsulated in ISO 13485 documentation, helped in streamlining various processes of BETIC.

To sustain and scale up the activities, BETIC initiated multiple measures. The 16 startup companies were exhorted to apply to different agencies (such as BIRAC and DST) and they obtained over Rs. 15 crores in total to fund further product development, lab testing, clinical trials and regulatory approvals. These funds go directly to the startup companies.

The BETIC-IITB team created several complementary project proposals to sustain or scale up ongoing activities. The DST had already agreed to fund metal 3D printing system and few other high-end equipment amounting to Rs. 7.85 crore. BIRAC has approved the establishment of 'BETIC Early Translation Accelerator' to convert existing R&D work into marketable products in collaboration with industry; the budget is about Rs. 3.6 crore, covering the cost of consumables and manufacturing. The ICMR has approved setting up a 'BETIC Hub for Medical Grade Pilot Manufacturing and Device Testing', with a budget of Rs. 16 crore, mainly for equipment. The Biosciences & Bioengineering Department and DS School of Entrepreneurship of IIT Bombay with inputs from BETIC applied to DBT for 'MEDIC Fellowships', with a budget outlay of Rs. 10 crore, which is likely to be approved. A not-for-profit company is planned to provide integrated services to startup companies in an efficient way by leveraging the facilities and expert network of BETIC.

The main challenge facing BETIC is adequate space to house the equipment and personnel for ongoing and new projects has been considerably delayed at all three institutes. While COE Pune has made some progress and shifted the project activities to a new facility, the construction work at IIT Bombay and VNIT Nagpur is yet to start. The lack of space would make it difficult to unlock the full potential of the ground work and good-will accumulated so far. This has to be urgently taken up and resolved at an institutional level.

Appendix 1: BETIC Centers & Faculty

	BETIC Main Centre	
	BETIC-IITB: OrthoCAD Lab, IIT Bombay, Powai, Mumbai - 400076	
1	Prof. B. Ravi, Mechanical Engineering, PI	prof.b.ravi@gmail.com
2	Prof. Asim Tewari, Mechanical Engineering, Co-I	
3	Prof. Parag Bhargava, Met. Engg. & Materials Sc., Co-I	
4	Prof. G.G. Ray, IDC School of Design, Co-I	
5	Prof. V.P. Bapat, IDC School of Design, Co-I	
6	Prof. B.K. Chakravarthy, IDC School of Design, Associate	
8	Prof. Abhishek Gupta, Mechanical Engineering, Associate	
9	Prof. Anirban Guha, Mechanical Engineering, Associate	
10	Prof. P.S. Gandhi, Mechanical Engineering, Associate	
11	Prof. Ramesh Singh, Mechanical Engineering, Associate	
12	Prof. Sushil Mishra, Mechanical Engineering, Associate	
13	Prof. Sripriya Ramamoorty, Mechanical Engineering, Associate	
14	Prof. Rohit Srivastava, Biosciences & Bioengineering, Associate	
15	Prof. Neeta Kanekar, Biosciences & Bioengineering, Associate	
16	Prof. Rohit Srivastava, Biosciences & Bioengineering, Associate	
17	Prof. Dipti Gupta, Met. Engg. & Materials Sc., Associate	
18	Prof. Maryam Baghini, Electrical Engineering, Associate	
19	Prof. Arti Kalro, SJM School of Management, Associate	
20	Prof. Anand Kusre, DS School of Entrepreneurship, Associate	

	BETIC Satellite Centres	
	BETIC-VNIT: CAD/CAM Centre, VNIT, S.A. Road, Nagpur - 440010	
1	Prof. A.M. Kuthe, Mechanical Engineering, Co-PI	amkme2002@yahoo.com
2	Prof. Shital Chiddarwar, Mechanical Engineering, Co-I	
3	Prof. Rashmi Uddanwadikar, Mechanical Engineering, Co-I	
	BETIC-COEP: Production Engineering, COE, Shivajinagar, Pune - 411005	
1	Prof. B.B. Ahuja, Production Engineering, Co-PI	bba.prod@coep.ac.in
2	Prof. Arati Mulay, Production Engineering, Co-I	
3	Prof. Sandip Anasane, Production Engineering Co-I	
4	Prof. B.U. Sonawane, Production Engineering Co-I	

	BETIC Cells (Engineering)	
	BETIC-KJSCE: Mech. Dept., KJ Somaiya College of Engineering, Vidyavihar, Mumbai - 400077	
1	Prof. Ramesh Lekurwale, Mechanical Engineering, Head	rameshlekurwale@somaiya.edu
2	Prof. Jyoti Joglekar, Computer Science, Associate	
3	Prof. Sonali Patil, Information Technology, Associate	
4	Prof. Sujata Pathak, Information Technology, Associate	
5	Prof. Sudha Gupta, Electronics, Associate	
6	Prof. Rajesh Pansare, Mechanical Engineering, Associate	
7	Prof. Shilpa Bhambure, Mechanical Engineering, Associate	
8	Prof. Priyanka Patil, Mechanical Engineering, Associate	

	BETIC-MIT: MIT Arts, Design & Tech University, Loni-Kalbhor, Pune - 412201	
1	Dr. Renu Vyas, School of Bioengineering, Head	renu.vyas@mituniversity.edu.in
2	Dr. Reema Shukla, School of Bioengineering	
3	Ms. Navya Sethu, School of Bioengineering	
4	Prof. Chetan Potdar, School of Bioengineering	
	BETIC-SIU: Symbiosis International University, Lavale, Pune - 412115	
1	Dr. Nishant Tikekar, Centre for Research & Innovation, Head	tikekar.nishant@gmail.com
	BETIC-GHRCE: G.H. Raisoni College of Engineering, Hingna Road, Nagpur - 440016	
1	Dr. Vibha Bora, Electronics Department, Head	BETIC.ghrce@raisoni.net
2	Dr. Nilesh Awate, Electronics Department, Associate	
3	Prof. Shailesh Bhalerao, Electronics Department, Associate	

	BETIC Cells (Medical)	
	BETIC-GMC&JJH: Grant Medical College & Sir JJ Hospital, Mazgaon, Mumbai - 400008	
1	Dr. Neetin Mahajan, Orthopedics Department, Head	
2	Dr. Prashant Howal, Associate	prashanthowal@gmail.com
	BETIC-HITRT: Haffkine Institute of Training, Research & Testing, Parel, Mumbai - 400012	
1	Dr. Nishigandha Naik, Head	director@haffkineinstitute.org
	BETIC-MGM: CHMS, MGM Hospital, Sanpada, Navi Mumbai - 400705	
1	Dr. Rajani Mullerpatan, Head	rajani.kanade@gmail.com
2	Dr. Triveni Shetty, Associate	
3	Dr. Juhi Bharnuke, Associate	
4	Dr. Bela Agrawal, Associate	
	BETIC-BJMC: B.J. Medical College & Sassoon General Hospital, Railway Station Road, Pune - 400011	
1	Dr. Sanjay Gaikwad, Head	sangaiabdc@gmail.com
2	Dr. Dasmit Singh	
	BETIC-DMIMS: Datta Meghe Inst. of Medical Sciences, Wardha - 442004	
1	Dr. Punit Fulzele, Head	punitr007@gmail.com
2	Dr. Abhay Gaidhane, Associate	
3	Dr Quazi Syed Zahiruddin, Associate	
	BETIC-BKLWH: BKL Walwalkar Hospital, Dervan, Chiplun - 415606	
1	Mr. Rohan Gupte, Head	nambiraj.konar@gmail.com
2	Dr. Neha Deshpande, Associate	
3	Dr. Sunil Nadkarni, Associate	
4	Dr. Pawan Kohli, Associate	

Appendix 2: Project Staff

IIT Bombay

Sl.	Name	Designation	Duration
1	Dr. Rupesh Ghyar	Senior Executive Officer	2014 - Present
2	Mr Arun G Krishnan	Senior Project Manager	2019 - Present
3	Mr Glen D'souza	Project Manager	2016 - Present
4	Mr Sagar Talele	Project Manager	2017 - Present
5	Mr Tapas Pandey	Project Manager	2016 - Present
6	Ms Bharti Dhaundiyal	Asst. Project Manager	2019 - Present
7	Mr Gaurav Parit	Research Assistant	2018 - Present
8	Mr Suraj Naik	Research Assistant	2019 - Present
9	Mr Yash Soni	Research Assistant	2019 - Present
10	Mr Poojan Dholakia	Research Assistant	2019 - Present
11	Mr Ajay Dusa	Research Assistant	2019 - Present
12	Mr Marivel Pillai	Research Assistant	2020 - Present
13	Mr Ameya Konkar	Research Assistant	2020 - Present
14	Mr Sahil Rajpurkar	Research Assistant	2020 - Present
15	Mr Asifali Ansari	Sr Technical Assistant	2019 - Present
16	Mr Aditya Desai	Technical Assistant	2019 - Present
17	Mr Prafull Sawant	Project Assistant	2019 - Present
Previous			
1	Dr Nishant Tikekar	Senior Project Manager	2018 - 2018
2	Mr Dinoj Joseph	Project Manager	2018 - 2020
3	Dr Nelson Muthu	Project Manager	2016 - 2017
4	Dr Vrishali Madav	Project Manager	2015 - 2017
5	Ms Karen Nathan	Project Manager	2017 - 2018
6	Mr Rachit jhaveri	Project Manager	2017- 2017
7	Ms Juilee Bhansali	Project Manager	2014 - 2016
8	Ms Namitha Nair	Asst Project Manager	2015 - 2019
9	Ms Lopaa Bagaria	Asst Project Manager	2015 - 2016
10	Mr Chetan Pakhare	Research Assistant	2016 - 2017
11	Mr Nishant Kathpal	Research Assistant	2018 - 2018
12	Mr Kunal Diddi	Research Assistant	2018 - 2020
13	Mr Aneesh Karma	Research Assistant	2018 - 2020
14	Mr Amit Maurya	Research Assistant	2014 - 2015
15	Ms Vijayalakshmi Krishnaswamy	Research Assistant	2014- 2015
16	Mr Sritam Rout	Research Assistant	2014 - 2016
17	Ms Lata Chawla	Research Assistant	2014 - 2016
18	Mr Adarsha K	Research Assistant	2015 - 2017
19	Mr Ketan Bhokray	Research Assistant	2016 - 2017
20	Dr Trimbak Kawdikar	Research Assistant	2016 - 2018
21	Mr Shrishail Hamine	Research Assistant	2016 - 2018
22	Mr Satyajeet Patel	Research Assistant	2018 - 2018
23	Mr Yash Gupte	Research Assistant	2018 - 2018
24	Mr Bushan Darekar	Research Assistant	2019 - 2020

VNIT Nagpur

Sl.	Name	Designation	Duration
1	Mr Ashutish Bagde	Project Manager	2014-2020
2	Mr Vinod Mandurkar	Project Manager	2014-2017
3	Ms Neha Lande	Research Assistant	2018-2020
4	Ms Shraddha Jaiswal	Research Assistant	2014-2016
5	Mr Jyotilal S	Research Assistant	2016-2017
6	Mr Prashant Ray	Research Assistant	2019-2020
7	Mr Sandeep Dahake	Research Assistant	2018-2020
8	Mr Pranav Sapkal	Research Assistant	2018-2020

COE Pune

Sl.	Name	Designation	Duration
1	Mr Swapnil Ajit Bukshete	Research Assistant	2019 - Present
2	Ms Charushila Khandait	Research Assistant	2019 - Present
3	Mr Sandesh Patil	Research Assistant	2018 - Present
Previous			
1	Mr Mayur Sanas	Research Assistant	2014 - 2018
2	Ms Anjali Rajan	Research Assistant	2014 - 2016
3	Ms Palak Gupta	Research Assistant	2016 - 2017
4	Mr Abhikeet Bhagat	Research Assistant	2017 - 2019
5	Mr Saiprasad Poyarekar	Research Assistant	2017 - 2018
6	Ms Shravani Barkund	Research Assistant	2016 - 2017

Many Post-Doctoral Fellows, PhD scholars, Masters students and B.Tech students worked for their projects at BETIC labs in IIT Bombay, VNIT Nagpur and COE Pune. Many interns (summer and winter) were also exposed to the BETIC innovation culture.

