Staff and Students Views on Industry-University Collaboration in Engineering

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Abstract—The university-learning environment in engineering is not sufficient for students to become engineers. The practical role of engineering is working on real world problems in an industry environment. Industry-university collaboration seems to be actively increasing in the development of engineering education in various parts of the globe. The close relationship between industry and university is a vital component of engineering pedagogy in Australia. This research paper is focuses on analyzing staff and students views on industry-university collaboration in engineering. The staff and students are playing vital role in industry-university collaboration. It is always worth analyzing staff and students' views about their experience on industry-university collaboration. This research inclined to conduct a paper based survey with a cohort of students in second year undergraduate engineering course and also conduct face-to-face interview with staff members in the School of Engineering at Deakin University.

Index Terms—Students' views, staff views, industry-university collaboration.

I. INTRODUCTION

The real value of industry collaboration is to create benefits for society. Universities focus on educating students as professionals while industry concentrates on giving opportunities to students to experience real world problems in a competitive environment. The core interest is different for both industry and university. Academics pursue the practice of teaching theory to practice through research projects within an engineering curriculum. The industry expects graduates with career ready skills such, as problem solving, analytical thinking, and design to work on real world projects. The industry expects creative and innovative academic practice that gives students valuable practical knowledge.

It's a drawback for students and young professionals in engineering who don't have any knowledge of real world problems, and it becomes a challenging task for any graduate to face their future career without a link to industry. The aim of all engineering degrees is to provide a strong grounding with principles of engineering science and technology. By determining the engineering methods and approaches in an academic environment, graduates unable to go into the world of work and tackle real world problems with innovation and creativity have difficulty.

This research paper is focused on analyzing staff and students' views on industry-university collaboration. The students and staff are playing vital role in industry-university collaboration. It is always worth analyzing staff and students' views about their experience on industry-university collaboration. This research inclined to conduct

a paper based survey with a cohort of students in second year undergraduate engineering course and also conduct face-to-face interview with staff members in the School of Engineering at Deakin University.

II. CHALLENGES AND OPPURTUNITIES

A. Challenges in industry-university collaboration

With close industry and university relationships; academics are more concerned about undesirable consequences to university life, such as loss of academic freedom, long-term research, and academic integrity. Industry is facing two fundamental issues that affect collaboration. First, the open nature of engineering science within the academy is at times in conflict with companies. Second, academic research focuses on long-term challenges, which take more time to complete. Research and development in industry are driven by time-sensitive product development projects and day-to-day problem solving drive research and development in industry.

In research and development based projects, student work experience and staff training are becoming the most frequent domains for university-industry collaboration. However, some industry enterprises are perhaps considered to be the most critical external factors, which affect the university's progress to produce student knowledge [1]. Author Kurtulus Kaymaz mentioned the barriers of university and industry collaboration from an academician's perspective. These barriers include lack of interest from both sides, management issues, lack of communication, ineffective legal regulations, ineffective university-industry collaboration centers and previous bad experiences. There is always room for cultural reform between university and industry relations. These cultural differences must not be considered as barriers for university-industry collaboration [2-4].

B. Oppurtunities in industry-university collaboration

University and industry collaboration will benefit the university in many ways. It provides training and employment opportunities for students to explore the visible impact of engineering on the local, regional and state economic problems [2]. Universities, moreover, have an important benefit of understanding the future needs of society regarding new products, processes, and services. In long-term university collaboration, industry will benefit with a possible higher recruitment rate of graduates every year, which fosters their brand name in the education marketplace. Students gain the chance to understand current challenges, career insights, and job training in industry.

Industry and university collaboration is driving and facilitating the innovative process in technologies with the interaction between the creators and users of knowledge. Research and Development (R&D) is a key process that enriches close relationships between industry and university. Industry helps academics change or update their methods of learning and teaching. Industry works together with educational institutions for renewal and redirection of engineering education [5, 6].

Universities provide basic research that is considered expensive for industry. It is time consuming and cost effective for industry to collaborate with university-based research. Even students get a chance to undertake an industry-based project that creates future career opportunities. Through industry and university collaboration, students can improve their knowledge of technology development and industry practices. Dr Andy K H SEO, Vice President of the Federation of Malaysian manufacturers mentioned industry and university collaboration.
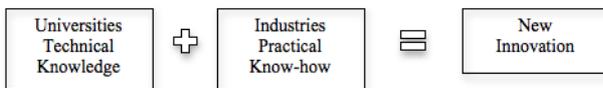

Figure 1. Win-Win relationship [2]

It is possible that academics might misunderstand or possibly overstate industry intentions which are clearly stated in a study of literature [2]. We need to clarify the industry expectations, requirements and conditions for academics in university collaboration.

