An Architecture Framework for Higher Education

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Abstract: In the realm of higher education, an educational architecture framework can play a pivotal role in fostering enhanced communication between program leaders and various educational stakeholders. Within this context, architecture views serve as comprehensive representations of the overarching architectural landscape, catering to the diverse requirements and needs of involved stakeholders. Embracing a view-based approach empowers higher education institutions to reinforce strategic alignment while seamlessly integrating change management practices to accommodate evolving requirements. In this perspective, this paper proposes six distinct views to reflect on how enterprise architecture could be applied to higher education. Examples are given based on ArchiMate models. These examples serve as compelling illustrations of how educational architecture frameworks can drive organizational transformation.

1 INTRODUCTION

The higher education (HE) sector has been under tension during the COVID-19 crisis. As identified by Gardner-Le Bars (2023), ”when Higher Education Institutions (HEIs) face crises, personnel are called upon to rapidly develop and deploy innovative solutions to maintain the integrity of teaching services. As HEIs often possess highly diverse employee and student populations, transboundary type crisis events, which can provoke campus closures, are particularly challenging. Such crises are often unforeseen, require rapid and radical changes to operations”. Changing requirements put some pressure on institution’s strategic plan, they affect goals, business processes, curriculums, as learning resources. As an example, in the public HE sector if less state aid are given, reducing operating costs can be a new strong requirement. This requirement can lead to a merger of two institutions to mutualize and thus reduce expenses. With new goals, a merger directly impacts business processes and the study programs, as the institution is being dispatched between different physical sites, with various learning resources. As another example, considering societal and environmental responsibility (SER) is now a must do in HE curriculums. Energy and environmental issues are taking on major societal importance. Integrating SER in an educational program can lead to a reform, impacting the curriculum but also the vision, goals, business processes, etc.

As a primer on how Enterprise Architecture (EA) could be applied to HE, this paper contributes to the field of HE management in the context of changing requirements. Changing requirements in a HES (Higher Education System) raise some questions, e.g. can a framework for HES with views improve collaboration and communication between stakeholders, reduce complexity, have better resources management, enhance efficiency and organizational coherency and sustainability? By adopting a view-based framework directly inspired from the TOGAF Open Group Architecture Framework, the paper explores six specific views that may be used in practical educational applications, to guide effective change.

As a context, this paper first overviews the broad lines of the TOGAF Architecture Development Method (ADM) for the changes and transformations within an organization. It presents the various stakeholders and users of a HES. Then it shares and discusses six views of an EA for HE, with examples.

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2 ENTERPRISE ARCHITECTURE AND VIEWS

EA is aimed at understanding the needs of all the stakeholders to meet the needs. As such, the Zachman Framework provided a taxonomy to analyze the different viewpoints of stakeholders and identify the different aspects of an enterprise (Zachman, 2008). Since then, several EA frameworks have been developed, such as The Open Group's Architectural Framework, TOGAF (TOGAF, 2024) and the Federal Enterprise Architecture FEA (Bellman & Rausch, 2004). A description of the most popular EA frameworks and a comparison of them is available from (Sessions & deVadoss, 2014). Some EA frameworks, such as FEA, are focused on standardization across enterprises, while others, such as TOGAF, are focused on the process. As such, TOGAF provides a method for the changes and transformations within an organization, could it be a HEI.

EA is a means of supporting the HESs and HEIs in an era where they are expected to be agile and flexible to meet changing requirements effectively. Universities have adopted EA to align their ICT with their strategic goals (Nottingham, 2012; Batmetan, 2022, Araya-Guzman et al., 2018). As reported in (Nur Shabrina et al. 2022), EA helps also to achieve the mission and objectives related to the education process (Ramadham & Arman, 2014), to plan the University infrastructure and to reduce disparity among the system development processes. More importantly, the HE sector is affected by the trend to undergo digital transformation. This requires a redefinition of the services and how these services are operated. EA has been identified as one of the approaches that can support digital transformations in HE (Sandkuhl & Lehmann, 2017. TOGAF appears to be the most popular EA framework among HEIs, due its completeness of the process (i.e. the TOGAF ADM), easy access and availability of best practice examples (Nur Shabrina et al. 2022).

