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Michele Della Ventura, *editor*

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International Conference on

New Music Concepts Inspired Education and New Computer Science Generation

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Michele Della Ventura
Editor

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Preface

This volume of proceedings from the conference provides an opportunity for readers to engage with a selection of refereed papers that were presented during the International Conference on New Music Concepts, Inspired Education and New Computer Science Generation. The reader will sample here reports of research on topics ranging from a diverse set of disciplines, including mathematical models in music, computer science, learning and conceptual change; teaching strategies, e-learning and innovative learning, neuroscience, engineering and machine learning.

This conference intended to provide a platform for those researchers in music, education, computer science and educational technology to share experiences of effectively applying cutting-edge technologies to learning and to further spark brightening prospects. It is hoped that the findings of each work presented at the conference have enlightened relevant researchers or education practitioners to create more effective learning environments.
This year we received 57 papers from 19 countries worldwide. After a rigorous review process, 24 paper were accepted for presentation or poster display at the conference, yelling an acceptance rate of 42%. All the submissions were reviewed on the basis of their significance, novelty, technical quality, and practical impact.

The Conferece featured three keynote speakers: Prof. **Giuditta Alessandrini** (Università degli Studi Roma TRE, Italy), Prof. **Renee Timmers** (The University of Sheffield, UK) and Prof. **Axel Roebel** (IRCAM Paris, France).
I would like to thank the Organizing Committee for their efforts and time spent to ensure the success of the conference. I would also like to express my gratitude to the program Committee members for their timely and helpful reviews. Last but not least, I would like to thank all the authors for they contribution in maintaining a high-quality conference and I hope in your continued support in playing a significant role in the Innovative Technologies and Learning community in the future.

March 2020 Michele Della Ventura

Conference Chair

Michele Della Ventura, Accademia Musicale Studio Musica, Treviso, Italy

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Renee Timmers, The University of Sheffield, UK
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Contextual Model Centered Higher Education Course and Research Project in the Cloud

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Abstract. This paper introduces theoretical, methodological, and systemics background of a novel project to introduce system level, knowledge intensive, autonomous, contextually active object models in university courses and research projects. This project applies world level modeling platform as classroom and virtual laboratory environment in the cloud. Thematically configured model system is in the center of course program and student research project in a fully virtual environment. Change for model system is motivated and enforced by change of industry towards system based autonomous products and facilitated by industrially proven and knowledge and research-intensive modeling platforms which are accessed in cloud. Beyond introduction of leading computer methodology, technology and tools in university processes, purposes of the project include accommodating the recent trend to integrate theory and practice in the same model system. The work for the project is based on two decades widely published research in model system-based teaching and student learning. To provide world level professional modeling environment, the laboratory joined to the 3DEXPERIENCE platform for Academia on the Cloud program of Dassault Systémes. The project includes analyses to reveal possibilities to apply results at areas other than engineering. Main issues in this paper are impact of the relevant development in industry on university processes, purpose, preliminaries and background of the work, model centered course and PhD research, and implementation in modeling platform.

Keywords. Autonomous model centered university processes, teaching and student research in cloud environment, model system for university course and PhD research project, virtual research laboratory.

1 Introduction

Everyone can see the dramatic change in engineering technology resulted by recent achievements such as cyber physical system (CPS), virtual engineering space, theoretically grounded and experience proven model of engineering achievement, contextually connected computer representation of object structures, and situation driven smart system in industry. New paradigm is the basis of a great advancement in which product and factory for its production are increasingly considered as CPS in industry [1, 11]. Smart methodology and systemics in engineering facilitate integration of recent achievements in information and communication technology (ICT) [2].

Response of higher education to the changes must be of high priority, not solely in engineering. In this way, first new thinking must be adapted at university processes to accommodate new achievements in university processes. Essential changes are needed in methodology and technical background of teaching and student research. Integration of formerly separated solutions into systems and autonomous operation of these systems enforce nesting teaching and research content in integrated solutions. Conventional teaching and learning methods, materials and laboratory environments are not suitable for using at the teaching and research content in the new age of cooperating systems, wide area contextual object structures, and autonomous equipment. It is obvious that future university courses and PhD research projects increasingly need autonomously operating models when all required contexts are included in chains. Missing context for any important relationship may result not proper reaction of model system. Moreover, contexts are frequently changed and rearranged during the life cycle of modeled objects. Higher education course and student project here act as objects to be modeled.

