
The Internationalisation of Postgraduate Programmes

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The article presents the efforts made and experiences gained in the globalisation of the study programmes within electronic engineering at Aalborg University, Aalborg, Denmark. The project-organised Problem-Based Learning (PBL) Model, which has been employed here since 1974, is presented and discussed. The consequences this Model has for the international students are examined in terms of, for example, the teamwork situation, as well as professional and cultural differences. Also considered in the paper is the student enrolment programme that is fostered with the provision of scholarships, which are jointly sponsored by government and industry.

INTRODUCTION

Since 1996, Aalborg University (AAU), Aalborg, Denmark, has offered engineering programmes conducted in English from the Bachelor level degree through to the MScEE degree. Some initial findings on this topic have been reported elsewhere [1]. Initially, there were two programmes: Acoustics and Intelligent Multi Media (IMM) [2]. More programmes have since been added.

Since September 2001, the AAU has been running 12 programmes conducted in English [3]. Students who attend these programmes come from around the world, with the majority coming from outside the European Union. This article focuses on the experiences gained from this effort in globalisation.

Aalborg University differs from most other universities by the pedagogical concept implemented there since 1974, namely project-organised Problem-Based Learning (PBL) [4][5]. The integration of students involves multicultural teamworking right from the start. Students with different cultural backgrounds and from different university traditions must learn to cooperate in teams on a full-time basis. Further details concerning this concept can be found in the papers by E. Moesby and S. Enemark in this issue of the *Global Journal of Engineering Education*.

This article presents international students' experience with PBL, how these students function in a

teamwork situation and experience cultural and language problems. The reactions from the Danish students are also discussed and some statistics on enrolment and the geographical distribution of the students are presented. The scholarship programme introduced by the Danish government is also discussed.

PROBLEM-BASED LEARNING (PBL)

In 1974, Aalborg University was established; at the same time, project-organised Problem-Based Learning (PBL) was introduced into the Danish engineering education system. From the beginning, project work has been the key element. Students must carry out a major project during each semester, generating approximately 500 hours of workload per student.

In groups of four to six students, this translates to 2,000-3,000 person-hours per project. This calls for a high demand of social, communicative and cooperative skills from the students. Because of the scale of the projects, the inherent demand for project themes stem from real-life problems. As such, there is a need to foster close cooperation with (often local) industry in order to identify real engineering problems.

Each problem-based project work comprises *problem analysis* and *problem definition* in engineering terms, *problem solving*, as well as *documentation* in terms of a report or a scientific paper and poster. Figure 1 illustrates the key components.

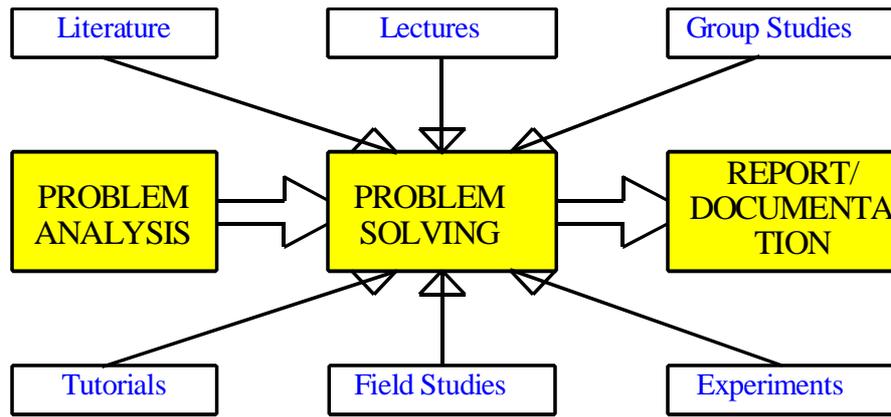


Figure 1: Principles of project-organised problem-solving [4].

The Learning Environment

Students at Aalborg University are organised in groups of up to six members. Each group is assigned an 18m² office for the duration of the project period (one semester), which effectively becomes their second home. This room is the group's base where they have discussions about the project; they can also carry out designs, simulations, communications, etc, using available software tools via the PC/terminal in the room. Students can personalise their office by putting pictures on the wall, bring their own PCs, etc. Group rooms have individual keys, which (apart from the building officer) are only issued to the group members.