III. RESEARCH METHODOLOGY

A. Paper based survey for students

The paper-based survey was conducted on the cohort of students in second year undergraduate engineering course. The survey questions were based on quantitative and qualitative analysis. In line with the ethics approval process and procedures, a third party carried out the paper based research survey. The data collected was anonymous and unidentified. The collected data was analysed to derive a quantitative outcome, which shows the students' perception on industry-university collaboration. The survey questions were proposed to analyse students experience and expectations on industry collaboration. The paper based survey questions were:

- What is meant by industry-university collaboration?
- List different ways to approach industry collaboration with an Engineering curriculum?
- At which level do you recommend a curriculum involve small or large industry based projects?
- How important is industry collaboration to your future career?
- How important is industry collaboration to your final year project?
- What is your assumption on graduate attributes, learning outcomes and industry based activities?
- To what extent do you feel industry collaboration will improve the graduates' ability to gain employment?

B. Face to face interview with staff

The face-to-face interviews were scheduled via e-mail or phone calls to indicate staff availability. Only the re-search assistant involved in this research project conducted the interviews. The plain language statement and consent form was attached with the initial e-mail sent to participants. The consent form was collected at the end of the interview. The call to participant was voluntary and did not infringe with any privacy requirements.

In line with the ethics approval process and procedures, the research assistant sent individual E-mails to every staff member in the School of Engineering. When a staff given an appointment time, the research assistant will conducted the face-to-face interview. An interview question set was asked to each staff that teaches and performs research in engineering design. The data collected was anonymous and non-identifiable. The collected data was analysed to derive a quantitative outcome that shows the staff perceptions on industry-university collaboration.

The data was collected through audio recordings during face-to-face interviews and it was fully non- identifiable and anonymous. No personal details were taken from the participants. Written consent forms from the participants will be maintained separately from the electronic data that is non-identifiable. Around 18 staff members who teach and perform research in engineering design at the School of engineering at Deakin University participated on face-to-face interviews. The inclusion criteria included staff members working in all engineering disciplines.

IV. RESULTS

A. Students views

Students and staff play a vital role in industry-university collaboration. It is always worth analyzing students' perspectives about their experience on industry-university collaboration. This research inclined to conduct a paper based survey with a cohort of students in second year undergraduate engineering course. Table I illustrates students' views on academic-industry partnerships. It was interesting to see that most of the students (34%) realized an industry-university collaboration is a supportive co-operation from both sides, which is a WIN – WIN situation. About 22% mentioned that an academic-industry partnership means sharing resources and funds to achieve a goal that benefits both sides.

Table II explains students' views on different ways to approach industry collaboration with engineering curriculum. Students (49%) believed that industry-university collaboration be approached through research projects (through industry sponsored projects), apprentice training and knowledge exchange events such as inviting industry representatives for guest lectures and organizing poster exhibitions.

TABLE I.
INDUSTRY-UNIVERSITY COLLABORATION

Students perceptions	%
Academic and industry partnership	11
Industry funding for university research activities	11
Technology/knowledge sharing by university and industry	22
Supportive cooperation from both sides Win-Win situation	34
Sharing research resources and funds to achieve a goal that benefits both sides	22

TABLE II.
DIFFERENT WAYS TO APPROACH INDUSTRY
COLLABORATION WITH ENGINEERING CURRICULUM

Students perceptions	%
Research projects, apprentice training and knowledge exchange events	49
Vacation employment and placements	16
Mutual understanding, industrial visit for students	11
Internship programs in engineering	12
Small research training that benefit students	12

Figure 2 shows students' views on recommending a curriculum to involve industry-based projects. About 44% students suggest to have industry based projects in year 3, 34% want projects in year 4 and 22% students expect industry projects in the year 2. John Webster [7] recommends that engineering courses must be outcome-oriented and equip graduates for lifelong learning. In addition, he also suggests that in an engineering first year, most of the time should spend on mathematical and scientific fundamentals that underpin all engineering disciplines. If the curriculum is based around projects, the actual projects should be defined and structured by teachers in the first year for students to obtain the fundamental knowledge. In the second and third year, students work in industry and/or community projects, and industry practice takes place in the final year [7]

The cohort of students of 55% and 44% says industry collaboration is necessary and does help with their future career (figure 3). Overall 100% of students revealed that industry collaboration is necessary and does help their final year project (figure 4). Figure 5 shows students views on industry collaboration. Approximately 100% of students mention that industry collaboration helps to improve the graduates' ability to gain employment.

