# The impact of engineering study on the development of self-stereotypes

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ABSTRACT: This article aims to reveal the characteristics of engineering students' stereotypes. Several studies reported that engineering stereotypes drive counterproductive practices. Thus, it is necessary to help instil new stereotypes and images of what it really means to be an engineer into the culture. The objective of this study was to test how students in different programmes and at different stages of development of their engineering knowledge think, and what qualities they attribute to the future professional occupations. For this study, an effective sample of 164 engineering students at Cracow University of Technology was used. The study of self-stereotypes was conducted among the freshman and senior students from the Faculties of Architecture and Civil Engineering. The results indicate the common determination of an engineer's description, and that the formation of self-stereotypes is supported by both the language and disciplinary differences across the study span. The students can reflect on these results and think about changing their work attitudes to align with what one really wants engineers to be.

Keywords: Stereotype, professional stereotypes, stereotype of an engineer, language, formation of stereotypes

## INTRODUCTION

The term *stereotype* derives from the Greek words *stereos*, firm, solid and *typos*, impression, hence, solid impression. The term comes from the printing trade and was first adopted in 1798 by Firmin Didot to describe a printing plate that duplicated any typography. The duplicate printing plate or the stereotype, is used for printing instead of the original. Outside printing, the first reference to *stereotype* was to be found in 1850, when it was used as a noun that meant *image perpetuated without change.* However, it was not until 1922 that *stereotype* was first used in the modern psychological sense by American journalist Walter Lippmann in his work *Public Opinion* [1].

Images and new age information and communication technology (ICT) shape the way individuals view both natural and social environments; thus, understanding the image and proper use of ICT by students in relation to engineers and engineering is extremely important. The general public and non-engineering students have an incomplete understanding of engineers and engineering as a profession [2][3].

Among several pieces of research about the general understanding of engineers, many have referred to the *conventional* stereotype of engineers as machine operators [4-6] with dominant adjectives to describe the profession as e.g. *accurate, hardworking, responsible, inventive*. Although this stereotype and related characteristics may exist among students, as well as the public, few investigations to date have focused on engineering students' ideas about engineers and engineering across the engineering study span.

## THE CONCEPT OF A STEREOTYPE IN SOCIAL SCIENCES

The concept of a stereotype has been permanently adopted by social science, but its definition has changed over the years, as has the ratio of researchers that process stereotyping. Initially, it was thought that the stereotype refers to social groups characterised by small cognitive activity. This can be accounted for as a kind of cognitive *laziness* [7]. The process of stereotyping was about the lack of analytical thinking about a particular person (or group of people) and the irrational perception of the world. Universal was also the view that the stereotype is an example of a rigidity of thinking [8], and even considering a person to be morally handicapped. Over time, these views have softened. It is worth noting at this point that by the 1950s, Allport (in his work *The Nature of Prejudice),* defined the stereotype without referring to its value aspect, and described it as an exaggerated belief associated with a particular category [9].

The definition most relevant and recognised by researchers of cognitive and social orientation is the one formulated by Ashmore and Del Boca, which specifies the stereotype as a …*combination of beliefs on the attributes of a certain group of people* [10].

Social, cultural and cognitive factors take part in the stereotype formation, which is associated with the way a group perceives its high position in the hierarchy. According to theory of social identity derived by Tajfela [11] and Turner [12], the membership of a group of people affects their self-esteem and, therefore, individuals increase their motivation to achieve and sustain a positive social identity, which is the basis of belonging to a particular group. The need for social identity and incentive mechanisms that stimulate positive assessment *of their* own traits, while viewing the negative traits in *foreigners*, contributes to the formation of social stereotypes.

The theory of auto-categorisation is the theory of the perception itself and it comes directly from social identity theory. However, leaving aside motivators, auto-categorisation is a theory of the cognitive system. People get a sense of *who they are* along with their participation in social groups and with the interpretation of the social context perceived similarity or they distinguish that sense from other participants in a given social situation. How people behave depends on how they perceive themselves in relation to others. The concept of *I* is made up of three auto-categorisation levels, namely: 1) *I* as a human being; 2) *I* as a member of various social groups; and 3) *I* as a unique unit of these levels. The levels are organised hierarchically. At different times, people see themselves as individual units compared with other units, and in other cases as members of groups in comparison with members of other groups [12][13].

## THE ROLE OF LANGUAGE IN THE FORMATION OF STEREOTYPES

There are several forms of transmission of stereotypes, which include verbal and non-verbal means of communication. When it comes to verbal communication, language is the most important way to transfer, define and assess the phenomenon of stereotyping. In the 1950s, Allport noted that …*linguistic concepts cannot only specify the content, but also serve as an organization and as a basis for the assessment of* [9]. So, one can talk about the content, as well as the relay functions, which are fully integrated with the context of the intergroup. The most important features include: 1) the transmission of stereotypes; 2) organisation of the content and structure of stereotyping groups; 3) maintaining stereotypes; and 4) expression through the language of stereotypical identity.