Another important function of the project group offices is connected to the learning process. After each lecture (lasting approximately two hours), the students are expected to go to their group rooms to solve assigned problems, simulations, etc, based on the content of the lecture. This takes another two hours where the lecturer walks from group to group in order to facilitate the process. Hence, the students meet the lecturer *in their own backyard*, which places them more on an equal footing.

The students learn how to communicate and cooperate in solving major engineering problems by being part of a team. They learn how to deal with professional discussions in situations like problem definition and argumentation for their personal choice of solution. Students learn how to argue about and explain in scientific terms what they believe is the right solution – it is not enough to claim you are right, you must be able to convince other group members. Likewise, they must be able to listen to the arguments of their group members and negotiate compromises. In this sense, argumentation is a good way to learn.

Furthermore, students also learn how to organise teamwork and learn that a team cannot function

effectively if everybody does not do their share of the work. In this way, the students adopt a certain attitude towards work that is different from those students doing traditional individual university study. Moreover, the PBL students get the feeling of safe social surroundings. The other students expect them to show up every morning and, if they do not appear, they will probably contact them in order to find out why they have not turned up.

Teamwork also has the effect that students encourage each other, particularly with regard to problem solving, and the students assign some sub-tasks for each group member. In order to succeed in these individual tasks, the student has to read the literature, seek out additional information, including scientific papers, search the Internet and do some programming or whatever is needed. As no student wishes to end up with an inadequate solution to the problem, all group members work very hard on their project. The project is the key element in the curriculum and applies the theoretical courses in problem solving. Further, the project offers opportunities for students to reflect on their professional work.

A supervisor or facilitator is assigned to each project group. The facilitator meets with the group approximately once a week to discuss the progress of the project, to guide them back on the track (if necessary) and to read and discuss drafts for their documentation. It is very important that the facilitator is aware that he/she should not be a problem solver, but rather a facilitator. At the end of the semester, this facilitator is responsible for the final examination of the project, together with external examiners appointed by the Ministry of Education.

One consequence of the PBL Model is that, on average, 80% of the students entering the University succeed in finishing their study, with most of them managing to do this within the standard study duration [6]. Compared with a traditional university, it can be

seen that PBL improves the learning effect twofold:

- A completion rate of 80% is regarded as being quite high.
- An average completion time close to the prescribed duration is unusual [5].

It can be said that the students both learn and socialise professionally. Discussion, argumentation and application is a strong method of learning, both for bright students and those who may be average. Furthermore, there has been no correlation found between the entrance level of academic skills and the completion probability.

THE INTRODUCTORY TERM

The PBL approach is very much an integral part of everyday life at Aalborg University (even the buildings, with the abundant number of group offices, confirms this).

International students, who enter Aalborg University at the graduate level (ie having completed their bachelor degree), stay for four terms (two years) in order to obtain their Master degrees.

The AAU has recognised that it is not possible for foreign students to be integrated directly into this structure from the day they arrive and be expected to work together in groups with Danish students who, at this point, have three to four years of experience with the PBL Model. Therefore, an introductory term has been set up for foreign students only. They must pass the examinations at the end of this term in order to be enrolled in the Masters programme.

Introductory Curriculum

Given the large variation in the backgrounds of those MSc students starting at Aalborg University, the courses of this introductory term were designed to bring the students up to a level that facilitate admittance to the courses during the subsequent programme terms. For some of the new students these courses refresh previous training but, for the majority, the curriculum presents several new concepts. Subjects like stochastic mathematics and digital signal processing are considered to be cornerstones for the majority of programmes and, hence, four ECTS point courses are allocated for these two subjects.

Other common courses are programming in C and *Matlab* to assist these students in their projects. Students who have completed these courses integrate more easily with the Danish students in the following term and, in general, the outcome of their training at the AAU is greatly improved.

One major objective of the introductory term is to give the new students experience in PBL and team-working. The term is therefore designed to ease this process by an initial problem definition phase along with a course in PBL. This course includes a number of hands-on exercises in teamwork that, it is envisaged, leave the students with the feeling that a group of students solve complex problems better than any individual student.

