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The Development of Career Resilience for Early Career Engineers in China: A Grounded Theory Study

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Abstract: The transition from college to the engineering workplace poses significant challenges for recent engineering graduates, as they navigate unfamiliar organizational context and negotiate real world engineering projects with escalating complexities and uncertainties. Career resilience plays an important role in early career engineers' identify transition from students to professionals, yet current literature examining the career resilience of engineers is rather limited, and the samples of resilience studies were largely confined to engineers in North America. Based on interviews with 16 early career engineers in China, this paper presents a grounded theory analysis of the development of career resilience for recent engineering graduates at the workplace. The study found that perceived mini-crises, supporting resources, and positive adaptation are the three ladders of career resilience for early career engineers. In particular, risk awareness resulted from perceptions of crisis triggers the needs of career resilience; internal and external resources of support help boost resilience; and positive adaption signals the completion of resilience for early career engineers. This study extends understandings of resilience for early career engineers in broader cultural contexts. The paper also discusses implications of the research findings for universities to create a more congenial environment for the development of career resilience and successful transition of engineering graduates to the workplace.
Keywords: career resilience; early career engineers; career adaption

1. Introduction

For early career engineers, the transition from university to workplace involves major changes in life (Kovalchuk et al, 2017). Faced with volatile natural environment, complex technical problems, and pressing project timelines, the young engineers have to jazz up what they have learned in classes and textbooks with significant flexibility.

Resilience, a personality trait noted in positive psychology, focuses on how individuals cope with difficulties and adversity (Yeagera & Dweckb, 2012). Resilience helps people convert 'adverse' conditions into 'manageable' ones, so as to restore their emotional balance, or even develop a more positive psychological state. Career resilience refers to the willingness and ability to adapt to new situations, overcome adverse career impacts and bounce back after career shocks (Scott et al, 2016). Therefore, engineers equipped with a robust level of career resilience are more likely to adapt to, utilize, and transform the adverse situations they encounter at work. Hence, the cultivation of career resilience helps early career engineers address complex engineering problems and facilitates their transition into professionals.

Literature in engineering education research has examined the career pathway (Martin et al, 2005) and career expectations (Ramadi et al,2016) of engineering graduates. However, in the process of transitioning from 'engineering students' to 'engineers', what remains largely unknown are the particular challenges faced by early career engineers and how the development of career resilience helps them overcome these challenges. The literature on career resilience, on the other hand, has yet to examine the trajectory of early career engineers. Furthermore, most studies of professionals' career resilience are conducted in North American and West European contexts, but the formation of resilient engineers in non-Western context has been barely examined. This study

attempts to begin to fill these research gaps by exploring the question: how is career resilience developed as early career engineers transition from engineering students to professional engineers? Based on in-depth interviews with 16 Chinese early career engineers, we propose a Model of career resilience development characterized by crises, resources, and adaptation. The study contributes to conceptualizing early engineers' development of career resilience; it also seeks to enrich literature on professional career resilience by noting the culturally specific features of resilience development in a non-Western country.

2. Literature Review

The concept of resilience, which originated in the field of system security, has gradually extended to social sciences such as psychology (David, 2015). A few scholars have also adapted the concept of resilience to the field of engineering education. For example, Hunsu and Carnell (2021) used the concept of 'academic resilience' to discuss the hindering and facilitating factors that affect the academic performance of engineering students. The authors contended that "in addition to cognitive skills and technical skills, resilience is an extremely important life skill for engineering students when dealing with academic difficulties" (Hunsu, 2021). As resilience describes the process through which individuals adapt to adversity, risk, crisis, or pressure (Martin & Marsh, 2006), it not only has a positive effect on the academic growth of engineering students, but also has a positive impact on the career development of new engineers.

Masten & Obradovi (2006) point out difficulties in directly describing resilience with quantitative and operational indicators, hence resilience was often inferred by researchers who first evaluated risks or adverse factors, and then judged whether the research subjects successfully overcame the setbacks caused by adverse factors (Masten & Obradovi, 2006). This view indicates that objective risk factors and subjective positive adaptation are two core components of resilience. In addition, Sandler found that appropriate resources at individual, micro and macro levels could help alleviate the harm caused by adversity (Sandler, 2001). Sarker and Fletcher also detected that protective factors could effectively reduce the negative impact of adversity and help individuals in distress to actively adjust their psychological states (Sarker & Fletcher, 2014). These studies note the protective role of supporting factors in shaping resilience. To sum up, adversity, support and positive adaptation are three pillars for cultivating resilience, which provides a theoretical framework for analyzing the career resilience of engineers.