For HE, an Architecture Development Method (ADM) as TOGAF may be used (cf. Figure 1). ADM phases are suggested, starting from Principles and Vision (A) entities, intended "to capture the surrounding context of formal architecture models, including general Architecture Principles, strategic context that forms input for architecture modeling, and requirements generated from the architecture".

The TOGAF standard relies on the various views aside vision:

- Business Architecture View (B) for the organization's business goals, processes, and structure with its stakeholders.
- Information Systems Architecture View (C) for the data, application, and technology architecture (D) view. These are not addressed in this study.
- Opportunities and Solutions View (E) for specific business needs to achieve strategic objectives. It can link the architecture to the implementation of educational purposes.
- Migration Planning View (F) for transitioning a HE system architecture to the target architecture, as for educational change or reforms.
- Implementation and Governance View (G) to specify the actual implementation of the HES architecture. It includes processes from the governance domain, as compliance mechanisms to ensure that the architecture is effectively implemented and maintained, most often for quality assurance purposes of the educational programs;
- The Change management view (H).

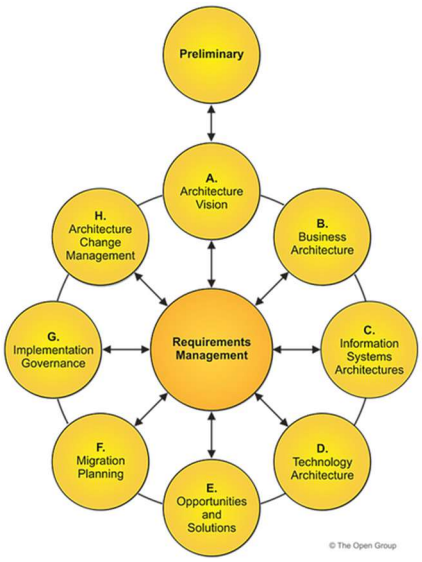

Figure 1. Structure of the TOGAF Architecture Development Method.

This paper proposes to organize the education parts of a HES with views. It presents six views that may be used to describe a HE system on its academic perspective. These views can be used to better understand the business, as well as for improving it. Each view is discussed in the following sections.

3 STAKEHOLDERS

Changing requirements and requirement management are in the scope of several stakeholders within the

HES. Stakeholders are at different level, they mainly comprise:

- At macro-level, on the mission and strategy side:
  - Internal: rectors, directors of education, higher and faculty managers, etc.
  - External; accreditation bodies, governmental and non-governmental organizations, local communities, professional communities, etc.
- At meso-level:
  - On the academic side and departments: professors, faculty, assistants, heads of programs, educational and curriculum, committee members, etc.
  - On the client side: students, student associations, alumni, enterprises and socio-economic environment, academic partners, territorial communities, etc.
  - On the service side: technicians, administration staff, communication members, IT service staff, scheduling officers, grading administrators, pedagogical service members, internship managers, international service members, industry liaison, etc.

These stakeholder profiles all form a constellation of roles, directly linked to business domains and processes. Understanding their needs and priorities help to shape the architecture to better serve changing requirements. Six views are suggested to manage changing requirements of an HES, as suggested in Figure 2.

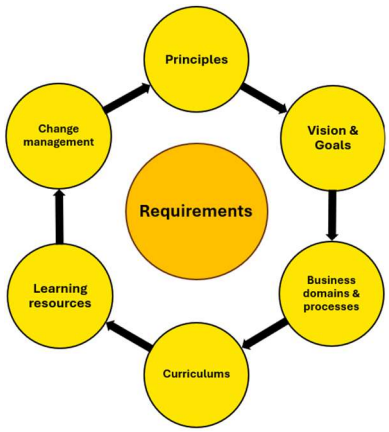

Figure 2. Proposed views for Higher Education.

4 FROM PRINCIPLES TO GOALS

4.1 Policy and principles

A policy aims to support University's strategy and provides a basis for making good strategic choices that strengthen the quality of the programme portfolio and each programme of study. Furthermore, the policy aims to ensure that the development of study programs and portfolios are within the frameworks and overarching principles specified in legislation, regulations, and political guidelines.