The problem definition phase covers the first five weeks and concludes with a seminar where the groups present their problem analysis and plans for the remaining part of the term. All students and supervisors attend this seminar and feedback is received both on the content of the project and on the teamwork process. The design, implementation and documentation phase of the projects covers the remaining ten weeks. During the entire term, the supervisors give extra attention to the groups compared to the ordinary semester projects so as to make sure that the groups progress satisfactorily.

Project examination takes place soon after the reports are due, which leaves sufficient time for possible re-examination to take place before the semester ends. The students are examined both in the content of the report and in the process of their teamwork, including their ability to communicate with fellow students and teachers. The students must be able to demonstrate a capability to work in a group. The students must pass the project exams before starting on their chosen specialisation. This means that they can be prevented from further study if their technical or communication skills, such as language skills or cooperative attitude, do not meet the required standard.

Cultural Integration

Adapting to the different culture at Aalborg University, and in Denmark generally, provides a major challenge for students in the introductory programme. Furthermore, the students also have to interact closely with students from a number of other nationalities through the project work.

The introductory academic programme is designed to provide assistance that allows students to adapt to this cultural challenge. The aim is to:

- Develop skills and learning habits within all students so that they can interact with staff and students at Aalborg University and benefit from the learning concepts used.
- Enable students to appreciate, benefit from and contribute to the richness and diversity of the student population.

- Encourage students who will accept responsibility and make positive contributions to an increasingly interdependent and multicultural world.
- Create an academic understanding among the students that fosters intellectual tolerance, freedom and integrity.

Services provided include academic supervision, cultural courses, a buddy system (a voluntary Danish student who helps with practical matters and gives an introduction to student life in Aalborg) and language assistance. A special course is given to specifically address the learning practice associated with the PBL concept.

In order to facilitate smooth integration into student life at Aalborg University the students go through an introduction week with limited academic lectures. During this first week, new students are introduced to the various services offered by the University. Typically, Danish graduate students handle this introduction. These students (or buddies) will help the foreign students in their first encounter with practical problems and serve as guides to the University's services and student facilities. In addition, the first week includes a course called *Orientation to Denmark*, which explores the challenges of cross-cultural integration and deals with Danish cultural issues.

The students are also introduced to their academic supervisors during this first week. The supervisors are given extra time to deal with problems that arise due to different learning habits and cultural issues. Typically, supervisors typically meet with the students once a week and try to oversee their academic progress, as well as help to resolve any cultural problems that may arise. A small social gathering is arranged at the end of the week to allow for a more informal discussion with supervisors and buddies.

The foundations of successful studies also rely on the fact that the students establish a strong social network during this introductory programme. Experience shows that the common excitement and confusion experienced during the initial period forms the basis for the generation of a network of people or friends that students benefit from during the remaining part of their studies.

INTERNATIONAL STUDENTS' EXPERIENCES WITH PBL

Traditionally, a critical point is the formation of groups at the start of each term. Groups are formed among the students who have chosen a particular study programme. These groups are partly formed from

professional interest in a particular subject, or, just as commonly later on in the programmes, from personal preferences. Fortunately, the formation is usually relatively unproblematic: the *native* students simply form the groups and assimilate the foreign students. As a rule, groups must include both Danish and international students. In some programmes, social activities are used to integrate the students, eg the groups are given the responsibility to arrange a party. After the first project period, preferences for group members of Danish and international students seem to be on an equal footing.

When problems occur, it is the responsibility of the semester coordinator to mediate and ensure that all students are put into a group.

Experiences from Group Work

Generally speaking, most of the students quickly learn to function well in the teamwork situation. However, a number of problems have been experienced. Apart from difficulties with language, almost all of the problems encountered have to do with different backgrounds in the way that the study is organised. Although most students have tried to work in teams at least once and completed a major project assignment, the proportion of time spent on the project is much larger than they have previously experienced. Many students are unprepared for this and care must be taken in explaining this fact. Also, the dependency between the members of the group is very high. Being responsible not only for your own study, but also for your fellow students, is an unknown concept for some students, which can sometimes lead to problems.

A study among the international students was conducted at Aalborg University in 1999 and showed that 26% (of 69 participants) found some aspects of the process problematic [6]. Yet there was a fine line dividing what was perceived as problematic and what was considered as challenging in a positive respect. One question from the study was:

If you could choose a parallel course of study here that did not use group work, would you choose that instead of working in groups?

