STUDY PROGRESS AND STUDY SUCCESS OF BACHELOR OF SCIENCE IN ENGINEERING STUDENTS AT KU LEUVEN

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INTRODUCTION

The engineering curriculum at KU Leuven (Belgium) consists of a three year Bachelor's program that prepares the students for a subsequent Master's program of two years. The Engineering Bachelor's program is divided in two consecutive phases. The first phase of the Bachelor lasts three semesters and is common for all engineering disciplines with the exception of the study leading to the degree in Architecture. For the subsequent three semesters – the second phase of the Bachelor's program – the students choose a Major and Minor discipline, that will prepare them for the subsequent Master's program. Hence the Faculty of Engineering Sciences combines teaching a broad base of scientific knowledge with educating very specialized technological knowledge and skills.

The curriculum of Bachelor and Master of Science in Engineering are amongst the most difficult study programs in Flanders (Belgium) and only (very) intelligent and motivated students will successfully complete these studies. In the period between 1970 and 2003, over 80% of the students who started the study of Bachelor of Science in Engineering at KU Leuven, achieved a Master's degree of Science in Engineering. Over 60% of the students finalised their studies without delay. In the

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same period, about 50% of all students at the Flemish Universities succeed in obtaining a Master's degree and only about 30% without delay [1]. The higher success rate for the studies of Master of Science in Engineering at KU Leuven, compared to other academic study programs, was at that time a direct consequence of the severe entrance exam the students had to pass before they could start an academic engineering study. The success rate for this entrance exam varied from year to year, but was in general between 50 to 70%. After 2003, the entrance exam was abolished and together with the bachelor-master system some major curriculum changes were implemented. The success rate of the engineering students decreased consequently.

High school GPA has always been a significant predictor for freshmen (engineering) success but also for upper-class (engineering) education academic success [2,3,4]. Of all the academic variables, Robbins *et al.* [5] conclude that high school Grade Point Average (GPA) has the strongest relationship to college GPA. However, Adelmann [6] and Ackerman Megert [7] stipulate that also the mathematics preparation is at the core of college success, irrespective of choosen study program at University or University College. Of all pre-college curricula, the highest level of mathematics has the strongest continuing influence on bachelor's degree completion. Therefore, the combination of math classes taken in high school and GPA seems to be a better indicator of University study success than GPA alone.

The main purpose of this paper is to investigate the present situation, in terms of study success, of 466 students enrolled in the Bachelor of Science in Engineering program in the academic year 2009 – 2010. Study success is, in this paper, defined as the percentage of students following nowadays (anno 2013) a first year Master of Science in Engineering Program; hence, having no delay in study progress. The relationship between study success and high school background parameters, such as the level of mathematical education, study program and GPA in high school of the 466 students are further investigated. Additionally, these results are compared with study success and high school background of students Bachelor of Science in Engineering in the period between 1970 and 2003.

1 MATERIAL AND METHODS

In 2009, at the start of academic year, all 466 students filled out a questionnaire, and indicated their level of mathematical education and GPA. Other data (high school study program and study progress anno 2013 at University or University College) were extracted from the KU Leuven Association[2] Student Administration database.

Data regarding the number of students, the high school background and the success rate in the period between 1970 and 2003 were gathered at that time at the Tutorial Services of the Faculty of Science and Engineering [9].

[2] The KU Leuven Association is based on a close cooperation between KU Leuven and eleven university colleges. It is a multi-campus network situated in 23 different cities and towns across Flanders and Brussels. With almost 100,000 students, the Association accounts for 43% of the entire student population in Flemish higher education. About half of these students are subscribed in a professional programme, 16% are academic students at university colleges, and 34% follow an academic programme at KU Leuven [8].

2 RESULTS

2.1 Study success and progress of the 466 fresh men students from the academic year 2009 - 2010

In the academic year 2009-2010, 466 freshmen students enrolled in the Bachelor of Science in Engineering program at KU Leuven. At present, 62,0% still follows a Science of Engineering program, 16,3% has switched to a University College Engineering program and 8,4% follows a totally different program, as can be seen on *Fig. 1*. For 13%, no further information was found in the KU Leuven Association database. This could indicate that these students are either following a study in a University or University College outside the KU Leuven Association or are currently at work or are searching for a job.

