Human and Institutional Capacity Building in Geoinformatics Through Educational Networking

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SUMMARY

Capacity building in any activity involves making available the critical mass of skilled manpower, the necessary equipment and an enabling infrastructure. Advances in space and information technologies have made tremendous positive impact on the production, management, dissemination and use of geospatial information (GI) for sustainable development globally through availability of geospatial information technology (GIT) tools. This has led to the emergence of spatial data infrastructure (SDI) as an overarching facility for handling GI. To be fully utilized however, the acquisition of GIT must be fully complemented by readily available skilled manpower at all levels and for all phases of SDI implementation. Adequate attention must be given to the "back-end" of SDI (fundamental data production and management) as well as the "front-end" (data sharing mechanism, access protocols, dissemination, marketing, etc.). In addition, institutional reforms must also be given prominent attention to enable sustainable realisation of SDI. Unfortunately, in many developing economies, many of the professionals, technologists and technicians in various organizations involved in GI activities were trained in the obsolete methods of map production whereas, the introduction of GIT demands a critical mass of well-trained staff at all levels in a reasonable time frame. This has led to the widening of the digital divide in SDI implementation between the developed countries on one hand and African countries on the other.

This is compounded by the fact that many organizations in African countries can no longer afford to send their members of staff abroad for long-duration training due to financial constraints, especially considering the number of persons to be trained before achieving capacity utilization. This paper therefore presents example of an alternative solution through educational networking aimed at achieving critical human and institutional capacity building, especially for personnel of national mapping organizations.

RÉSUMÉ

Le rendement, dans quelle activité soit-elle, implique la disponibilité de la masse critique d'employés compétents, de l'équipement nécessaire et de la mise en place d'une infrastructure. La progression dans le temps et la technologie informatique ont eues un énorme impact constructif dans la production, la gestion, la dissémination et l'utilisation de l'information géospatiale (GI) pour un développement globale et justifie avec la disponibilité d'outils d'information technologique spatiale (GIT). Ceci a conduit à la naissance de

l'infrastructure des données spatiales (SDI) comme un moyen pour gérer le GI. Pour une utilisation maximale, l'acquisition du GIT doit être entièrement et aisément complétée par une main-d'oeuvre compétente et présente a tous les niveaux et pour toutes les phases d'application du SDI. Une attention particulière doit être donnée au "back-end" du SDI (production fondamentale des données et gestion) et aussi au "front-end" (mécanisme des données-partagées, les protocoles d'accès, diffusion, marketing, etc.). De même, une attention proéminente doivent être données aux reformes institutionnelles pour permettre une réalisation justifiable du SDI. Malheureusement, dans maintes économies en voie de développement, un grand nombre de professionnels, technologistes et techniciens, dans différentes organisations, intéressés par les activités du GI furent formes avec des méthodes démodées de production de cartes, alors que, l'introduction du GIT demande une masse critique d'employés bien entraînés a tous les niveaux et dans une période de temps raisonnable. Ceci conduit a l'augmentation de la division digitale, dans l'exécution du SDI, entre les pays développés d'un coté et les pays africains de l'autre.

Ceci est aggravé par le fait que beaucoup d'organisations dans les pays africains ne peuvent plus se permettre d'envoyer leurs membres du personnel a l'étranger pour une longue durée d'entraînement. Ceci est du aux contraintes financières, spécialement considérant le nombre de personnes a être entraînés avant d'arriver a la capacité d'utilisation. Cet article présente l'exemple d'une solution alternative a l'aide d'un réseau d'éducation s'efforçant d'accomplir une main-d'oeuvre humaine compétente et institutionnelle, spécialement pour le personnel d'organisations nationales cartographiques.

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1. INTRODUCTION

As expressed by UNECA (2001), the vision of the Geo-information (GI) community should be "…to ensure that spatial data permeates every aspect of society and that they are available to people who need them, when they need them, and in a form that they can use to make decisions…." and that "…
Collected data sets should be put to the maximum possible uses by publicising their existence and making them easily available to the widest possible audience". These statements clearly imply the need for capacity building in all components of Spatial Data Infrastructure including both "back-end SDI" (dealing with production of the geospatial datasets) as well as the "front-end of SDI (data sharing mechanism, access protocols, dissemination, marketing, etc.). The required capacity deals with the development of a critical mass of skilled human personnel, organizational reforms, technological capacity and institutional strengthening.