Appendix 3: Clinical Mentors & Experts

Sl	Clinician	Specialization	Hospital, Location
1	Dr Manish Agarwal	Orthopaedic Surgery	PD Hinduja Hospital, Mumbai
2	Dr Hemant Bhansali	Laparoscopy Surgery	Nanavati Super Speciality Hospital,Mumbai
3	Dr Suresh Deshpande	Laparoscopy Surgery	Swarup Hospital, Kolhapur
4	Dr Anvay Mulay	Cardiac Surgery	Fortis Hospital, Mumbai
5	Dr Rajani Mullerpatan	Physiotherapy	MGM Institute of Health Sciences, Navi Mumbai
6	Dr Vijay Shetty	Orthopaedic Surgery	LH Hiranandani Hospital, Mumbai
7	Dr Rasik Shah	Paediatric Surgery	Sir H N Reliance Foundation Hospital, Mumbai
8	Dr Deepak Bhatia	Orthopaedic Surgery	SportsMed, Mumbai
9	Dr Nambiraj Konar	Anaesthesiology	Tata Memorial Hospital, Mumbai
10	Dr Lancelot Pinto	Respiratory Medicine	Hinduja Hospital, Mumbai
11	Dr Alaric Aroojis	Paediatric Orthopedic	Kokilaben Hospital, Mumbai
12	Dr Shalin Maheshwari	Paediatric Orthopedic	Surya Hospital, Mumbai
13	Dr Sudheer Ambekar	Neurology surgery	Jaslok Hospital and Research Centre, Mumbai
14	Dr Rujuta Mehta	Paediatric Orthopedic	Nanavati Super Specialty Hospital, Mumbai
15	Dr Dharmesh R. Agrawal	Cardiac Anaesthesia	Apollo Hospital, Bangalore
16	Dr Sanjay Chhajed	Ayurveda Medicine	Chhajed Ayurved Clinic & Academy, Mumbai
17	Dr Mayank Shah	Cosmetic Dentistry	Gentle Dental Care, Mumbai
18	Dr Nagesh Waghmare	Cardiologist	Sir JJ Group of Hospital, Mumbai
19	Dr Srivalli Natrajan	Maxillofacial	MGM Dental College, Navi Mumbai
20	Dr Rangnath Jhawar	FacioMaxillary & Cleft	Crowns & Roots Dental Solutions, Mumbai
21	Dr Sujata Iyer	Orthopedic	KEM Hospital, Mumbai
22	Dr Mitul Shah	Cardiologist	Fortis Hospital, Mumbai
23	Dr Arun Prasad	VATS & Robotic	Apollo Hospital, New Delhi
24	Dr. Subhash N. Luley	ENT Otolaryngology	IGGMC, Nagpur
25	Dr. Padma G. Pawane	Ophthalmic surgeon	ESIS Hospital, Nagpur
26	Dr. Ritesh Kalaskar	Pediatric Dentistry	GDCH, Nagpur
27	Dr. Naresh Tirpude	Anaesthesiology	GMCH, Nagpur
28	Dr Darshan Dakshindas	Dentistry	GDCH, Nagpur
29	Dr Ravishekhar Dhakate	Ophthalmology	Public Health Dept., Nagpur
30	Dr Madan Kapre	ENT surgery	Nursing Home, Nagpur
31	Dr Rajendra Saoji	Pediatric	CARE Hospital, Nagpur
32	Dr Jitendra Chawla	Maxillofacial Surgery	GDCH, Nagpur
33	Dr Ashish Ranade	Orthopaedic Surgery	Sumitz Orthopaedic & Physio Center, Pune
34	Dr Sunil Nadkarni	Spine surgery	B K L Walawalkar Hospital, Ratnagiri
35	Dr Anita Dharma Sharma	Acupuncture, pressure	Inlaks & Budhrani Hospital, Pune
36	Dr S.K. Jain	Prosthetic and Orthotic	Sancheti Hospital, Pune
37	Dr Atul D. Sajgure	Nephrology	Sahyadri Hospital, Pune
38	Dr Charudutta Apte	Neurosurgery	Sahyadri Hospital, Pune
39	Dr Nikhil Panse	Plastic surgery	B.J Medical College & Sassoon Hospital, Pune
40	Dr Rohit Phulwar	Plastic surgery	B.J Medical College & Sassoon Hospital, Pune
41	Dr Sonali Salvi	Geriatric Medicine	B.J Medical College & Sassoon Hospital, Pune
42	Dr Prakash Bhave	Radiology	Dr Prakash Bhave X-Ray Clinic
43	Dr Dasmit Singh Khokar	Paediatric surgery	B.J. Medical College, Pune
44	Dr Punit Fulzele	Pediatric Dentistry	SPDC, Wardha
45	Dr Zahiruddin Quazi	Community Medicine	Datta Meghe Inst. of Medical Sciences, Wardha
46	Dr Abhay Gaidhane	Community Medicine	J N Medical College, Wardha
47	Dr Prasanna L Zade	Ph. D, Electronics Engg.	Datta Meghe Inst. of Medical Sciences, Wardha
48	Mr Shirish Gandhare	Ph. D, Mechanical Engg	Datta Meghe Inst. of Medical Sciences, Wardha
49	Dr Dinesh Kabre	Orthopedic Surgery	Kabre Orthopedic, Pune
50	Dr Taufiq R. Panjwani	Orthopaedic Surgeon	Lokmanya Hospital, Pune

Appendix 4: Project Equipment

IIT Bombay

Sl.	Electronics Equipment	Model	Manufacturer	Install Yr
1	PCB Milling Machine	LPKF E34	LPKF GmbH	2017
2	Soldering Station	Weller	Weller	2018
3	Mixed Signal Oscilloscope	MSO 2012B	Tektronix	2016
4	Arbitrary Function Generator	AFG 1022	Tektronix	2016
5	Triple Channel DC Power Supply	2231A/30/3	Keithley	2016
6	Handheld Rishabh Multimeter	Keithley DMm4050	Rishabh	2017
7	Benchtop Multimeter	DMM4050	Tektronix	2017
8	Battery Simulator	IT64411	ITECH	2019

Sl.	Mechanical Equipment	Model	Manufacturer	Install Yr
1	3D Printer	Protocenter 999	Aha 3D	2015
2	Interactive Projector	Optoma	Unicomp Infosolutions	2016
3	3D Scanner	Comet LƎD	Steinbichler, Germany	2015
4	X-ray Digitizer	Medi-6000 Plus	Vikmans Multimedia	2015
5	Laser Cutter	Epilog Laser mini	Laser Lab India Pvt. Ltd.	2015
6	Multi-Material Plastic 3D Printer	Fortus 380mc	Stratasys, USA	2015
7	Ultrasonic Cleaner	-	Supersonic Enterprises	2015
8	Ergonomic Assembly Workstation	Work Table	Fabtech India Pvt. Ltd.	2019
9	Surface grinding machine	NH500	Alex Machine Tools	2019
10	Drilling machine	AMI 19	AMI Machine Tools	2019
11	EDM Drilling Machine	638 R3	Sparkonix India Pvt.Ltd	2019
12	Digital Image Correlation (DIC) sys.	VIC-3D	Correlated Solutions, USA	2018
13	Static Universal Testing Machine	Instron 5566A	Instron, USA	2014
14	Medical Metal Printing machine	M280	EOS, Germany	2017
15	Medical Grade Air Compressor	SA-1.5-50L-OF-HT	Samarthair Pneumatics	2020

Sl.	Software Licenses	Version	Manufacturer	Install
1	Altium Designer	AD20 & AD21	GSAS Microsystems	2019
2	CorelDraw	15.0.0.486	SETU Technology Pvt. Ltd.	2020
3	MIMICS	23	Materialise	2020
4	Keil	u Vision 5	Arm Limited	2018
5	CircuitPro	2.30.546	Bergen Electronics	2016

VNIT Nagpur

Sl.	Equipment	Model	Manufacturer	Install
1	3D Printer	uPrint SE	Stratasys, USA	2014
2	3D Bio-plotter	Developer series	EnvisionTEC	2015
3	Biological Safety Cabinet	Level A2	Thermofisher	2015
4	CO2 Incubator	Refrigerated	Thermofisher	2015
5	Ultra low freezer	1331	Thermofisher	2015
6	Refrigerated centrifuge	SONVALL ST*	Thermofisher	2015
7	Inverted Microscope	EVOS	Life Technology	2015
8	Microwave Sintering Furnace	-	Enerzi Microwave System	2017
9	Hot Air Oven	-	I-thermo bio techno lab	2018
10	Bacteriological Incubator	-	I-thermo bio techno lab	2018

COE Pune

Sl.	Equipment	Model	Manufacturer	Install
1	FDM 3D Printing Machine	PlusBot 2.0	Softtach Technologies	2015
2	White Light portable 3D Scanner	Artec Spider 3D	Altem Technogies	2016

Appendix 5: Products Developed

Licensed to Startup Companies

Sl	Product	From	To Startup	Year
1	Orthopedic Surgery Planner	IIT Bombay	Algosurg	2016
2	Smart Stethoscope Module	IIT Bombay	Ayu Devices	2017
3	Hybrid Plaster Splint	COEP	MediAsha Technologies	2017
4	Skin Spray Gun	COEP	Pacify Medical Technology	2018
5	Temporal Bone Phantom	VNIT Nagpur	NU Ossa Mediquip	2018
6	DICUL AM (Lucid Implants)	VNIT Nagpur	Craniofacial & Neuro Implants	2018
7	DiaBETIC Foot Screener	IIT Bombay	Ayati Devices	2019
8	Endotracheal Blockage Detector	COEP	Atmen Technovention	2019
9	Knee Ankle Foot Orthosis	IIT Bombay	Aumeesh Tech	2019
10	Glaucoma Screening	VNIT Nagpur	OKO Icare Solutions Pvt Ltd	2019
11	Surgical Guides	VNIT Nagpur	Precisurg	2019
12	Jaw Centric Relation	MIT-ADT – IITB	Prosthocentric	2019
13	Menstrual Cup	MIT-ADT - IITB	Care Form Labs	2020
14	Portable Sterile Enclosure	IIT Bombay	MEDGHYOR	2020
15	Auto Suturing Device	IIT Bombay	Denovo Bioinnovations	2020
16	Dental Bur	IIT Bombay	Aur Innovations	2020

Licensed to / Developed for Industry Partners

Sl	Product	From	To Industry	Year
1	Multi-Use Biopsy Gun	IIT Bombay	Tenon Meditech	2018
2	Wireless ECG patch	IIT Bombay	Ayu Devices	2021
3	Laparoscopy Instrument	IIT Bombay	Eclipse Instrumentation	2016
4	Nasal Osteotomy Forceps	VNIT Nagpur	Om Surgicals	2016
5	Electro-Chemo Therapy Device	IIT Bombay	Tenon Meditech	2019
6	Dental IOS	IIT Bombay	Sameday Dentistry Pvt Ltd	2020
7	Above-Knee Prosthetic Leg	IIT Bombay	Ratnagiri Charitable Trust	2015
8	Clubfoot Brace Monitor	IIT Bombay	Metwiz Materials	2017
9	Cooling Cap	IIT Bombay	Curotherm	2020
10	Auto CPAP	IIT Bombay	Lifeline	2020
11	Oxygen concentrator	IIT Bombay	Lifeline	2020
12	RF Ablation	IIT Bombay	Malpani Ventures	2019
13	Drug Nanosol Device	IIT Bombay	Curotherm	2020
14	Modular Recording System	IIT Bombay	Eclipse Instrumentation	2020

