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Engineering Education and Self Dependence: A Nigerian Experience

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Abstract

The emphasis on producing graduates with entrepreneurship abilities have heightened in recent times in Nigeria due to the persistent decline in public and private job opportunities. This has mounted unprecedented pressure on the engineers who were previously thought to be drivers of job creation and technological transformation. Rather than confronting the unhealthy job scarcity appreciably, engineering graduates have surprisingly ranked high in the profile of job seekers, to the extent of scampering for lean banking and allied jobs, sales and security agents etc. An attempt is made in this paper to review engineering education with a view to ascertain the root cause of graduating massive job seeking engineers from Nigerian institutions, short of job creators or entrepreneurs, at least. The making of a Nigerian engineer is presented in terms of education and training, including the qualification for admission and the eventual admission criteria set by government and institutions. The effects of the prevailing factors surrounding engineering education are delineated with specific merits and shortfalls. Opportunities for improvement and areas needing reforms were suggested. The policy results of the research, if properly implemented, can reposition engineering graduates and engineering educators for accelerated job creation in the country as well as embolden the self-dependence prospects of engineers.

Keywords: Engineering Education, Job Creation, Engineering Graduates, entrepreneurship, Self-Dependence

1. Introduction

Engineering education and its expectations have long relished an advantage point among policymakers and researchers concerned with technology development in Nigeria (Ozor and Mbohwa, 2017, Akinyemi, 1987, Eze, 2008). The need to reform the curriculum and other emerging trends necessary for administration of engineering education in line with global practice has been stressed (Olunloyo, 2002, Adegbuyi and Uhomoibhi, 2008). Advanced economies have turned to sustainability and improvement of developed policies while some developing countries have regrettably been caught in a web of vicious circle, occasioned by policy summersault, thereby hampering development. Sustainability of engineering education has attracted the concern of some researchers and Institutions alike (Staniskis and Katiliute, 2016, Cristina, 2016). There seems to be a notion that instructional approaches so far evolved can result in self-employable Engineering graduates in some quarters, but more continuity and streamlining efforts are still needed. Evaluation of the place of sustainability and social responsibility (S-SR) domains and identification of some paradigm shift in quality system of Engineering Education and European Scientific and Technical Education for Sustainable Industry (ESTE-SI) programme, as new objectives and department strategy for efficient planning has been canvassed (Staniskis and Katiliute, 2016). The authors used a four step evaluation and reporting technique to assess S-SR organization, content of Engineering programmes, Student participation and culture issues as well as research and innovation in a selected pilot institute. The presentation underscores the need for a properly defined implementable interim and long term results oriented template for sustainability. Cristina (2016) present a glossary of qualities needed to make Engineering graduates who are able to motivate, create, and think outside of the box and suggest original course of action when promotion of authentic graduate entrepreneurs matter. The authentic engineering entrepreneurs should fit into the job description of any Industry in the sphere of the graduates discipline and go further to create jobs upon graduation. Results of past research on engineering education in Nigeria show that the graduates are still

subjected to ample remoulding and retraining by Industry before employment (Ozor and Mbohwa, 2017). The authors regrets the inadequate skill, low self-esteem and lack of requisite technical know-how inherent in the category of graduates from Nigeria tertiary Institutions. Curriculum review to strengthen University-Industry collaborations was recommended as means of improvement among better funding, creation of skills acquisition centres and better welfare package for teachers. The implementation policies were not suggested.

