**PRIOR ART REPORT**

# INTRODUCTION

The purpose of this Prior Art Report is to look into what prior art exists with regard to the topics that the project spans. This means that for this project the purpose of the report is to uncover any related literature regarding questionnaire data creation and processing, algorithmic solutions to generate group assignments, and analytical tools to examine resulting outputs.

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## Document Context

Given the nature of this project, several universities have already created their own algorithmic solutions to assign students to projects, each with their own specifications and biases. While their reports provide a necessary foundation to glean insight from, no one solution satisfies everyone’s requirements. This is evident from the fact that several different teams have created similar but unique solutions. Additionally, several patented technologies are relevant to the project while only being designed for a tangentially related subject. Social media in particular has to digitize and define relationships between individuals based on characteristics for easy organization and use. The establishment of relationships between members is a central idea to the project development team’s goal with the major difference being the characteristics being used. The first phase of the student allocation process is the completion of several questionnaires that then have to be interpreted by a machine. This is a common step that any organization that wishes to convert human concepts into manageable data must perform. Patented solutions for survey processing are appropriate research materials as these technologies are required to create the characteristics the assignment algorithm relies on.

# OVERVIEW OF THE DESIGN PROBLEM

The project is the designing of a computer program to effectively create optimal group assignments of electrical and computer engineering students for capstone design projects at the University of Texas at Austin. The computer program takes in input files of the preference and areas of expertise of the students as well as expertise requirements from the industry companies and creates group assignments that best optimizes these factors while also preventing bad outlier teams or accounting for students who do not want to sign non-disclosure or intellectual property agreements. The computer program is important as it automates a currently manual process done by the professor and allows for faster creation of the groups.

# REVIEW OF THE PRIOR ART

Within the realm of prior art there is prior art exclusive of patent and prior art that is patented. There are seven total documents of prior art reviewed in this paper that will be useful for this project.

## First Prior Art Exclusive of Patent Information

The Project Group Assignment System by Kim Doyle, Susan Kroha, Arunima Palchowdhury, and Wei Xu of Pace University began work on a student assignment project under the guidance of Professor Charles Tappert in 2002 [1]. The project consisted in collecting together team member survey data (project preferences, availability times, preferred locations for meetings, academic/professional experience, etc.), executing an algorithm to assign members together into their teams based on such data and how it corresponds to project needs, and reassigning the remaining members where necessary. Having been implemented successfully in a capstone Software Engineering course for Pace University to hedge against potential problems such as tedium, wasted time, or unfair team-assignments, the project goals bear resemblance to our own, and their methodology can serve as a guide to our own. Though, we will want to implement certain additional features that allow our user to tweak factors underpinning the algorithm and to even provide additional criteria.

## Second Prior Art Exclusive of Patent Information

Mashael S. Maashi, Ghaida Almanea, Rajwah Alqurashi, Nouf Alharbi, Reem Alharka and Fahdah Alsadhan conducted a case study into a greedy linear heuristic algorithm to solve their engineering department’s student to project assignment issues for the King Saud University in Riyadh, Saudi Arabia in 2020 [2]. While this project has similar goals to the former, the team’s greedy approach results in two resultant stable-matchings, a best-possible for students and a best-possible for supervisors. The team emphasized their encounter with the issue of maximum stable-matching being an NP-hard problem. It may be that the team’s greedy linear heuristic approach will inspire our own algorithm, though we will have to decide on whether to seek after a student stable-match or a supervisor stable-match.

## Third Prior Art Exclusive of Patent Information

Brendan William McGuirk of the University of New Hampshire made creating a solution to organizing study groups for the university’s chemistry department the focus of his 2020 master’s thesis [3]. His thesis has been approved by Wheeler Ruml, the thesis director and professor of computer science, Marek Petrik, assistant professor of computer science, and Christopher Baur, professor of Chemistry. McGuirk developed an integer linear program solver to assign student groups within the Chemistry department with increasingly well-received results among students. He noted that the problem seems to fall between NP-hard and polynomial-time semi-assignment. Considering McGuirk’s positive results and extensive outline of his work, we may find it useful to follow his steps as we implement an algorithm into our system.

## Fourth Prior Art Exclusive of Patent Information

In 2007, Theodor Freiheit and Julian Wood detailed their solution to the student assignment problem for the University of Calgary’s capstone design course. Their solution is notable for the ability to download group reports to be viewed in excel sheets, a satisfaction score for both individual and group placements, and the elimination of unpopular projects from the pool of those available. Their algorithm is run multiple times to generate several different solutions so as to compare alternate combinations and their resultant scores. For an orderly runtime, the algorithm attempts to achieve project groups that manage to have an enrollment within a certain range or no members at all and stops when this has been achieved. Their solution includes what they have deemed the “Bumping Routine”, where students who were not assigned originally are directly examined for possible new solutions [4]. If one is not possible, the student is assigned to a group of students that were not able to be assigned so as to generate an incomplete solution. While this incomplete solution is not ideal, the ability for this algorithm to generate several different solutions to compare in an easily readable way is commendable and should be considered for our project’s own solution.