But this has been generally difficult to achieve in less developed countries such as African countries due to a lot of constraints some of which have been addressed by various authors in different forums e.g., Ruther, 2001; UNECA, 2001; Kufoniyi et al, 2001. These include:

- Low enrolment in geoinformatics education in many African tertiary institutions, which makes the authorities in those institutions hesitant (though wrongly) in releasing money for the upgrading of their curricula, including instrumentation.

- Even with the low enrolment, only few institutions run geoinformatics courses because of the high cost since the program is technology-intensive.

- Many of the same few institutions are running obsolete programs with analogue-dominated, or completely analogue equipment, methods and academic staff such that moving from this phase to a completely digital domain will require a huge capital outlay and human resources, which are lacking in most African countries.

- Rigid curricula that do not give room for intake of serving personnel to undergo short-term courses as part of the long duration courses.

- Some of the GI-related production organizations still operate in the analogue domain, which means that new graduates who have been trained in a completely modern technology will be "misfits" in such organizations as there will be no appropriate equipment and environment for them to work. This creates dilemma for institutions in deciding on whether to go the whole hog of modernizing their curricula or to "hybridize" the obsolete programs.

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– The number of serving career officers that require retraining are so many whereas it is not feasible to allow more than a few to go for a long-term training (within or outside the country), making short-term training a very important component of our education programs. This further gives credence to the need for modular curricula that will enable interested persons to join short module(s) of interest and then go back to their jobs. This will be more efficient than running the regular programs in their present long (semester) structure and running separate short-term courses, which will create a lot of pressure on the staff and equipment. A modularized education program will limit the need to run separate short courses to only customized training. This is however difficult in our institutions, some of which are still teaching subjects that span a whole session.

– Lack of cooperation and networking among relevant departments in our higher institutions leading to duplication of effort and uncoordinated programs and courses. Every department in the same institution wants its own program even departments that have no single qualified teaching staff are mounting separate geoinformatics programs in uncoordinated manner. Even though no single program can satisfy all the GI education requirements of all the socio-economic sectors of a country but there are common (core) courses (e.g. Principles of GIS, Principles of Remote Sensing, etc.), which should be organized and run (as separate modules) in one department such that students from other departments can attend the course rather than duplicating the subject in every department. A good example of this arrangement is the education curricula of The International Institute for Geo-Information Science and Earth Observation (ITC).

– Many organizations in African countries can no longer afford to send many members of staff to more developed countries for training due to financial constraints, especially considering the number of persons to be trained before achieving capacity utilization. Consequently, with the small ratio of lecturers that are trained in the modern technology to those that are yet to be trained, developing new curricula may end up being a mere paper exercise that will not produce graduates who are genuinely trained in the new technology.

– Absence of uniform academic standard and lack of networking to facilitate sharing of human and other training facilities, which would have addressed the problem of inadequate number of trained lecturers.

– Lack of provision for continuing education & training for African geoinformatics lecturers, which make them rapidly out of date and therefore unable to sustain a dynamic curriculum Moreover, there is a lack of coordinated program in Africa on applied research and development in geoinformatics in addition to a lack of coordinated, unified professional forum across Africa on Geoinformatics.

– Many of the enabling technologies for modern geoinformatics curricula are in various stages of development in Africa. For example, even though internet is commonplace in some countries, the bandwidth is often too narrow while there are still countries where it

is still very difficult to come by, consequently developing a curriculum in web-based cartography in such countries will not make sense.

Capacity building for the production, management, dissemination and use of GI is therefore of immense importance, which requires focused and concerted efforts towards strengthening of national and regional capacity building institutions including harmonization of GI curricula within a mutually beneficial GI capacity building network.

Figure 1 shows a categorization of capacity building for Geoinformatics of which education and training are part and parcel.