Ready to License (Functional prototype available)

Sl	Product	From	Description
	Diagnosis Devices		
1	Stroke Detection	IIT Bombay	IVD to differentiate ischemic/hemorrhagic stroke
2	Pulse-Based Diagnostics	IIT Bombay	Classify body type using radial pulse (*Naadi Vaidya*)
3	OPD Screening Device	IIT Bombay	Chronic obstructive pulmonary disease/Asthma
4	Hemoglobin Quantifier	COE Pune	Quantify hemoglobin using blood samples
5	X-Ray Based Diagnostics	COE Pune	Accurate images without increasing radiation dos
6	Glaucoma Screener	IIT Bombay	Screening device for people suffering from glaucoma
7	BP Measurement Assist	VNIT Nagpur	Device for direct detection of Korotkoff sound
8	Hemoglobin measurement	VNIT Nagpur	Non-Invasive hemoglobin measuring device
9	Asthma Detector	VNIT Nagpur	Low cost, easy-to-use indicative device for rural areas
	Surgical Instruments		
10	Heart Valve Template	IIT Bombay	Create heart valve using tissue from the patient
11	Endo Retractor	IIT Bombay	Gall bladder retraction for Calot's triangle visibility
12	Monopolar Hook	COE Pune	To minimize thermal and mechanical injuries
13	Endoscope Insertion & Fixation	COE Pune	Correctly insert & position guide wire for spine surgery
14	Cleft Palate Impression Tray	VNIT Nagpur	Create the palate impression accurately and rapidly
15	Pre Surgery Planning	COE Pune	Pre surgical planning using non-invasive imaging
16	Suture Anchor	IIT Bombay	Improved fixation for arthroscopic rotator cuff repair
17	Bicondylar Compression Screw	IIT Bombay	Rigid compression, early weight bearing capability and early union to fractured tibial bones
18	Path guidance for minimum invasive lumbar	COE Pune	Assist in minimum invasive surgery of lumbar spine.
19	TKR Ligament Balancer	VNIT Nagpur	Ligament balancing device for TKR survery
20	Tray for OT	VNIT Nagpur	Tray for Operation Theatre
	Assistive Devices		
21	Smart Acupressure Glove	COE Pune	An automated device for acupressure therapy
22	Dialysis Cuff	COE Pune	An automated assistive device for dialysis patients
23	Wearable Module for Knee Joint	COE Pune	Real-time data of patient's movement after surgery
24	Hand Splint for Burn Patients	COE Pune	Assist rehabilitation of burn injuries of hands.
25	Hand Rehabilitation Device	COE Pune	A rehabilitation device for hand movement.
26	Pre-Dialysis Limb Exerciser	COE Pune	Automated assistive device to mimic limb exercise
27	ICU Ventilator	IIT Bombay	ICU grade mechanical ventilation
28	Lung Disease Rehab Device	IIT Bombay	Aiding rehabilitation for COPD/Asthma patients
29	Modified feeding bottle	VNIT Nagpur	Suitable for feeding cleft palate babies
30	Syringe Sleeve for Pediatrics	VNIT Nagpur	Distract patient attention during vaccination.
31	Jaw Gym	VNIT Nagpur	Exercising device for jaw with the right opening
32	Smart Infusion Pump	VNIT Nagpur	Dose error reduction delivery infusion pumps
	Custom Medical Devices		
33	Surgery Planning Models	IIT Bombay	3D printed models to pre plan the surgery
34	Orthopedic Surgery Guides	IIT Bombay	3D printed custom guides for accurate surgery
35	Patient-Specific Implants	IIT Bombay	To reconstruct the tumor region after resection
36	Patient Specific Guidance	COE Pune	Customized guidance tool during surgery
37	Bone Scaffolds and Implants	VNIT Nagpur	3D printed bone scaffolds for tissue engineering
38	Silicone Implants	VNIT Nagpur	High-quality cost-effective custom implants

Appendix 6: Patents Filed (India & PCT)

Indian Patent Filing

IIT Bombay

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4. Rachit Jhaveri, Rupesh Ghyar, B. Ravi, Sudheer Ambekar, “Device to detect stroke,” 201821030041, 10 Oct 2018.
5. Chetan Pakhare, Yash Gupte, Nishant Kathpal, Rupesh Ghyar, B Ravi, Rajani Mullerpatan, “Device for screening of diaBETIC foot,” 201821005692, 15 Feb 2018. PCT.
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4. Sagar D. Talele, Rupesh E. Ghyar, B. Ravi, Suresh Deshpande, “Laparoscopic surgical instrument with interchangeable modular heads, PCT/IN2018/ 050885, 28 Dec 2018.
5. “A Connector configured to allow acoustic transmission or digital transmission for a stethoscope” [IN201621029618] – PCT Application No.: PCT/IN2017/050558, 27 Nov 2016.
6. Sritam Rout, R. Ghyar, B. Ravi, Suresh Deshpande, “A Surgical Instrument with Multiple Degrees of Freedom,” PCT/IN2016/000093, 11 April 2016. WO/2016/ 162883, 13 Oct 2016.
7. R. Ghyar, B. Ravi, Hemant Bhansali, “An Automated Needle Holder and Suturing Device” PCT/IN2016/000077, 28 March 2016; WO/2016/157211, 06 Oct 2016.
8. Vikas Karade, “A System and Method for Obtaining 3-Dimensional Images Using Conventional 2-Dimensional X-Ray Images,” PCT/IN2016/00002, 20 Jan 2016; WO/ 2016/116946, 28 July 2016.
9. Saiprasad Sanjay Poyarekar, Chetan Namadev Mahale Dr. Sandip Sharadrao Anasane, Dr. Bharatkumar Bhagatraj Ahuja, Dr. Nikhil Shreekrishna Panse, Dr. Rohit Dagadu Phulwar,” An Epidermal Suspension Spray Device”, Patent publication No.US2021-0008299-A1, 14 Jan 2021.
10. Abhijeet Vilasrao Bhagat, Dr. Sonali Pankaj Salvi, Mayur Mohan Sanas, Dr. Sandeep Sharadrao Anasane, Dr.Bhagawan Uttamrao Sonawane, Dr. Arati Vinayak Mulay, Dr.Bharatkumar Bhagatraj Ahuja, “A Device To Monitor And Detect Obstruction In An Endotracheal Tube”, Patent Application No: 11202009573T, SINGAPORE, 28 March 2019.

Appendix 7: Books & Journal Papers

Books & Chapters

1. B. Ravi, The Essence of Medical Device Innovation, The Write Place (Crossword), Mumbai.
2. B. Ravi, "Medical Device Innovation: Idea to Impact," Chapter in *Engineering for the Future*, *Centenary Book*, Institution of Engineers (India), 2020, 371-382.
3. B. Ravi, *Technology Incubation and Startup Creation in Med-Tech: Challenges and Enablers*, chapter in iVEIN Report *(Innovation-Venturing and Entrepreneurship in India Network),* 2020.
4. B. Ravi, *The Essence of Medical Device Innovation*, The Write Place (Crossword), Mumbai, ISBN: 978-9-38728-218-6, 2018, 2nd Print.
5. S. Dahake, A. Kuthe, M. Mawale, A. Bagde, "Rapid manufacturing of customized surgical cutting guide for accurate resection of malignant tumour in mandible", chapter in Advances in 3D Printing & Additive Manufacturing Technologies, Springer, Editors- David Ian Wimpenny, Pulak M. Pandey and L. Jyothish Kumar (DOI 10.1007/978-981-10-0812-2).

Journal Papers

IIT Bombay

1. Ahilan Krishnan, Rupesh Ghyar, and B. Ravi, "Comparison of Stresses in Four Modular Total Knee Arthroplasty Prosthesis Designs," Int. Journal of Biomedical and Clinical Engineering, 5(2), 2016, 1-16.
2. Ahilan Krishnan, Rupesh Ghyar, and B. Ravi, "Effect of Modularity on the Fatigue Performance of Tibial Tray Designs in TKA Prostheses" Journal of Long Term Effects of Medical Implants, 26(1), 2016, 89-95.
3. V. Karade and B. Ravi, "3D Femur Model Reconstruction from Biplane X-ray Images: A novel method based on Laplacian Surface Deformation for Template Reconfiguration," Int. Journal of Computer Assisted Radiology and Surgery, 10(4), 2015, 473-485.
4. Darshan S. Shah, Rupesh Ghyar, B. Ravi, Chintan Hegde, Vijay Shetty, "Morphological Measurements of Knee Joints in Indian Population: Comparison to Current Knee Prostheses," Open Journal of Rheumatology and Autoimmune Diseases, 4, 2014, 75-85.
5. Vikas Karade and B. Ravi, "Analysis of Anatomical References to Assess the Coronal Alignment of Tibial and Femoral Cut in Knee Replacement," Journal of Orthopaedics & Traumatology, 15(2), 2013, 87-93.
6. Lalitrao Amrutsagar, Gaurav Parit, Rupesh Ghyar and B. Ravi "Parametric Design and Hybrid Fabrication of Above – Knee Prosthesis", Indian Journal of Orthopaedics, 2020 Mar 11; 54(3):381-390.
7. B Ravi, "Medical Device Innovation: Idea to Impact", Centenary Book "Engineering for the future" Institution of Engineers (India). (to be published)

VNIT Nagpur

1. Mahesh Mawale, "Modeling and simulation of human cornea for the measurement of intraocular pressure through eyelid," Computer Modeling in Engineering & Sciences, 2018.
2. Mahesh Mawale, "Development of a device in detection of glaucoma for rural eye care using additive manufacturing and TRIZ," Molecular and Cellular Biomechanics, 2017.
3. Mawale, M., Kuthe, A., Dhakate, R., Pawane, P. and Dahake, S., "Additive layered manufacturing: State of the art applications in product innovation," Concurrent Engineering Research and Applications, 24(1), 2016, 94-102.
4. Mawale, M., Kuthe, A., Dhakate, R., Pawane, P. and Dahake, S., "Development of a device to prevent the late consequence of non treated glaucoma", Technology and Health Care, 25, 2017, 1177-1181.
5. Mawale, M., Kuthe, A., Dhakate, R., Pawane, P. and Dahake, S., "Development of a Device for Detecting Glaucoma Using Classical and Expanded TRIZ Matrix," The TRIZ Journal, Dec 2016.
6. Mawale, M., Kuthe, A., Dhakate, R., Pawane, P. and Dahake, S., "Glaucoma: A new approach for detection in rural eye care, Community Medicine and Public Health, 4(8), 2017.
7. Dahake. S., Kuthe. A., Mawale. M., Bagde. A. "Applications of medical rapid prototyping assisted customized surgical guides in complex surgeries", Rapid Prototyping Journal, 22(6), 2016, 934-946.
8. Dahake. S., Kuthe. A., Mawale. M. "Rapid prototyping assisted fabrication of customized surgical guides in mandibular distraction osteogenesis: A case report," Rapid Prototyping Journal, 23(3), 2017, 602-610.
9. Dahake. S., Kuthe. A., Kulkarni. S., Mawale. M. "FEA of customized mandibular reconstruction implant after resection of tumor with and without using customized surgical osteotomy guide," Medical Robotics and Computer Assisted Surgery. (DOI: 10.1002/rcs.1854).
10. Dahake. S., Kuthe. A., Mawale. M. "Precision of customized surgical osteotomy guide in mandibular reconstruction with a customized implant: An in-vitro study," Journal of Cranio-Maxillo-Facial Surgery.
11. Dahake, S., Kuthe, A., Sapkal P., and Bagde A, "Development of customized implant and customized surgical osteotomy guide in ablative tumor surgery for accurate mandibular reconstruction", International Journal of Medical Robotics and Computer Assisted Surgery.
12. Dahake. S., Kuthe. A., Mawale. M. "Mandibular reconstruction: An overview," Journal of Cranio- Maxillo-Facial Surgery (under review).
13. Dahake. S., Kuthe. A., Mawale. M. "Generalize methodology for design and development of customized implant and customized surgical osteotomy guide for mandibular reconstruction," Computer Assisted Surgery (under review)
14. Sapkal, P. and Kuthe, A., "CAD based approach for patient specific scaffold for bone tissue Engineering", Trends in Biomaterial & Artificial Organs, 29(4), 2015, 301-305.