It is instructive to note that Engineering and Technology graduates drive regional development in many economies of the World (Kemeny and Osman, 2018). The sector is expected to spur growth in jobs and wages in non-tradable activities, especially as economic crisis has consistently increased unemployment rates in Nigeria. This invites new challenge of inculcating greater entrepreneurship character into engineering education. Entrepreneurial education has been fingered as the fulcrum of independence of future engineers and the antidote to job deficits in Spain (Barba-Sanchez and Atienza-Sahuquillo, 2018). Proper placement of engineering graduates requires that the skills needed during education and training should be in tandem with the skills needed to fit into the Industry or be self-dependent. Mismatch ultimately results in job dissatisfaction and lower earnings, though higher turnover is possible. The interaction between mismatch and self-employment has been undertaken (Bender and Roche, 2013). Previous researchers (Youn and Choi, 2015) agree that gender plays significant role in the study-to-be self-employed campaign. The gender discrepancy have been traced to household chores, cultural effects, occupational discrimination resulting from structural inequality and quality of training received during higher education (Pedulla, 2016, Shauman, 2016). In a very recent study, Pullman (2018) took data from the Canadian National Graduates Survey (CNGS), to delineate the variation of rate of non- standard jobs due to field of study and show paucity of women in jobs descending from Science, Technology, Engineering and Mathematics (STEM). This can imply that economies with a preponderance of women are likely going to suffer from reduced human resources in Science and Technology related jobs. Religious beliefs can constitute a monumental siege in graduation of women Engineers that can be self-employed while creating job opportunities in some Countries. Nigeria is a hit zone in this regard due to the unabated decade onslaught of a terror organization (*Boko haram*, which literarily means book is abomination) agitating for total withdrawal of women from formal education, among other objectives.

Employment opportunities resulting from quality engineering education can be myriad, since the discipline provides a good driver of stable, profitable and seamless economic activities. For instance, Cai and Winters (2017) posit that STEM graduates are less likely to be self-employed than the non-STEM counterparts. This assertion resulted from empirical computations from Survey of American Communities conducted in 2015. The study further investigate the disparity in taking self-employment jobs among foreign graduates and natives. Results show that foreigners ranked higher. While better earnings can cause natives to prefer non self-employment jobs, the significant differences between STEM and non-STEM graduates in taking self-employment jobs remain inexplicable. The case is somewhat different in Nigeria where unemployment rate is all time high. Unlike developed countries where choice can be made between public service jobs and self-employed ones, the Nigerian fresh graduate Engineer is constantly threatened by the danger of digressing completely from the engineering education received in formal Institutions. The number of engineering graduates turned out of schools each year, instead of driving job creation in the polity, have increasingly suffocated the already saturated job seekers auditorium. This paper is an attempt to elicit some of the causes of non-viability of the Nigeria engineering graduate of today. Some recommendations on how the situation can be remedied are suggested.

2. The Education of Nigerian Engineer

Oluka *et al*. (1999) summarize the legendary of formal education a prospective engineering graduate must undergo in Nigeria. The presentation suggests that the lower and middle courses of education of the Nigerian engineer follows the same procedure for other disciplines in Sciences. In the procedure, the would-be engineer child passes through nursery school where applicable. Otherwise primary schools form the starting point. The pupil advances to the secondary school where some form of diversification commences after the first three years. Scientific thinking, process skills and technology ideas and subjects are introduced to the student at this stage. It is normally a period when laboratory demonstrations and practices are inculcated into the student. The quality and manner of training is at worst an average of what the future engineer requires to make a world class engineer. This is culminated in subjecting the student to both sub-regional examination organized by the West Africa Examinations Council as well as National examination organized by National Examination Commission (NECO). A prospective engineer is expected to make

credit or distinction grades in all science related courses including Physics, Chemistry, Biology or Agricultural Science, as well as English language and Mathematics, to qualify partly for higher education.
The second part of qualifying examination for full entry into a tertiary institution is organized by Nigerian based Joint Admissions and Matriculations Board (JAMB). An engineering student should be able to make 200 out of 400 available points to be considered as having passed JAMB. Different institutions can adjust the JAMB pass mark point heterogeneously upwards in line with available space and teaching resources in the first instance. The seed of weakening of engineering education in Nigeria is undoubtedly planted at this critical future engineer's selection stage. That is; second instance of recommending students to be admitted. Suffice it to say that the actual admission letters are issued by JAMB based on the recommendation of the Universities and other higher institutions. What are the drivers of the recommendation?

2.1 Drivers of Engineering Students Admission into Higher Institutions in Nigeria

Some of the factors that come into play while considering the prospective engineering student in Nigeria for admission are discussed hereunder.

1. Merit

A percentage of the total number of engineering students admitted in higher institutions in Nigeria is based on merit. This is essentially the quality of being particularly worthy, qualified and good for the purpose of engineering education. Whenever merit is compromised, mediocrity rules. When mediocrity is perfected, quality and character are callously and insensitively slain. Engineering does not obey sentimental pleas. The functions must be differentiated, transformed and integrated following definite rules. It follows that the students of engineering must demonstrate significant readiness to be effective in confronting the tenets of engineering education. The logical aptitude needed to successfully correlate engineering principles, lectures and practices with the realities in the industry in particular, and life in general cannot be bent to accommodate sentimental considerations and policy inflections guiding engineering student admission in Nigeria today.