Educational principles play a vital role in upholding the rule of Ministries of HE by promoting adherence to legal norms. An educational principle can for example emphasize active learning to provide technical knowledge along with communication and professional skills to students. Another can prompt to societal, economic, and environmental responsibility (SER) in the curriculums on all semesters. At design level, the constructive alignment (Biggs, 1996) principle can be a formal requirement of the accreditation body (i.e. aligning all learning objectives, assessments, and instructional activities), as inclusive curriculum design.

For example, in 2024, IMT Atlantique, grad/postgrad School of engineering in France, is supported by several policies, e.g. policy of non-discrimination; equivalent rights; ethical sourcing policy; building energy renovation and construction; biodiversity and ecosystems; robust and sustainable technologies in training activities. They directly irrigate the educational programs. Quality policies are most often formally required. For NTNU in Norway, five main principles are presented in Figure 3. National guidelines for quality assurance and compliance with legislation, regulations & political guidelines are external requirements.

Figure 3. NTNU principles for educational concerns.

In France, a Master-level curriculum in engineering education is evaluated every five years by the French accreditation body (CTI, *Commission des Titres d'Ingénieurs*, somehow same process and references as with the ABET US accreditation system for engineering education). As stated in CTI references, "the school has defined a strategy and a quality policy that has been made public. The school defines the appropriate processes and tools that enable it to ensure the quality of its activities and results; these elements form an integrated and coherent system of internal and external management of global quality. The bodies and personnel in charge of the quality approach are duly designated and identified as such in the school. All staff are committed to the process of continuous improvement". In Norway, all courses offered at the

NTNU follow the national guidelines for quality assurance issued by NOKUT (the Norwegian Agency for Quality Assurance in Education). NTNU's Policy for Quality and Development of the Study Programme Portfolio is intended to help ensure high quality in the study programmes, and to stimulate student's personal development.

4.2 Vision and goals

Principles can be implemented through various strategies, e.g. thanks to pedagogical styles as project-based learning, experiential learning. Work-Integrated-Learning model can be beneficial when University-Industry-Business collaboration is an institution principle. Also, to be aligned with principles, vision and goals impact the organizational structure, academic programs, student services, as administrative processes.

As an example, IMT Atlantique's vision is to combine digital technology, energy, and the environment to transform society and industry. This vision translates into a scientific ambition focused on interdisciplinarity, an assertive technological dimension, and scientific strengths at the service of the school's strategy. IMT Atlantique aims to develop academic programs in line with the needs of companies, to contribute to innovation and entrepreneurship. I can be linked to University-Industry collaboration principle. NTNU's vision is "knowledge for a better future" and aims to benefit society. In Norway, NTNU's mission includes providing research-based education at all levels and to participate in a knowledge-based public debate and use the knowledge to benefit society. It recognises its responsibility for creating outstanding graduates and to contribute to the development of Norway. The university's strategy includes providing an excellent learning environment that could lead to internationally outstanding graduates. The strategy also states that it will contribute actively towards achieving the United Nations' SDGs. The strategic goals at the university level are then adapted at the faculty and department levels as shown in Figure 4 (left part at university level, right part at department level). Minimum 30% female students in all study programs is an example of Department goal.

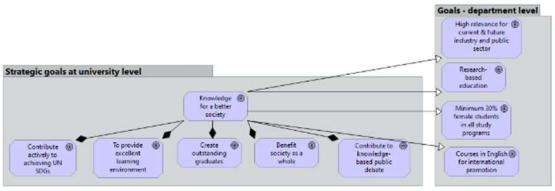

Figure 4. strategic Goals at University and Department levels.

4 DOMAINS AND PROCESSES

4.1 Business Domain in Higher Education

Organizing the HES into the proposed business domains is to help architects to benefit from a better understanding of strategic needs, requirements, and challenges of educational reforms or change to optimize business functions. As seen previously, on a pure educational level, some domains include processes at Faculty level, at Programme level, some other are more at micro-level, e.g. course level domain. In the interface are some other domains, e.g. R&D, finances, resources (cf. Table 1).

Table1. Business domains.

Higher Education business domains		
Faculty-level domain (FD)	Programme-level domain (PD)	Course-level domain (CD)
Administration & Financial domain (AFD)	HR & Resources domain (RD)	R&D domain (RDD)

Business domains are linked to functional areas, e.g.