15. Sapkal, P., Jaiswal, S. and Kuthe, A., “Rapid Prototyping Assisted Scaffold Fabrication for Bone Tissue Regeneration,” Materials Science Research, 5(4), 2016, 79-95.
16. Sapkal, S., Kuthe, A., Kashyap, R., Nayak, A., Kuthe, S. and Kawle, A., “Rapid prototyping assisted fabrication of patient specific β-tricalciumphosphate scaffolds for bone tissue regeneration”, Journal of Porous Materials, 23(4), 2016, 927-935.
17. Sapkal, S., Kuthe, A., Kashyap, R., Nayak, A., Kuthe, S. and Kawle, A., “Indirect fabrication of hydroxyapatite/b-tricalcium phosphate scaffold for osseous tissue formation using additive manufacturing technology,” Journal of Porous Materials, 23(6), 2016, 1-8.
18. Sapkal, S., Kuthe, A., Kashyap, R., Nayak, A., Kuthe, S. and Kawle, A., “Indirect casting of patientspecific tricalcium phosphate zirconia scaffolds for bone tissue regeneration using rapid prototyping methodology,” Journal of Porous Materials, 24(3), 2016, 1-11.
19. Sapkal, S., Kuthe, A., Ganapathy, D., Mathankar, S. and Kuthe, S., “3D Bio-Plotted composite scaffold made of Collagen treated Hydroxyapatite Tricalciumphosphate for Rabbit Tibia Bone Regeneration”, Molecular & Cellular Biomechanics, 13(2), 2016, 115-136.
20. Sapkal, S., Kuthe, A., Mathankar, S. and Deshmukh, A., “3D Bio-Plotted Tricalcium Phosphate/Zirconia Composite Scaffolds to Heal Large Size Bone Defects”, Molecular & Cellular Biomechanics, 14(2), 2017, 125-136.
21. Mawale. M., Kuthe. A., Mawale. A., Dahake. S., “Development of an ear cap in chronic suppurative otitis media (CSOM) using Additive manufacturing and TRIZ”, Journal of Engineering in Medicine, 2018.
22. Bagde, A.D., Kuthe, A.M., Quazi, S., Gupta, V., Jaiswal, S., Jyothilal, S., Lande, N. and Nagdeve, S., “State of the Art Technology for Bone Tissue Engineering and Drug Delivery”, Innovation and Research in Biomedical Engineering, (doi.org/10.1016/j.irbm.2019.03.001), 2019.
23. Bagde, A., Kuthe, A., Nagdeve, S., Dahake, S., Sapkal, P., Daronde, S., Lande, N. and Sarode, B. (2019), “Geometric modeling and finite element simulation for architecture design of 3d printed bioceramic scaffold used in bone tissue engineering”, J. Indian Inst. Sci., ISSN: 0970-4140.
24. Dahake. S., Kuthe. A., Mawale. M., Sapkal, P. and Bagde, A. (2020), “Development of customized implant and customized surgical osteotomy guide (CSOG) in ablative tumor surgery for accurate mandibular reconstruction”, International Journal of Medical Robotics and Computer Assisted Surgery. Vol. 16, pp e2046. (Wiley), (https://doi.org/10.1002/rcs.2046).

COE Pune

1. Chougule, V. N., Mulay, A. V., & Ahuja, B. B. “Clinical Case Study: Spine Modeling for Minimum Invasive Spine Surgeries (MISS) using Rapid Prototyping,” Bone (CT), 226, 3071.
2. Anjali P. Rajan , A. V. Mulay, B. B. Ahuja, “An Automated Acupressure Glove for Stress and Pain Relief Using 3D Printing”, Chapter, Advances in 3D Printing & Additive Manufacturing Technologies, pp 155- 167, 24 Aug 2016, ISBN 978-981-10-0811-5
3. V.N. Chougule, A.V. Mulay, B.B. Ahuja, “Development of Patient Specific Implants for Minimum Invasive Spine Surgeries from Non-Invasive Imaging Techniques by Reverse Engineering and Additive Manufacturing Techniques,” Elsevier Procedia Engineering, 97 (2014), 212–219; doi: 10.1016/j.proeng.2014.12.244.
4. Chougule VN, Mulay AV, Ahuja BB, “Patient Specific Bone Modelling for Minimum Invasive Spine Surgery”, J Spine 4:249. doi:10.4172/2165-7939.1000249, 2015.
5. Bagde, A. D., Kuthe, A. M., Quazi, S., Gupta, V., Jaiswal, S., Jyothilal, S., Nagdeve, S., “State of the Art Technology for Bone Tissue Engineering and Drug Delivery”, Innovation and Research in BioMedical engineering, 40(3), 133-144, https://doi.org/10.1016/j.irbm.2019.03.001
6. Dahake, S., Kuthe, A. and Mawale, M., "Precision of customized surgical osteotomy guide in mandibular reconstruction with customized implant”, Rapid Prototyping Journal, https://doi.org/10.1108/RPJ-03-2019-0078.

Appendix 8: Conference Papers

International Conferences

IIT Bombay

1. Richa Agrawal, Rashmi Uddanwadiker, J. Veerababu, Sunil Goyal, R. Sandhya, Pramod Padole, "Low Cycle Fatigue Life Prediction of Circumferentially Notch Round Bars", 9th International Conference on Mechanical and Aerospace Engineering, Budapest, Hungary, 10-13 July 2018 (Awarded Best Paper)
2. Guruprasad Rao, S.R. Mohanty, S.D. Muskawad, B.K. Chakvarthi, B. Ravi, "3D Printing Patient-Specific Anatomical Model of Complex Congenital Heart Disease for Enhancing Surgical Decision-Making," 6th Int'l and 27th All India Manufacturing Technology, Design and Research Conf., Pune, 16-18 Dec 2016.
3. Guruprasad Rao, Vijay Shetty and B Ravi, "Custom Design & Fabrication of 3D Printed Cast for Ankle immobilization," Int. Conference on Design and Technology, Geelong, Australia, 6-8 Dec 2016
4. Karade V. and Ravi B., "Automatic method to determine anatomical coordinate systems for 3D bone models of isolated arthritic knee," 6th European Conference of Int. Federation for Medical and Biological Engineering, Dubrovnik, Croatia, 2014.
5. Vikas Karade and B. Ravi, "Application of Laplacian Surface Deformation and Self-Organizing Maps to Calculate Shape Correspondence for Statistical Shape Modeling," 11th IEEE Int. Conf. Biomedical Imaging, Beijing, 28 Apr - 2 May, 2014, 369-372.
6. Lalitrao Amrutsagar, Gaurav Parit, Rupesh Ghyar, B. Ravi, "Hybrid Digital Fabrication Approach for Trans-femoral Prostheses", Poster, 10th International Conference on Materials for Advanced Technologies (ICMAT 2019), Singapore (23-28 Jun 2019).
7. Prabhat Kumar, Rupesh Ghyar, B. Ravi, "Topology Optiization of Compliant Mechanism for Lapraroscopic Surgery Instruments", International Conference on Robotics, Intelligent Control and Artificial Intelligence (RICAI 2020), Shangai China. (17-19 Oct 2020)

VNIT Nagpur

8. Dahake. S., Kuthe. A., Mawale. M., "Treatment of Brodie's Syndrome using parasymphyseal distraction through virtual surgical planning and RP assisted customized surgical osteotomy guide - A mock surgery report," 20th ESAFORM Conf., Nantes, France, 2017.
8. Sapkal, S., Kuthe, A., Kashyap, R., Nayak, A., Kuthe, S. and Kawle, A. Mathankar, S. and Deshmukh, A., "3D Bio-Plotted Tricalcium Phosphate/Zirconia Composite Scaffolds to Heal Large Size Bone Defects", Int. Conf. Computational Intelligence (ICCI-2017), IIT Kanpur, 6-8 Dec 2017.
9. Mawale, M., Kuthe, A., Dhakate, R., Pawane, P. and Dahake, S., "Intraocular pressure measurement device", 6th Int. and 27th All India Manufacturing Technology, Design and Research (AIMTDR), College of Engineering, Pune, 16-18 Dec 2016.
10. S. Dahake, A. Kuthe, M. Mawale, A. Bagde "Rapid Manufacturing of Customized Surgical Cutting Guide for the Accurate Resection of Malignant Tumor in Mandible", 5th Int. Conf. Additive Manufacturing Technologies, AMSI, Bangalore, 7-8 Sept 2015.
11. Dahake, S., Kuthe, A., Mawale, M. and Bagde, A., "Innovative development of the RP assisted customized surgical guides in various surgeries", ICCM 2015, 14-17 July 2015, Auckland, NZ.
12. Sapkal, P. and Kuthe, A., "CAD based approach for patient specific scaffold for bone tissue Engineering", Indo-Australian Conf. on Biomaterials, Tissue Engineering, Drug Delivery System & Regenerative Medicine (BITERM 2015), Anna University, Chennai, 5-7 Feb 2015.
13. D. Bhiogade, A.M. Kuthe "Critical Analysis of Rapid Prototyping assisted Investment Casting for Medical Implants," 63rd Indian Foundry Congress, Noida, 27-28 Feb 2015.
14. P. Sapkal, A.M. Kuthe "CAD based approach for patient specific scaffold for bone tissue engineering," Indo–Australian Conference on Biomaterial, Tissue Engineering, Drug Delivery System & Regenerative Medicine, Chennai, 5-7 Feb 2015, Best Paper Award.
15. S. Dahake, A.M. Kuthe "Design of Customized Surgical Guide Using MIMICS and 3MATIC for Accurate Resection of Malignant Tumor in Mandible: An Engineering Approach," Present Scenario and Future Trends in Biomedical Engineering and Healthcare Technologies, IIT BHU, Varanasi 17-18 Oct 2014.

COE Pune

16. V. N. Chougule, A. V. Mulay, B. B. Ahuja, "Clinical Case Study: Spine Modeling for Minimum Invasive Spine Surgeries (MISS) using Rapid Prototyping," Proc. 10th Int. Conf. on Precision, Meso, Micro and Nano Engineering (COPEN 10), IIT Madras, 7-9 Dec 2017, 96-102.
17. Anjali P Rajan, "An Automated Acupressure Glove for Stress and Pain Relief Using 3D Printing," 5th Int. Conference & Exhibition on Additive Manufacturing Technologies, Additive Manufacturing Society of India, 7-8 Sept 2015.
18. V.N. Chougule, A.V. Mulay, "Methodologies for Development of Patient Specific Bone Models from Human Body CT Scans," Int. Conference on Additive Manufacturing and 3D Printing, Chennai, 6-7 Feb 2015.
19. V.N. Chougule, A.V. Mulay, B.B. Ahuja, "Conversions of CT Scan Images into 3D Point Cloud Data for the Development of 3D Solid Model using B-Rep Scheme," Int. Conference on Precision, Meso, Micro & Nano Engineering, NIT, Calicut, 13-15 Dec 2013.
20. V.N. Chougule, A.V. Mulay, B.B. Ahuja, "Three-Dimensional Point Cloud Generations From CT Scan Images For Bio-CAD Modeling," 3rd Int. Conference on Additive Manufacturing Technology, Bangalore, 6-7 Oct 2013.