2. Direct Entry

Admission is given to direct entry students without any examination [O]. However, the direct entry students are expected to have spent up to two academic sessions in higher Institutions and obtained required grades. It is assumed that the form of training and drills within the probation years is enough to position the students for full engineering education courses. The percentage composition of the engineering students admitted through direct entry can vary from institution to institution, and from discipline to discipline.

3. Educationally Less Developed States (ELDS)

A very important factor that characterize who eventually become an engineer in Nigeria derive from the state of origin of the student. A student from a state considered as ELDS is preferred to a more qualified counterpart from a non-ELDS state. Yet, the process of interchanging the engineering academic abilities of ELDS students with the non-ELDS ones are still not in sight. The implication is that prospective quality engineers are forced to be slaughtered at the work-bench of equity, right from the very beginning. The stronger problem of this factor is that some students that were not supposed to be in the engineering education lecture rooms are forced into it by human and political factors. The result can be production of unemployable graduate engineers, lacking fundamental engineering professional ideas to fit into the purpose of training an engineer in the first place.

4. Discretion

Discretion is another clear method used to admit engineering students into institutions of higher learning in Nigeria. This part is at the mercy of the judgement of the authorities. It is not normally clear whether evidence for such admission is excluded or established. Data acquisition on the suitability of students admitted through this process is difficult.

2.2 Engineering Education Administration

Upon successful admission, the student engineer is introduced to university wide courses in the first two years, spanning from Physical and Social sciences through Arts and humanities, as well as entrepreneurship courses and short industrial training, to provide the basis for balance of reasoning, future analytical prowess and innovative culture that will be inherited at later stages of life. The engineering student is expected to use the period to prepare for eventual specialty courses at the third year, which are normally domiciled at the various departments. There is also a six months industrial training programme aimed at introducing engineering students to the industry and providing the opportunity of interacting with experienced professionals in the specific field of study. The training takes place in the penultimate year. It is administered within the Industrial training fund (ITF). The tertiary education of the Nigerian engineer is expected to last for five years. The current engineering education system somehow fall short of what it takes to produce engineers who are willing and able to convert ideas of inventions into innovation. It does not break the boundaries of disciplines and most importantly, it does not inspire or provide its recipients with the 'art of capability' needed for technology development and self-employment. This is part of why the Nigerian engineers seem to lack professional political influence and hence cannot press home any demand from the government through compulsive action. Also, engineers in the civil service are treated just like graduates of social sciences, arts and humanities at the elevation of their professional counterparts from law, medical and pharmaceutical sciences. In other words, the current engineering education system produce mainly graduate engineers with good analytical ability and mastery of requisite English language and Computer skills needed to fill administrative positions in Government institutions, Banking industry and other nongovernmental organizations. Others struggle to become contractors, traders and in extreme cases, political thugs. The teeming population of engineering graduates who are not accommodated anywhere become unemployable by anyone, including themselves, since there is no capacity for self-employment. As a result of the foregoing, engineering education appear to have stagnated if not retarded technology development and self-reliance among graduate engineers in Nigeria instead of accelerating it. The ideal engineer should be proficient in a broad sense to an extent of being able to synthesize ideas, design and analyze systems, as well as manage a complex mix of resources (men, materials, machinery and money) in the first instance. The Engineer should be able to convert locally sourced materials into some forms that generate better income, while creating jobs for self and others within the transformation process. Such ideas might not be in the thoughts of Nigerian Engineering students of today because the basic need for reading an engineering course is to work in "oil companies or multinationals" with a high pay package or secure Government pensionable job at least. In terms of availability of institutions where engineering courses are taught, Nigeria has paid her full dues. However, the availability of good training infrastructure, organization of curriculum content, quality of students admitted into the engineering schools and standard of examinations among other things go a long way in determining the effectiveness of engineering graduates produced in these institutions.