From the 404 students (87%) who are still following a study program within the KU Leuven Association, 79% is following a Study program at University level and almost 95% is pursuing a (professional or academic) Bachelor's and/or Master's degree in Science and Technology.

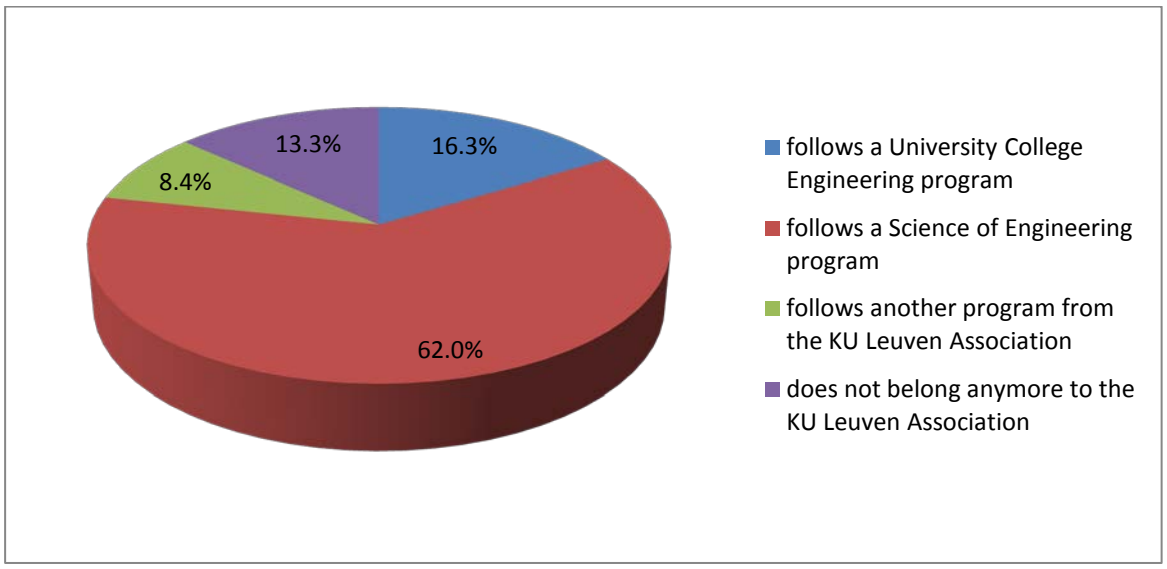

Fig. 1. Overview of the present study situation of 466 fresh men students, who followed at the academic year 2009 – 2010 the first phase of Bachelor of Science in Engineering

Regarding study progress (*Fig. 2*), 52% will (normally) finish this year a first Master year; hence, they will achieve their Master's degree within 5 years of study. This group consists mainly of students who did not choose another study program. 28% of the investigated group will receive a Bachelor diploma from the KU Leuven association with one year and 7% with 2 (or even more) years delay. As already mentioned, from 13% no further information is known. Therefore, especially the aforementioned numbers 28% and 7%, are minimal possible values. When assuming that most of these 13% are still studying, but outside the KU Leuven association, it can be expected, that about 38% of the 466 students have one year delay and about 10% of the students have two or more years delay.