National Conferences and Other Publications

21. Akshay S. Panchbudhe and Rashmi V. Uddanwadikar, “3D Modelling and Stress Analysis of Restored Monolithic Dental Restorations and Teeth,” National Conference on Digital Dentistry, VNIT, Nagpur, 10-11 Aug 2018 (First Prize in Best Research category)
22. Harshita Vemula, Sowmya Sri, Zynul John, Rashmi V. Uddanwadiker and Sunita Shrivastava, “Design and Development of Snoring Controlling Device,” National Conference on Digital Dentistry, VNIT, Nagpur, 10-11 Aug, 2018 (Second Prize in Best Research category)
23. Abhishek M. Thote, Rashmi V. Uddanwadiker, Krishna Sharma and Sunita Shrivastava, “Computer Software Based Estimation of Force Parameters for En-masse Retraction of Six Maxillary Anterior Teeth in Labial and Lingual Orthodontics,” National Conference on Digital Dentistry, VNIT, Nagpur, 10-11 Aug 2018 (First Prize in Best Presentation category)
24. Mawale, M., Kuthe, A., Dhakate, R., Pawane, P. and Dahake, S. (2016), “Additive Layered Manufacturing and TRIZ: A Collaborative Tool for Product Development”, 10 Pointer, National Conf. on Innovations Using Triz, Bionics, Layered Manufacturing and Computer Aided Manufacturing, CAD/CAM Center, VNIT, Nagpur 29-31 Jan 2016.
25. Pranav Sakpal, Dr. A.M. Kuthe, “3D Bio-Plotted Tricalcium phosphate/Zirconia Composite Scaffolds to Heal Large Size Bone Defects,” The 3D-Bioplotter Archives, EnvisionTec (Website).
26. Lalitrao Amrutsagar, Arvind Bhallamudi, Viren Dhumal, Rupesh Ghyar, “Customised Socket for Transfemoral Prosthesis using 3D-CAD”, National Conference of Indian Association of Assistive Technologists, Bhubaneshwar, Orissa (22-23 Dec 2018).
27. Lalitrao Amrutsagar, Gaurav Parit, Rupesh Ghyar, B. Ravi, “Parametric Design and Hybrid Fabrication of Above-Knee Prosthesis”, Indian Journal of Orthopaedics (provisionally accepted), 2019.
28. Bagde, A. D., Kuthe, A. M., Nagdeve, S. R., Dahake, S. W., Sapkal, P. S., Daronde, S. B., Sarode, B. D., “Geometric Modeling and Finite Element Simulation for Architecture Design of 3D Printed Bio-ceramic Scaffold Used in Bone Tissue Engineering”, Jounral of Indian Institute of Science. https://doi.org/10.1007/s4175-019-00120-0

Appendix 9: Invited Talks

IIT Bombay

1. "Smart Medical Devices for Affordable Screening and Diagnosis," Symposium on 'Towards a New Healthcare regime for the Nation,' 90th Annual Session of NASI, 7 Dec 2020 (via VC).
2. "Research, Innovation and Entrepreneurship (RE.INV.ENT) Ecosystem," IUCEE Workshop, 10 Jan 2021 (via VC).
3. "Medical Device Innovation: Stories and Lessons," Decennial Celebration Mini-symposium, Institute of Liver and Biliary Sciences, New Delhi, 1 Jan 2021 (via VC).
4. "Role of 3D Printing in Medical Devices," FDP on Advanced in 3D Printing and Its Future Scope, Symbiosis Institute of Technology, Pune, 10 Dec 2020 (via VC).
5. Innovation and Entrepreneurship: How to create Success Stories", IEEE WIE International Leadership Summit 'Ignite, Inspire, Engage', Nagpur, 6 Nov 2020 (via VC).
6. "Medical Device Innovation: Opportunities, Challenges and Best Practices," Emerging Trends in Advanced Medical Systems, Application & System Design Methodologies, AICTE STP, GHRCE Nagpur, 15 Oct 2020(via VC).
7. "Medical Device Innovation: Opportunities, Challenges and Best Practices", TechEX, Venture Center, Pune, 14 Oct 2020(via VC).
8. "Essence of Medical Device Innovation in India," Digital Health & Imaging, IISc Bangalore, 11 Oct 2020 (via VC).
9. "Medical Devices: Scope, Challenges and Opportunities," Biotech Innovation Ignition School, BIRAC & SRISTI, 1 Oct 2020 (via VC).
10. "Medical Device Innovation: Idea to Impact," ATAL FDP on Design Thinking for Innovative Medical Devices, MNIT Jaipur, 21 Sep 2020 (via VC).
11. "Innovation in HealthTech in India," The Sync (Panel Discussion), Bionest Initiative, Villgro Innovations Foundation, Chennai, 11 Sep 2020 (via VC).
12. "Medical Device Innovation: Stories and Best Practices," PharmaTalk, School of Pharmacy & Technology Management, SVKM'S NMIMS, Hyderabad, 25 July 2020 (via VC).
13. "Medical Device Innovation: How to create success stories," Manipal - Karnataka Government Bioincubator, MAHE, 13 July 2020 (via video conference).
14. "Innovations to battle COVID-19: Opportunities and Challenges," Technological Challenges & Opportunities in COVID-19 Outbreak, NIT Uttarakhand, 6 July 2020 (via video conference).
15. "Research to Reality: How to Traverse the 'Valleys of Death'," Gandhigram Rural Institute, Dindigul, 12 June 2020 (via video conference).
16. "Healthcare Innovation & Entrepreneurship Eco-System," National Academy of Sciences Workshop on Healthcare Innovation in India, NIRRH Mumbai, 1 March 2020.
17. B. Ravi, "Healthcare Innovation and Entrepreneurship," Workshop on Healthcare Innovation in India, NIRRH, Mumbai, 29 Feb 2020.
18. B. Ravi, "Innovation and Entrepreneurship Eco-System at IIT Bombay," Leadership for Academics Programme, for participants from Tata Institute of Social Sciences, Mumbai, 22 Jan 2020.
19. B. Ravi, "Translating Research Prototypes into Marketable Products," 89th Annual Symposium on Science and Technology based Entrepreneurship Development, National Academy of Sciences, NAARM, Hyderabad, 22 Dec 2019.
20. B. Ravi, "Innovation & Entrepreneurship Eco-System in Academic Institutes," IIITDM Kanchipuram, 16 Dec 2019.
21. B. Ravi, "3D Printing Applications," Workshop on 3D Printing, Benaras Hindu University, 8 Oct 2019.
22. B. Ravi, "Innovation and Entrepreneurship Eco-System in Academia," Leadership for Academicians Programme, Benaras Hindu University, 5 Oct 2019.
23. B. Ravi, "Innovation and Entrepreneurship Eco-System," SRTMU Nanded, 24 Aug 2019.
24. B. Ravi, "Innovation and Entrepreneurship Eco-System at IITB," Leadership for Academicians Programme by TISS Mumbai, IIT Bombay, 20 Aug 2019.
25. B. Ravi, "Biomedical Device Innovation Eco-System," Meeting on Medical Devices, NITI Aayog, New Delhi, 14 Aug 2019.
26. B. Ravi, "Innovation and Entrepreneurship Eco-System at IIT Bombay," Regional Interstate Knowledge Sharing Workshop on Startups, Maharashtra State Innovation Society, IIT Bombay, 5 Aug 2019.
27. B. Ravi, "Assistive Technologies: Idea to Invention to Innovation to Impact," National Conference on Assistive Technologies for All, Bangalore, 2 Aug 2019.
28. B. Ravi, "BETIC Eco-System," TEQIP Course on Entrepreneurship, Innovation and Incubation, IIT Bombay, 10 July 2019.
29. B. Ravi, "Healthcare Innovation Eco-System," CII-AMTZ Startup Day, AMTZ, Visakhapatnam, 25 Mar 2019.
30. B. Ravi, "Innovation Eco-System: The Golden Spiral from Idea to Impact," LEAP – Leadership for Academics Programme, IIT Bombay, Taj Lands End, Bandra, 7 Mar 2019.
31. B. Ravi, "Bioengineering: Medical Product Design and Manufacturing," Paediatric Orthopaedic Society of India Conference (POSICON 2019), 5 Jan 2019.
32. B. Ravi, "Product Innovation: Idea to Impact," Center for Advanced Manufacturing, University of Southern California, Los Angeles, USA, 19 Oct 2018.
33. B. Ravi, "Medical Device Innovation: Toward Inclusive Healthcare (BETIC Experience)," Faculty Alumni Network Symposium: Healthcare Session, Stanford University, USA, 13 Oct 2018.
34. B. Ravi, "Practical Insights in Medical Device Innovation," BIRAC BIG Conclave, NCL Venture Centre, Pune, 27 July 2018.
35. B. Ravi, "Enabling Rapid Innovation and Customized Production", Seminar on Additive Manufacturing Technologies for Aerospace Applications, Aeronautical Society of India, Hyderabad, 15 July 2018.

