EARLY CAREER PATTERNS, EXPERIENCES, AND INFLUENCES: REFLECTIONS FROM WOMEN ENGINEERS IN SENIOR ROLES

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ABSTRACT

Early career experiences provide the foundation for career progression and inform career choices and decisions. For women in the engineering profession, positive early career experiences have been linked to persistence and retention within the profession A recent focus on early careers within engineering has provided insight into early career role types and related competencies, competency and capability gaps experienced by novice engineers, and their perceptions of meaningful engineering work. There is opportunity to diversify and contextualise this understanding by exploring early career experiences of women working within the engineering profession, and by considering the influence of gender on early career experiences and decisions.

This paper reports on an empirical investigation of the career experiences of 22 women engineers in senior roles within engineering organisations in the Australian context. Phenomenological and temporal analysis of their career reflections provides evidence of three early career patterns of varied sequence and focus. The influences shaping these career paths are described. By making explicit possible, diverse early career paths, determinants and outcomes, this paper aims to continue to bridge the engineering education-practice gap and to contribute to greater equality, diversity, and inclusion within the profession.

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1 EARLY CAREERS IN ENGINEERING

1.1 Early Engineering Careers

Engineering careers are diverse, with divergence observed from early career [1]. The understanding of early career experiences, as an aspect of engineering practice, is important as they provide the foundation for career progression and inform career choices and decisions.

Early careers within engineering have been conceptualised according to role type and focus, for example: technical, managerial, entrepreneurial, project-based [2]. An alternative approach by [3] provides a nuanced insight into the types of roles occupied by junior engineers by considering role expectations, rather than role type. Examination of engineers' pathways to senior roles provides information about the early career paths and mobility patterns. [4] found that the length of time spent in by engineers in early roles and the mechanisms by which they moved beyond these into more senior roles varied, according to the type of senior role.

The competencies and capabilities required to perform the early engineering roles have been identified. While there are generic graduate competencies [5], early career competency priorities vary according to the type/expectation of the role and the context of the role (i.e.: organisation, industry, country) [3]. Capability 'gaps' experienced by young engineers, encompass personal attributes, relational capabilities, cognitive abilities such as lateral thinking and problem solving, and industry-specific knowledge [6].

Exploring engineers' lived experiences has revealed motivations, values and meaning for early career engineers. [7, 8] highlight the importance of agency, relational and structural factors on the quality of early career experiences.

1.2 The Current Study

While it is recognised that women in the engineering profession experience reduced rates of participation and progress than their male colleagues [9], the 'early careers in engineering' research has not considered the career patterns and experiences of female engineers. To this end, this paper explores the early career experiences of senior women engineers in Australia. The aims of this paper are to identify and describe i) their early career patterns and ii) the key factors that have shaped their early career patterns and experiences.

The paper contributes to a more expansive, inclusive, and nuanced understanding of early careers in the engineering profession. By making explicit possible, diverse early career paths and determinants, this paper aims to continue to bridge the engineering education-practice gap and to contribute to greater equality, diversity, and inclusion within the profession.

2 METHODOLOGY

2.1 Theoretical Framework

This paper draws on a broader study informed by phenomenological and feminist perspectives to investigate women engineers' experiences of transition to positions of influence within technical organisations. The phenomenological perspective focused the research on the phenomenon of movement into management and leadership roles, and placed to accounts and experiences of the participants at the centre of the research [10]. The feminist perspective acknowledged gender as a basic organising principle, and that choices made and experiences relayed by participants were shaped by gendered social systems and organisations [11]. It also acknowledged the absence of women's perspectives from the current understanding of engineering careers.

2.2 Data Collection

Semi structured in depth interviews were conducted with 22 degree-qualified engineers who self-identified as female, and as working in a managerial or leadership role in a technical organisation within Australia for a minimum of 12 months. Participant recruitment used criterion and snowball sampling, drawing on the membership of Engineers Australia (the national peak professional representative body), and the authors' professional networks.

The focus on technical organisations excluded engineers who had left the profession or were pursuing alterative careers in non-engineering centric industries or organisations. An objective of the broader study was to understand the conceptions of management and leadership form the points of view of the participants. As such, a managerial or leadership role was not pre-defined.