	PURPOSE	FOCUS
CAPACITY BUILDING FOR GEOINFORMATICS	Human resources development	Supply of technical and professional personnel
	Organizational strengthening	Strengthening the management capacity of organisations; institutionalise geo-ICT solutions (systems and processes(as well as strategic management principles
	Institutional strengthening	Strengthen the capacity of organisations to develop & negotiate appropriate mandates and modus operandi as well as appropriate (new) legal and regulatory frameworks

Figure 1: Three levels for capacity building (Georgiadou and Groot, 2002)

In the context of human capacity building, three major groups of required GI-professionals have been identified (Molenaar, 2002):

- Experts in the field of spatial information handling (or specialists in certain aspects of this field),
- Users of geo-information and
- Professionals and policy makers (to enable their awareness of the importance of geo-information for Civil Society.

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The required geoinformatics education and training programmes should therefore be geared towards the following four levels in order to provide the three groups of the afore-mentioned GI professionals (Kufoniyi, 1999):

–   High-level policy-makers: This can be achieved through short-term intensive training in the fundamental aspects of geoinformatics particularly when GIS implementation is being initiated.
–   Management and Professional staff: New employees in this category should be already educated in the modern technology while opportunity must be also provided for mid-career (re-)training of those already in employment for the purpose of broadening their outlook and keeping up to date on modern developments in geoinformatics.
–   Technical Support Staff: Education and (re-)training of technicians and technologists for efficient production, management and use of geospatial information.
–   General Public: through mass media and public lectures, to sensitise the public and users on the benefits derivable from GIS and geospatial information production.

2. EDUCATIONAL NETWORKING

One of the ways of minimizing the afore-mentioned obstacles is through educational networking. In the context of the less developed countries (LDC), this can be south-south network or a north-south (including south-south) network.

The South-South education network is where the network is limited to collaboration among two or more institutions of learning on joint education, research and consulting thereby sharing facilities. The collaboration can be among institutions that are located in the same country (intra-national) or in different countries (international) but only involving LDCs. Examples of intra-national collaborations exist in various countries. In Nigeria for example, working collaboration exists between RECTAS and Obafemi Awolowo University for Masters degree programmes (MSc and Professional Masters), which started in 2003.

Nkambwe (2001) also gave two examples of south-south education network: the South African Network for Training on the Environment (SANTREN) and the SADC EIS Training and Education sub-programme (SETES), both of which cuts across many countries in Southern Africa.

The north-south network on the other hand involves the collaboration of one or more institution(s) in the south and one or more institution(s) in the developed countries. This type of network has the advantage of regular update of curriculum including north-south staff and student exchange programmes.

2.1 GI-Net

An example of a prominent North-South educational network is the International Capacity Building Network on Geo-information Science and Earth Observation code-named 'GI-NET' involving some 43 partner-tertiary institutions and initiated/piloted by ITC. The ITC-RECTAS collaboration described in the next section is one of the partners in the network.

The network will contribute to rapid national and regional development by:

- Providing qualified graduates for immediate employment and productivity.
- Retraining existing personnel for improved productivity and introduction of modern production techniques.
- Retraining academic staff of other institutions so as to be able to modernize their curricula in line with modern trend.
- Significant saving in foreign exchange through efficient local training and reduced stay abroad.
- Assisting production organizations through well-equipped consultancy services.

The network actually evolved consequent upon the education decentralization policy of ITC which aims at increasing the critical mass of trained manpower in the LDCs. By having part of the training in the home partner institution of the students thus shorter stay in the Netherlands, it follows that more people will be trained when compared to when the student carries out the entire programme in ITC. The network also facilitates faster technology transfer by running part of the education programme in partner institutions by taking advantage of the strengths of the partners.

The network focuses on joint education, joint research, joint consulting as well as exchange of staff. The education component of the partnership targets the mid-career professionals as well as institutional and organizational strengthening.

The partnership has capitalized on the long history of efficient international education of ITC with many positive points to support the partnership. This includes: strong ITC partners in home regions (countries) of ITC students; availability of many ITC alumni; efficient quality assurance and accreditation schemes; use of ITC for distance learning and distance supported lecturing; and the modular system of ITC course curricula (facilitating part time education).