It is interesting to look at figure 6 illustrates the student assumption on graduate attributes, learning outcomes and industry based activities. Students were given the option to rate their assumption from 1 to 5 (low to high level). Nearly 44% of students rated the curriculum content as rating 4 (high level) and industry based activities as rating 5 (very high level). Only 22% - 33% rated student initiative from 3 – 4 (Medium to High level). Overall, student views were expected to show more interest in curriculum content and industry based activities than their own initiatives. These survey results show students' involvement and expectations of industry-university collaboration.
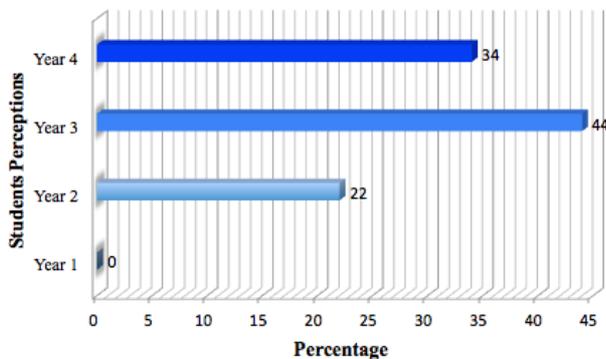

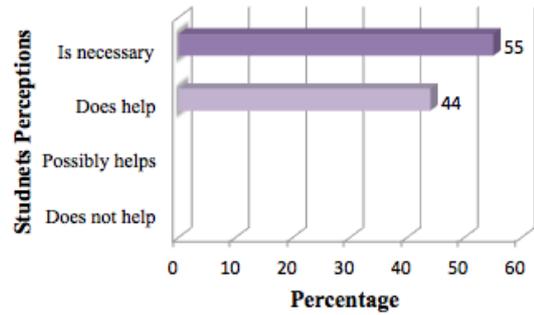Figure 2. Students recommending a curriculum to involve industry based projects

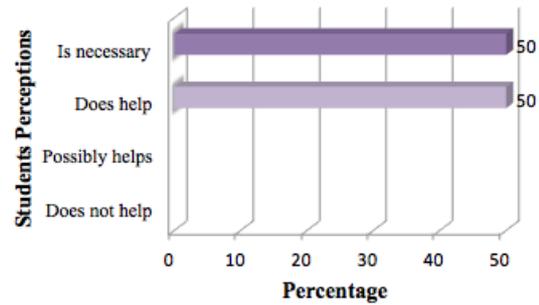Figure 3. Industry collaboration to future career

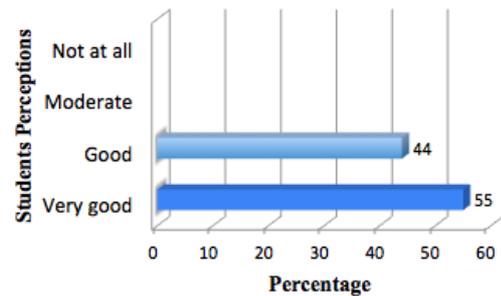Figure 4. Industry collaboration to final year project

Figure 5. Industry collaboration improves the graduates' ability to gain employment
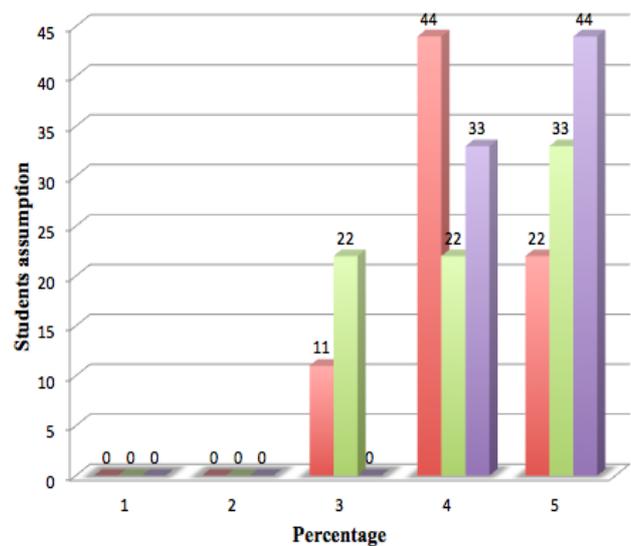