Although there are a few research (French et al, 2005; Brown & Matusovich, 2016; Choi & Loui, 2015) in engineering education that attempt to carry out correlation analysis on the variables related to resilience in the context of engineering learning, they only verify the correlation indicators between the individual emotion, resilience, psychology and learning of engineering students. These studies do not reveal the specific mechanism of resilience formation among engineers, nor do they assess the role of risk or intervention factors. Furthermore, no engineering education research to date has examined the career resilience of early career engineers.

Notably, some Chinese scholars have recognized the importance of resilience in the professional development of engineers. In their study of "excellent engineers" who have already achieved career success, Li et al. (2009) note that resilience in the face of adversity is an integral element of the excellent engineers' competence, an individual trait that plays a positive role in their career growth (Li & Hu, 2010). Hu and Wang (2019) report that resilience is an ideal quality that employers expect from engineering employees (Hu &Wang, 2019). In addition, Tang (2017)

suggests that educators should aim to produce "3R" (resourceful, resilient and responsible) engineers through the reform of engineering education, so as to cope with the complex challenges brought about by the paradigm shift toward advanced manufacturing. The literature in Chinese indicates that engineering education researchers in China have noted the importance of resilience in the training of engineers. Nonetheless, the literature in Chinese has not examined the process through which young engineers develop resilience at work. This study investigates the process of resilience development.

3. Method

3.1 Sampling

We used homogeneous sampling method, which is a purposive sampling technique that aims to recruit research samples similar in characteristics relevant for the study. Based on Kovalchuk' (2017) study and the actual working situation of Chinese engineers, we created three inclusion criteria for participant recruitment: (1) the duration of specialized engineering work is between three months and three years; (2) the current professional title is not above junior engineer;[1] (3) no experience in participating in major national engineering projects. According to the above criteria, we sought interviewees through references by acquaintances, and asked about their willingness to be interviewed. We continuously increased the number of samples by the snowball method. Finally, a total of 16 early career engineers were interviewed.

3.2 Interview Procedures

The qualitative data was collected using the critical incident interview method, the purpose of which is to analyze the best or worst events in the interviewees' work and to identify the behavior that caused these incidents. According to the 'STAR' principle (Zhu & Han, 2021), interviews were carried out from four aspects to comprehensively reproduce the process of key events, including situations, tasks, actions, and results. In this study, we encouraged early career engineers to recall critical incidents with a notable sense of achievement or frustration in their work.

Semi-structured interviews were conducted in person or online, according to the interviewees' preferences. In person interviews were conducted at locations familiar to the interviewees, such as seminar room, self-study room, or quiet restaurant; online interview were conducted using telephone, We-Chat voice call or Tencent conference. Six categories of interview questions were designed based on the 'STAR' principle, which inquired into the interviewees' work situation, career dilemma, psychological feelings, behavior choices, external support, and subjective needs.

3.3 Data Analysis

After the interviews, we transcribed and read the interview records word by word. Following Creswell's (2013) suggestions for conducting grounded theory analysis, we conducted three rounds of coding for the interview transcripts: open coding, axial coding, and selective coding. We conceptualized and systematized the textual data, from which we constructed conceptual categories and theoretical frameworks to describe the development of career resilience among early career engineers.

The detailed process of data analysis is as follows: First, open coding was conducted to conceptualize and categorize the texts, guided by the principle of using the original words of the interviewees as much as possible. A total of 226 initial concepts were identified, and 34 first-level

[1] Professional title (*zhicheng*) is a system of credentials for ranking engineers in China. "Junior engineer" is the first rank one can earn, after having worked in professional engineering roles for a few years. Professional title is not the same as registered professional engineer.

concepts were formed. Second, nine categories were extracted from the axial coding, which aimed to establish relationships among first-level concepts and to determine the higher level categories or dimensions. Finally, we used selective coding to systematically analyze and determine the core categories and secondary categories in the resultant concepts, which laid the foundation for building the theoretical framework.