Stereotypes are an important element in the way people perceive the world and social groups. There are the judgments that people have about the group. Stereotypes exist due to the language, since the concept of language reflects the knowledge of a particular social group that works within their unit. The cognitive nature of stereotypes is manifested in linguistic categorisation.

The words *engineering* and *engineer* are derived from the French words: *ingénierie, ingénieur*. The French *ingénieur* (human creative mind, inventor, designer within the meaning of the designer and contractor in one) is an expression derived from the Latin *ingeniosus* (incl. *ingegnoso*) meaning a person who is trained, which again comes from the Latin *ingenium* (character, intelligence, talent) [14]. With the Latin language, the words engineering and engineer passed into other Indo-European languages. The semantics of the concept of engineer constitutes the basis for the search of characteristics, which are considered typical for people with this type of education. At the same time, a set of typical (and stereotypical auto- stereotypical) attributes that engineers have, can provide an important psychological mechanism that contributes to the perception of this professional group in a wider social context. Analysis of the terms used to describe engineers allows identifying their characteristics, *inter alia*, in terms of cognitive and emotional.

## RESEARCH OBJECTIVE

The objective of this research is to survey how engineering students think, and what qualities they attribute to the future profession of students from different engineering studies and across different stages of development of their engineering knowledge and skills. The findings may be useful in identifying differences in the way the role of a professional career as an engineer is perceived. They might also be used for changes in the long-term development of education and work related competencies, also at the global level, to achieve a competitive engineer competencies profile [15].

## STUDY GROUP

The sample consists of freshman engineering students and their senior counterparts (N = 164) from Cracow University of Technology. The students were recruited from two faculties, namely: 1) the Faculty of Architecture (N = 84) with 44 freshman students and 40 senior students; and 2) the Faculty of Civil Engineering (N = 80) with 40 freshman students and 40 senior counterparts. Gender was not evenly distributed; there were 72 male students and 92 female students. The majority of female students were from the Faculty of Architecture (N = 59) where a decisive learning style is an accommodator, with a strong perception of feelings and concrete actions [15]. Architects seem to be random learners with a global image on things, objects and other human-created environments [15]. Students from the Faculty of Civil Engineering are rather pragmatic, with a strong orientation on the sense of thinking along with doing active experiments [15]. Nevertheless, a sequential thinking about civil engineers boosts a deeper image on the human environment and how it is processed [15].

Both of the selected faculties aim to educate and train students for their future work as engineers, but, the process of developing study skills and knowledge differs in other areas. It is assumed that the subject matter depending on the field of study will reveal specific and distinct features of the stereotype of an engineer. It is also assumed that the students from the Faculty of Civil Engineering select more engineer-like stereotypical terms, while the stereotype's profile of the students from the Faculty of Architecture consists of fewer engineer-like stereotypical terms, especially, among the senior students.

## INSTRUMENT AND PROCEDURE

The Adjective Checklist - ACL consists of 300 adjectives and adjectival phrases commonly used to describe a person's personality (such as *intelligent*, *cautious*, *clear-thinking*, *determined* and *poised*) [16]. It may be administered to an individual to elicit a self-evaluation or a characterisation of someone or something else. Respondents select the adjectives that they believe describe themselves (or someone else). The assessment might be administered to an individual or used by researchers to describe study participants. The surveyed students were asked to choose an adjective which they associate with being an engineer.

Administration of the ACL was performed on site in the winter semester of 2015/2016. A high response rate was obtained by the direct presence of the instructor, researcher and test administrator. A paper and pencil survey was distributed accordingly. Data analysis was conducted using SPSS software (v. 22). Descriptive analyses were conducted to present the basic information and the frequencies of selected survey items from the ACL.

## RESULTS

The results are reported as frequency-preference items, selected as response alternatives from the ACL. Figure 1 depicts the results of the most popular five adjectives in the ACL describing person as an engineer. The results presented here apply to the entire sample including freshman students and their senior counterparts from the Faculty of Civil Engineering and from the Faculty of Architecture.