Figure 6. Student assumption on graduate attributes, learning outcomes and industry-based activities

B. Staff views

The staff members in the School of Engineering at Deakin University also illustrated their views on industry and university collaboration. Staff views were about understanding what the industry needs and strength of academics in industry collaboration were, identifying what the industry problems are, and what their capabilities are to solve these issues. Staff views were collected through face-to-face interviews, and collected data was presented in quantitative form. Table III illustrates staff views on how university collaborates with industry. Overall staff members expect industry and university to work together in research areas. As the university is a provider of engineering graduates to industry, there must be strong collaboration.

Table IV shows staff perceptions on curriculum involvement in industry-based projects. Roughly 92% of staff members say their curriculum involves industry-based projects through final year projects, industry placements in 2nd and 3rd year and through unit content (program structure). Only 8% say there is not much involvement of industry-based projects in their curriculum.

Staff members who practice design projects at Deakin University state their views on the impact of industry and university collaboration in Table V. Most of the staff members say industry and university collaboration is beneficial by implementing more industry relevant curriculum, which helps the students for their future career opportunities through short term and long-term industry based projects.

Table VI shows staff views on barriers to industry-university collaboration. Staff revealed that research priorities differ between university and industry, such as timing, short term or long-term research interest, lack of frequent communication, and investing funds for research. There is not enough space for student welfare or academic development in industry and university collaboration. Table VII illustrates staff perceptions on an academic curriculum displaying the expectations of industry requirements. More than 50% of staff expects the academic curriculum to have a flexible university system, which helps to maximize industry collaboration.

Table VIII explains staff views on their goals to drive the collaboration of industry and university. Table IX lists some staff teaching activities that help their curriculum include industry partnerships. A larger number of staff mentioned their teaching activities such as problem solving through final year projects and design projects by active learning.

TABLE III.
UNIVERSITY COLLABORATION WITH INDUSTRY

Staff perspectives	%
By attending relevant open meetings or workshop	21
Final year projects, industry placements, industry advisory boards	21
Through suppliers such as tooling companies satisfying research end users	18
Project collaboration, research or consulting	21
Curriculum industry readiness, several ways such as straight contract research, potential for more scientific problems (future needs) blue sky project, Engineering lecture (top researcher)	18

TABLE IV.
CURRICULUM INVOLVING INDUSTRY-BASED PROJECTS

Staff perspectives	%
Yes, through the final year project, 2nd/3rd year industry placements (scholarships for students)	92
No	8

TABLE V.
IMPACTS OF INDUSTRY-UNIVERSITY COLLABORATION

Staff perspectives	%
Research objectives will be more user friendly (Huge impacts)	14
Implementing more industry relevant curriculum, employable graduates, beneficial to students	35
Beneficial to overall development of science, industry and university, stakeholders in research	15
Benefit through small problems (industry), good for reputation, real world problems relevant to industry (university)	14
Learn more about the real application (university), solve problems wisely (industry), industry focus on specific problem	22

TABLE VI.
BARRIERS TO INDUSTRY-UNIVERSITY COLLABORATION

Staff perspectives	%
Industry focus on products but academic focus on research	28
Staff publish or perish, forced to focus on research, intellectual property issues, reluctance by staff	14
Lack of experience of staff in the industry, lack of contact (communication)	30
Timely availability of staff, dependent people, commitment of staff member, encouragement from management	14
Time issue, no funding, no interest, hard to fulfill the industry requirement	14

TABLE VII.
ACADEMIC CURRICULUM DISPLAYING INDUSTRY REQUIREMENT

Staff perspectives	%
60%	28
30%	14
Flexibility in university system	44
Should be maximized, align with industry	14