4.Findings

Through analyzing the interview transcripts of 16 early career engineers in different professional fields, we found that the shaping of early career engineers' career resilience consists of three stages: perceived mini-crises, supporting resources, and positive adaptation.

4.1 Perceived mini-crises trigger the need of resilience

The early career engineers interviewed in this study frequently recognized the perception of mini-crises at work that demand resilience, including the challenges of work characteristics, social network, external environment, and personal struggles.

Crises resulted from work characteristics

When early career engineers first enter the professional workplace, they encounter significant challenges resulted from the work environment and the engineering tasks, such as the mismatch between what they learned at school and what is required at work, time-consuming and even dangerous tasks, high work pressure, idle organizational atmosphere, and uncertain career prospects. In particular, these newcomers sometimes find to their dismay that that the work contents include a large amount of work that they consider "external" or "irrelevant" to engineering, and the organizations they work for often have informal codes of conduct beyond the written rules, including overtime work that require them to stay up late (02-LC, 04-XH, 08-ZC, 10-ZH, 11-YY, 12-WZ).

The interviewees almost unanimously noted the mismatch between college education and the requirements of work. Several interviewees remarked on the almost insurmountable gap between the theory-oriented engineering training provided by Chinese universities and the practical knowledge that was actually required at work (01-HZ, 02-LC, 03-LB, 06-HL, 07-MX, 10-ZH, 11-YY, 12-WZ, 14-SQ).

Other characteristics of work that pose serious challenges to new engineers include: time-consuming engineering experiments, rapidly updated engineering design knowledge, stringent corporate management, and limited opportunities for career development（02-LC、08-ZC、14-SQ、15-TW、16-CM）.

Crises resulted from social network

Tensions resulted from interactions between early career engineers and others at work are the most frequently perceived mini-crisis situations expressed in the interviews. Specifically, these tensions stem from interactions with supervisors, peers, and clients. Firstly, several interviewees reported that communications with their leaders were not smooth, due to unequal power relations, information asymmetry, or untimely feedback. This type of relationship conflict often makes early career engineers feel at loss, not knowing to what extent they retain control of the work process.

Secondly, peers could act as another source of tension for early career engineers, especially when a healthy collaborative culture is lacking and responsibilities are not clearly allocated due to unwise division of labor or ineffective task coordination. For example, one interviewee repeatedly mentioned that "*it is not our business to do it...the assignment of our tasks is too chaotic"(02-LC).*

Thirdly, significant tensions might arise from early career engineers' interactions with their clients. Due to information barriers or inexperienced communication, it is difficult for early career engineers to handle their relationship with clients calmly. Especially when the clients make demands that seem excessive, or when the clients were involved in complicated situations like bankruptcy, complaints to the engineering company, or legal disputes, early career engineers might feel overwhelmed.

"Having known that the project could not be completed this year, we still decided to waste time to do it. In the end, the contract was unsurprisingly not signed." (01-HZ)

"Sometimes you can't explain a policy or regulation to the grassroots customers, especially those in small villages and towns. They don't understand it at all. It's a waste of energy." (03-LB)

An early career engineer vividly compared the handling of customer relations to thesis defense: *"The relationship with customers is like that of students participating in the graduation thesis defense. They have to admit mistakes and apologize." (07-MX)*

Crises resulted from external environment

The work of early career engineers not infrequently encounter delay or even unexpected termination because of external policy, social, and market environment, as well as the limitations of natural environment and natural resources. First, extreme weather conditions (e.g., heavy rain, strong wind, snow, and low temperature) will affect the field survey of the environmental impact assessment engineer (01-HZ) and the marine engineer (10-ZH).

Second, in the past few years, the work of some early career engineers was significantly interrupted by the Covid-19 pandemic and public health restrictions. For example, travels might be cancelled, material delivery might be delayed, and arrivals at project sites were not always guaranteed. All 16 interviewees in the study mentioned the negative impact of having to work from home on work efficiency and engineering project progress during the pandemic.

In addition, the interviewees noted uncertain prospect of the industry as one of the crises they were facing. Industrial transformation and technological upgrading that threaten traditional industries, as well as the slowing down economy due to the Covid pandemic, caused anxieties among early career engineers about their job security.

Crises resulted from personal struggles

This dimension mainly illustrates the incompatibility with work that resulted from early career engineers' own physical and psychological reactions, including physical repulsion, grievance, and self-confusion.