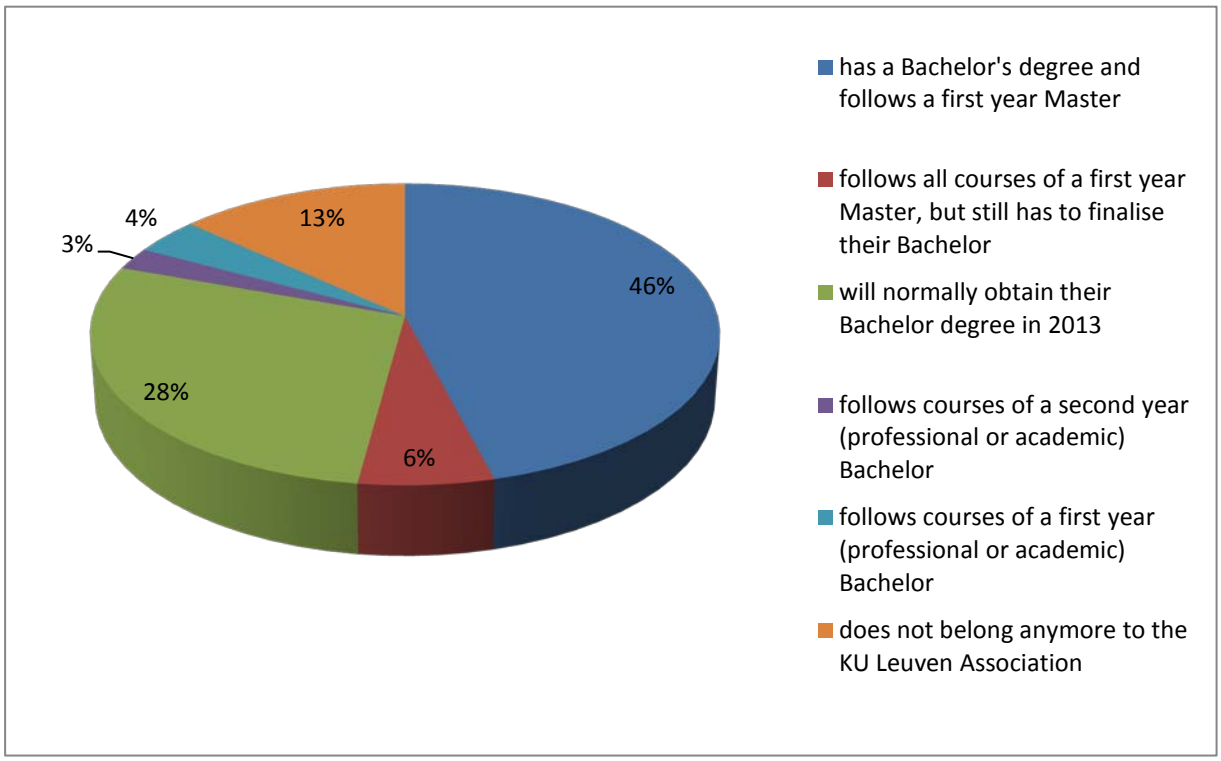

Fig. 2. Overview of the study progress of 466 fresh men students, who followed at the academic year 2009 – 2010 the first phase of Bachelor in Science and Engineering

Fig. 3 gives an overview of the present situation of the 289 (62%) students who still follow a study program of Science in Engineering (either Bachelor or Master). 72% of this group follows nowadays a first year Master of Science in Engineering, 9% follows all courses of a first year Master of Science in Engineering but still has to obtain a Bachelor's degree. They still need a few (less than 10) credit points on a total of 180 for a Bachelor's degree, but it is expected that most of them will succeed. 16% follows mainly courses of the last phase Bachelor of Science in Engineering. And 3% of the students are following mainly course of the second phase. This all will lead nowadays to an average study duration for Master of Science in Engineering of 5,2 years.

Finally, combining the results given in *Fig. 2* and *3*, leads to the following facts: around 50% of the 466 students will obtain a Master's degree of Science in Engineering within 5 years of study. 10% of the 466 students will have one year delay and around 2% will have two (or more) years delay before obtaining a final Master's degree of Science in Engineering.