3. TC-RECTAS JOINT INTERNATIONAL POST-GRADUATE EDUCATION PARTNERSHIP

The ITC-RECTAS node of the GI-NET focuses on education and training in geoinformatics at the MSc and Postgraduate Diploma including refresher courses of duration of one to four weeks. Under this partnership, the joint MSc programme commenced in September 2004 while two refresher courses each of two weeks duration had been run to date. The first was a refresher course in digital Photogrammetry, organised in November 2001 for alumni of ITC and RECTAS from national mapping organizations of eight West African countries (Nigeria, Benin, Cameroon, Ghana, Niger, Mali, Burkina Faso and Senegal) and the second was on new approaches in geosciences organized in October 2002 also for alumni of ITC and RECTAS.

The Regional Centre for Training in Aerospace Surveys (RECTAS), is a legally recognized regional education and training institute established in 1972 under the auspices of the UN ECA to provide education and training, research and advisory services in the field of geo-

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informatics, including in particular photogrammetry, remote sensing, cartography, geographic information systems (GIS), and their applications in geophysical surveys, environmental surveys etc. (see www.rectas.org).

The International Institute for Geo-Information Science and Earth Observation (ITC) is a well-known autonomous foundation for education, research and advisory services in the application of geo-information science and earth observation techniques and the use of spatial information for management of space and resources, including the establishment of geographic information systems and the management of geo-information (see www.itc.nl)

3.1 The Joint Courses:

The joint ITC-RECTAS education programme consists of the following levels:

− Master of Science course with a duration of 18 months;
− Post-Graduate diploma course with a duration of 12 months. Although RECTAS has been running its own independent PGD for the past 20 years, the "new" PGD is being considered 'joint' from September 2004 because 9 of the modules of the RECTAS PGD are actually ITC MSc modules. (This course is subject to the formal approval of both ITC Institutes council and Scientific Council).
− Short term refresher courses taking advantage of the modular design of RECTAS and ITC courses.

3.2 Programme Execution Strategy

In general, each partner will be responsible for the execution of its part and obligations resulting from the partnership.

A Board of Directors comprising of designated ITC and RECTAS representatives provides overall guidance and decides on policy matters, general strategic issues and possible conflicts that transcend the operational level.

For quality control and degree assessment, ITC has the overall responsibility for quality assurance and adherence to the ITC rules and regulations as well as degree assessment for the MSc course while RECTAS is responsible for the quality of the Post-graduate diploma course. For the MSc thesis, each student will have a RECTAS and an ITC supervisor at the beginning of the thesis work of the student. The supervisors from RECTAS and ITC are then responsible for the supervision of the student, and will keep each other informed on the feedback given to the student.

The joint programme, consisting of lectures, practical exercises, fieldwork, thesis writing and examination, will be completely in the English language. The two institutions will use the ITC Blackboard site: to access course materials, to give feedback and for module evaluations.

ITC and RECTAS will jointly arrange for a proper staff exchange programme for the lecturers involved in the modules at RECTAS and ITC. This programme will include missions by RECTAS staff to ITC as visiting lecturers, and ITC staff to RECTAS to supervise students in the joint PG and MSc courses, attend mid term presentations, and attend the final examinations while providing input in teaching modules at RECTAS where it fits into the mission plan.

3.3 Programme Structure and Formats

The joint MSc course has a modular set-up with 23 modules of three weeks each, of which 9 modules are common to 9 modules of the joint PG courses run at RECTAS, 2 modules are electives (one at RECTAS and the second at ITC) while the last 8 modules consist of the MSc research project.

The joint MSc course will run in three formats, according to the following corresponding implementation phases:

- Phase 1 applies for two years, (2004 & 2005) whereby the course runs under ITC assessment regulations. Exemption for the first 10 ITC modules is assigned, based on the 10 modules that are attended at RECTAS while the remaining 13 modules, including the research period, are attended ITC. The curricula of ITC and RECTAS will be adapted in this phase.

- Phase 2 applies for the next two years (2006 & 2007) whereby the course will run under ITC's and RECTAS' assessment regulations as a joint course. The first 14 modules will run at RECTAS and the research will run in ITC with thesis defence at RECTAS or ITC.

