IMAGES OF THE FUTURE: GENDER AND PORTRAYALS OF FACULTY AND INDUSTRY MEMBERS IN CANADIAN ENGINEERING SCHOOL RECRUITMENT MATERIALS

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Abstract –Engineering remains a male-dominated profession, despite efforts toward change. It is possible that the images used in undergraduate recruitment materials could influence how an individual might perceive their “fit” within engineering. We considered both the representation and context of individuals shown in images and videos collected from 18 Canadian English-language engineering schools, using content analysis. In this paper, we focus on individuals coded as either faculty or industry members, as they illustrate the future possibilities of a career in engineering in this material.

We found an overrepresentation of women faculty and women industry members compared to their population percentages at the schools (faculty) and in the profession (industry). We also found that women professionals of both types were under-represented among those professionals wearing business attire, and women industry members were over-represented among those industry members whose names and credentials were given, in both the images and videos.

We encountered a similar overall over-representation of women among student imagery, and suspect that it is the result of intentionally highlighting women within the schools and the field of engineering. However, we believe that context, as well as presence, matters. The under-representation of women in some cases is worth examining for the message it may send about the future prospects of a student considering engineering.

Keywords: Gender, recruitment, images, videos, content analysis, undergraduate engineering, faculty and industry members

1. INTRODUCTION

Engineering is still a predominantly male profession in Canada, despite efforts to increase the number of women [1]. While there are some concerns about retention [2], the imbalance primarily begins with the low enrolment of

women into engineering programs [3]. In exploring this issue, we previously examined Canadian engineering schools' recruitment materials for the presentation of gender in the text [4] and in the imagery involving students [5]. In this paper, we consider how people working in engineering – faculty members and industry members – are presented in recruitment materials, given that these images may also influence how students anticipate what a career in engineering might be like and what potential role models may be available for them along the way.

Based on our previous work, we suspect that a lot of importance is placed on the inclusion of women in recruitment materials, as we found that female students were being represented well above their actual enrolled levels [5]. This representation is notable given that both male and female students more often draw men when asked to draw a scientist [6], and given that textbooks for prerequisite high school science courses are likely to show only a small number of women scientists [7], along with other forms of subtle sexism in images [8]. The process of distinguishing between male and female occupations has been shown to begin sometime between childhood and adolescence [9]. Weisgram et al. shows that during childhood girls and boys have similar occupational values, but that during adolescence, these values begin to increasingly conform to the sex-segregated occupational structures and their attendant values (i.e. girls expressing a preference for altruistic occupations and boys expressing a preference for high status occupations). Gender identity becomes increasingly stable as youth enter adulthood, with masculine identifying persons expressing a preference for “thing” oriented occupations and feminine identifying persons expressing a preference for “people” oriented occupations [10], [11].

However, we believe it is equally important to consider the *context* of the image – where people are, what they are doing, and what they are wearing – because these factors can change the message being delivered. They can signal a person's social status through indicating

their role, competence, educational attainment, or industrial affiliation. For example, images of a person using a machine tool and a person watching as someone else uses it may provide different messages to the viewer about who is or is not knowledgeable and competent, who is in charge, and who belongs. The way women are presented in engineering recruitment materials is salient given that high-achieving female students have been shown to develop self-concepts wherein they see themselves as unlike other students in science, mathematics and engineering – an identity formation process associated with reduced interest in those fields [12]. The perceived availability of role models is one factor that has been shown to influence students' decisions to enter professions [13]. Images of faculty and industry members in recruitment materials is one medium through which potential role models – and the social environments they are situated within – are portrayed.

Our analysis is informed by the social constructionist assumption that language, symbols and images are fundamental to how individuals make meaning and understand the world [14]. In other words, how people feel about themselves (including their abilities and career prospects), how they are treated and expect to be treated by others, and what they think is possible, are all negotiated through interaction within the context of social institutions, such as work, school and the media. This study provides a baseline for what exists in the current recruitment documents; this will allow us to perform future work exploring the effect of changes from the status quo on student perceptions of engineering.