2.3 Organization of Curriculum Content

The big question is; has the subsisting engineering curriculum been capable of providing the needed manpower development to drive self-employment and job creation amidst illusionary existence of "Oil Companies, Multinational Corporations" or public service jobs? An answer can emerge after considering the following factors: 1) the present curriculum is more or less the same with that used during the training of professional engineers of Nigeria extraction making waves globally; including those paraded at the apex Engineering societies and regulatory agencies; like the Nigeria Society of Engineers (NSE) as well as Council for the Regulation of Engineering in Nigeria (COREN); 2) the activities of all other Engineers, faculties and Institutes of engineering are scrutinized by the mentioned agency, who can only advise within the boundaries of what the curriculum permitted; 3) One of the authors of this presentation is privileged to be an engineering faculty member, for over a decade in a typical first generation public University in Nigeria, and has access to significant primary data on engineering students education and training. On the basis of the above premise, the answer to the question of the first sentence in this paragraph is not Yes or No. Additional to this, Eze (2008) present the report of engineering activities as contained in an independent survey by an indigenous project managing firm. The author put the input of all sorts of engineering related activities (ERA) to the National GDP at merely 1.5%. The presentation observe that the value is at big variance when matched with the contribution (6%) to GDP in many advanced and developing economies. For instance, ERA account for about 8% of the UK's GDP and 16% of Republic of Ireland's. In United Arab Emirates, the contribution of ERA to GDP is 11%. Both India and South Africa have 6% ERA input to GDP. The failure of engineering education to motivate needed job and wealth creation in Nigeria as well as birth self-employed engineers cannot completely be blamed on curriculum. The politicization of engineering education as well as severed relationship or disconnect between the industry and academia matters more. In the first instance, the heads of departments of public engineering schools are appointees of Vice chancellors (VCs), who (VCs) are in turn appointed by the federal government. The leadership arrangement makes it difficult for the

department that actually train the engineer to make needed changes. It is commonplace to see departments implementing some "window-dressing" to pass accreditation from various commission and engineering regulation bodies, a step that will find no space in any developed economy. The engineering school-Industry nexus; as it were, makes application of research results to practical societal problem very difficult. In particular, engineering educators can do a god job of teaching courses in the curriculum properly. The students can understand appreciably. But the competences to use the knowledge remain a mirage. The scenario can be appreciated using what plays where equipment is installed in a process but abandoned at the slightest problem due to lack of maintenance resources, yet the maintenance engineer can mention all forms of maintenance and the latest maintenance techniques as well as derive imposing models for maintenance planning and control.

Today, the technological development of the country seem to be stagnating amidst many universities and private organizations churning out engineering graduates yearly. Graduated students cannot fit into the mould of self-reliant engineers. The reason is not unconnected with the fact that the engineering students' selection and education path cannot guarantee putting square pegs in square holes. The emphasis seems to be more on becoming an engineer later in life without regards to possession of engineering traits. Graduate engineers are therefore faced with the difficulty of readily gaining jobs immediately after school due to the deficiencies in the build up to admission, less than problems caused by curriculum and evaluation configuration in which engineering education is administered. This trend has adversely affected the professional relevance of the engineer in Nigeria as well as hindered production of engineers with the capability of driving job creation. Eze (2008) argue that the curriculum are based on a foreign model involving ideal conditions (staff, equipment, infrastructure, training opportunities, etc.) that are not easily duplicated in developing countries. This paper blames this observation on politicization issues because nothing precludes engineering educators from leading improved quality of life. The presentation (Eze, 2008) further maintain that curricular seems to exhibit some imbalance between pure and applied sciences and the practical engineering and technology realities, project/business management and innovation concepts and entrepreneurship skills development. The duration of the sectional semesters for the teaching of engineering courses is very short to allow for good comprehension and application by the students. The semester duration should be adjusted to match that of similar demanding professional courses. The student evaluation and grading is almost dependent on his performance on theoretical examinations devoid of consolidating practical orientation.

3. Positioning Engineering Graduates for Self Employment

There is no better pillar of support to optimum engineering education than efficient and functional training infrastructure. What obtains in many engineering schools today is that the students are compelled to imagine systems whose analyses are being made. Where laboratories exist, the equipment there has been the same ones installed at the inception of the institution. A state-of-the-art laboratory filled with modern equipment should be made available in all engineering institutions in the country in other to arm engineering graduates with the technical know-how needed to accommodate the Country in the fast changing World. We are all witnesses to the rapid rise of information technology and growing complexity of industrial processes and machinery. This presupposes that today's engineers are expected to possess both in breath of capability, a specialized up to date technical and managerial competence than required of the generation that made use of the infrastructure prevalent in most of our institutions today.