Important concept is virtual engineering space (VES) [10]. VES is organized computer representation of a contextual segment of the physical world. Key part of essential methodology for a VES comes from systems engineering (SE) [11]. Other related emerging area is biologically inspired engineering which researches engineering solutions based on observations in nature [13]. Fortunately, new principles, methodologies and systemics are integrated in computer model and modeling solutions to fulfill the above new requirements against industrial engineering. Knowledge intensive and research eligible modeling systems are available as very complex software platforms offering tools which also can be utilized at higher education processes to be able to cope with the new requirements. Work in this paper assumes availability of suitable modeling platform. In this way, this paper introduces a research to prepare application of industrial professional modeling platform at university processes. First, main recent changes in engineering technology, their impact on university processes, and essential idea of the proposed model centered teaching and research methodology are discussed. Following this, purpose, preliminaries and background of the reported research are explained. The subsequent section of the paper outlines the proposed model centered higher education course and PhD research project scenarios. Finally, implementation of research results in professional modeling platform laboratory environment is introduced.

2 Changed Industrial Technology and its Impact on University Processes

Current engineering related university processes, teaching content and programs, and research projects behind them still often are based on industrial technology which is on the level of end of the past century. However, well proven conventional methods, teaching materials and practice together with joint programs with industrial companies may be outdated soon as result of the current transformation of the industry. Changes are mainly in integration of processes and operations into computer-controlled systems, development of conventionally controlled equipment towards CPS, integration of engineering knowledge and processes into lifecycle applied complex model systems, and development of smart products with increasingly autonomous features. Another essential change is in interactions between equipment and human. Equipment is situation controlled by numerous cooperating systems. Humans who operates this equipment must be aware of actual situation to intervene work of systems in case of malfunction of highly automated autonomous equipment.

Essential trend is integration of everything in networked computer system, mainly in high level actual knowledge dependent organizations as universities. Any connected human can worldwide access publications, knowledge, office affairs, stores, etc. Access conventional and not efficient knowledge and information sources required long time, work, and expenses till recent years. Today access takes only minutes using the complex info-communication device which is in the pocket of all students. The key word of knowledge communication is stay connected! The connected sites and accessible content are increasingly active. The long era of passive documents will be ended soon. By now, the cloud technology has become essential for geographic independent access of university course and research content.

Dramatic changes make the stay connected style essential for universities among others because of wide spread of intelligent and smart systems in engineering. Autonomously working model systems with consistent outside and inside context structures serve engineering processes from the first idea to recycling including research and other stages of the innovation. Universities which are involved in different levels of engineer education must cope with this new situation. Other challenge is that the above model system is developed in group collaboration with participation by systems engineers, information engineers, modeling and simulation experts, mathematicians, physicians, and experts from relevant areas of engineering depending of the multidisciplinary characteristic of systems in product under development.

The above changed situation revealed strong need for advanced model-based university laboratories which can serve university courses and research activities. Relevant publications emphasize importance of university laboratories in virtual to utilize new information technology [3], high level expertise to enhance engineering related education [4] and learning sciences to theoretical and empirical support of research in engineering education [5]. Laboratory of Intelligent Engineering Systems at Óbuda University joined to efforts to establish multipurpose virtual research laboratory (VRL, [9]).

3 Purpose, Preliminaries and Background

Óbuda University (OU) places emphasis to theoretically grounded practice orientation at teaching and student research processes in engineering. This emphasis is the same as that is prevailing in professional lifecycle modeling of smart products at leading industries.

Moreover, developers of smart products are enforced to include fundamental, problem solving, and product related research activities in engineering modeling practice. As a result, advanced industrial modeling platforms offer suitable capabilities for research. Motivated by these platforms and the virtual technology realized in them, Laboratory of Intelligent Engineering Systems at OU recently started a program to establish model centered teaching and student research processes using latest knowledge and research eligible industrial modeling technology and platform.

In this paper, the main objectives of the reported research are developing methodologies for the integration of active knowledge in model system for thematic units of course program and organizing student research project around purposeful experimental model. Task specific course and experimental model systems are developed and configured to accommodate teaching competences and research results. Models, simulations, systems, procedures, mathematical functions and other applied informatics, mathematics and physics research results are placed in proper context then tested, analyzed, and verified using model system in accordance with experiment plan.