2. METHODS

We used content analysis to code images and videos collected during the 2014-2015 school year from the websites of 18 English-language Canadian engineering schools (out of a total of 38 such schools) representing a wide range of location, size, and female enrolment. This material was collected simultaneously with text used in another analysis [4]. Faculty members at these schools are 9.3-33.3% women, with all but one school below 19.5% women faculty, and with an overall median of 14.2% women faculty. The national average for practicing engineers is 13.3% women (including both P.Eng. and EIT), and 11.7% women among P.Eng. holders [15].

2.1. Image coding

440 unique images were analyzed from 17 schools (one school did not have images of people). Each image was assigned a unique image identification (ID) code. One coder examined each image and coded each person in the image, including assigning that person a unique person ID code, which was used in subsequent images if that individual appeared again in a recognizable way

within the collected material for a school. In images with many people, only individuals who could be clearly seen (faces were visible) were coded, and individuals in the background were not included.

Gender was coded as *male* or *female* based on outward gender presentation, with the assistance of captions when available, and we coded based on a gender binary, with people who could not be categorized coded as *unknown*, although we acknowledge that this may not adequately represent the gender spectrum.

Roles (student, faculty, industry, unknown) were determined through image context as well as captions and other textual information. We previously presented the *student* results [5], and in this paper we focus on the *faculty* and *industry* roles. (Coding details in [5]).

Setting (classroom, worksite, etc.), activity the person was engaging in (using tools, instructing, etc.), and attire (business clothing, safety clothing, etc.) were also coded, as well as whether names or credentials were provided.

2.2. Video coding

37 unique videos were analyzed from 11 schools. Each video was assigned a unique video ID code, and each scene (a temporally-, and sometimes physically-, grouped section of video) was also given a unique scene ID code. One coder examined each image and coded each person in the image, including assigning that person a unique person ID code, which was used in subsequent images if that individual appeared again in a recognizable way within the collected material for a school. In images with many people, only individuals who could be clearly seen (faces were visible) were coded, and individuals in the background were not included.

In addition to the categories above (gender, roles, activity, setting, names, credentials), videos were transcribed and word counts were used to measure the number of words spoken. We also measured the amount of time individuals appeared on screen and whether they spoke, or narrated when not on screen.

3. RESULTS

3.1 Image results

Of the 440 images that were coded, 149 images (33.9% of all images) from 13 schools included faculty, and 57 images (13.0% of all images) from 11 schools included industry members.

A total of 854 individuals appeared in images, and they were coded as students [5], faculty, industry members, and people whose role was unknown. Of these, 170 were faculty (21.8% of whom were women), and 104 were industry members (35.6% of whom were women) (Table 1).

Schools

The percentage of female faculty shown in images ranged from 0% to nearly 60%. The percentage of female industry professional engineers ranged from 0% to 66.7% (Table 2).

We calculated the mean fraction of women faculty in tenured/tenure-track positions (13.7%) and overall faculty positions (14.7%) for the particular schools these images came from, weighted for the number of images per school. In 6 cases, schools portray 0 female faculty in images, and in the remaining 7 cases women faculty account for an average of 28.8% of faculty in images. This suggests that at schools where women faculty are portrayed in images, they are portrayed at rates that are

disproportionate to their institutional presence. Professional engineers are similarly over-represented. Compared to the national practice statistics (13.3% EIT + P.Eng. and 11.7% P.Eng. only), when industry professionals are included in images (10 out of the 13 schools), they comprise 44.9% of industry professionals portrayed.

Table 1: Distribution of people by role and gender in images.

All images	Total	Male	Female	% female in images
Faculty	170	133	37	21.8%
Industry	104	67	37	35.6%

Table 2: Faculty and industry members in images by school. Number of images with faculty (149 of 440 images) and industry (57 of 440 images), percent women faculty and industry in images, percent faculty (total and tenured/tenure track) [1], percent women P.Eng. and E.I.T. (by province of school) [15], and percent women students enrolled. Indust. = industry member, ten. = tenured/tenure-track, prov. = provincial values, stud. = students. [1], [15].