3.1 Quality of Students Admitted

Given a very good reading environment with world class engineering training infrastructure derived from a societal problem solving responsive curriculum, engineering education administration must also be devoid of mediocrity. My participation in teaching, supervision, examination and invigilation of engineering students' examinations elevated concerns that continues to beat my imagination as a lecturer, and as a resource person expected to contribute positively to the graduation of credible engineers. Significant percentage of the students find it very difficult to understand or apply basic principles of engineering science courses and hence put a dismal performance in the examinations. This show that they are not supposed to have been admitted into the engineering school in the first place. In event of escaping a dependable and credible admission scrutiny, mainly due to the admission procedures listed above, COREN in conjunction with the engineering school administration should device a process of pruning the engineering misfits and placing them in other disciplines where they would perform better and later contribute to Nation building and self-employment as well. This measure is already practiced in some professional courses in the Faculty of Health Sciences and Pharmaceutical Sciences. Engineering is in no manner less in importance and demands every effort that could

result in obtaining finely divided and filtered Engineers. The problem recognition, formulation and solution task of an engineer is a precursor for admitting a little above average students, who will later embrace technological needs and ramifications of development opportunities and requirement. Suffice it to acknowledge that successful adaptation to societal expectations of the engineer demands unflinching capability to analyze constraints using all the instrument already encountered during training as well as ideas which the engineer will inherit in the course of experiences. Certain admission policies which include educationally disadvantaged states and discretion should be relaxed during students' admission to engineering schools in Nigeria, but can be invoked elsewhere. The only gate way should be merit. With this, the researchers strongly believe that the quality of students that graduate from our engineering schools will be able to match the immediate need to advance the Nation technologically and proffer original solutions to emerging problems. Presently, the quality of students that pass through our schools of engineering has continued to experience gradual degeneration due to unwarranted compromise.

3.2 Full scale key sector reform

There is no gainsaying the fact that Nigeria is grappling with hosts of key sector- security, economic, religious, social and political problems, to mention but just few. The clamor for restructuring the Country has turned into an overarching political campaign issue suggested for lasting democratic governance in several quarters. In the light of many unaddressed but reiterating short term solution problems, the government should brace up to the challenge of addressing the myriads of issues on a long term note. Undermining or wishing critical questions away does not possess the ability of shaping techno-politically balanced economy. There must be stability in the polity to enable selfless and honest treatment of problems that hinder graduation of quality engineers that will steer the country's ship to regions of industrial development and job creation safety. The vision 20-20-20, and other development plans has almost turned into a mirage, since the date is almost at hand without a reasonable realization of the transformational goals hoped during its inauguration more than three decades ago. The basic problem in this direction has been how to actualize elegant development plans marshalled out by successive administrations. Indeed, the country cannot have infrastructural development at the altar of inter-regional suspicion of insincerity among federating regions or states. For sustained technological development, the country should urgently set up a mechanism that would elevate indigenous engineers' position in the auditorium of World useful engineers, and to ensure that the job creation requirement of Nigerian engineers are aggressively confronted with certainty of victorious outcome. The 4th industrial revolution has fully birthed with the consequence of measuring economic growth of Nations by ease of adaptation to towering supersonic technological changes introduced by the revolution. Nigeria should immediately review her past and present policy confines to welcome an active engineering education and technological training procedures anchored in state-of-the-art methodologies and infrastructure, and also inspired by rewards for excellence and meritocracy. The 4th Industrial revolution is too fast to be tamed by unrealistic equity policies that slaughters quality and talent. Nature herself does not award inventions on the guise of ethno-political balance, but majorly on the altar of talent and hard work.

The fact that many graduates of our institutions are underemployed or unemployable, let alone, job creators raises questions to the nature of engineering education and training offered by different institutions. What was the intention of the training ab initio? Was it to provide a ticket for social climbing, or a passport for civil service three-to-four year's regular promotion appraisal support condiment, in form of an A-4 size paper certificate? If the answer to the later question is no, then there is urgent need to reassess the entire engineering landscape such that Nigerian engineering grandaunts exercises can match global expectations from qualified engineers. This include problem recognition capabilities and application of engineering principles to transform natural resources into development ready consumables. The process of doing this requires guided admixture of manpower, machines, money and ultimately culminates into job creation and self-employment.