TABLE VIII.
GOALS TO DRIVE INDUSTRY-UNIVERSITY COLLABORATION

Staff perspectives	%
Through research collaboration, by partnership, patent and grants	28
To base our research on real time industrial environment. Be an efficient provider of solutions for growth of the industry and university	8
Correct balance of knowledge, skills, program relevant to industry requirement	28
Make easier for the industry, enhance certain academic professional skills, make students ready for jobs	21
Blue sky + big package projects, undergraduate training, final year projects, acknowledgement of expectations, courses with sufficient practical experience	15

TABLE IX.
TEACHING ACTIVITIES THAT HELP CURRICULUM TO INCLUDE INDUSTRY PARTNERSHIP

Staff perspectives	%
Inviting external speakers	14
Workshops, Industry partner mentoring	8
Guest lectures, focus identity groups	14
Making students adapt to practical based teaching such as in manufacturing	8
Problem solving relevant to industry, final year projects, industry placements, design projects	42
Active learning, group design work, industry based projects (12 weeks)	14

The overall staff perceptions explain their curiosity and flexibility in developing and improving industry collaboration. This is a positive sign for the School of Engineering at Deakin University to further develop industry partnerships. During the research process industry perspective on industry and university collaboration was also obtained. A paper-based survey was conducted with all industry representatives in an engineering industry advisory in the School of Engineering at Deakin University. Industry is always looking for revised skills from graduates to work on future customer needs in the industrial environment. Table X shows several attributes expected by the industry in recent graduates.

Industry expects graduates to be self-confident, ready to learn new things, to have good practical knowledge with management skills, communication with customers, analytical thinking and leadership skills. The overall industry perspectives are encouraging for academics. From these survey results, academics and industry are very clear they want to work together for enhanced collaboration.

V. COLLABORATIVE RESEARCH

Industrial participation in learning and teaching provides further opportunities for students to acquire knowledge on specialist engineering topics, awareness about industrial and commercial realities, and development of vital transferable skills. When identifying graduate attributes, particularly for undergraduate engineering programs in Australia, the program accrediting body (EA) initiates a set of attribute elements mentioned in 'Stage1 Competencies and Elements of Competency'. It states that one of the important abilities is the application of systematic engineering synthesis and design processes. Industry and academic collaborative research is highly regarded by the professional accreditation bodies such as Engineers Australia (EA), Accreditation Board of Engineering and Technology (ABET) and, European Accreditation of Engineering Programs (EUR-ACE) [8-10].

A research study performed by the Australian Industry Group (AIG) shows that most employers reported difficulty in recruiting people with practical trade skills as well as generic skills. The inadequate skills of existing employees were also reported [11]. Australian industries are facing an increasingly tougher environment. Graduates need world-class skills in order to survive and grow to compete with the current global manufacturing market. Universities need to deliver higher quality teaching and learning in engineering and technology. Collaborative research is a flexible approach that always opens new proposals and new partnerships.

This research study performed a paper-based survey to investigate industry and academic requirements for students focusing on achieving job ready skills through collaborative research. From the survey results, a collaborative research model for sustainable design for industry and academia is illustrated in figure 7.

University projects require students to undertake their own fact-finding and analysis, either from library/internet research or from gathering data empirically. Industry projects are project-based activities in partnership with an industry organisation. Students complete a research project focused on a given leisure, event or industry issue, problem or opportunity. Community projects provide a unique opportunity to extend student learning and broaden

TABLE X.
ATTRIBUTES LOOKED FOR IN RECENT GRADUATES

| Industry perspectives	%
Communication skills – leadership skills/ Industry knowledge / technical / analytical skills Broad management skills	28
Intelligent, forward thinking, takes responsibilities for their actions, willing to learn, has an understanding that engineering is a career not a means to make money	21
Technical knowledge, good personality, i.e., able to communicate at a reasonable level, have an open mind	14
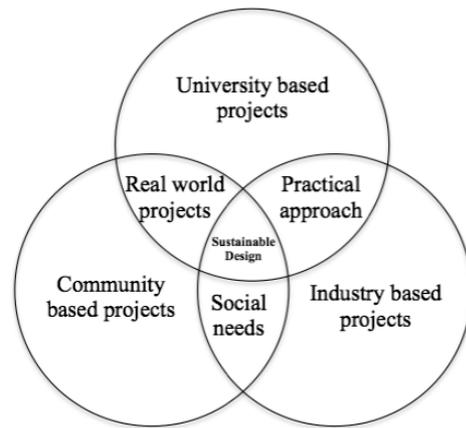
Figure 7. Collaborative research model

experiences beyond the academic environment. The collaborative research model benefits all the stakeholders such as students, industry, community, and of course the university[12-15]. It provides a framework for embedding experiential and rich learning activities, integrated with discipline-based curriculum that improves employment and career outcomes [16, 17].