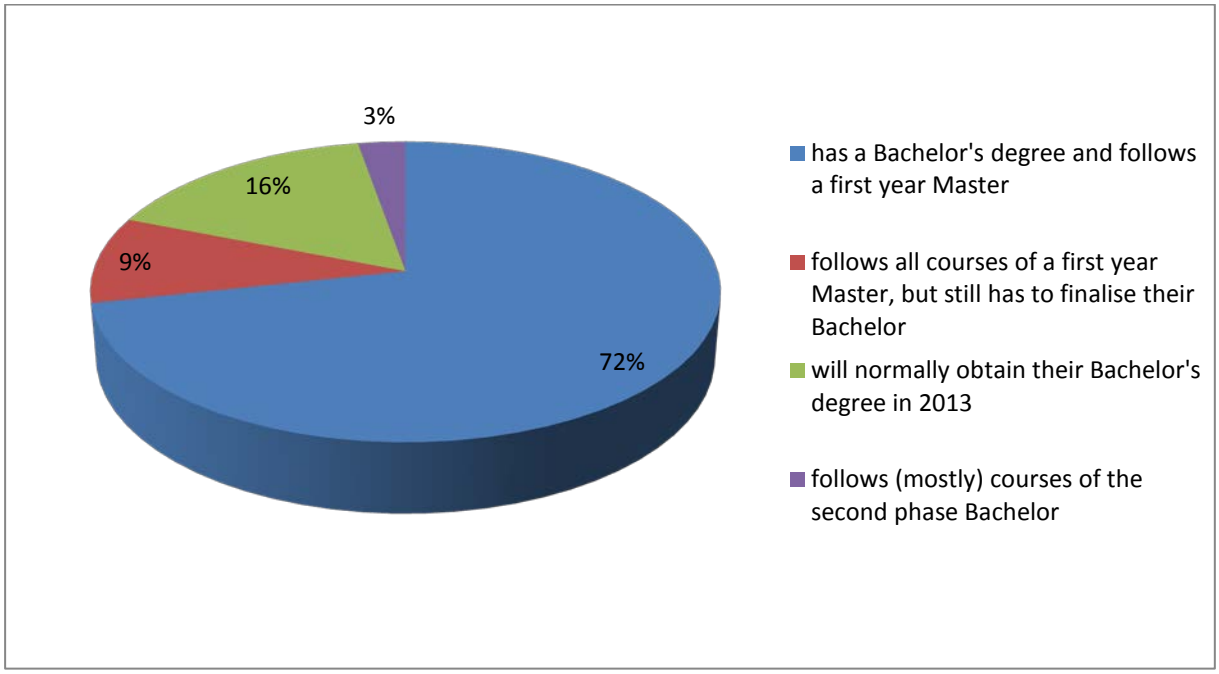

Fig. 3. Overview of the present study situation of 289 fresh men students, who followed at the academic year 2009 – 2010 the first phase of Bachelor of Science in Engineering and are now still pursuing a Master's degree of Science in Engineering.

2.2 Study success and progress in the period 1970 - 2009

Fig. 4 gives an overview of the success rate of first year students between 1970 and 2009. Only data is available since 1970 [9]. In the period 1970 – 1990, the success rate in the first year was always between 60 and 65%. In this period, the number of fresh men students in the first year was increasing from around 200 students, to almost 350 students at the end of the 1980s, but the success rate of the first year students did not vary significantly.

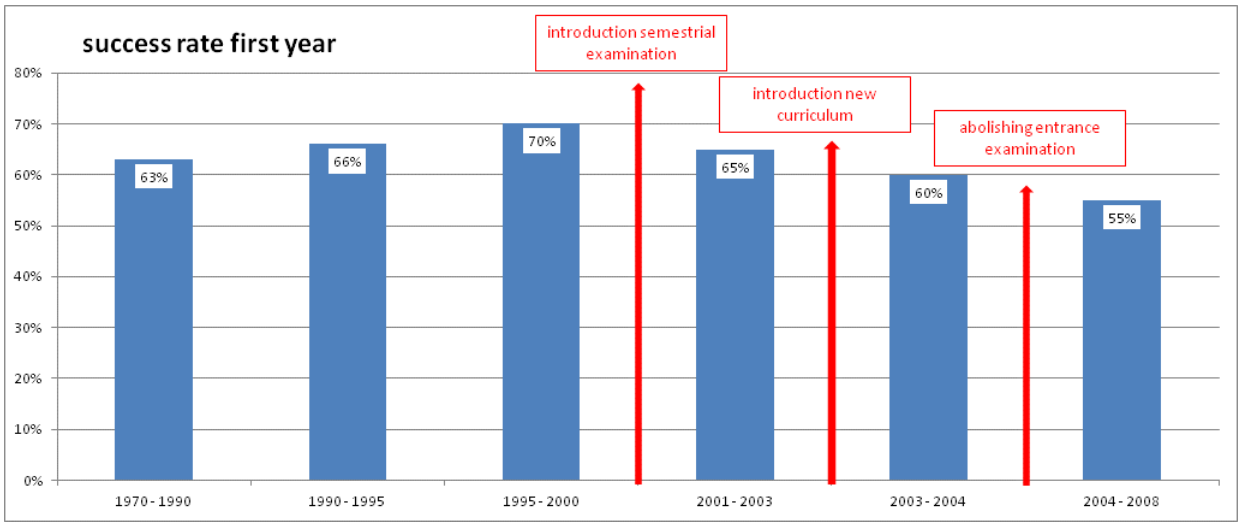

Fig. 4. Overview of the success rate of fresh men first year students between 1970 and 2008. Three important differences are indicated: the introduction of semestrial examination, the introduction of a new curriculum and the abolishing of the entrance examination.