The platform environment which is applied at model centered higher education processes is introduced in Fig. 1 in connection with smart CPS. The whole scenario in Fig. 1 is full contextual. This means that models and other cyber units have contexts as representation of all active inside and outside connections. In this way, any context change results automatic update of all related object parameters in the actual model system. Context and the knowledge represented in it are always actually active. This method is well proven in professional modeling platforms and supposed as capability available at model-based university activities.

Contexts for active connections with outside systems have outstanding importance because they control both model in platform and smart CPS. Driving direction of context in each block connection is represented by arrows in Fig. 1. Modeling platform consists of management, cloud services, APPs, and multilevel model. Management activities are for modeling capabilities, human roles with given set of accessible capabilities, projects to organize group of participants, and assigning roles for participants. Multilevel model serves engineering activities for the lifecycle of smart CPS. Organized intellectual content (IC) drives requirements against CPS. IC is available in outside systems and/or collected inside of multilevel model. Requirements drive system level CPS components on system levels of multilevel model. System levels are for functional and logical component structures of CPS [4, 14]. This type of system level modeling comes from systems engineering (SE). It is well proven in the recent professional product modeling practice [5] and it is also applied at research and higher education activities by the Laboratory of Intelligent Engineering Systems for several years.

Physically operating smart CPS cannot be omitted in the scenario of Fig. 1 because one of the key research issues is connection of virtual CPS with physically operating CPS. This research is one of the preliminaries of research for this paper [6]. Key concept of smart CPS is automatic situation recognition which applies models, contexts from outside, and actual sensor information abut real parameters of physical units. Recognized situation drives autonomous decision making on control of physical units. In case of malfunction of smart CPS caused by system generated erroneous situation, human recognized correct situation is critical often in time pressure. Situation awareness is key issue in model centered teaching and PhD research methodology.

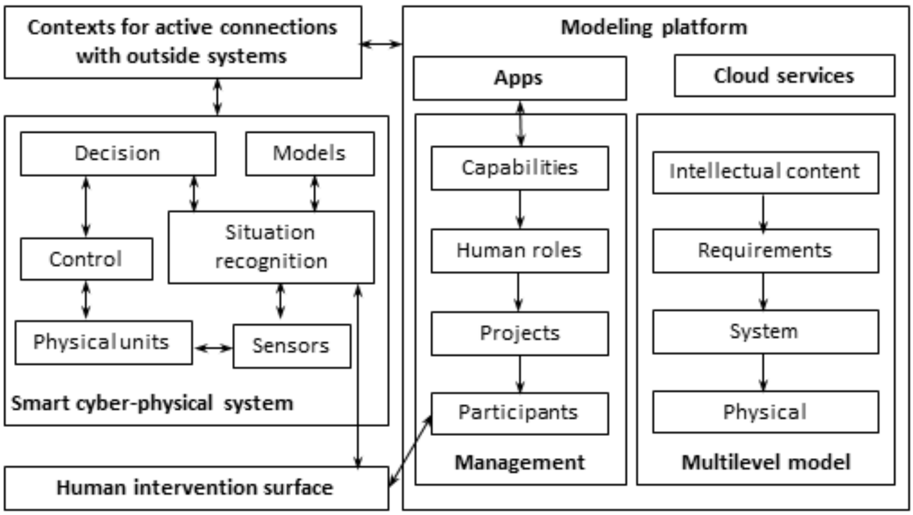

Fig. 1. Modeling platform driven smart cyber physical system.

Preliminary relevant research results were published in model mediated higher education course [7], in model mediated university course in engineering [8], in laboratory in cloud for model systems of system-based engineering structures [9], and in virtual research laboratory for smart engineering in the cloud [10].

4 Model Centered Higher Education Course and PhD Research Project

Increasing complexity, system level development, deep knowledge, bionics, and other advanced features of industrial products enforced engineering practice to accommodate best object modeling, intelligent computing, applied mathematics, cloud computing, and other latest achievements. Conventional engineering methods including entry level modeling and application of passive documents cannot provide suitable media for communication and representation purposes anymore. New media complex is introduced in the form of full contextual, generic, self-adaptive multilevel model system for any complex engineering achievement. The main objective of the research in this paper is to analyze, establish, and implement the same in the form of model centered higher education processes. As it was discussed above in this paper, model centered higher education is proposed to apply the same theoretical, methodological, and systemics background which is researched, developed and implemented for leading industries during the past four decades. The main essence of model centered higher education and PhD research processes is explained below in Fig. 2. and Fig. 3, respectively.