- The third phase is scheduled to commence in 2008 whereby the whole course runs at RECTAS with the same structure, curriculum and quality aspects as at ITC. In this phase, common course material development and joint research with ITC will take place.

3.4 Award of Degree and Diploma

The joint programme will result in PG Diploma and Master of Science Degree. The Master of Science degree is issued under the auspices of ITC as "Master of Science degree in Geo-information Science and Earth Observation with specialisation in Geoinformatics" for the joint MSc Geoinformatics course, together with a course record with logos of ITC and RECTAS and signatures from both institutions. The course record will also reflect the contribution of the partners in the applicable implementation phase.

If a participant fails to comply with the conditions, which are described in the ITC MSc assessment regulations, s/he will be issued the PG Diploma (if s/he complies with the laid down conditions for the award of the diploma) or a certificate of attendance by RECTAS for the components/modules successfully completed subject to the approval of RECTAS' Course Board.

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The PG Diploma course will result in a "Postgraduate Diploma in Geoinformation production and Management" with a joint logo course record.

Any participant who fails to comply with the requirements for the PG course will be issued a certificate for the components/modules successfully completed.

3.5 Target Participants

The courses aim at two types of students, i.e. young students who continue their education and mid-career professionals who want to upgrade their skills and knowledge. The first group are the BSc students wishing to obtain a Postgraduate Diploma or MSc degree and develop a career in the field of geo-informatics. Most of them will be self sponsored candidates. The second group consists of the mid career professionals who are already working in a professional organization, such as survey organisations, Remote Sensing and GIS companies, engineering consultants, IT companies, universities, NGO's etc.

3.6 Quality Assurance

The entrance requirements of the courses are designed to satisfy the rules and regulations of both partners. The PG Diploma students at RECTAS undergo the same course as the MSc stream for the first 10 modules except the module on research skills. The students, who get the joint PG Diploma (purely through study at RECTAS) in 2005 or later, would be allowed to enter the MSc joint course in module 11 if they fulfil the academic criteria and under the condition that the module on research skills is attended (if not already so). This entrance option is valid within a period as described in the ITC assessment regulations.

The quality and quality assurance of the joint programme have to meet the internal requirements of both Partners as well as the criteria of the accreditation bodies in the Netherlands. In case of differences the most stringent applies.

ITC will provide the facilities and library services during the ITC part of the joint programme as provided to other courses at ITC's premises. RECTAS will extend the same facilities and library services to participants and staff under this Joint Programme as to participants and visiting scientists. ITC will give access to the ITC library and e-journals during the whole course including the study period at RECTAS.

3.7 Supervision during MSc thesis period

Participants will be assigned a RECTAS and an ITC supervisor that will help them to prepare a detailed research proposal during modules 15. If the participant is at RECTAS, the RECTAS supervisor will discuss the topic and coordinate with the ITC supervisor and the opposite will happen if the participant is at ITC. The participant's research proposal will be formally assessed under the responsibility of the ITC programme Board.

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During the MSc research period, participants will make a progress report every two weeks, which will be sent by e-mail to the ITC and RECTAS supervisors.
The midterm presentations in phase 1 and 2 of the joint programme are under the same circumstances as those for the ITC group of students.

RECTAS supervisors, Course Coordinators and at least one ITC representative will attend the midterm presentations, in phase 3 of the joint programme. The MSc participant will receive a written report with recommendations from the Course Coordinator.

The MSc thesis defence and graduation ceremony, in phase 1of the joint programme, is identical to that of the ITC group of students with at least one RECTAS expert as member of each thesis assessment board.

The MSc thesis defence and graduation ceremony, in phase 2 will be held at RECTAS or ITC depending on the chosen format for the course in this phase. In the first of the two formats, the whole research period, including defence is executed at ITC. At least one RECTAS expert will be member of each thesis assessment board. In the second format, the last month of the research period, including the defence and graduation ceremony, is executed at RECTAS. In this case, at least one ITC professor or associate professor will be member of each thesis assessment board.

The MSc thesis defence and graduation ceremony, in phase 3 of the joint programme will be held at RECTAS. At least one ITC professor or associate professor will be member of each thesis assessment board.