Between 1990 and 2000, an increase in success rate was noticed, this is probably due to the fact that less (around 250-300), but probably more motivated, students started the studies of science in engineering, and also following the "Plan Dillemans - less is more"[3], a decrease in study load was implemented.

However, after 2000, some major changes are introduced: at first, from the academic year, 2001 – 2002, the students are having two examination periods (one in January and one in June) instead of one (only in June). In the academic year 2003 – 2004, following Bologna, a Bachelor – Master structure was implemented and a new curriculum was introduced for the first year. From the academic year 2004 – 2005, the entrance exam was abolished. These three facts all had a significant influence on the success rate as can be deduced from *Fig. 3*.

The first year is considered to be the most difficult to pass, and the success rates of the following study years were above 90%. Therefore, the percentage of students achieved a final master's degree of Science in Engineering without any delay can be deduced from *Fig. 4*: around 60-65% of all students achieved their Master's degree in Science and Engineering within 5 years of study. In addition, around 10-15% of the students got their degree in 6 years, 2-5% in 7 years (or even more) and about 15-20% of the students did not get a Master's degree of Science in Engineering. Therefore, before 2003, around 80 to 85% of the students did finalise their initial study and obtained a Master's degree of Science in Engineering. The average study duration for a Master's degree of Science in Engineering was in this period between 5,2 and 5,3 years.

2.3 Relationship between study success and student's background: level of mathematics (at present) (before 2003)

In a next step, the relationship between study success (defined as following nowadays a Master of Science in Engineering Program) and student's background is discussed. 60% of all 466 freshmen students of the academic year 2009 – 2010 had in high school 7 or 8 hours/week Mathematics. 64% of this group is successful; hence, has no study delay. 39% had 6 hours Mathematics and 44% of this group is successful. 1% of all students had less than 6 hours Mathematics and from this group, only 20% is successful.

2.4 Relationship between study success and student's background: level of mathematics (before 2003)

In the period 1970 – 2003, almost 90% of the incoming students for the study of Bachelor of Science in Engineering had in high school 8 hours/week of Mathematics [9]. The specific success rate of the students with a different high school background regarding hours of mathematics in the period before 2003 is not known for KU Leuven students. However, a study at the University of Ghent [10] for the period 2000-2003 showed that students who had 8 hours of mathematics had a success

[3] Plan Dillemans: in 1988, the KU Leuven Rector Roger Dillemans launched a reform plan in which he pleaded for less encyclopaedic courses and a curriculum that is more focused on learning to think than learning to memorize.

rate in the first year of 50-60%, whereas only 30-35% of the students with 6 hours passed. Hence, a significant difference in study success was observed.

2.5 Relationship between study success and student's background: high school study program (at present)

The freshmen students are further divided according to their high school study program: 37% of the 466 students followed Latin/Greek-Mathematics, 56% followed Sciences-Mathematics and 7% followed another program (eg. Latin – Greek, Latin-Sciences, Industrial Sciences, ...). The study successes of these three groups are respectively: 54%, 52% and 24%.

2.6 Relationship between study success and student's background: high school study program (before 2003)

In the 1990s, it was observed that at that time over 65% of the fresh men students, had followed a Latin/Greek-Mathematics study program in high school and only 22% followed Sciences-Mathematics. And the study success of the first group was significantly better than the Sciences-Mathematics group (68% versus 44%). 11% of the students followed another study program and their study success was 40% [9].

2.7 Relationship between study success and student's background: high school GPA (at present)

The overall score in high school (GPA) is calculated as a weighted average of all the grades a student gets on all courses in the final year at high school. For this third parameter, the group is again divided into three: 1) having a percentage of >=80% (32% out of 466), 2) having a percentage between 70 and 80% (51% out of 466), and 3) having a percentage <70% (17% out of 466). When looking at study success: 80%, 55%, and 23% of these groups are successful.