- Faculty domain (FD) which support governance processes.
- The programme (PD) and course (CD) level domains include functions and processes related to programs, program reforms, curricula, course management, grading, academic support services, etc.
- Administration and Finance Domain (AFD) addresses functions and processes related to budgeting, expenses, facilities and resource management, as administrative activities.

Some other domains can be added, e.g. Alumni and Business relation Domain (ABD) for functions and processes related to interactions with alumni, internships, work integrated learning, as fundraising or donor relations; or Student Service Domain (SSD) for functions and processes related to student admissions, registration, student records, financial aid, counselling, and career services.

The information technology domain is not addressed in this paper and is out of the scope of this study. Almost, the IT domain covers technical infrastructure and its network, its service applications (e.g. an LMS as Moodle or Teams) or the IT support.

Interfaces exist between domains, with a relative proximity between domains. As an example, the Research & Development business domain (which include research activities, research projects and contracts, business and industry partnerships, innovation, or IP management) can impact and feed

curriculum updates, as business and industry partnerships may add values to education.

4.2 Business Processes

Business domains group similarities and shared characteristics of business functions, processes, and activities. They can have their own set of processes, data, as stakeholders. They permit to organize the business architecture view, allowing HE architects to design, understand, share, analyze and more easily manage different aspects in a structured manner, breaking down some complexity.

Governance processes are more in the hand of the director, direction services and deans, for meeting strategic requirements, school transformation, quality assurance, external and internal communications, engagement of the institution in the SDGs. Some operational macro processes exist, they are out of the scope of this paper, e.g. (i) developing research and innovation, (ii) developing and strengthening relations with companies, or (iii) developing the school internationally. As support macro-processes can be: (i) optimizing material and financial resources, (ii) developing the IS, or (iii) managing HR resources.

Linked to curriculum, several processes coexist and interoperate, linked to principles and goals, e.g.:

- Designing and developing quality training courses by integrating quality processes;
- Carrying out and managing training course;
- Implementing accreditation or certification processes;
- Recruiting and graduating students;
- Providing administrative and social support for students, socio-cultural and professional activities.

4.3 Example

The main processes include (i) preparing the course, (ii) delivering the course to the students, i.e. teaching, (iii) conducting the learning activities, (iv) assessments and (v) improving the course based on feedback from the students. An overview of the main processes is shown in Figure 5. Each of these main processes are detailed in the different sub-processes. Preparing the course involves designing (or improving or revising) the course, preparing the course material, such as lecture slides and learning tasks and activities, developing assessment guidelines, and publishing the course on the university's Learning Management System (LMS) which can be a Blackboard application. Delivering the course includes giving lectures, coordinating and conducting tutorials, assessments of the students' work and doing the final grading. The university encourages and recommends the use of engaging learning activities (cf. e.g. principle on active learning) and therefore, the process also includes coordinating and conducting learning activities (e.g., student presentations and peer reviews), providing the necessary instructions to the Learning Assistants, developing the relevant material for the activities, e.g., some hints and recommendations, and integrating any formative assessments into the final grade. The final process is improving the course for the future. Many activities are part of this course process, which are to be best aligned with principles and goals as with the changing requirements.

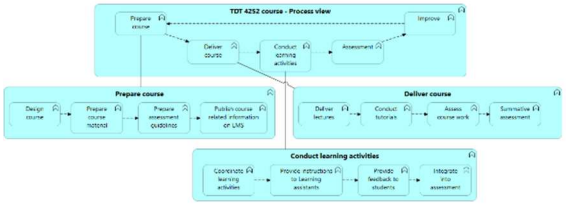

Figure 5. Course process view in ArchiMate.

5 CURRICULUMS

Educational leaders are given considerable latitude in terms of programme contents, teaching methods, assessment procedures, targeted skills, course type and volume, or scheduling. Designing and operating an educational programme is an engineering activity by itself which requires methods and tools (Rompelman & De Graaff, 2007). Concerns of the educational programme domain can be structured in a dedicated curriculum HE architecture view, e.g. with the following three distinct curriculum models (Harden 2001): (i) the syllabus composed of learning outcomes (intended curriculum), (ii) the programme with its T&L constituents (taught curriculum), and (iii) the validated curriculum. These three curriculum perspectives can be part of a curriculum view in the HE architecture.