First, some early career engineers noted their physical repulsion at the work environment. For example, a process development engineer said, *"When contacting with chemicals, I always produced uncomfortable reaction." (02-LC)* An environmental assessment engineer also had similar experiences, *"When entering the sewage treatment plant for the first time, I immediately felt seriously uncomfortable." (01-HZ)*

Second, a sense of grievance becomes salient for early career engineers who dare not resist undue administrative pressure, professional authority, or unfair demands of customers. In the interviews, the respondents tended to describe their frustration with *"being wronged" (12-WZ), "no face" (01-HZ), "no confidence" (01-HZ), and "we are like shrimps and crabs" (14-SQ).*

Furthermore, self-confusion is another common psychological mini-crisis facing engineers just entering the workplace. The confusion usually come into place when the young engineers think about the meaning of life or future career development, when dissatisfactions with the gap

between ideal and reality become clear. In other words, the negotiation between the "ideal self" and the "real self" is a part of the process of forming the career resilience. Several early career engineers expressed similar ideas, *"facing lots of work and engineering problems at the beginning of engineer career, I often had self-doubt or self-confusion, and even considered looking for work again or returning to school." (02-LC, 03-LB, 05-NT, 16-CM)*

4.2 Supporting resources facilitate the development of resilience

Supporting resources can play protective and motivating roles for early career engineers in the midst of adversity, and help them get out of difficulties and cultivate career resilience. The interviews found that supporting resources of this kind mainly included three dimensions: exogenous conditions, endogenous personalities, and the engineers' ideals and convictions.

Exogenous Conditions

The exogenous supporting factors are mainly provided by the companies or institutions that the early career engineers work for, such as generous economic incentives, fair rules and regulations, adequate training opportunities, extensive resource platforms, and role models. These external supporting conditions help raise the morale of early career engineers in overcoming adversity.

When encountered with extraneous tasks beyond their formal obligations, additional financial compensation plays an instrumental role in enhancing early career engineers' endurance. *"Although the work was particularly tedious, we were always inexplicably not supposed to do it. After all, the salary was so high, just bear it" (09-HY).*

In addition, a fair system of performance evaluation and promotion helps early career engineers maintain psychological balance and emotional stability in dealing with challenges at work. As one interviewee explained, *"Our company is very fair. As long as you make achievements, it will not complain that your use a little more resources, and you will also have the due reward. And it does not need to be so collusive as other people. In short, it is fair to us" (07-MX).*

When early career engineers are assigned new challenging tasks or face sudden irresistible forces, the availability of targeted training opportunities and flexible resource platforms in the company help improve their adaptability to new situations and new changes, which leads to quality enhancement of their work and reduction of repeated efforts. Several interviewees recognized the role of corporate training and resource platforms in their adaptation to new roles at work (such as 01-HZ, 03-LB, 05-NT, 06-HL, 07-MX, 09-HY, 10-ZH, 14-SQ, 15-TW)

Finally, when tight construction schedules lead to frequent overtime or nearly unbearable pressure, the exemplary of role models, such as team leaders or more experienced colleagues, can act as a source of psychological support. As an interviewee mentioned, *"Our leaders are not tired. I can't say I am tired. Others are much tired than me. Seeing them doing it, I am immediately energized" (01-HZ).*

Endogenous Personalities

In addition to external resources, the personality or mentality of early career engineers are also important endogenous factors for the formation of career resilience. During the interviews, respondents named values like toughness, open-mindedness, interest and enthusiasm, and active personality as supporting traits for early career engineers to avoid being overwhelmed by perceived crises and adversity. Their references to these values indicate that the development of career resilience is not entirely determined by the adversity trigger, but is also related to the early career engineers' personal characteristic.

Qualities like toughness and open-mindedness help shape the career resilience of young engineers according to the Broaden-and-build Theory of Positive Emotions, which argues that positive emotions can expand the range of one's coping strategies, thereby enhancing the resilience of coping with stress (Gloria & Steinhardt, 2014). In the interviews, some engineers also emphasized the role of *"good mentality" (01-HZ), "optimistic" (04-XH)* in handling the crisis situations.