4. Improvement Opportunities

There could be no other improvement opportunity in engineering education in Nigeria better the opportunity provided by the ongoing democratic dispensation. Prior to this period, expression of divergent views was difficult and members of academic unions were treated as common criminals and had paid the supreme prize in some cases. Today, the apparent lack of recognition and influence among Nigerian graduates can only be resolved within a revolutionized engineering education. Democracy provides the forum for issue based debates, articulated expression of honest interest and reason to transcend the unprofitable status quo, and a wider door to take a bolder step into negotiations geared at reprioritizing National development goals in a manner to allow engineering education enhance technological

transformation in the republic and produce engineering graduates that can drive job creation. It is noteworthy that engineers have recorded a general apathy to participation in politics and by extension ceded critical leadership positions to graduates from other disciplines, and only wait to be appointed into any office without reason or proper discretion. Even offices directly under the purview of engineers are manned by lawyers, take for example, the Nigerian Ministeries of Works and housing is Babatunde Fashola-a lawyer. The minister for Labour and Productivity is Dr Chris Ngige- a Medical doctor. The storey is same for many state Governors, National and state house of assembly members. This ought not to be so. Engineers must strive to occupy decision making positions that can influence every facet of the profession, beginning from education or training to real World practice. With this, engineers will be able to transcend the prevailing ordinary to become professionals whom others would want to emulate. It could be argued that engineers are not capable of being leaders due to paucity of requisite skills, and should be invited whenever there is a function to differentiate or integrate. This perception seems correct considering that many graduate engineers today lack the soft skills required for effective leadership. Worse still, they (graduate engineers) lack the basic skill to become self-reliant and original. If not, why should an engineer be declared unemployable?

4.1 Updating of engineering education resources

The complaint of poor performance among Nigerian engineers, especially in terms of practical dexterity has been lingering for some time. These engineers whose impact per se cannot be felt in the industries has classmates and colleagues who returned to become lecturers and laboratory instructors. The implication is that the students being thought by the said lecturers has already inherited a gen of non- good practical performance. Like every other that can be transferred from parents to offspring, the students will eventually graduate as no-better-than-lecturer engineers. To contain this, there must be a sort of training reform that cuts across every player in engineering education. Sufficient is the fact that engineering educators had obtained a grounded knowledge and detailed experience in real world aspects of engineering theories, policies and global best practices.
More emphasis should be laid on current status and future dynamics of the practical aspects of the discipline to drive not only job creation, but entrepreneurial capabilities that guarantee the engineers realistic independence. The educators ought to be subjected to continuous training workshops and short period visits or even training in emerging industries. Achieving this will be more possible policy adjustment and agreement between government and industries. Industries should be ready to contribute to making of total world class Nigerian engineer as part of cooperate social responsibility. Engineering must be treated as a professional course, which it qualifies in intent, theory and practice. Medical doctors and pharmacists are well taken care of right from training to practice and students as well as graduates from these professions are in no wise better than engineers. A mouth-watering welfare package should be arranged for the engineering educators in other to spur better performance. The subsisting practice of treating engineering educators in direct disparity with some fellow professional disciplines should be discouraged forthwith. This will not only rekindle the ebbing flame of lecturing and arouse the needed interest in the job but also prevent brain drain in engineering schools. It will also provide for more efficient teaching and research exercise.

Conclusion

The performance of Nigerian engineering graduates is largely dependent not on the end, but is much of a path process. The time to wake up and embrace the deafening challenges to engineering graduates in Nigeria cannot be postponed any further. There is no generation of homo-sapiens with a monopoly of intelligence. The difference is mostly on the environmental conditions surrounding the nurture of individuals. Towards this, the environment and training path of engineers in Nigeria can be re-engineered to provide for graduation of quality world class engineers that will transform the country technologically and economically. Qualitative mastery of the tenets of engineering by lecturers and students will aid ample job creation and self-employment, as well as inadvertently effect the actualization of the change mantra of the federal government.

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