One of the responses was as follows:

No, I think for the purpose of the challenge, different ways of learning things. The purpose of learning abroad is, I think, to adjust to another way of studying. That's why I am here. So, even though there are many challenges in group work, many challenges

and difficulties, I still think it is useful for myself. I would definitely choose the group problem oriented [7].

Cultural Differences

Based on AAU's experience, it is not possible to form general conclusions about particular problems being related to a certain cultural or ethnic background. This is also the case in a study reported elsewhere [6].

However, specific events indicate that problems sometimes occur that may have cultural roots. Several examples can be cited: Chinese students feel very strongly about *losing face*; therefore they do not want to involve the supervisor in, for example, solving internal group problems. Students from Africa do not (at their arrival) fully appreciate how important *being on time* is in Europe, that it is very important to keep appointments, etc (although they quickly realise this). Students from Europe *claim their rights* and would ask for changes in the programme if it is better for their private planning, whereas a Chinese student would never *cause problems* for the professor.

Language Skills

According to the AAU's experience, the most decisive factor as to whether a student succeeds or not is his/her language proficiency, particularly in English. At a more abstract level this can be seen as the ability to communicate. Even though most students are quite capable of (and used to) following lectures and reading literature in English, most of the day is spent communicating verbally with fellow students. Furthermore, all written material must be in English, which generates minor difficulties for many students.

The admission requirement is a score of 550 in the standard TOEFL-test (being the only worldwide English test), which actually gives no information about conversational skills. This is also concluded in the following statements:

The most often cited problems with using English were those involving communication among foreign students from different parts of the world where English is used as an official second language or is only learned as a foreign language. Differing accents, pronunciation and syntax customs often made communication difficult, a problem that was mentioned particularly in connection with group work. It was also reported that some foreign students were so poor at English that they couldn't contribute to the group work and, in one instance, that a

student wrote in his native language after which a fellow countryman translated into English ...

Some of the problems experienced by using English to communicate among foreign students, doubtless reflect inadequacies in English qualification testing at foreign universities. Other problems, however, appear to stem from regional differences in using English. Even though students from the same part of the world understand each other's spoken English without problems, local language conventions can make it extremely difficult for people from other parts of the world to understand what is being said. In some instances, these problems can give rise to further misunderstandings, especially in groups that suspect that they are discriminated against for other reasons [7].

Students (both Danish and international) are offered courses in the English language in both oral and written aspects, but these are at an advanced level (eg *Scientific English* for writing professional reports and papers) and cannot correct more fundamental problems. It is difficult to make generalisations, but it seems that West European students experience the least amount of problems, whereas East European, Middle and far East and, to some degree, African students suffer more from language problems.

Reactions from Danish Students

The Danish students' situation is, of course, influenced by the arrival of the international students. The most obvious change is that the Danes have to switch to English.

Less evident is the fact that, due to the teamwork model, the assimilation of inexperienced students into groups can directly affect the grade given for the project work. In general, this does not seem to be something that concerns the Danish students very much but, in some cases, there has been a reluctance to accept new members into the groups. Furthermore, the Danish students also actively help the new students get settled in and aid in the formation of social networks.

A further indication that this is not a major concern for the Danish students is that the two most popular graduate programmes among the Danish students (Intelligent MultiMedia and Mobile Communication) are also those with highest number of international students (35-80% of the total number of students).

Enrolment

A large number of leaflets and posters were printed and distributed to over 500 universities and institutions throughout the world at the programme's initiation. At the same time, the material was also placed on the Web, together with application forms, applications for student housing, etc. However, an investigation later showed that applications almost exclusively originated from the Web, or were transmitted by word of mouth. As a consequence, advertisement is now only done via the Web.

Table 1 shows the distribution of international students in the eight programmes starting February 2000. Table 2 details the number of foreign students arriving for the academic years 2000/01 and 2001/02. The September enrolment figures for the introductory semester and the February enrolments for the MSc programmes are given in Table 3.

The figures indicate that the majority of international students come from Europe, but the relative high number of French students is due to the fact that the AAU has a special agreement with several French engineering schools/universities. The decrease in the number of Chinese students enrolled must be seen

as a consequence of some poor experiences with Chinese students' language skills. Note that only students who are admitted for the full MSc programmes are included in the table. The clear dominance of European students can be determined from the number of students in a one-semester exchange programme: nearly all come from Western Europe. Furthermore, Danish students constitute approximately half of the total number of students.