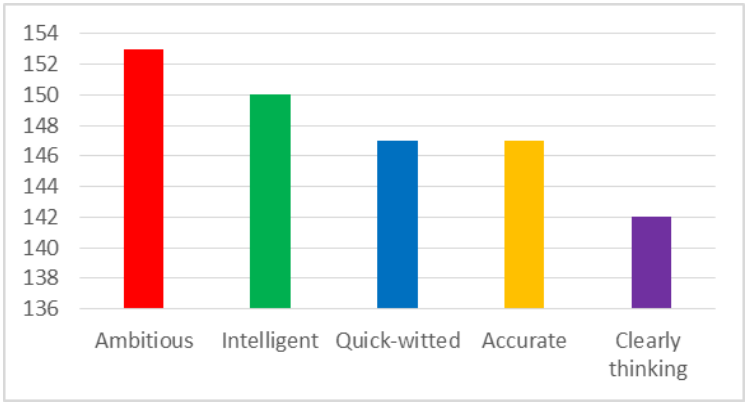


Figure 1: Characteristics of the most frequently chosen adjective in the entire test sample (N = 164).

The most common adjective of choice across the study sample was the adjective *ambitious* followed by the adjective *intelligent.* The adjectives *ambitious and intelligent* were almost evenly selected by both freshman and senior students. Male students perceived the adjective *ambitious* as dominant (*f* = 67) followed by the description *clearly thinking* and *intelligent* both with frequency of *f* = 65. The frequency of the most chosen response alternatives by females was markedly higher; namely: *ambitious* (*f* = 86) and *intelligent* (*f* = 85), but this was also due to a different (larger) sample size. As a significant distinguisher between the female and male engineering students' profiles, the adjective *accurate* appeared high for the female students (*f* = 83) along with adjective *quick-witted* (*f* = 82).

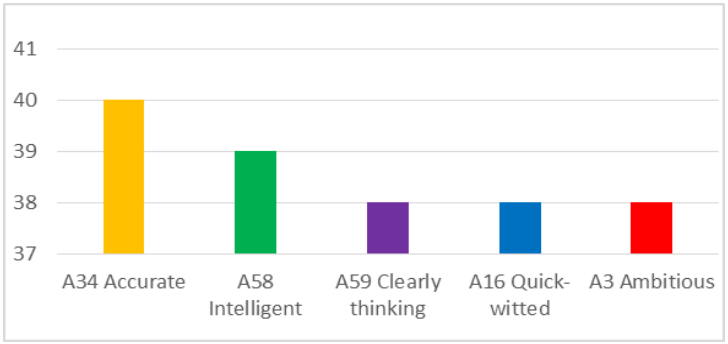


Figure 2: Characteristics of the most frequently chosen adjective (A) in the freshman group from the Faculty of Civil Engineering (N = 40).

The freshman students from the Faculty of Civil Engineering had the highest frequency, because in 40 cases, they recognised that the adjective *accurate* best describes the engineer (Figure 2). The senior students from the Faculty of Civil Engineering considered that the two adjectives *intelligent* and *ambitious* to be almost equal in describing the engineer (Figure 3).

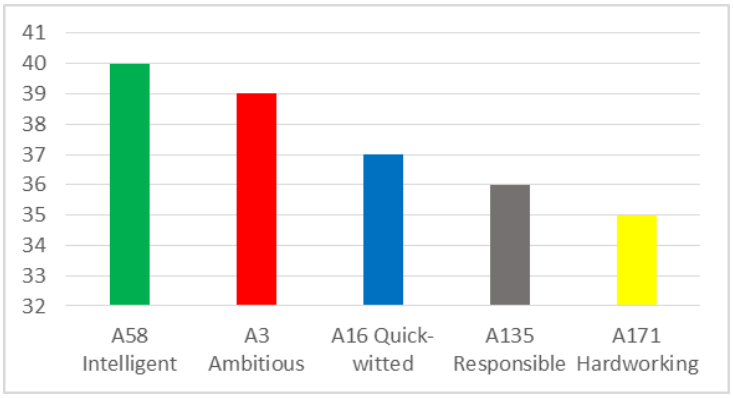


Figure 3: Characteristics of the most frequently chosen adjective (A) in the senior student group from Faculty of Civil Engineering (N = 40).

The freshman students from the Faculty of Architecture perceived two characteristics: *responsible* and *ambitious* to be the most characteristic in the description of an engineer (Figure 4).

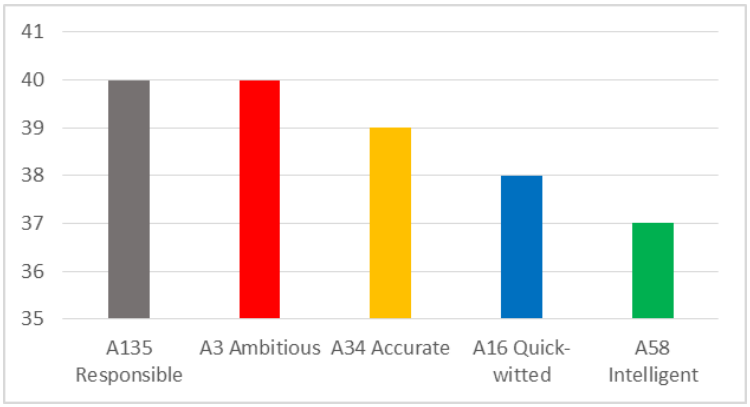


Figure 4: Characteristics of the most frequently chosen adjective (A) in the freshman student group at Faculty of Architecture (N = 44).