2.8 Relationship between study success and student's background: high school GPA (before 2003)

No information is available for the situation before 2003. But, seen the fact that high school GPA is a significant predictor for academic success [2,3,4], it is expected, that in those days, similar trends in success rates could be found.

3 DISCUSSION AND FUTURE PERSPECTIVES

Regarding study success and progress, it is expected that 50% of the 466 freshmen students of the academic year 2009 – 2010, will have no delay in finalising their Master's degree of Science in Engineering in 2014. This percentage is (a lot) higher compared to the present situation in Flanders, where around 40% of the fresh man students will get an academic Bachelor's degree (and also Master's degree) without delay [11]. This indicates that nowadays, still the better and more motivated students start a study Bachelor of Science in Engineering. But at the other hand, when comparing with the situation before 2003, 10% less students obtained a degree in Science and Engineering without delay. This is obviously a direct consequence from the fact that new students do not have to pass the severe entrance exam.

However, seen the fact that in the past, the vast majority (90%) of the student population of Science in Engineering consisted of students who had followed 8 hours/week Mathematics, it must be emphasized that for this group no differences is found between the study success percentage (around 65%).

When looking at the study time duration of Master of Science in Engineering at present and before 2003, no different is observed (around 5.2 years). As it is expected nowadays that – due to the so-called "Diploma Space", where the students could more easily postpone some courses – the total study time duration will increase, but at the moment, this seemed not the case for the study of Bachelor/Master of Science in Engineering. However, it is too soon to make a final conclusion on this matter, seen the fact that the success rate of the first year students are still decreasing after 2009 [12].

All mentioned results are in agreement with Adelmann [6] and Ackerman Megert [7] meaning that the combination of high school GPA and a high level of Mathematical Education in high school are the best predictors for student success.

Regarding study program in high school, nowadays, the success rates of the two major groups (i.e. Latin/Greek – Mathematics and Sciences – Mathematics) are more or less equal. However, in the investigated period between 1990 – 1995, there was a significant difference in study success, where the performances from the Latin/Greek – Mathematics group were much better than from the Sciences – Mathematics group. This probably means that in high school there seems to be an attitude change where before the best students often followed a Latin/Greek-Mathematics program, and nowadays the best students are equal distributed between the different study programs. This is probably due to the fact that in high school some major curriculum changes were done in the 1990s to create a more uniform school system for all schools in Flanders, where both study programs can be followed [13].

There seems, however, to be a great difference in study success for the group with other study programs (e.g. Latin – Greek, Latin – Sciences) before 2003 and nowadays. Before 2003, at KU Leuven, students who did not pass the entrance exam (and often had 6 or less hours/week Mathematics or had followed a high school study program other than Latin – Mathematics and Sciences – Mathematics), followed a preparatory year where their Mathematical skills were enhanced, before (re)doing the entrance exam. Nowadays, this preparatory year is not organised anymore. Hence, to this group who succeeded to finalise the study of Master of Science in Engineering within 5 years (around 40%), one should bear in mind that most students of this group followed the preparatory year. Therefore, the study period duration of the group who had followed in high school a different study program (before 2003) is not that different with the present situation.

Concurrently with the decrease in success rate, a steadily increase in number of fresh men students is observed: from 350 in the academic year 2003 – 2004, 466 in the academic year 2009 – 2010, to 520 in the present academic year 2012 – 2013. Hence, more and more, students are entering the studies of Bachelor of Science in Engineering. But as already mentioned, when looking further at the situation after 2010, the success rate for fresh men students is still decreasing (<50% [12]), and therefore, it expected that all aforementioned numbers for study success could decrease in future. It can therefore be concluded that more and more fresh men students seem to lack the suitable skills for success.

To overcome this situation, the Faculty of Science and Engineering at KU Leuven started the development of a new instrument (a so-called "Positioning Test") to advise future students whether they have sufficient domain-specific knowledge and skills to start a bachelor program in Science and Engineering [14]. In July 2013, the first group of students will take this test. The results of this test are non-binding, but (hopefully) forces future students, who have scored insufficiently on this test, to

reconsider their study choice or to follow eg. a summer school in Mathematics before starting their studies in Bachelor of Science in Engineering.

The research presented in this paper will be repeated in a few years in order to investigate whether there has been a change in study success and background of the freshmen students due to the Positioning Test.

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