Scholarships

As in many other countries, there is a strong demand for engineers in Denmark, especially in the IT sector, and demand exceeds the output from Danish educational institutions. Given this situation, the Danish Government initiated an extensive programme for the provision of scholarships so as to attract foreign students. The intention is that the Danish Government pays for the education (there are no tuition fees at Danish universities) and also for the living costs (in collaboration with various companies), which are considered prohibitive for most non-Western European students. In return, it is hoped that a reasonable proportion of these students gain jobs in Denmark and

Table 1: Foreign MSc student arrivals February 2000.

<i>W. Europe</i>		<i>E. Europe</i>		<i>M.F. East</i>		<i>Africa</i>		<i>N.&S. America</i>	
France	5	Bulgaria	2	China	5	Ghana	3	Mexico	2
Greece	1	Hungary	1	Pakistan	2	Egypt	1		
Italy	1	Lithuania	8	India	1	Nigeria	1		
Spain	2	Romania	1			Vietnam	1		
Total:	9		12		8		6		2

Table 2: Foreign MSc students arrivals September 2001 / February 2002.

<i>W. Europe</i>		<i>E. Europe</i>		<i>M.F. East</i>		<i>Africa</i>		<i>N.&S. America</i>	
Cyprus	1	Lithuania	2	China	5	Cameroon	1	Chile	2
France	24	Romania	4	Pakistan	2	Egypt	1	Colombia	1
Spain	1			Thailand	1	Ghana	5	Guatemala	1
						Vietnam	1	Mexico	1
Total:	26		6		8		8		5

Table 3: Number of foreign MSc student arrivals from September 2000 to February 2001.

<i>W. Europe</i>		<i>E. Europe</i>		<i>M.F. East</i>		<i>Africa</i>		<i>N.&S. America</i>	
Austria	1	Lithuania	13	Bangladesh	1	Cameroon	2	Mexico	2
France	11	Romania	4	China	13	Ethiopia	2	USA	1
Germany	2			Indonesia	1	Ghana	2		
Spain	1			Iraq	1	Vietnam	1		
				Israel	1	Zambia	1		
				Pakistan	3				
Total:	15		17		20		8		3

stay for a number of years after graduating before they return to their home countries. However, there is no compulsion to do so.

Table 4 shows that there has been a sharp rise in the number of students arriving, primarily due to the government-funded scholarships that were initiated in the academic year 1999/2000. It can be seen that only one third of the admitted students arriving in Denmark start their studies without the aid of scholarships. This number increases to approximately one-half after the introduction of scholarships. This can be partly prescribed to the fact that, in many cases, students cannot apply for funding (such as from foundations, companies, etc) until they have actually been admitted.

Other problems include insufficient student housing in Aalborg and, sometimes, obtaining a visa, which can be a problem, especially for those students from third-world countries.

Industrial Funding

As stated earlier, Aalborg University has a very strong tradition of undertaking PBL in collaboration with industry. As an example, a majority of MSc students are completing their Masters thesis project in some form of collaboration with an industrial partner, such as LEGO, Bang & Olufsen, Siemens, Nokia or Ericsson. The benefits here are mutual. The students work on real-life engineering problems, often receiving support in the form of equipment or access to in-house expert knowledge, and the companies receive a thorough analysis and proposed solutions to their problem, as well as a base for recruiting the students when (or even before) they graduate.

Given this background, it was only natural to seek support from some of Aalborg University's traditional partners in collaboration and, as can be seen from Table 4, a few scholarships were donated.

However, it was not until the government scholar-

ship programme was initiated that companies readily committed themselves. One important condition for public funding is that a company should cover a third of the costs for every scholarship granted.

When a student applies for a scholarship, a university committee evaluates the application and, depending on the outcome of this, the application is forwarded to those companies that are considered to be interested in sponsoring. Companies often directly target their donations to certain groups of students following specific programmes, eg Nokia and Siemens Mobile Phones each sponsored four IMM and four Mobile Communications students in 2000.