36. B. Ravi, “Relevance of Research: Idea to Impact,” FDP on Development of Research Skills, Mukesh Patel School of Technology Management and Engineering, NMIMS, Mumbai, 10 July 2018.
37. B. Ravi, “Biomedical Device Innovation: A Silent Revolution,” Seminar on Bioengineering: Scope and Opportunities, Haffkine Institute, Mumbai, 24 June 2018.
38. B. Ravi, “Better Health without Breaking the Bank: How Low-Cost Innovations are Revolutionizing Healthcare,” Lead Panellist, INVENT (Innovative Ventures and Technologies for Development) workshop, KIIT Technology Business Incubator, Bhubaneswar, 26 May 2018.
39. B. Ravi, “Medicine? Engineering? Why not Both,” Talent Search Program Workshop, MAIYA (Mentoring to Accelerate Individual Youth Achievement), NIAS, Bangalore, 19 May 2018.
40. B. Ravi, “Affordable Medical Devices: Idea to Impact,” H.H. Mathur Award Talk, IIT Bombay, 27 Feb 2018.
41. B. Ravi, “Affordable Medical Devices: Idea to Impact,” Int. Conference on Recent Trends in Bioengineering, MIT Arts, Design & Technology University, Pune, 17 Feb 2018.
42. B. Ravi, “The Golden Spiral: Idea to Impact by Connecting Education, Innovation and Translation,” Living Science, IIT Delhi, 15 Feb 2018.
43. B. Ravi, “Idea to Impact in Healthcare,” Technological Innovation for Social Impact, Annual Symposium, Tata Centre for Technology & Design, IIT Bombay, 17 Jan 2018.
44. B. Ravi, “The Golden Spiral: Connecting Education, Innovation and Translation,” Workshop on Smart Manufacturing, IIT Gandhinagar, 11 Jan 2018.
45. B. Ravi, “Product Innovation and Entrepreneurship,” Aditya Silver Oak College, Ahmedabad, 10 Jan 2018.
46. B. Ravi, “How Engineers and Technology Can Change Diagnosis and Treatment,” CUTICON Maharashtra, Indian Association of Dermatologists, Venereologists & Leprologists, Mumbai, 31 Dec 2017.
47. B. Ravi, “Product Innovation and Smart Manufacturing,” KL University, Vijayawada, 28 Nov 2017.
48. B. Ravi, “Idea to Product: Connecting Teaching, Research and Application,” Siddaganga Institute of Technology, Tumkur, 27 Oct 2017.
49. B. Ravi, “Medical Device Innovation at BETIC,” Synergize – Biotech Club launch, IIT Bombay, 7 Oct 2017.
50. B. Ravi, “Hackathons for Problem Solving and Innovation: BETIC Experience,” Smart Gujarat for New India Hackathon Launch Event, Gandhinagar, 26 Sep 2017.
51. B. Ravi, “Medical Device Innovation – Stories and Best Practices,” NCL Innovation Park, Pune, 16 Sept 2017.
52. B. Ravi, “Bringing Doctors and Engineers Together for Medical Device Innovation,” BJ Medical College, Pune, 7 July 2017.
53. B. Ravi, “Make in India: Role of Teachers,” Baba Inst. of Technology & Science, Visakhapatnam, 16 June 2017.
54. B. Ravi, “Indigenous Medical Device Innovation: Need, Examples and Best Practices,” Medical Product Design Course (through Skype), VIT University, Vellore, 26 May 2017.
55. B. Ravi, “Healthcare Innovations by Bringing Clinicians and Engineers Together,” Int. Conference on Healthcare in a Globalizing World, Symbiosis International University, Pune, 5 May 2017.
56. B. Ravi, “Framework for Academic Research and Industry,” Inclusive Manufacturing Forum, NIAS, Bangalore, 4 April 2017.
57. B. Ravi, “Indigenous Medical Device Innovation,” TEQIP Course on Innovation, Entrepreneur-ship and Incubators, IIT Bombay, 15 March 2017.
58. B. Ravi, “Research to Reality: Connecting Education, R&D and Entrepreneurship,” Research Colloquium, VJTI, Mumbai, 14 Feb 2017.
59. B. Ravi, “Medical Device Innovation: From Research to Reality,” Medical Technology Innovation Workshop, AIIMS Jodhpur, 12 Feb 2017.
60. B. Ravi, “From Idea to Reality: Connecting Education, Research, Development and Application,” DST NSTEDB NIMAT Entrepreneurship Awareness Camp, Siddhaganga Institute of Technology, Tumkur, 27 Jan 2017.
61. B. Ravi, “Reinventing the Prosthetic Leg for Above-Knee Amputees,” Abhyuday, Annual Festival focusing on the disabled, IIT Bombay, 22 Jan 2017.
62. B. Ravi, “Medical Device Innovation: From Research to Reality,” 6th Int. Conference on Research into Design, IIT Guwahati, 11 Jan 2017.
63. “B. Ravi, The Golden Spiral: Connecting Education, Research, Development and Application,” Annual Convention, Indian National Academy of Engineers, Ahmedabad, 8-9 Dec 2016.
64. B. Ravi, “Medical Device Innovation in India,” Advanced Manufacturing and Innovation Workshop, Bangalore, 11 Nov 2016.
65. B. Ravi, “The Road Ahead for Indian Healthcare Innovation”, Panel Discussion, IoT Next, IESA and TiE, Bangalore, 9 Nov 2016.
66. B. Ravi, “The Golden Spiral: Connecting Education, Innovation and Application,” NASSCOM Product Conclave - Deep Tech Summit, Bangalore, 26 Oct 2016.
67. B. Ravi, “Made in India: Idea to Reality,” IIT Dharwad, 30 Sep 2016.
68. B. Ravi, “Made in India: Idea to Reality,” BVB College of Engineering & Technology, Hubli, 29 Sep 2016.
69. B. Ravi, “Made in India: Idea to Reality,” SDM College of Engineering & Technology, Dharwad, 29 Sep 2016.
70. B. Ravi, “Made in India: Idea to Reality,” Srinivas Inst. of Technology, Mangalore, 27 Sep 2016.
71. B. Ravi, “Medical Device Innovation: Research to Reality,” Bosch India Technology Day, Bangalore, 16 Sep 2016.
72. B. Ravi, “Medical Device Innovation: Research to Reality,” Engineering Design Department, IIT Madras, Chennai, 13 Sep 2016.
73. B. Ravi, “The Golden Spiral: Research to Reality,” Center for Product Design & Manufacturing, IISc Bangalore, 25 August 2016.
74. B. Ravi, “The Golden Spiral: Connecting Education, Innovation and Translation,” National Institute of Advanced Studies, Bangalore, 19 August 2016.
75. B. Ravi, “Medical Device Innovation: Research to Reality,” Centre for Bio Systems Science and Engineering, IISc Bangalore, 25 July 2016.
76. B. Ravi, “Rapid Development and Testing of Medical Devices,” Short Course on Applications of Tribology in Engineering and Health Sciences, Manipal University, 19 May 2016.
77. B. Ravi, “Medical Device Innovation: Bringing Ideas to Reality,” Tech Forte, Fortis Hospital, Mulund, 13 May 2016.

78. B. Ravi, “Innovations in Laparoscopic Instruments,” 13th Annual Congress of Indian Association of Gastrointestinal Endo-Surgeons (IAGES), 22 Apr 2016.
79. B. Ravi, “Make in India,” Samwad: Talk-cum-interaction session, IIT Bombay, 21 Mar 2016.
80. B. Ravi, “The New IT Revolution: Innovation Translation for ‘Made in India’ Products,” National Science Day Seminar, The Institute of Science, Mumbai, 24 Feb 2016.
81. B. Ravi, “The New IT Revolution: Innovation Translation for ‘Made in India’ Products,” Make in India Week – Hackathon, IIT Bombay, 12 Feb 2016.
82. B. Ravi, “Medical Device Innovation: Research to Reality,” Inaugural keynote talk, TEQIP Int. Winter School on Nano-Bio Techniques, IIT Roorkee, 9 Feb 2016.
83. B. Ravi, “Medical Device Innovation at BETIC,” Center for Biomedical Innovation and Design, Johns Hopkins University, Baltimore, USA, 12 Oct 2015.
84. B. Ravi, “Medical Device Innovation at BETIC,” Stanford Biodesign Center, USA, 9 Oct 2015.
85. B.Ravi, “IT Enabled Innovation in Manufacturing Supply Chains,”Int. Manufacturing Symposium, Cambridge, UK, 24 Sep 2015.
86. B. Ravi, “Need Identification for Medical Device Innovation,”MSME Conclave on New Product Development, CII & DSIR, IIT Bombay, 11 Sep 2015.
87. B. Ravi, “Golden Spiral: Connecting Education, Innovation and Application,” S.G. Balekundri Institute of Technology, Belagavi, 13 July 2015.
88. B. Ravi, “Made in India: Idea to Reality,” Kolhapur Engineering Association, Kolhapur, 14 July 2015.
89. B. Ravi, “Made in India: Past, Present and Future,” Rajiv Gandhi Institute of Technology, Mumbai, 29 June 2015.
90. B. Ravi, “Made in India,” Brainstorming meeting on Manufacturing Technology, TIFAC, New Delhi, 17 Apr 2015.
91. B. Ravi, “3D Printing Technology (Metal Casting and Medical Applications),” Technical Talk, ASM and Institute of Indian Foundrymen, Mumbai, 25 Mar 2015.
92. B. Ravi, “Rapid Design, Prototyping and Manufacture of Medical Devices,” Symbiosys Institute of Technology, Pune, 17 Feb 2015.
93. B. Ravi, “Rapid Design, Prototyping and Manufacture of Medical Devices,” Int. Conf. on Additive Manufacturing and 3D Printing, The Hilton, Chennai, 5-7 Feb 2015.
94. B. Ravi, “Bringing Clinicians, Scientists and Engineers Together for Medical Device Innovation,” Indo-Australian Conf. on Biomaterials, Tissue Engineering, Drug Delivery System & Regenerative Medicine, Anna University, Chennai, 5-7 Feb 2015.
95. B. Ravi, “Made in India: From an Idea to Reality,” Workshop on Modeling, Simulation and Computational Techniques, LMNIIT Jaipur, 15 Jan 2015.
96. B. Ravi, “OrthoCAD Lab and Medical Device Innovation,” TEQIP Programme on Mechanical Engineering, IIT Bombay, 22 Dec 2014.
97. B. Ravi, “The Golden Spiral: Connecting Teaching, Research and Industry for Product Innovation,” IIT Jodhpur, 4 Nov 2014.
98. “B. Ravi, The Golden Spiral, Connecting Teaching, Research and Industry for Medical Device Innovation,” 9th Asia Pacific Conference on Medical and Biological Engineering, NCKU, Tainan, Taiwan, 9-12 Oct 2014.
99. B. Ravi, “Made In India: Software and Hardware Products,” DJ Sanghvi College of Engg, Mumbai, 23 Sep 2014.
100. B. Ravi, “Medical Device Innovation in India: The Journey from Idea to Reality,” CONTINUUM, School of Management, IIT Bombay, 22 March 2014.
101. Rupesh Ghyar, “BETIC Spearheading Innovations in Endoscopic Surgery,” Continued Medical Education (CME) talk, PESICON 2020, Pune, 28 Feb 2020
102. Rupesh Ghyar, “To Understand Entrepreneurship Ecosystem at IIT Bombay,” Kelley School of Business, Indiana University, United States, 30 Jan 2020
103. Rupesh Ghyar, “Sharing the BETIC experience,” Meeting of experts on setting up of liver translation centre at ILBS, Institute of Liver and Biliary Sciences, New Delhi, 7 Jan 2020
104. Rupesh Ghyar, Workshop on Cognizance of Industry 4.0 towards Implementation and Security, Industry 4.0 in Healthcare, KJ Somaiya College of Engineering, Mumbai, 30 Dec 2019
105. Rupesh Ghyar, “3D printing practicality in today’s day and age,” TEaD talk, MOACON, Pune, 3 Nov 2018
106. Rupesh Ghyar, “Medical Device Innovation,” Asian Bio Materials Conference, SCTIMST, Trivandrum, 25 Oct 2017.
107. Rupesh Ghyar, “Blurring the Lines Between Doctors and Engineers,” TEDx, Topiwala National Medical College, 25 Feb 2017.
108. Rupesh Ghyar, International Conference on Transforming Lives & Healthcare through Technology, Datta Meghe Institute of Medical Sciences, Wardha, 9-10 Jan 2017.
109. Rupesh Ghyar, IITB-Monash-CSIRO Summit and Workshop on Medical Devices, Monash University, Australia, 20-23 Nov 2016.
110. Rupesh Ghyar, International Conference on Future Healthcare & Economic Development in Southeast Asia, National Cheng Kung University, Taiwan, 14-19 Aug 2016
111. Rupesh Ghyar, 8th Indian Med-Tech Summit, Stanford India BioDesign Program, 20 Dec 2014.
112. Rupesh Ghyar, Workshop on Computational Methods for Interdisciplinary Research, Manipal University, 15 Dec 2014

VNIT Nagpur

1. A M Kuthe, “Advances in Manufacturing and Industry 4.0,” STTP, 26 Feb 2019.
2. A M Kuthe, “Organizational Transformation through Industry 4.0” International Workshop under Quality Improvement Program of SPPU, 14-15 Feb 2019.
3. A M Kuthe, “Rapid prototyping beyond CT,” Workshop at BETIC Innovation Cell, Research House, DMIMS, 16-17 Feb 2018.