Participants were employed in a range of industries and organisation types, including technical service companies, consultancies, government organisations and owner companies, across resource, infrastructure, construction, transport, and defence industries. The types of managerial and leadership roles that the participants held were predominantly in middle management. Managerial or leadership experience ranged from 12 months to over 20 years.

Interviews focused on engineers' experience of becoming manager and leaders in the engineering profession. Interviews lasted between 45 to 80 minutes.

2.3 Data Analysis

The Broader Study

Interview transcripts were analysed using phenomenological and temporal approaches, informed by Van Manen and Moustakas [10, 12]. Phenomenological analysis yielded ten key themes that were condensed into three categories, representing the influences shaping the women's transition to management and leadership roles:

- Individual: relating to participants' characteristics, motivations, agency, and identity.

- Relational: relating to the influence of other people on women's career advancement, including relational capitals such as reputation, credibility, and visibility.
- Structural: relating to the influence of 'structures' including the organisation, the engineering profession, and broader society.

Consideration of the move to management and leadership roles as an experience unfolding over time generated a series of transition phases: 'Getting Started', Making a Move', 'Encountering Change and Challenge', 'Negotiating the Environment' and 'Resolving and Reconceptualising'. A detailed discussion of identified themes and categories is presented elsewhere [13].

The Current Paper

While not a primary focus of the broader study, the detail provided in interviews by participants about their early careers was surprising and indicated the importance of this career stage. Women engineers' transition to manager and leader was revealed as a process commencing in and influenced by early career experiences.

For this paper, we revisited the participants' career narratives to focus on the early career stage. To address the first aim of the paper, a chronological sequence of roles preceding and following the first management or leadership role established for each participant. Role sequences were then categorised according to the types of roles characterising early career and the timing of the first manager/leader role. To address the second aim of the paper, interpretation of the phenomenological themes and categories focused on sections of transcript relating to early career.

In engineering practice research, early career is considered as the period following graduation from an engineering qualification at university and entry to the engineering profession as a graduate or novice engineer, to the point in time when a professional engineer can work unsupervised [14]. This may be marked by a professional or organisational norm such as chartership or reaching of a certain level within the organisation. For our study, we focused on the first 7 years of participants' careers. This is a critical career point for women engineers, after which their attrition from the profession is thought to peak.

3 RESULTS AND DISCUSSION

3.1 Early Career Patterns

Three early career patterns emerged from the data. They are presented in Table 2, with indicative early career role focus and timing of the move to first managerial role (as average years of engineering experience).

Table 2. Early Career Patterns of Women Engineers

Pattern **(Number of participants)**	**Early Career Role Focus**	**First M/L Role Timing (average years)**

Early Responsibility (6)	Technical, then quickly into a management/leadership role	2 years
Solid Technical (15)	Technical	11 years
Broadening (1)	Technical plus other functional roles	9 years

Most participants described a 'Solid Technical' early career pattern, characterised by technically focused engineering roles with increasing seniority and autonomy. This is akin to the 'technical' track commonly documented in engineering careers literature. The dominance of this career path is not surprising, given the technical basis of the engineering profession. [4] describe these early career engineers as highly driven problem solvers motivated by complex technical challenges. They make career choices to align with these preferences and are likely to occupy Technical Specialist roles later in their careers. This was partly supported by our findings. Some women with this early career path did display a strong technical orientation, however others used this as a mechanism for navigating motherhood during early career, going on to occupy broader roles in later career rather than remain as technical specialists.

A smaller group had 'Early Responsibility' moving into management/leadership roles quickly. This included women in the military, where technical and managerial responsibilities are combined from the start of career. Early career engineers following an Early Responsibility pathway moved quickly out of technically focused engineering roles into project management; broader roles with a technical aspect, but not a technical focus; or, per women in the military, integrated technical-management roles. Rottman and colleagues [4] describe these early career engineers as becoming *Company Men,* likely to be tapped for progression and eventually groomed for organisational leadership roles. In contrast, the early move to management/leadership roles seen in our study was primarily due to organisational design rather than relational factors or driven by the individual.

Only one participant's early career was categorised as 'Broadening', with movement through technical engineering roles, commercial and other functional roles within the same organisation.