5.1 Three curriculum perspectives in the view

As presented in Rouvrais and Chiprianov (2012), using UML class diagram modeling, for the intended curriculum, authors define the associations for a generic syllabus including learning outcomes, being knowledge, skills, or competencies of activity domains. These learning outcomes are linked with process view activities, e.g. learning outcomes definition, curriculum design activity, course process, etc. A specific curriculum can be described by its own

type of learning outcomes and instances. For the taught curriculum, associated concepts to the educational programme are courses, internships, extracurricular activities, majors, minors, electives, T&L styles, etc. They are linked with the previous view example on the course process. A specific educational programme is specified by its own course instances, which could be included in semesters. For the validated curriculum, concepts are assessment, proficiency level, portfolio, interview, report, oral exam, questionnaire, a.s.o. Here also, some links from the assessment business processes with curriculum concepts are to be defined.

5.2 Curriculum associations

The three previous curriculum models in this view have also linked concerns, which are echoed in some business processes of the previous view, e.g. to ensure constructive alignment principle (Biggs, 1996). Each course activities of the taught curriculum (cf. right of the Figure 6) are to meet some learning outcomes (e.g. knowledge, skills, dispositions) of the intended curriculum (cf. left of the Figure 6), and the assessment permit to reach a proficiency level in the validated curriculum (cf. bottom of the Figure 6). Curriculum maps and proficiency matrix are tools to facilitate the alignment checking, e.g. for coherency and completeness of learning achievements.

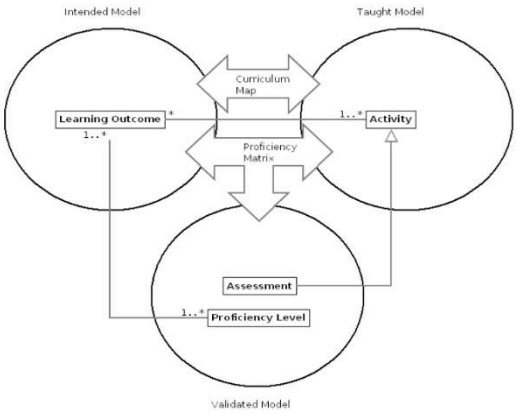

Figure 6. Curriculum mapping.

6 RESOURCES

In the HE architecture, the fifth Learning Resource View, human and material, is to include all elements which support operation in the HESs, being the staff, the LMS or so. It can include also external resources, as industrial partners, collaborations, etc. As an example, it is to ensure as a requirement that the school has enough permanent teachers and teachers and researchers as well as administrative and technical staff enabling it to define and implement its educational project. This view permits to operate the curriculum view, where links to stakeholders, workspaces, material, IT can be made.

6.1 Resource requirements

As required by the CTI in France, the requirements can be at institutional level "The school has premises and material resources which allow it to accomplish its educational mission and all its activities in good conditions: training premises, IT resources, equipment for experimental work, multimedia documentation center, platforms high technology. The school offers material conditions which allow students to benefit fully and safely from training and to promote their personal development. The school provides engineering students with premises enabling them to develop a quality student and community life: residences, university restaurants, sports facilities, association premises […]. The school is making its premises more accessible to people with disabilities".

6.2 Resource example

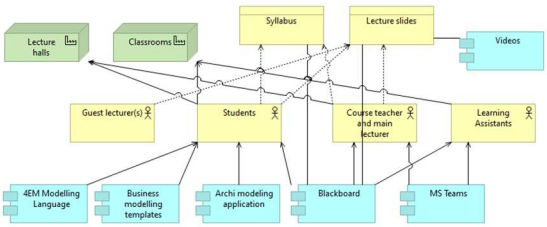

Figure 7. Resources in ArchiMate.

Resources mainly support the taught model of the curriculum view. They are of different types and at different levels, as described below for a course example at NTNU on EA (cf. Figure 7):

- Human resources which are primarily the course teacher, which is also the main lecturer, guest lecturer(s) and the Learning Assistants. These are shown as business actors (in yellow) in the model.
- Physical facilities (shown in green), which include lecture halls and classrooms for the students to work in.
- Software applications and other support tools (shown in blue). The modeling applications include the ArchiMate modeling tool Archi and iDraw templates for modeling the 4EM language. The LMS system, Blackboard, is used to share all the learning resources such as lecture slides, the syllabus, which consists of a set of

research articles and books. In addition, Microsoft teams is used to coordinate the work among the lecturer and the Learning Assistants.