4. A M Kuthe, “3D printer and Rapid prototyping,” STTP on 3D Technology and Embedded Electronics, Ramdeobaba College of Engineering and Management, Nagpur in association with IITDM Jabalpur, 13 Nov 2018.
5. A M Kuthe, “Funding and Importance of Research and Development,” JD college of Engineering and Management, 4 Aug 2018.
6. A M Kuthe, “Emerging Trends in CAD/CAM & its Application in Mechanical Engineering,’ Induction Program, Babasaheb College of Engg., Pusad, 19-24 June 2018.
7. A M Kuthe, “Innovative product development for medical and manufacturing sectors in academic setting,” Interactive Workshop on Product Innovation and Smart Manufacturing, IIT Gandhinagar, 11 Jan 2017.
8. A M Kuthe, “Transforming Lives & Healthcare through Technology,” TLHTion-2017 International Conference, Datta Meghe Institute of Medical Sciences, Nagpur, 09 Jan 2017.
9. A M Kuthe, “Rapid Prototyping for Product Development”, Prof. Ram Meghe Institute of Technology & Research, Badnera, 05 Dec 2016
10. A M Kuthe, “Biomedical Instrumentation,” Shri Ramdeobaba College of Engg. & Management, Nagpur, 01 Oct 2016.
11. A M Kuthe, “Invention and Application of Biomaterials and Biomechanics,” Dr. Bhausaheb Nandurkar College of Engineering and Technology, Yavatmal, 01 March 2016.
12. A M Kuthe, “Rapid Prototyping for Customized Medical Implant and Biomedical Research Projects,” Govt. Dental College, Nagpur, 28 May 2015, with Dr. Rashmi Uddanwadikar.
13. A M Kuthe, “Theory of Rapid Prototyping,” Dr. Ambedkar College of Engineering & Research, Nagpur, 29 April 2015.
14. A M Kuthe, “RP Assisted Tissue Engineering,” IIT Roorkee, 3 Mar 2015.
15. A M Kuthe, “Tissue Engineering: New Era,” Raman Science Centre, Nagpur, 10 Jan 2015.
16. A M Kuthe, “3D printing for medical application,” Ramdeobaba College of Engg. and Technology, Nagpur, 5 Jan 2015.
17. A M Kuthe, “3D printer Challenges & Constraints,” Govt. College of Engineering, Amravati, 23 Dec 2014
18. A M Kuthe, “Medical Rapid Prototyping,” B. N. College of Engineering, Pusad, 27 Jun 2014.
19. A M Kuthe, “Future Perspective of Design for Manufacturing,” Dr. Ambedkar College of Engg. & Research, Nagpur, 16 Jun 2014.
20. A M Kuthe, “Latest Development in CAD,” College of Engg. & Technology, Akola, 24 April 2014.
21. A M Kuthe, “RP & Tissue Engineering,” Video Conference, LNM Institute of Technology, Jaipur, 16 April 2014.
22. Rashmi Uddanwadiker, “Research Avenues in Dentistry” National Conference on Digital Dentistry, 10 Aug 2018, Nagpur
23. Rashmi Uddanwadiker, “Ergonomic Postures during Work”, Home Science Department, SGB University Amravati, 16 Oct 2018
24. Rashmi Uddanwadiker, “Role of research in women Empowerment”, IIIT Nagpur, 8 March 2019.
25. Faculty development program on “3D printing and its applications,” Government College of Engineering, Jalgaon, 11-15 Dec 2018.
26. Mahesh Mawale , “Development of Innovative Medical devices using TRIZ and Rapid Prototyping”
27. Pranav Sapkal, “Bone tissue engineering and regenerative medicine”
28. Sandeep Dahake, “Engineering on Anatomy”

COE Pune

1. B.B. Ahuja, “Biology for Engineers”, COE Pune, 9-13 January 2017.
2. B.B. Ahuja, “Application of 3D Printing in Medical Device Fields,” Krishna Institute of Medical Sciences Deemed University, Karad, 29 July 2017.
3. B.B. Ahuja, “Purpose of BETIC and Medical Device Innovation Camp” Government Dental College and Hospital, Mumbai, 09 August 2017.
4. B.B. Ahuja, "Medical Image and Signal Processing,” JSPM's Rajarshri Shahu College of Engg., Tathawade, 23 Dec 2017.
5. A.V. Mulay, “Medical Device Innovation and Rapid Prototyping” Datta Meghe Institute of Medical Science, Wardha, 17 Feb 2018.
6. A.V. Mulay, “Process Chain of Additive Manufacturing” ARDE, Pune, 11-15 Dec 2017
7. A.V. Mulay, “Additive Chains - Interdisciplinary Research in Biomedical Engineering” VNIT, Nagpur 11 Oct 2017
8. Sandeep S.Anasane, “Rapid Prototyping for Bio-Medical Applications” Mechanical Engineering Dept. Prof. Ram Meghe Institute of Technology & Research, Badnera, 15 Dec 2017
9. Sandeep Dahake, “Engineering on Anatomy”

Appendix 10: Hackathons and Camps

Medical Device Hackathon (MEDHA)

Sl.	Organizer, Location	Date	Participants
1	Haffkine Institute for Training, Research & Testing, Mumbai	13-14 July 2019	40
2	Venture Center, NCL Innovation Park, Pune	21-21 July 2019	40
3	G H Raisoni College of Engineering, Nagpur	27-28 July 2019	40
4	K J Somaiya College of Engineering, Mumbai	07-08 July 2018	32
5	G H Raisoni College of Engineering, Nagpur	21-22 July 2018	32
6	School of Bioengineering, MIT-ADT University, Pune	04-05 Aug 2018	32
7	K J Somaiya College of Engineering, Mumbai	14-16 July 2017	32
8	B J Medical College, Pune	21-23 July 2017	32
9	Datta Meghe Institute of Medical Sciences, Wardha	04-06 Aug 2017	32
10	Shivaji University (Dept. of Science & Technology), Kolhapur	18-20 Aug 2017	40
11	Center for Product Design and Manufacturing, IISc	03-06 Nov 2016	44

Medical Device Camp

Sl.	Organizer, Location	Date	Participants
	Medical Device Innovation Camps (MEDIC)		
1	BETIC IIT Bombay	28 Sep-2 Oct 2019	60
2	BETIC IIT Bombay	28 Sep-2 Oct 2018	64
3	BETIC COE Pune	13-17 Sep 2017	60
4	BETIC VNIT Nagpur	19-23 Sep 2016	60
5	BETIC IIT Bombay	11-15 Sep 2015	60
	Rural Medical Camps (with RNCT)		
6	Mahakaruna Diwas Camp, Leh	23-27 Jun 2017	488
7	Maha Arogya Shibir, Shengaon	23 Dec 2018	200
8	Chandrapur Medical Camp, Chandrapur	17-23 Dec 2019	10,000

Clinical Biomechanics Workshop

Sl.	Organizer, Location	Date	Participants
	Medical Device Innovation Camps (MEDIC)		
1	MGM Institute of Health Sciences, Sanpada	26-28 Feb 2016	49
2	MGM Institute of Health Sciences, Sanpada	01-03 April 2016	30
3	MGM Institute of Health Sciences, Sanpada	09-10 Jan 2017	75
4	MGM Institute of Health Sciences, Sanpada	11-12 April 2019	~50

Appendix 11. Product Exhibitions

Organized by BETIC / Partner Institutes

Sl.	Organizer, Location	Date
1	BETIC Medical Device Expo, IIT Bombay	15 Apr 2015
2	MEDEX, IIT Bombay	15 Sep 2015
3	Medical Device Innovation Competition, BETIC-VNIT	14-18 Dec 2015
4	Indian Medical Device Expo, BETIC-COEP	08-09 Apr 2016
5	Tissue Engineering Lab, BETIC- VNIT	14 Jul 2016
6	MEDEX, VNIT Nagpur	23 Sep 2016
7	BETIC Medical Device Expo, VNIT Nagpur	01 Mar 2017
8	MEDEX, COE Pune	17 Sep 2017
9	BETIC Medical Device Expo, IIT Bombay	19 Apr 2018
10	MEDEX, IIT Bombay	02 Oct 2018
11	BETIC Medical Device Expo, IIT Bombay	12 Apr 2019
12	MEDEX, IIT Bombay	02 Oct 2019

Organized by Other Agencies

Sl	Event name, Location	Organizer	Date
1	Dervan Biomedic Initiative, Dervan	B.K.L. Walawalkar Rural Hospital, Dervan	5-6 Dec 2015
2	Global Business Forum (GBF), Goa	IIT Bombay Alumni Association	16-18 Oct 2015
3	World Disability Day 2015, Mumbai	Ratna Nidhi Charitable Trust	03 Dec 2015
4	India International Science Festival, Delhi	IIT Delhi	04-08 Dec 2015
5	Make in India Week, Mumbai	Dept for Promotion of Industry and Internal Trade, GoI	13-18 Feb 2016
6	Medical Fair India, Mumbai	Bombay Convention and Exhibition Centre	10-11 Mar 2016
7	COPD Update Conference, Navi Mumbai	Hinduja Hospital	25 Sep 2016
8	MGM CHMS Annual Progress Review Meeting	MGM CHMS, Navi Mumbai	10 Oct 2016
9	World Disability Day 2016, Mumbai	Ratna Nidhi Charitable Trust	03 Dec 2016
10	India International Science Festival, Delhi	Ministry of S&T & Earth Sciences and Vijnana Bharti	7-11 Dec 2016
11	6th Int. & 27th AIMTDR,COEP Pune	COEP	16-18 Dec 2016
12	Innovations in Manufacturing - Make in India	ACMA Centre for Technology, Pune	09-10 Jan 2017
13	Indian Medical Device Expo 2017, Bangalore	Department of Pharmaceuticals and FICCI	11-13 Feb 2017
14	Transform Maharashtra	Maharashtra Government	01 May 2017
15	India International Science Festival, Chennai	Ministry of S&T & Earth Sciences and Anna University	13-16 Oct 2017
16	TechConnect 2017, IIT Bombay	IIT Bombay	29-31 Dec 2017
17	Magnetic Maharashtra, Mumbai	MMRDA	18-23 Feb 2018
18	India International Science Festival, Lucknow	Ministry of S&T & Earth Sciences and Vijnana Bharti	08-11 Oct 2018
19	KUTUHAL, VNIT Nagpur	VNIT Nagpur	09-11 Feb 2019
20	India International Science Festival, Kolkata	Ministry of S&T & Earth Sciences and Vijnana Bharti	05-08 Nov 2019
21	Global Bio India, New Delhi	BIRAC and Ministry of Science & Technology, GoI	21-23 Nov 2019
22	Alumni Day 2019, IIT Bombay	IITB Bombay	22 Dec 2019
23	TechConnect, IIT Bombay	IIT Bombay	03-04 Jan 2020
24	KUTUHAL 2020, Pune	S.P. College, Pune	07-10 Feb 2020