DISCUSSION AND CONCLUSION

The article has presented some of the experiences gained by Aalborg University in the globalisation of its MScE programmes. Although Project-Based Learning (PBL), in combination with project oriented teamwork, has proven its worth, it is a very different situation compared to what most students have been used to at other universities. A number of problems have arisen concerning educational backgrounds, language and different professional levels. Since autumn 2000, an introductory half-year semester has been introduced in order to counter this.

One important issue concerns the enrolment of students. A scholarship programme has been initiated wherein government funding is combined with company sponsorships.

A large number of skilled BScEE candidates around the world are looking for an opportunity to study abroad, combine further professional development with personal development and explore another part of the world. On the other hand, industry, especially in the electronics and IT sector, has become international and continues to expand worldwide.

In the information society increasingly more (consumer) products require progressively more

Table 4: Statistics for admitted students, students who actually commenced their studies and the number of students with scholarships.

Academic Year	Admitted	Arrived	Scholarships
February 1997	7	2	0
September 1997/February 1998	31	9	2
September 1998/February 1999	52	19	1
September 1999/February 2000	103	50	26
September 2000/February 2001	117	50	21
September 2001/February 2002	110	53	8
Total:	420	183	58

knowledge to produce. Given this, knowledge and competence have become some of the most competitive parameters in the IT-industry. Therefore, graduates with the highest level of competence are needed worldwide. These industrial and social needs have been combined in the initiative undertaken by Aalborg University.

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BIOGRAPHIES



Assoc. Prof. Flemming K. Fink is currently Director of Studies in Electronics and Information Technology at Aalborg University, Aalborg, Denmark. He received his MScEE from Aalborg University in 1978. Subsequently, he was a researcher at Odense University and established an educational programme in Digital Signal Processing at the

Engineering College in Odense. Since 1986, he has been with Aalborg University doing research and teaching within speech recognition and digital signal processing. His major research is in auditory modelling, and he has patented a new concept for parametric hearing aids in cooperation with three colleges.

Fink has been Director of Studies since 1993 and has initiated an internationalisation of the curriculum. He is presently doing research in Continuing Engineering Education as Head of the Centre for Continuing Engineering Education in Electronics and IT (ELITE). Currently, he is also Director of the UICEE Centre for Problem-Based Learning (UCPBL), a satellite centre of the UICEE. Fink has published several papers on Problem-Based Learning (PBL), university-industry cooperation and Continuing Professional Development (CPD).

Fink is member of The National Advisory Board for Technology in Denmark, a Senior Member of the IEEE and represents Aalborg University on several national and international boards.



Ole K. Andersen has a PhD degree in Biomedical Engineering and is currently an associate professor at the Department of Health Science and Technology at Aalborg University, Aalborg, Denmark. Dr Andersen teaches engineering students in signal processing and biomedical engineering. He has published 28 peer-reviewed scientific papers on human sensory mechanisms and motor control.



Thomas Bak received his PhD degree in electrical engineering from Aalborg University in 1998. He is a currently associate professor in the Department of Control Engineering, where he is a member of the intelligent autonomous systems group. He is programme leader for the graduate study programme in intelligent autonomous systems and has been the coordinator for the introductory semester for foreign students. His current research interests include hybrid systems, estimation theory and vehicle systems (robots and spacecraft).



Lars Bo Larsen has a Masters degree in Electronic Engineering in 1984 from Aalborg University, Aalborg, Denmark. He worked as an assistant professor in the field of control engineering until 1987, when he joined the Center for Person-Kommunikation (CPK)

where he holds a position as associate research professor and is head of the CPK's Spoken Dialogue group, where his research interests are centred around multi modal HCI, usability engineering and spoken dialogue systems.

Assoc. Research Prof. Larsen was involved in the initiation and setting-up of the International Masters Programme and has been the coordinator of the Intelligent MultiMedia (IMM) programme at Aalborg University since 1997.

3rd Global Congress on Engineering Education: Congress Proceedings

edited by Zenon J. Pudlowski

This volume of Congress Proceedings is comprised of papers submitted for the *3rd Global Congress on Engineering Education*, which was held at Glasgow Caledonian University (GCU), Glasgow, Scotland, UK, between 30 June and 5 July 2002. The prime objective of this Congress was to bring together educators, professional organisations and industry leaders from around the world to continue discussions covering important issues, problems and challenges in engineering and technology education for this new millennium.

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