3.8 Internal Quality Assurance System

The participants will evaluate the course, and most of the separate modules. The Course Board will issue the module- and end-of-course evaluation forms, and will manage the results. Content, quality of teaching and teaching materials will be evaluated. In addition, yearly evaluation reports (based on results of module and end-of-course evaluations, progress of participants, retention and completion rates and preferably also graduate and employer evaluations) and also improvement plans per programme will be made by the ITC Programme Director and the RECTAS Course Coordinators jointly and submitted to the ITC Programme Board and RECTAS Course Board.

3.9 Course Fees

The following table gives the planned payable course fee for the joint MSc course*. In the first four years (2004 – 2007) of the partnership, funding has been provided for the best five candidates that meet all the admission criteria to participate in the course. The five positions are however reserved for the candidates of RECTAS' member states who will be selected from among the PG diploma students of RECTAS. Private and other students have to source for their own funding.

Period	Tuition Fee (Euro)	Additional (Costs) (Euro)	Allowance and Accommodation (Euro)	Total Cost (Euro)
Phase 1 (2004 & 2005)	8,275	5,400	9,925	23,600
Phase 2 (2006 & 2007) MSc Defence in ITC	7,650	4,300	7,925	19,875
Phase 2 (2006 & 2007) MSc Defence in RECTAS	7,300	4,125	6,350	17,775

* ITC and RECTAS reserve the right to vary these fees depending on unforeseen external factors.

4. CONCLUSIONS

To achieve a rapid capacity building in geoinformatics in African countries, it is essential to put in place education networks and partnership at national level (intra-national network) and international level with the latter involving both south-south and north-south networks. Example of a north-south network under implementation has been presented in this paper. Such collaboration will facilitate the training and retraining of personnel at various levels in order to bridge the digital divide between the developed countries on the one hand and developing countries on the other hand. The partnership will be further invigorated if the joint education can be run on multi-lateral basis such that a student will be able to take courses from different partner institutions according to the education requirements of the student.

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BIOGRAPHICAL NOTES

Dr. Olajide Kufoniyi

Dr Olajide Kufoniyi has a B.Sc (Hons) in Geography (University of Ife, now Obafemi Awolowo University), PGD in Surveying (University of Lagos), PGD (with distinction) in Photogrammetry, MSc (with distinction) in Photogrammetry (ITC, Netherlands) and a PhD Geoinformatics (ITC/Wageningen University, Netherlands).

A Registered Surveyor (1989), and a Fellow of the Nigerian Institution of Surveyors (NIS). Dr Kufoniyi was a Senior Lecturer (1995-1998) at the Department of Surveying and Geoinformatics, University of Lagos and the Rector of Federal School of Surveying, Oyo, Nigeria (1998 – 2000).

Currently the Executive Director/ Chief Executive of the Regional Centre for Training in Aerospace Surveys (RECTAS), under the auspices of the UN Economic Commission for Africa, located within the Obafemi Awolowo University Campus, Ile-Ife

Has published many journal papers and made presentations at international conferences in the areas of GIS, SDI, Capacity building, etc.

Gerrit Huurneman

Gerrit Huurneman has a HBO in Informatics (UT), a MO in mathematics (SWOT), and an MSc with distinction in Geoinformatics (ITC, Netherlands)

Gerrit Huurneman was a Senior Lecturer (1995-2002) at the Department Geoinformatics, ITC , The Netherlands and Students research advisor(1999-2002) for the MSc Geoinformation course at that institute.

Currently, he is Director of the Geoinformatics Programme at ITC and the ITC representative for joint programmes in Geoinformatics in several other countries.

John Horn

John Horn holds Bachelors and Masters degrees in Photographic Technology.

Since 1981 he has worked at ITC, Enschede, initially as Lecturer / Senior lecturer in Primary Aerospace Data Acquisition.

He has served as Director of Studies for the ITC Postgraduate course in Integrated Map and Geoinformation Production (IGP3), and Chairman of Course Board for the Diploma in Geoinformatics.

Currently he works as Senior Project Officer in the Bureau of Project Services at ITC.

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TS12.4. Human and Institutional Capacity Building in Geoinformatics Through Educational Networking

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