Besides qualities that enhance one's tolerance, personal traits like interest and enthusiasm can also induce career resilience. In areas where the engineers are interested, enthusiastic, and actively seeking to excel, a stronger form of resilience is present. In contrast, if the work does not align with the engineers' personal interests, they are more likely to shrink back in the face of challenges and frustrations. *"It depends on my interest. I will try to overcome [to achieve] what I want to do. Mainly because I am not interested in this project at all, it is difficult to promote it" (16-CM)*

Ideals and Convictions

When the combined effects of exogenous and endogenous conditions are considered, some engineers tended to emphasize a sense of mission and responsibility for the profession or for their chosen career; in other words, a few of the interviewees very firmly associated their self-actualization with the achievement of professional values and professional recognitions in engineering. For these interviewees, ideals and convictions have a profound impact on their ability to endure and overcome crisis or adversity at work.

For some engineers, a strong sense of responsibility stems from their commitment to professional ethics, especially to concerns for user needs, public safety, and social stability.

"It is ridiculous that the process table requires 98 degrees. If this process must require this temperature, we should simply give up sampling and production. Why should we take such a big risk to pick something with 98 degrees?" (02-LC)

"When adjusting the research and development of chemical composition, we can't just see whether it is feasible in theory. The key is to ensure the safety of customers. We must make sure that there is no problem with the safety of the public." (12-WZ)

Furthermore, a few early career engineers are also eager to gain professional status and recognition, viewing them as indicators of fully demonstrating their professional value.

"I expect to have new cognitive output to others at work. Even at the beginning of my career, how can I improve my voice, and then establish a professional position to play what I have learned... is what I am thinking about. It is my value to share my professional knowledge with others and then be recognized as an expert …… Even if I encounter difficulties, I will have motivation when thinking of my vision "(14-SQ)

These sublime ideals and pursuits drive some early career engineers to transform challenges into constructive motivations, and to actively utilize other supporting conditions to overcome adverse situations.

4.3 Positive adaptation demonstrates the presence of resilience

Positive adaptation, to a certain extent, marks early career engineers' transforming of crisis situations into advantages. This study found that the interviewees' adaptation behaviors primarily fell into two categories, namely, "compliance and pressure resistance" and "reform and breakthrough." In the former category, young engineers cope with mini-crises primarily through patience and self-adjustment. In the latter category, early career engineers make active efforts to change their conditions or perceptions by means of avoidance, feedback, change, and

compensation.

Compliance and Pressure Tolerance

The focus of this adaptive behavior is to "change yourself," which means not failure or cowardice but a kind of stress-resistance in high-pressure working environment and high-intensity engineering practice. In the choice of compliance and pressure resistance, early career engineers demonstrated significant stress tolerance and self-adjustment.

The most basic (and common) way of coping is to endure, especially to intentionally endure after rationally thinking about their status. These early career engineers used words like *"hard on the scalp" (01-HZ), "hard endure" (06-HL), "put down face" (03-LB), and "just endure" (05-NT)* to express this type of behavior.

However, tolerance alone is not always the best strategy to deal with adversity. Instead, some interviewees found the need to combine stress tolerance with efforts to transcend the difficult situations in which they found themselves, so as to overcome the setbacks, and/or to cultivate a more positive and enterprising attitude. This shift from tolerance to transcendence leads to two other ways to adapt to adversity, namely, adaptation and transformation. The former refers to adapt gradually through repeated interactions between the subject and the environment, just as some early career engineers mentioned *"gradually get used to the climate" (11-YY), "slowly adapt" (09-HY)*, whereas the latter refers to strategies that reduce the impact of the environment on the interviewees' emotions and perceptions by changing their own mentality, such as *"empathy and think in others' position " (07-MX)* or *"Spiritual victory method" (03-LB).*

Reform and Breakthrough

The second category of adaptive behavior for early career engineers emphasizes "changing the environment," through taking initiatives to challenge adversity and break through difficulties. Behaviors in this category include avoidance, feedback, change, and compensation.