School	No. images			% women						
	Total	Incl. faculty	Incl. indust.	Among faculty in images	Faculty (all)	Faculty (ten.)	Among indust. in images	PEng (prov.)	EIT (prov.)	Enrol. (stud.)
Alberta	18	3	-	20.0%	9.4%	9.4%	-	-	-	20.0%
Carleton	62	12	3	58.3%	10.2%	9.9%	66.7%	11.2%	19.5%	13.9%
Concordia	9	1	2	0%	16.5%	16.4%	22.2%	13.6%	17.4%	19.6%
Dalhousie	10	1	1	0%	13.8%	15.2%	50.0%	11.0%	17.9%	19.7%
Manitoba	10	4	1	0%	12.5%	12.2%	33.3%	8.4%	15.6%	17.7%
McGill	107	36	30	10.4%	11.9%	11.2%	34.0%	13.6%	17.4%	22.8%
Memorial	12	2	2	50.0%	14.2%	13.4%	66.7%	9.2%	28.2%	26.1%
Regina	5	1	2	0%	15.3%	16.7%	0%	9.2%	18.4%	23.0%
SFU	76	65	2	26.4%	16.7%	15.3%	14.2%	9.9%	20.1%	13.9%
UBCV	31	1	3	0%	15.0%	10.2%	60.0%	9.9%	20.1%	21.2%
UNB	35	2	3	0%	11.2%	13.1%	66.7%	13.2%	16.9%	15.4%
UPEI	9	6	-	16.7%	33.3%	25.0%	-	-	-	14.2%
Waterloo	40	15	8	20%	14.3%	13.9%	35.3%	11.2%	19.5%	18.8%

Setting

Women industry members made up a larger percentage of professionals in irrelevant settings than expected by their prevalence in the images (Table 3). Among relevant settings (laboratory, classroom, worksites), women faculty are over-represented in laboratory or worksite settings, following the pattern we found with female engineering students [5]. Women industry members are shown at a worksite at about their expected prevalence (Table 4).

Activities

There were very few images showing either group doing activities – most of the images were of people posing. Because of the small numbers, it is likely to be

over-reaching to identify any differences, though the high percentage of women industry members who are shown using machines or tools is striking (Table 5).

Table 3: Relevance of settings by male and female faculty and industry members in images.

Faculty	Men	Women	% female
Relevant setting	59	13	18%
Irrelevant setting	74	24	23%
Industry	Men	Women	% female
Relevant setting	60	29	33%
Irrelevant setting	7	8	53%

Table 4: Specific relevant settings by male and female faculty and industry members in images.

Faculty	Men	Women	% female
Laboratory	11	6	35%
Classroom	10	2	17%
Worksite	2	1	33%
Industry	Men	Women	% female
Laboratory	7	2	22%
Classroom	0	0	-
Worksite	24	12	33%

Table 5: Specific activities by male and female faculty and industry members in images.

Faculty	Men	Women	% female
Using computer/mobile device	0	0	-
Using machine/tool	5	0	0%
Writing	1	0	0%
Guiding	7	1	13%
Observing	9	3	25%
Posing	108	32	23%
Industry	Men	Women	% female
Using computer/mobile device	2	0	0%
Using machine/tool	4	4	50%
Writing	3	2	40%
Guiding	5	4	44%
Observing	13	4	24%
Posing	33	20	38%

Attire

The number of faculty wearing safety attire was small, so we should be cautious about interpretations, however women are shown wearing it at rates above what is expected based on their overall representation in the images (Table 6). Women industry members are shown wearing safety attire on the body at higher than expected proportions. Both women faculty and industry members were portrayed wearing business attire at rates below what is expected based on overall representation, with faculty members being well below.

Names/credentials

Among industry members, women's names and credentials were given at rates well above what was expected based on overall representation in images (Table 7).

Table 6: Attire by male and female faculty and industry members in images.

Faculty	Men	Women	% female
Safety attire on head (glasses, hard hat)	3	2	40%
Safety attire on body	3	2	40%
Business clothes	111	15	12%
Industry	Men	Women	% female
Safety attire on head (glasses, hard hat)	16	8	33%
Safety attire on body	12	10	45%
Business clothes	42	17	29%

Table 7: Names or credentials given for faculty and industry members by gender in images.