Early roles had a bearing on the path or opportunities available later in career:

> *You can't be the head if you haven't got the grounding. It depends on which role you take as to what your opportunity may or may not be. (M9)*

A common thread linking the three career shapes was movement and mobility between sections of an organisation, from one organisation to another, from site to office-based roles, or between geographic locations. A particular mobility pattern was observed: most of the engineers with an 'early responsibility profile' oscillated between managerial and technical roles in their early career and did not follow a consistent and linear path of increasing managerial responsibility. For some, this was related to parental leave, but more often this was associated with international relocation. This oscillation pattern was also observed in the later careers of some

participants. These patterns are consistent with non-linear patterns observed in women's careers beyond the engineering profession [15], but are not reflected in current early engineering career models.

3.2 Early Career Influences

3.2.1 Individual

Participants' early career was influenced by their **individual characteristics, abilities, and preferences**. Personal qualities such as confidence, ambition, curiosity, a desire for autonomy and willingness to lead were apparent. Many expressed a clear preference for certain types of work and were aware of these preferences from early career. Self-awareness of these qualities and the ability to choose roles that enable them to exercise their preferences was noted:

> *I didn't ever see myself as purely technical, no. I always thought that my skills were broader, and I could bring more to the profession than just technical skill. And I was interested in more than that. (M4)*

During early career, participants built their **human capital**. It was important to be a 'good engineer' in early career. Early career roles enabled the accumulation of technical and practical knowledge, described as "technical grounding", and demonstration of technical competence. This generated confidence which impacted their readiness to pursue senior roles and perceived ability to perform them in later career. Technical grounding was considered an essential foundation for becoming a manager or leader in engineering related industries:

> *You have to understand what it is that you are managing if you want to be a manager, so you need a good technical grounding and a breadth of experience in the field, I think. (P3)*

In addition to technical grounding, participants gained exposure to managerial work in early career. Roles in which they were second in charge (2IC), instances in which they themselves were "doing the job anyway", informal opportunities, or exposure through small projects enabled sampling of management work and building of experience and skill for official or larger managerial roles.

3.2.2 Relational

Participants described the relationship with the direct supervisor in early career as influential. **Relationships with superiors** facilitated or hindered access to subsequent roles. Good relationships with their superiors enabled participants to demonstrate their abilities rather than being held back. Poor relationships or conflict served to limit their career prospects.

Superiors were described as role models, providing a vision of a 'possible self'. Others saw them as mentors and guides who helped them to navigate early career and provided advice on career decisions or moves. One participant recanted advice received from her direct supervisor:

> *He said to me after five years 'get yourself a new job because you are not getting anywhere in this company, get out, you are not made for this job, you will never get anywhere, the company is too conservative'. (M17)*

Beyond early career, supervisors and other colleagues became **mentors, sponsors, and advocates**. Positive shared work experiences provided a connection and established trust used in later career.

Relational aspects of **credibility** and **visibility** created opportunity for advancement and allowed the women to build relationships with others within their organisations, which became influential in later career.

In early career, credibility was linked to accumulation of practical experience and demonstration of technical competence. Practical experience and the willingness to engage with hands-on work was especially important in establishing credibility with peers and those working in trade-based occupations:

> *I'd done work experience with Company A where I'd literally just driven trucks and shovelled dirt and that sort of thing. And whilst that didn't teach me a huge amount about individual sections of the work I managed, it gave you the ability to talk to the people that were doing that sort of work. (M2)*

Linked to credibility and reputation, **visibility**, or being known or noticed by others within the organisation in early career was consequential in later career. In early career, visibility was established by working on high profile projects or taking on roles that gave exposure to people across the organisation. For some women, early career roles enabled the showcasing of both 'engineering' and 'non-engineering' skills:

> *I was involved on the bid team for the [large contract name] which was a really interesting experience. I think that might have been where others around me notice that I might have skills other than just engineering. (M3)*

Gender, or being one of a small number of women, also provided heightened visibility. One woman was guided to use this point of difference to her benefit:

> *My supervisor always said 'Well, they'll remember you because you are a girl and there's very few other girls', he used to say it was a great thing to be remembered. (M16)*

Descriptions of paternalistic relationships with a 'father / grandfather – daughter' dynamic were common and were perceived to facilitate career progression, consistent with [16]. Interestingly, this relationship dynamic was perceived as limiting in later career by some.