The senior students from the Faculty of Architecture selected most frequently the adjective *ambitious* in order to describe the engineer (Figure 5).

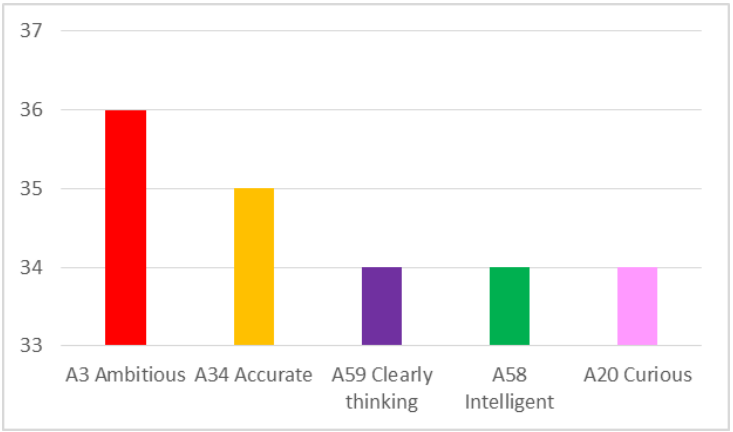


Figure 5: Characteristics of the most frequently chosen adjective (A) by the senior student group from the Faculty of Architecture (N = 40).

CONCLUSIONS

The present study yielded some interesting results. The cross examination of different faculties and different ages (levels of engineering knowledge and skills) of students (freshman student group, senior student group) revealed the following

similarities: adjectives, which appeared in all treated groups from both faculties identified *ambitious* and *intelligent* as strong qualities in the engineer. Next in line, based on the frequency of perceived alternatives, were the adjectives *quick-witted* and *accurate*. The term *clearly thinking* appeared in three of these results; namely, in the freshman group from the Faculty of Civil Engineering, in the senior group students from the Faculty of Architecture and in the characteristics of the most frequently chosen adjective in the whole test group. The adjective *responsible* starred in two groups; namely: in the senior students group from the Faculty of Civil Engineering and in the freshmen group from the Faculty of Architecture. The adjectives *hardworking* and *curious* emerged in the group of senior students from both disciplines.

Thus, it seems that among the surveyed groups of future engineers the description of an engineer shares common terms, such as *ambitious, intelligent, quick-witted and accurate*. Perhaps this result is swayed by the female dominant perception of an engineer.

At the same time, it is worth having a look at the differences revealed in the selection of descriptors among students of different years, studying at the same faculty. The students from the Faculty of Civil Engineering claimed that in addition to common terms like: ambitious, intelligent and quick-witted, the engineer is also *accurate* and *clearly thinking*, but this adjective only occurred in the group of freshman students. In contrast, the senior students considered that the engineer is also characterised by the words *hardworking* and *responsible*.

Among the students from the Faculty of Architecture, the most commonly selected adjectives were: *ambitious, intelligent* and *accurate;* one of them was different compared with the common choices among the students from the Faculty of Civil Engineering. The freshman group from the Faculty of Architecture recognised that the description of an engineer should include terms such as: *responsible, quick-witted,* while the senior students added other adjectives, such as *clearly thinking* and *curious* to the description of an engineer.

The results indicate that there is a common determination in describing a person as an engineer, and that the determination of students appears common for the different years of study and for the different disciplines of engineering. These descriptors correspond in a positive way to the definition and etymology of the word outlined in the introduction of this article.

It is worth noting that among the presented terms, there are only positive characteristics, confirming assumptions about the phenomenon of self-stereotype and the fact that the group's own engineers or engineering persons view themselves only in positive terms. In this article, the authors do not provide a comparison with results of engineering students profiled as not typical engineers.

However, as has been shown in other studies, when students think about the computer scientist, they often think of *geeky* guys who are socially awkward and infatuated with technology [17]. The work in computer science and engineering is seen as isolating and highly cost-effective, dissociated from communal goals, such as helping society and working with others [18][19].

The comparison of the most frequently selected adjectives in the Adjective Checklist that describe the engineer's profile by other group of students will be the subject of the next study, and the gender issue at engineering should also be discussed and tested more thoroughly.

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