Faculty	Men	Women	% female
Named	85	28	25%
Credentials given	73	27	27%
Industry	Men	Women	% female
Named	9	8	47%
Credentials given	4	5	56%

3.2 Video results

Of the 37 videos that were coded, 27 videos (73%) at 10 schools included faculty members (106 scenes, some of which included more than one faculty member), and 15 videos (41%) at 7 schools included industry members (47 scenes, some of which included more than one industry member) (Table 8).

Table 8: Distribution of people by role and gender in videos.

All videos	Total	Male	Female	% female in images
Faculty	98	74	24	24.5%
Industry	53	41	12	22.6%

98 unique faculty members appeared in the videos, with some appearing in as many as four scenes, for a total of 117 person-scenes. 53 unique industry members appeared in videos, again with some appearing in up to 4 scenes, for 64 person-scenes. Of 117 person-scenes with faculty, 23.9% involved women faculty members. And,

of 64 person-scenes with industry members, 23.4% involved women industry members.

Schools

The mean percentage of women faculty for the schools listed (weighted by number of observations per school) are 13.2% for all faculty, and 12.6% for tenured/tenure track faculty. For the provinces of the

schools with videos, an average of 11.0% of P.Eng. holders and 20.6% of EITs are women (weighted by number of observations per school; Table 9).

Settings

Women industry members are in irrelevant settings at rates lower than expected by their prevalence in the videos (Table 10).

Table 9: Faculty and industry members in videos by school. Number of videos, total words spoken per video, total persons in videos (industry or faculty), percent women faculty and industry members in videos and percent women students enrolled, as well as the percent faculty who are women at each school, and the percentage of P.Eng. and E.I.T. holders who are women in each school's home province [1], [15].

School	No. videos, total words, included faculty and industry				% women						
	No.	Total words	Incl. fac.	Incl. ind.	Among fac. in videos	Fac. (all)	Fac. (ten.)	Among ind. in videos	PEng (prov.)	EIT (prov.)	Enrol. (stud.)
BCIT	2	635	7	-	14.3%	11.6%	11.6%	-	-	-	9.3%
Carleton	10	4320	29	4	27.6%	10.2%	9.9%	25.0%	11.2%	19.5%	13.9%
Concordia	1	421	8	-	12.5%	16.4%	16.4%	-	-	-	19.6%
Conestoga	3	2043	12	-	8.3%	10.0%	10.0%	-	-	-	5.1%
Manitoba	1	1212	11	7	18.2%	12.5%	12.2%	57.1%	8.4%	15.6%	17.8%
McGill	2	997	6	9	50.0%	11.9%	11.2%	55.6%	13.6%	17.4%	22.8%
Memorial	7	5549	29	25	41.4%	14.3%	13.4%	12.0%	9.2%	28.2%	26.1%
SFU	3	999	3	1	0%	16.7%	15.4%	0%	9.9%	20.1%	13.9%
UNB	4	1031	7	6	0%	11.3%	13.1%	33.3%	13.2%	16.9%	14.3%
UPEI	3	1151	5	12	0%	33.3%	25.0%	0%	13.0%	12.3%	18.8%

Table 10: Relevance of first setting by male and female faculty and industry members in videos.

Faculty	Men	Women	% female
Relevant setting	71	21	23%
Irrelevant setting	15	5	25%
Industry	Men	Women	% female
Relevant setting	32	11	26%
Irrelevant setting	17	3	15%

Table 11: Relevance of settings by male and female faculty and industry members in videos (all settings included).

Faculty	Men	Women	% female
Laboratory	52	18	26%
Classroom	10	4	29%
Worksite	0	0	-
Industry	Men	Women	% female
Laboratory	2	3	60%
Classroom	12	1	8%
Worksite	14	0	0%

Women faculty were shown in a classroom at a higher proportion than expected (Table 11). Women industry members were shown at well over their overall representation (60%) in laboratory settings, and no women industry members were shown at worksites.

Activities

Again, there were few faculty members engaged in some activities, so we must be careful not to overreach. In activities with greater than 10 total faculty members, women are depicted at about their expected rate (based on their overall presence in the videos; Table 12). We have similar low overall numbers in the industry member video imagery, but, in the single case with more than 10 samples, women industry members were depicted at well below their expected rate in observing.