The case of one interviewee (02-LC) exemplifies reform and breakthrough behaviors. When this process development engineer was faced with sudden boiler overturning and hot soup overflowing that endangered his own safety, he did not submit to the company's existing norms, but actively persuaded other employees to put safety first and to avoid the occurrence of similar hazardous events. In other cases that involved unreasonable work intensity, unfair division of labor, or significant obstacles in customer communication, early career engineers (such as 01-HZ, 02-LC, 03-LB, 06-HL, 07-MX, 09-HY, 10-ZH, 12-WZ) also actively communicated upward and tried to adjust the existing resource integration mode, personnel division mechanism, patterns of knowledge sharing, etc., so as to make the project management more scientific, standardized, and efficient. In addition, some early career engineers chose to solve the problems from a different perspective. As one electrical engineer remarked,

"The oil field has also been sluggish in recent years, so it is still a little difficult to change the industry, especially if the working place is not changed. Therefore, I can only find some places within the company where I can play a little bit of what I learn in my own work, and then I have my sideline. " (03-LB)

5. Conclusion and Discussion

This study explored the development of career resilience among Chinese early career engineers through interviews and a grounded theory analysis. The main conclusions are as follows: First, Perceived mini-crises, supporting resources, and positive adaptation are three pillars of career

resilience formation for early career engineers in China. Second, the risk awareness resulted from perceptions of crisis triggers the need of career resilience; internal and external resources of support facilitate the development of resilience; and behaviors of positive adaption signal the presence of resilience. Third, perceptions of mini-crises are specifically manifested in the conflict between early career engineers and the work characteristics, the social networks, the external environment, and the engineers' personal struggles; supporting resources for developing career resilience include exogenic conditions, endogenous traits, and ideals and convictions; the adaptive behaviors include 'compliance and pressure resistance' and 'reform and breakthrough.'

Our research confirms the validity of a prior finding about resilience that has been discovered in fields outside engineering, namely, that adversity is a trigger for the development of resilience. Research on resilience has extensively discussed the behavior of individuals in the face of difficulties or adversity, and has noted the manifestation of resilience in adverse situations (Yeagera & Dweckb, 2012). In the mainstream resilience framework, adversity usually refers to major destructive life events or experiences that negatively affect the satisfaction of basic human needs, such as physical safety, sense of value, sense of efficacy and social belonging, etc. If not properly handled, these disruptive events may hinder an individual's ability to effectively realize social needs, develop meaningful interpersonal relationships, or effectively exercise their professional skills (Sandler, 2001). However, scholars in engineering education contended that although adversity usually refers to major events that cause paralyzing outcomes, it was also valuable to recognize more subtle pressure and risk factors as well as their impact on resilience (Hunsu et al., 2021). This view is echoed in our study, which found that when first entering the workplace, early career engineers were more likely to encounter not major destructive setbacks but mini-crises or subtle pressure, which nonetheless call for the need of career resilience just as well.

Furthermore, this study found that in the Chinese context, the mini-crises experienced by early career engineers often reflected not a lack of technical knowledge, but rather, a lack of relevant non-cognitive abilities or non-technical skills, such as communication and coordination, knowledge of organization and management, and the ability to make proper on-site responses. In fact, the most frequently mentioned mini-crises recalled by interviewees were related to communication difficulties. This finding highlights an additional aspect of liberal education in the preparation of competent engineers. Scholars have examined the role of liberal education in honing engineering students' professional skills(Grasso & Burkins, 2010). This study extends the existing literature by suggesting that the professional skills acquired through liberal education not only influence how young engineers perform their tasks at work but also how they navigate the professional environment and ultimately, whether they stay as engineers.

This finding became more salient from a study of early career engineers in the Chinese context in part because, despite the establishment of an accreditation system recognized by the Washington Accord, the "style" of engineering education in China arguably emphasizes disproportionately on the technical side of engineering training. However, this tendency to look up for the "world class" models of engineering education exists not alone in China, but is indeed shared by many more developing nations in Asia, South America, and Africa (Tang et al., 2023). This state of affairs underscores the responsibility of engineering educators in leading nations like the US to think about how to represent a more balanced version of the "state of the art" of engineering education to the global community, given the fact that early career engineers in our

study generally believed that the difficulty and complexity of dealing with interpersonal relationships is far greater than that of dealing with technical problems.

Finally, as resilience reflects not only cognitive and professional skills but also important aspects of mental health, we suggest that universities should incorporate resilience into the objectives of engineering students' cognitive and professional development, and begin to shape engineering students' adaptability in the face of complex engineering problems, while taking measures to strengthen their endurance and change-making capabilities in the face of interpersonal conflicts.

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