7 CHANGE MANAGEMENT

As part of quality assurance, study programs can be assessed by an external accreditation body. For internal quality improvement loops, the curriculums and courses are often required to identify a reference group, who act as representatives of the class and provide feedback from the students to the teacher, and recommend actions for improving the course in the future. This is similar to an Action Research cycle where feedback is first gathered, and the course is improved based on the feedback. As an example, at NTNU (cf. Figure 8), the improvement process includes gathering feedback from students and learning assistants, synthetising feedback, checking updates from the university's strategy, quality assurance recommendations and guidelines, and then updating the course within the overall study program, and its three curriculum perspectives. The course syllabus and educational activities are then updated, ensuring also coherency with the overall curriculum architecture view.

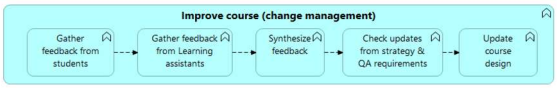

Figure 8. Change management process example in ArchiMate.

As stated in the introduction, when a HEI faces changing needs or even crises, personnel are called upon to rapidly develop and deploy solutions to maintain the integrity of learning activities, teaching services, and overall curriculum coherency. A pandemic crisis, an institution merge, a new formal SER policy, ask for rapid transformations which can impact the institution vision and goals, its processes, its curriculums, its resources. Overall, the changing requirements can impact several views, which are to remain aligned as best as possible. Specific views can be envisioned to facilitate transformations and change management in the educational offers, e.g.:

- Opportunities and Solutions View (OOV) to enhance the educational offerings, improve student services, and optimize administrative or support processes. Examples include implementing a new T&L models, migrating some course delivery mode to online, using flipped classrooms, moving to more formative assessments, etc.;
- Migration Planning View (PMV) would outline the roadmap for change management as identified in the OOV, with resource allocation to facilitate a smooth transition;
- Implementation and Governance View (IGV) for implementing the educational changes, including project management, governance processes. The accreditation requirements, university or school policies as regulations are considered. It would ensure that the architectural changes of a curriculum are effectively aligned with the strategic objectives.

8 CONCLUSION

An EA framework incorporating models of a HES can play a crucial role in facilitating sense making within an educational organization. A HES involves multiple stakeholders and can be comprehensively described through a structured architecture. To this end, this study proposed six views inspired by the TOGAF Architecture Development Method (ADM) to specify an HES, enabling easier adaptation to evolving requirements while maintaining strategic alignment. Changing requirements, stemming from internal or external factors or events, impact both vision and goals, business processes, curriculum offers, as learning resources. Illustrated examples have shown that views and well documented models, using ArchiMate, can enhance collaboration and communication among stakeholders across different perspectives. The proposed framework helps to find solutions when overarching goals conflict with educational reality, guiding decision-making on necessary actions to align educational programs with emerging needs. Once the HE architecture is established, detailed descriptions provide the rationale behind strategic alignments, ensuring coherence and effectiveness in organizational transformations.

In future endeavours, HE architects and educational program leaders may benefit from comprehensive guidelines and a meta-model to aid in change management processes. These resources would provide valuable insights on constructing, utilizing, and updating each view effectively. Change within HES can stem from various sources such as strategic realignments at the organizational level, quality assessments based on student feedback, recommendations for accreditation, new or rationalized processes, evolving industry requirements, shifts in graduate profile expectations, as well as the identification of outdated or emerging opportunities in T&L, could it be courses, T&L

models, human or physical resources. Also, in the context of crisis, unanticipated change, resilience is to be addressed, a property that reinforce the ability of a system to continue operating effectively during VUCA times (Bennett & Lemoine, 2014). Hollnagel (Hollnagel, 2010) defines organizational resilience as "the intrinsic ability of a system or an organization to adjust its functioning prior to, during, or following … disturbances, so that it can sustain required operations under both expected and unexpected conditions". Business operations can adapt and respond to internal or external dynamic unknown changes. Resilient organization can recover more quickly as they have built processes that minimize downtime (McManus, Sonia et al., 2008).

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