Fig. 2 outlines activities on course model system. It also lists special participant roles because any activity is human role dependent. One of the main features of a modeling platform is the high configurability which is essential for model based higher education processes. Although a modeling platform product includes a choice of roles with modeling capabilities assigned to them, task specific roles can be configured and defined.

Main task in case of a model centered course is development of structured content for teaching within a purpose-built model system. Main challenge is to provide any communication between participants strictly through model system which generates response for any interaction using previously defined active content.

In a conventional course, material consists of passive documents. Teacher explains topics using documents and assesses student performance using oral interviews and written documents. In model centered course, passive documents are replaced by active model system. Depending on the level of the realized abstraction, theory, methodology, object background, and engineering practice are represented in the model. High level modeling practice must be applied together with rich active knowledge content at the development of model system during the lifecycle of a course. As preliminary of the research reported in this paper, Laboratory of Intelligent Engineering Systems has been engaged in problem reveal, conceptual, and case study analysis research in model centered university course for six years [6-9].

Model system for a group of competences in a university course is developed in the course of definition of objects, contextual connections between object parameters, and representations. Beyond its development and management, course model system serves university activities such as presentation using active model to explain given thematical elements, supervision and assessment of student work for tests and assignments, and individual or group study of existing active course model system.

Model centered course is included in modeling platform installation where task specific user defined roles are required for participants with specific responsibilities. Course developer uses modeling to build course for its lifecycle. Lifecycle starts from decision on the course and ends with its last use. Course activities are tracked and checked by participants with supervisor role. As normal in classical courses, lecturer conducts course as well as assesses tests, coursework, and assignments. Student roles authorize participants for passive studying of active model with no contribution allowed, for tests where student is active under inspection of model assessing knowledge and skill using response of course model. Finally, model developer is active student who works on assignment or degree work.

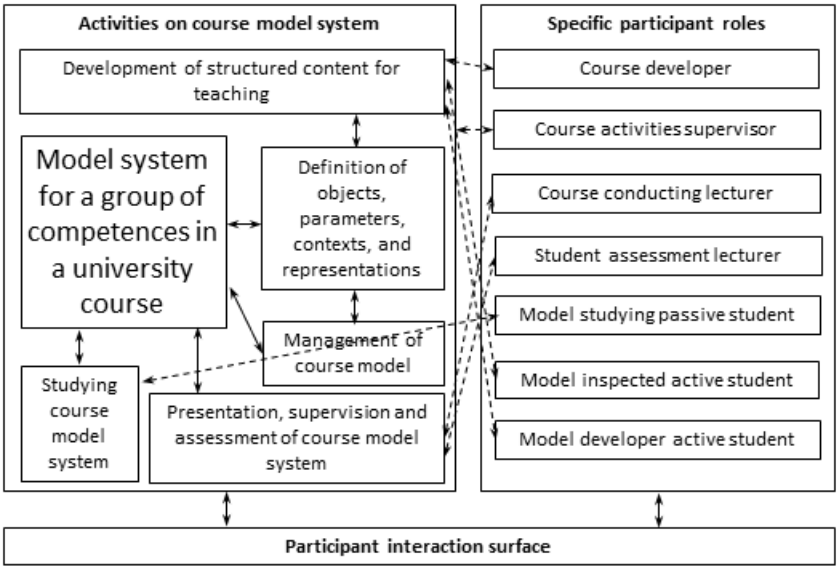

Fig. 2. Model centered higher education course.

Fig. 3 shows model centered research work by students for PhD degree and other student research. This also may be high level realization of project-based teaching and learning. Activities on experimental model system and the relevant roles are purposeful and different from ones with model centered course. An interesting issue for the future is mixed application of the two areas using specific connecting contexts.

Virtual research laboratory (VRL, [9]) was inspired by replacing conventional laboratory arrangement by full virtual arrangement. During development history of laboratories, mechanical units were extended by electric, electronic, measuring, and computer units. VRL is considered as XXI. century solution for university laboratory to cope with the dramatically changed tasks in engineering and other education.