Attire

Women faculty and industry members are depicted in safety attire above expected rates, and business clothes below expected rates, based on overall representation (Table 13). Significantly, no women industry members are shown wearing safety attire, which we have posited may be a visible marker of “being” an engineer.

Table 12: Specific activities by male and female industry and faculty members in videos (all activities included).

Faculty	Men	Women	% female
Using computer/mobile device	1	0	0%
Using machine/tool	8	3	27.3%
Writing	3	0	0%
Guiding	34	11	24.4%
Observing	15	5	25.0%
Posing	3	3	50.0%
Industry	Men	Women	% female
Using computer/mobile device	0	0	-
Using machine/tool	4	1	20.0%
Writing	0	0	-
Guiding	3	3	50.0%
Observing	18	1	5.3%
Posing	0	0	-

Table 13: Attire by male and female faculty and industry members in videos.

Faculty	Men	Women	% female
Safety attire on head (glasses, hard hat)	12	5	29.4%
Safety attire on body	12	7	36.8%
Business clothes	39	7	15.2%
Industry	Men	Women	% female
Safety attire on head (glasses, hard hat)	11	0	0%
Safety attire on body	8	0	0%
Business clothes	32	8	20.0%

Names/credentials

Women faculty were named and assigned a credential at a lower proportion than expected by their overall representation in the videos; women industry members were at a higher proportion than expected (Table 14). Women faculty may be under-assigned an important status distinction in videos and women industry members are assigned this status distinction at higher than expected rates.

Table 14: Names or credentials given for faculty and industry members in videos.

Faculty	Men	Women	% female
Named	35	7	16.7%
Credentials given	30	7	19.0%
Industry	Men	Women	% female
Named	17	10	37.0%
Credentials given	17	10	37.0%

Video-specific (speaking, narrating, and screen time)

There is no clear trend for screen time, based on our categories (Table 15). If we group appearances into “below 10 seconds”, and “10 seconds or more”, women faculty appear at about their expected proportions (24% and 25%), and women industry members appear at a higher rate in longer shots (21% to 29%).

Table 15: Screen time for faculty and industry members by gender in videos.

Faculty	Men	Women	% female
< 2 seconds	9	4	30.8%
< 5 seconds	44	15	25.4%
< 10 seconds	12	1	7.7%
10-30 seconds	16	6	27.3%
> 30 seconds	3	1	25.0%
> 1 minute	5	1	16.7%
Industry	Men	Women	% female
< 2 seconds	22	3	12.0%
< 5 seconds	7	3	30.0%
< 10 seconds	5	3	37.5%
10-30 seconds	9	4	30.8%
> 30 seconds	5	2	28.6%
> 1 minute	1	0	0%

Videos were often narrated or had people talking off-screen. In these cases, women faculty were represented at rates a little lower than expected compared to their visual representation in videos (Table 16). Women industry members spoke or narrated off-screen at rates that were higher than expected given their representation in videos.

Table 16: Speaking and narrating when off-screen for faculty and industry members by gender in videos.

Faculty	Men	Women	% female
Speak	32	9	22.0%
Narrate	27	6	18.2%
Industry	Men	Women	% female
Speak	23	10	30.3%
Narrate	18	10	35.7%

3.3 Video transcripts

Words spoken

There were a total of 121,928 words spoken by people of every role in the collected videos. Of these, 29,295 (24.0%) and 15,413 (12.6%) were spoken by industry members. Women faculty and industry members spoke a number of words proportionate to their representation in the videos (Table 17).

Table 17: Distribution of words spoken by gender in videos.