## Patent Search and Findings

It is not possible in the United States to patent an enumerated grouping of a purely abstract idea for organizing human activity, as indicated by the US Patent and Trademark Office[5]. This, however, is exactly the key issue of our project: to effectively and optimally organize groups of students based upon certain inputs and facilitate productive activity in Senior design projects. As such, we were only able to find patented works which were at most tangentially related to our own. Nevertheless, such works do provide some partial insights for a solution in our project.

## First Prior Art Patent

“Creating Groups of Users in a Social Networking System” was filed and granted as a patent in 2004 to Facebook, Inc., invented by Thomas M. Lento, Menlo Park, CA (US); Scott Alex Smith, San Mateo, CA (US); and David Edward Braginsky, San Francisco CA (US). The idea under this patent consists in organizing individuals within common social media networks based on commonly held characteristics between users and other individuals (or between individuals the user does not wish to be associated with); individuals are to be fed to the user as recommendations for possible friends. While our goal is not to feed friend list recommendations, the principle which facebook utilizes to make these recommendations, applied to the evaluation of characteristics among projects more or less appealing to students, will be relevant to more optimally pairing students with one another for their Senior design projects. Of particular interest is how the members of a specific group will change the suggestions generated using the collective feedback of all members.

## Second Prior Art Patent

“Survey Data Processing” was filed and granted as a patent in 2012 to Tata Consultancy Services in Mumbai, invented by Jayasekar Mani, Chennai (IN); Suresh Babu P., Chennai (IN); and Padmanaban Vadivel, Chennai (IN). The idea under the patent consists chiefly in [a] the polling of a survey question to a user, [b] the storing of the answer to that question in the form of an XML file, [c] the immediate semantic analysis of that answer, and [d] the dynamic generation of a new survey question to be sent to the original user, based upon the first response. It may indeed be that we wish to incorporate a feature that allows for the dynamic generation of needed survey questions dependent upon the inputs of companies, students, or the instructor.

## Third Prior Art Patent

As a potential patent, “Team Formation” was filed in 2008 and abandoned by IBM, invented by Michele M. Franceschini, White Plains, NY (US); Tin Kam Ho, Millburn, NJ (US), Luis A. Lastras-Montano, Cortlandt Manor, NY (US); Oded Shmueli, New York, NY (US); and Livio Soares, Yorktown Heights, NY (US). This idea consisted chiefly in grouping individuals into sets by means of vector-representations of individual concept sets (themselves containing individual concepts associated with other individuals) and of project concept sets (containing corresponding project concepts). It may well be that the use of vector representation–or of some other machine learning methods related to those outlined in this patent–could be utilized for the assignment of students into groups, especially insofar as we desire to create a program that can adapt to new conditions or requirements given as inputs by the instructor without having to change the code undergirding our application.

# IMPACT OF PRIOR ART SEARCH ON DESIGN DECISION-MAKING

Initially the search was reassuring in that there were other universities that had undergone the exact same problem and created a solution that would effectively create optimal groups based on an algorithm, the same process for this project. Additionally, the different approaches of each of the university sourced projects help to highlight that while each algorithm works to solve the same overall problem, the specifications of their criteria affect each of their resulting solutions, giving us insight into how to design the specifications for our criteria. In general the search for patents also brought to mind new ideas and concepts that could potentially be integrated, while remaining in scope, into the current conception of the project.

The prior information serves as a starting point to inform and guide the planning and creation of the project. Specifically, the algorithms and calculations for the goodness of a permutation, which was completed by other universities, will greatly inform the project due to the similarity. These other implementations are tailored to fit the criteria required by individual universities meaning that their solutions alone will not suffice for the University of Texas’ assignment problem. The patents included provide useful inspiration for meeting the specific challenges imposed by our client’s requests. Meta’s patented social media networking technology can be used in service for the dynamic optimizing of group assignments based on current and possible members. Tata Consultancy’s survey processing patent provides us with a possible feature by generating further questions to distinguish between students based on previous answers. IBM’s use of vector representation for the purpose of team assignment for their abandoned patent along with their use of machine learning technology provide a potential contemporary solution not yet implemented by previous universities.

# CONCLUSION

In looking to create a computer application to effectively assign electrical and computer engineering students to industry companies for capstone design projects based on preference and expertise factors, an analysis of prior art gives good information into what has been done before that is similar or relevant to this project. The main prior art investigated in this report were examples of group assignment algorithms and processes done at other universities and patented processes and technology that more broadly relate to and could be used to influence the process that this project will use to create the computer program. Each prior art has its own contribution to influencing ideas and changes that could be implemented into the development of the computer program for this project. For instance, the different approaches to grouping done at the various universities will certainly affect the algorithm that this project uses to group the students as well to evaluate the optimality of the groupings.

The next step after collecting this information is to present it to the client, Dr. Leonard Frank Register, and the mentor, Dr. Elizabeth Moliski, for further review to prepare and plan for beginning risk reduction experiments. Initial risk reduction experiments include creating prototype user interfaces for immediate feedback, drafting of the larger algorithm with smaller implementations of more complex aspects, and overall designing of important class objects; the information gathered and ideas formed through analyzing prior art will be vital in this step.

# REFERENCES

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