Appendix 12. News Media Coverage

Mainstream Newspapers

1. "Low-cost portable diaBETIC foot screener makes debut at IIT-Bombay innovation camp," *The Indian Express*, 1 Nov 2019.
2. "15 novel medical devices conceived within 100 hours at camp in IIT Bombay," *India Today Online*, 7 Oct 2019.
3. "15 innovations at BETIC IIT Bombay med-tech camp," *Economic Times Health World*, 1 Oct 2019.
4. "IIT-B's BETIC making a difference in healthcare industry," *Medical Equipment & Automation*, 1 Aug 2019.
5. "15 sec pH measurement, new CPAP device developed at MEDHA Hackathon by BETIC-IIT Bombay," *India Today Online*, 16 July 2019.
6. "BETIC IIT-B launches Medical Device Hackathon – MEDHA 2019," *India Today Online*, 25 June 2019.
7. "Hybrid plaster splint, biopsy gun among 20 new products," *Hindustan Times*, 26 July 2019.
8. "How IIT Bombay's healthcare innovation centre BETIC is solving India's massive doctor shortage," *India Today Online*, 28 March 2019.
9. "Haffkine Institute, IIT to Start Biomedical Incubation Centre," *The Hindu*, 15 Feb 2019.
10. "We Need More Screening Devices for Specific Diseases," *Express Healthcare*, 12 Feb 2019.
11. "Tried, Tested in Rural Maha: New Low-Cost Device to Diagnose Glaucoma in Time, Prevent Blindness," *The Hindustan Times*, 11 Jan 2019
12. "How IIT-Bombay's MEDIC Initiative is Making a Difference: New Technology for Smarter Medical Aids," *Mumbai Mirror*, 29 Aug 2018
13. "New Technology for Smarter Medical Aids," *Mumbai Mirror*, 29 Aug 2018.
14. "Mood Modi at IIT-B," *Sunday Mid-Day*, 12 Aug 2018.
15. "More Than Just a Heartbeat: Ayu's Smart Stethoscope Will Help in Spotting Cardiac and Pulmonary Disorders Early," *Outlook Business*, 22 June 2018, pp. 22-25.
16. "The Frugal Innovators," ***Forbes India***, 11 May 2018, pp. 42-44.
17. "IIT-B Researchers Develop Steth That Can Filter Noises," *The Free Press Journal*, 3 May 208.
18. "CoEP develops instant splint for injured limbs", *Times of India*, Pune, 10 Feb 2017.
19. "Jaipur foot gets a leg-up, 3D-printed version ready", *Times City, Times of India*, Mumbai, 7 Nov 2016
20. "Engineers, Doctors, join hands to solve real-life medical problems", *Deccan Herald*, 7 Nov 2016
21. "Meet produces prototypes for 20 new medical devices", *Times of India*, Nagpur, 24 Sep 2016
22. "Buzz at medical device innovation meet", *Times of India*, Nagpur, Friday, 23 Sep 2016
23. "Google to back three non-profit organisations in India," *Times of India*, 4 March 2016.
24. "Low-Cost High-Quality Medical Devices Created at IIT-B Lab," *Hindustan Times*, 24 April 2015.
25. "IITan Develops Software to Convert 2D X-Ray into 3D, *Times of India*, 26 Feb 2015.
26. " Innovation led technology excellence - BETIC -VNIT case study" along with DMIMS Wardha during 26 Oct.to 31st Oct 2020

Local and vernacular press

1. Sakal Times, Pune, 9 Dec 2019
2. Maharashtra Saamna, 11 June 2019
3. Afternoon Despatch & Courier, 18 Dec 2018.
4. Maharashtra Dinman, 14 Dec 2018
5. Lokmat, 29 July 2018
6. The Hitwada, 26 July 2018
7. Lokmat, 25 July 2018
8. Hindustan Times, 15 Sep 2017
9. Daily SAKAL Times, 14 Sep 2017
10. Daily PUDHARI, 26 July 2017
11. Sakal, 26 July 2017
12. Daily SAKAL, 24 July 2017
13. Daily SAKAL, 25 June 2017
14. Daily SAKAL, 25 June 2017
15. Sakal Pune Today, 4 March 2017
16. Maharashtra Today, 10 Feb 2017
17. Sakal Times, Pune, 9 Dec 2019
18. The Hitavada, March 2020

All India Radio: FM 107.1 Rainbow channel, 16 Feb 2020

TV coverage: Z 24 Tas (13 Aug 2017), ABP Maza (29 July 2017), and NDTV

Appendix 13. Innovation Awards

Sl	Awards (Organization)	Received by	Year	Amount
	Biotechnology Ignition Grant (BIRAC, New Delhi)			
1	Orthopedic surgery planner, Dr. Vikas Karade, IITB	Algosurg	2016	Rs. 50 lakh
2	Smart stethoscope, K. Adarsha and Tapas Pandey, IITB	Ayu Devices	2017	Rs. 50 lakh
3	Hybrid splint for fractures, Mayur Sanas, COEP	MediAsha	2018	Rs. 49.5 lakh
4	Dermo-epidermal suspension spray device, Saiprasad Poyarekar, COEP	Pacify Medical	2018	Rs. 50 lakh
5	Endo-tracheal tube obstruction monitor, Abhijeet Bhagat, COEP	Atmen Technovention	2019	Rs. 50 lakh
6	Portable diaBETIC foot screening device, Nishant Kathpal, IITB	Ayati Devices	2019	Rs. 50 lakh
7	Stance-controlled knee ankle foot orthosis, Aneesh Karma, IITB	Aumeesh Tech	2020	Rs. 50 lakh
8	Jaw relation recorder, Dr. Jayant Palaskar, MITADT	Prosthocentric Pvt Ltd	2019	Rs. 50 lakh
9	Surgical Guides, Dr Sandeep Dahake, VNIT	Precisurg	2020	Rs. 48.2 lakh
10	Glaucoma screener, Neha Lande, VNIT	OKO iCare Solutions	2020	Rs. 50 lakh
11	Artificial temporal bone, Piyush Ukey, VNIT	Nu Ossa Mediquip	2020	Rs. 48.6 lakh
12	Auto suturing device	Denovo	2020	Rs. 50 lakh
13	Affordable Isolation Room for Burns patients (AIR-B)	Medgyor	2020	Rs. 50 lakh
14	Novel Dental Burr	Aur Innovations	2020	Rs. 50 lakh
15	Mensural Cup	Care Form Labs	2020	Rs. 50 lakh
	BETIC-IITB			
16	Gandhian Young Technological Innovation Award for XRayTo3D, by SRISTI, given to Vikas Karade, 2014.	Dr. Vikas Karade	2014	Non-cash
17	Gold Medal, India Innovation Growth Programme, DST, Delhi, for X-Ray to 3D, given to Vikas Karade, Apr 2015.	Dr. Vikas Karade	2015	Non-cash
18	Google Impact Award (US$350,000), for 3D technology for leg prosthesis, to Ratna Nidhi Charitable Trust and BETIC-IITB, Dec 2015.	RNCT & BETIC	2015	Rs.245 lakh
19	American Bazaar StartUp Competition, US-India Startup Forum, Mumbai, won by AlgoSurg, BETIC startup company, Feb 2017.	Algosurg	2017	Non-cash
20	Emerging Start-Up of the Year award by Bombay Management Association, to Ayu Devices Pvt. Ltd., Oct 2017.	Ayu Devices	2017	Non-cash
21	Y-combinator startup accelerator program, San Francisco, USA for AlgoSurg to set up an office in USA, Jan 2018.	Algosurg	2018	Non-cash
22	H.H. Mathur Award for Excellence in Applied Sciences to Prof. B. Ravi for his work in medical device innovation, Mar 2018.	Prof. B. Ravi	2018	Non-cash
23	Top 10 Innovation in India, Academia-Industry Training Programme, DST and Swissnex, to Ayu Devices, Apr 2018.	Ayu Devices	2018	Rs. 10 lakh
24	Abdul Kalam Technology Innovation National Fellowship, to Prof. B. Ravi to support translational research activities, Aug 2018.	Prof. B. Ravi	2018	Rs. 57 lakh
25	Global StartUp Challenge at Fintech Festival, Visakhapatnam: AlgoSurg won $25000 investment award, Sep 2018.	Algosurg	2018	Rs. 18.2 lakh
26	Qiantang Star Innovation & Entrepreneurship Competition, Hangzhou, China: Algosurg came second, Oct 2018.	Algosurg	2018	Non-cash
27	Big Idea Summit by Kutchhi Bhanushali Seva Samaj Trust 'Innovator-Gold' prize Rs. 50,000 to Anish Karma for KAFO, Mumbai, Dec 2018.	Anish Karma	2018	Rs. 0.5 lakh
28	Maharashtra Startup Week: Ayu Devices among top 3 winners in healthcare sector (smart stethoscopes to rural PHCs), Jan 2019.	Ayu Devices	2019	Rs. 15 lakh
29	AI Innovation Challenge by Maharashtra Government: Ayu Devices among top 3 in healthcare segment, March 2019.	Ayu Devices	2019	Non-cash
30	India Innovation Growth Programme 2.0, DST, Delhi, award to Ayu Devices for for smart stethoscope, Apr 2015.	Ayu Devices	2019	Rs. 25 lakh
31	NCPEDP-Mphasis Universal Design award: category A – persons with disabilities, to Aneesh Karma for KAFO, Aug 2019.	Aumeesh Tech	2019	Non-cash
32	IET IOT Challenge: Healthcare Track award to Nishant Kathpal, for diaBETIC foot stiff measurement unit, Aug 2019.	Ayati Devices	2019	Rs. 1 lakh
33	Aarohan Social Innovation award by Infosys Foundation to Aneesh Karma (Aumeesh Tech) for KAFO, Feb 2020.	Aumeesh Tech	2020	Rs. 10 lakh

34	DST NIDHI-PRAYAS award to Ayati Devices	Ayati Devices	2020	Rs. 6 lakh
35	ATTD 2021 Start-up Grants to Ayati Devices	Ayati Devices	2020	Rs. 2.5 lakh
36	Facebook Award	Ayati Devices	2020	Rs. 1 lakh
37	CAWACH Award	Ayu Devices	2020	Rs. 100 Lakh
38	Millennium Alliance COVID Challenge	Ayu Devices	2020	Rs. 50 lakh
39	BIRAC Fast Track fund	Ayu Devices	2020	Rs. 116 lakh
40	Millennium Alliance Round six	Ayu Devices	2020	Rs 30 lakh
	BETIC - COEP			Non-cash
41	Seaside Startup Summit Goa, 3rd Prize in Healthcare Track to Mayur Sanas, 2018	MediAsha	2018	Non-cash
42	Entrepreneurship Award to Mr. Mayur Sanas by Unix Horizon, Pune	MediAsha		Non-cash
43	Shuruvaat Bus–100 second pitch contest, Mayur Sanas, 20 Nov 2017	MediAsha	2017	Non-cash
44	Young Innovator Award, 26th Annual Conference of Pune Obstetric & Gynaecological Society, to Bhushan Darekar and Yashodhan Morye, 12 Nov 2017.	Bhushan Darekar & Yashodhan Morye	2017	Non-cash
45	DST NIDHI-PRAYAS award to assistive device for burn patients	Swapnil Bhukshete	2020	Rs 9 lakh
46	Young Innovator Awards at InnoHealth,	Pacify Medical	2019	Non-cash
47	Startup Innovation Awards at CAHOTech 2019, awarded in 2020	Pacify Medical	2019	1 lakh
48	List of top-40 start-up pioneer defence innovation by Ministry of Defense Production, Govt of India, 2020	Pacify Medical	2020	Non-cash
49	MeitY TIDE Grant Rs 7 Lakhs in 2020	Pacify Medical	2020	7 lakh
50	Biotechnology Industry Partnership Programme (BIPP)	Atmen Technovention	2020	Rs 47.7 lakh
51	Most promising Innovation Award, IKMC 2018	MediAsha	2018	Rs 0.5 lakh
52	Social Innovator Award in National Conference on Social Innovation (Top 6)	MediAsha	2019	Non-cash
	BETIC - VNIT			
53	Certificate of Appreciation, given by Mr. Deepak Sawant, Hon. Health Minister of Maharashtra, at Bhandara, 10 Feb 2017.	Dr. Mahesh Mawale	2017	Non-cash
54	Dr. Albert Schweitzer International Health Award of Mahatma Fule Talent Research Academy, Pune, given by MLA Mr. Milind Rane to Mahesh Mawale, for glaucoma screening device, 5 Mar 2017.	Dr. Mahesh Mawale	2017	Non-cash
55	Dr. B.C. Roy International Award by Mahatma Fule Talent Research Academy for Excellence in Health-2017 to Prof. A. M. Kuthe and Mahesh Mawale for Glaucoma Screener	Prof. A.M. Kuthe Dr. Mahesh Mawale	2017	Non-cash
56	International Women's Day – The Ministry of MSME, new Delhi and German International Cooperation felicitated Prof. Rashmi Uddanwadiker as Women Innovator for 2019	Prof. Rashmi Uddanwadiker	2019	Non-cash
57	IIGP - Patient-specific custom implants, Dr. Pranav Sapkal	DICUL AM Pvt Ltd	2020	Rs. 10 lakh
58	MIMICS Innovation Award 2020	Precisurg	2020	Rs 0.87 lakh