All videos	Male	Female	% female spoken words
Faculty	21869	7426	25.3%
Industry	12041	3372	21.9%

4. DISCUSSION

In the images, we saw an over-representation of both women faculty and industry members compared to their presence at the included schools (faculty: 22% versus 15%) and in professional societies in the provinces with those schools (industry: 36% versus 13%). In the videos, we also saw an over-representation, with women comprising 24.5% of faculty (98 total) and 22.6% of industry members (53 total). This over-representation of women reflects only schools that contain faculty or industry members in images or videos, and were included in the analysis. Looking at the entire sample of 18 schools, we found that 10 schools did not utilize any images of women faculty (5 featured only men), and 11 did not use women faculty in videos (3 of these featured male faculty). Likewise, 8 schools did not feature any images of women industry members (3 of these featured male industry members), and 13 schools did not include any videos of women industry members (5 included only men). Women, when they are portrayed, are over-represented, but in many cases they are left out of the camera entirely.

We encountered a similar over-representation of women among student imagery, and suspect that it is the result of intentionally highlighting women within the schools and the field of engineering. While it is generally positive to portray engineering as a field accessible to women, the overrepresentation of women in recruitment images could also potentially create expectations for gender demographics for role models in school and the workplace that may not be realistic for students who enroll in the near future. Furthermore, we believe that context, as well as presence, matters. The under-representation of women in some contexts (for example, wearing business clothes) is worth examining for the message it may send about the future prospects of a student considering engineering.

One notable finding relates to attire. In both images and videos, women are consistently shown less often wearing business clothing than expected due to their overall representation. This pattern holds for both faculty and industry, and parallels representations of women students in Canadian engineering recruitment materials [5]. This trend is worthy of consideration given that status is conveyed through business attire. For instance, research documents that students believe professors adorned in formal clothing are more credible than those in casual attire [16]. Women industry members' names and credentials were given at a higher rate than expected in both the videos and images.

There was a mix of results about women faculty and industry members in irrelevant settings, which specific relevant settings, and wearing safety and business attire. The relatively consistent proportion of faculty members show in relevant and irrelevant settings may relate to the lack of using stock photos to represent this group (unlike what may be a higher rate of women *students* appearing in stock photos). Women industry members are shown at a high proportion of irrelevant settings in the images, and a low proportion of irrelevant settings in the videos. It is not clear why there is a difference. Meanwhile, women industry members are appropriately represented at worksites in images, but there are no industry members portrayed at worksites in videos, and women faculty members are underrepresented in images of classrooms, but overrepresented in videos of classrooms.

For safety attire, there was a mixed result as well, with relatively few people of either gender wearing it. However, the lack of any women industry members wearing safety attire in the videos may represent a missed opportunity to highlight the technical background of women professionals through signaling their belonging in engineering.

Beyond gender identity, social status has a similar level of importance to an individual's identity and it is interesting to see how social status is signaled in images and videos. Women faculty are named and assigned credentials at lower than expected rates compared to both their representation and compared to women industry members. Industry women are named and assigned credentials at rates that are much higher than we expect given their representation in images and videos. Women industry members are also given narrating and speaking roles in videos at higher than expected rates. This trend suggests that women in industry are being assigned higher status compared to women faculty in images and videos.

One reason for this might be that women industry members are identified through professional networks, while faculty members are seen as easily accessible on a university campus. But another possible explanation is that women academics have not been as successful as women in industry at advocating for recognition.

From a social constructionist perspective, it is important to notice that the portrayal of women in engineering school recruitment websites is uneven, that women are over-represented when they are represented at all, and that they are portrayed in ways that are unpredictable. These images and videos are communicating a version of femininity and gender, and are a reflection of the institutional context of engineering in Canada. Our contribution to this conversation is to call attention to how gender is being depicted with the goal of helping institutions reflect and determine what version of gender they want to promote.

We acknowledge that:

1. We have drawn upon a gender binary in coding these images and videos – a binary that may not reflect all lived experiences.
2. We do not know how students perceive these images and videos, which is an area for future research.
3. There were fewer industry and faculty members in the recruitment materials compared to students, and the low numbers inhibit drawing conclusions (particularly about activities).

5. CONCLUSION

There was clear over-representation of women as both faculty and industry members in the Canadian engineering school recruitment materials examined, which we suspect is due to intentionally highlighting women engineers. Women professionals of both types were portrayed less frequently in business attire than their overall proportion in the images and videos suggests, and women industry members were consistently named and credentialed at higher rates than expected. These results may lead to conflicting messages about the place and importance of women in engineering.

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