VI. RECOMMENDATIONS

The 2010 Australian survey of student engagement (AUSSE) reported that Deakin first year students who engaged in their learning obtained sound learning outcomes in a supportive learning environment. The study also shows that Deakin's later year students were well prepared to enter the workforce (career readiness) through work integrated learning [18]. At Deakin University, work integrated learning contributes to provide opportunities for students to effectively combine study, work and other interests by integrating opportunities for experiential learning into appropriate courses. Deakin University has used its strong linkages with business, industry and community organizations in enhancing work integrated learning placements for the students [19].

Work integrated learning provides students the opportunity to learn a variety of skills by expanding the walls of classroom learning to include the community [20]. By narrowing the gap between theory and practice, work integrated learning creates meaning for students. They provide opportunities for students to learn a variety of skills through in-depth academic preparation with hands-on project focused experiences. Under the guidance of facilitators, students learn to work in teams, solve problems, and meet employers' expectations. Through work integrated learning experiences students see how classroom instruction connects to the world of work and future career opportunities. Experiences include, but not limited

to, apprenticeships, career fairs, field studies, guest speakers, job shadows, and student internships [20].

The collaboration of industry with university aims to approach practical knowledge applied with scientific knowledge created by academics to create innovative outcomes. It is necessary to establish a knowledge flow between industry and university that enhances collaborative knowledge on both sides. Table XI summarises the following key points for academics collaborating with industry and industry that seeks to collaborate with university staff members. Academia is a provider of graduates to industry. Universities have always enhanced partnership regulations to work with industry.

This research analysed the views of staff and industry representatives to propose an industry and academia-training agenda, which is shown below in Figure 8. The agenda includes industry partners acting as mentors for academic staff members to clarify what industry problems exist and what is needed to resolve these issues. Projects can be developed to resolve these issues will occur through industry advisory group meetings, industry based workshops, design discussion forums and identity focus groups.

VII. CONCLUSION

This research project analyses students and staff perceptions on academic-industry partnerships at Deakin University. The data was collected through paper-based surveys, face-to-face interviews, and focus groups. It remains a challenging task for academics and industry representatives to maintain active participation in industry-university collaboration. Academics and industry possibly maintain this sustained relationship by providing regular feedback, reviewing goals and objectives, improving communication, keeping focused and sharing the vision. It is clearly stated in this research that the students and staff obtained positive and encouraging views on industry-university collaboration. Students, staff realized the value of close collaboration between industry and university.

TABLE XI.
MOTIVATIONS FOR COLLABORATION

Motivations for collaboration	
Academics views	*Industry views*
a) To achieve knowledge development about practical problems useful for curriculum enhancement. b) To create internships and job placement opportunities for students. c) To obtain insights in the area of staff members own research. d) To examine the practical application of current research for future needs. e) To share government funding on small and big research projects.	f) To develop new product and processes. g) To improve product quality by enhancing research and development progress. h) To maintain an ongoing relationship with the university. i) To conduct blue-sky research and to recruit graduates. j) To conduct fundamental research with open research ideas.

Figure 8. Collaborative training agenda

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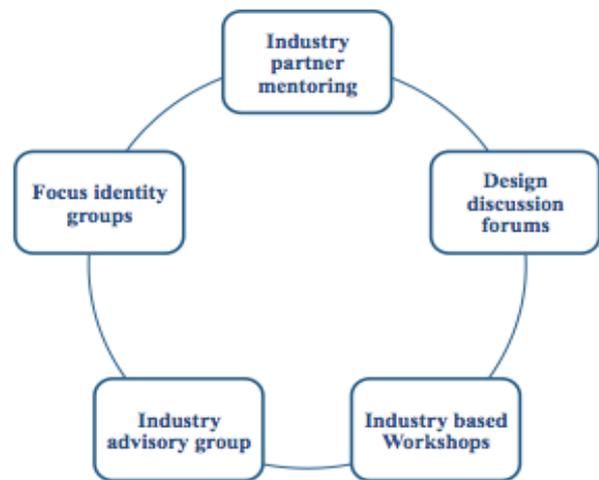
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