> *I won't say that I milked it, but I was grateful for it and therefore built relationships with men in that way. Sort of purged them for information that they had, that sort of thing. (M2)*

Relational factors have been related to experiences of positive and meaningful work for novice engineers [7, 8]. Collaborating with others, feeling valued as part of a team, and receiving feedback and validation are important during early career. Our findings provide further detail of key relationships and relational mechanisms present

in early career and highlight the gendered nature of these interactions for female engineers.

3.2.3 Structural

Organisational norms acted to facilitate and constrain the participants' early careers. Younger participants, or those that worked in government or defence organisations, accessed structured graduate programs. Other organisations did not have formal programs, but the organisational norms determined typical career and promotion pathways:

> *Yeah, it was very early. Company A were good like that. Company A were very much a sink or swim company… as a result they put you in these positions very quickly. (M2)*

Such structures enabled the building of human capital by providing developmental or significant experiences (such as site, field-based roles, or deployments) or formal professional development opportunities by design.

Prescribed pathways and **highly structured, visible, and explicit hierarchies** provided career path frameworks. Available career pathways, described as 'typical', 'well-worn, 'generalist' or 'technical' paths were also made visible by the choices and opportunities taken by others, revealing organisational values and shaping participants' impressions of career possibilities. While career pathways are highly visible and organised in many organisations, the process of accessing that path can be opaque and mysterious:

> *It was all a bit like secret men's business… there was no transparency whatsoever as how you go from A to B. (M8)*

Others felt constrained by their organisation. **Rigid recruitment criteria** – *"because of the structure of local government you have to fill the boxes"* (P2) - meant that promotions were applied for but not achieved. **Organisational attitudes** restricted women from accessing developmental experiences:

> *Most of the company's work was remote mine site construction and there was an element within the company that thought that women weren't suitable for that. Quite happy to have the site secretary and the site nurse being women, but not the engineers. (P3)*

Provision of clear and documented progression pathways have been recommended by multiple sources. Organisational culture has been posited as the key influence on women engineers' workplace experiences [9].

3.2.4 Gender

Gender was acknowledged by most women as a point of difference, however its impact in early career was contested. Some participants felt that being a woman was disadvantageous. Early career was perceived as a "hard road", or a "steeper curve" compared to their male colleagues. Others perceived their gender as having little or no impact. Regardless of position, the data revealed a focus on competence and merit as the determinants of career progression. The reaction to tempered

opportunity or differential treatment was to prove competence and capability by working harder. One woman spoke of “working very tirelessly” (M8) in early roles. Another woman working in construction emphasised the importance of merit with regards to the availability of work roles through her career.

> *It wasn’t “You were given the role because you are female” I think you were given the role because of the experience that I had in the type of work that I did and the roles that I had previously. (M13)*

For women engineers, interactions and relationships in the workplace are coloured by gendered roles and stereotypes, and by heightened visibility from the beginnings of their careers. Our study highlights the gendered nature of some of these relationships and relational aspects, in particular paternalistic relationships, visibility, and credibility and competence. A strong focus on competence and credibility is a way of ‘doing gender’ in early career - that is, it is a tool for managing the male-dominated profession of engineering and masculine workplaces.

4 SUMMARY AND ACKNOWLEDGEMENTS

4.1 Implications, Limitations and Future Directions

Graduate engineers often have loosely held expectations of what their roles will entail, and the career paths available to them [17]. A misalignment between expectations and reality can lead to issues with performance and satisfaction. The possible, diverse early career patterns, the experiences (positive and negative) and drivers of early career presented in this paper contribute to a more accurate understanding of engineering practice. This serves to bridge the education-practice gap, by emphasising a variety roles and career paths available to junior engineers. This may be helpful for engineering educators who wish to better prepare their female students for engineering workplace by providing a realistic view of early engineering careers and provide focal points for skill development and provision of support. These findings are also relevant for organisations who wish to better support their women engineers.

A limitation of this study is that early careers of women engineers was not the primary focus of the broader study. Instead, the importance of this career phase emerged during the analysis of the study. In addition, several of the participants were very experienced engineers, and as such their ‘early career’ was some time ago. The nature of their early careers may be different to those of the present day. These limitations indicate an opportunity for a purposefully designed study of the early careers of women in engineering in the current societal context.

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