Development of experimental model system for a research project is twofold. Research result purposed components (segments) of model system are developed by students who work on PhD or another project. On the other hand, virtual laboratory offers modeling tools as assistance to elaborate research tool purposed model components of the experimental model system in which the research result components are contextually placed. Development of model system for research includes definition of objects, parameter contexts, and representations similarly to the case of model system for course.

Research specific activities are experiments according to plan and thesis recognition based on models and experiment results. Modeling platform to be installed in the laboratory system of the VRL at the Laboratory of Intelligent Engineering Systems includes numerous representations, analyses, simulations, communication surfaces for outside solvers, and experiment planner as research related software service in the cloud.

Specific participant roles for research (Fig. 3) start with researcher student and research supervisor who do the same as in case of a conventionally operated doctoral school but in a potentially enhanced level using changed methodological and technical environment. Research tools developer prepares model system environment for research result to represent, analyze, simulate, and evaluate it. Industrial, modeling, and analyzer advisers provide outside professional support for research. Doctoral process supervisor follows and evaluates the progress of the doctoral research project considering applicable laws and regulations.

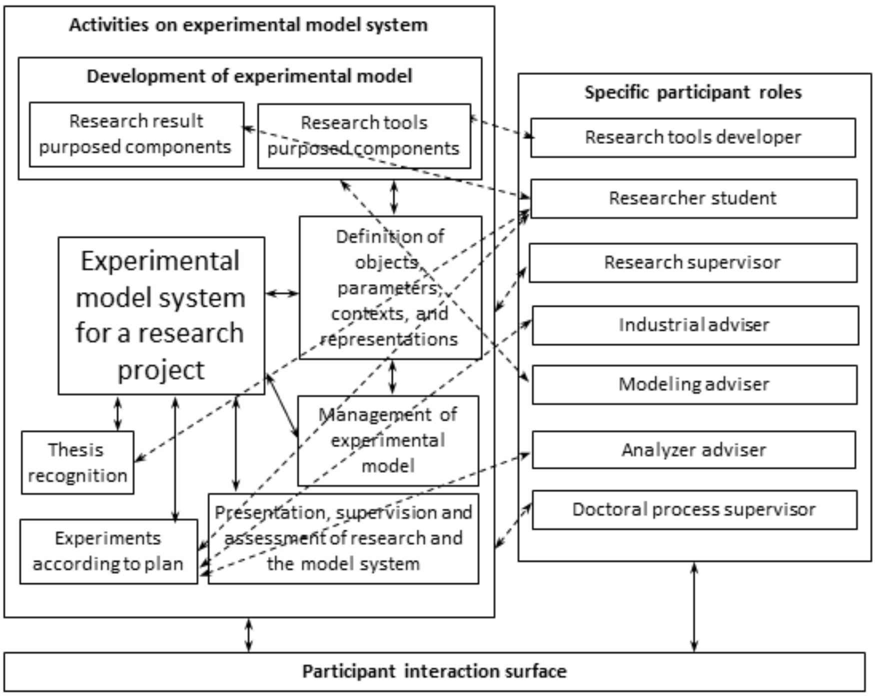

Fig. 3. Model centered PhD research project.

5 Issues at Implementation of Model Centered Higher Education

The reported research supposes full featured availability of world leading engineering purposed modeling platform at the Laboratory of Intelligent Engineering Systems. At planning stage of VRL it was concluded that installation, update, upgrade, operation and service of the extremely complex platform need system and human related resources which are impossible to provide for VRL in the premises of the university. The solution was found as own system which is provided as service in professionally operated cloud. For that reason, the laboratory joined to the 3DEXPERIENCE platform for Academia on the Cloud program of Dassault Systémes. This solution provides modeling

platform in cloud with all the demanded capabilities for the VRL including APPs for modeling (SaaS), platform for custom applications (PaaS), and infrastructure (IaaS).
Activities at research for PhD degree under control in the above modeling platform are summarized in Fig. 4. Topic of PhD student research is one of the accredited topics at the doctoral school. Students are enrolled in the usual way. VRL start is planned with research project which are in research topics related with the laboratory modeling system. Besides making own research in this system, these students build up the VES initially and prepare it for students work on other research topics. Doctoral School of Applied Informatics and Applied Mathematics (DSAIAM, ÓU) offers four accredited research topics for this purpose [8].

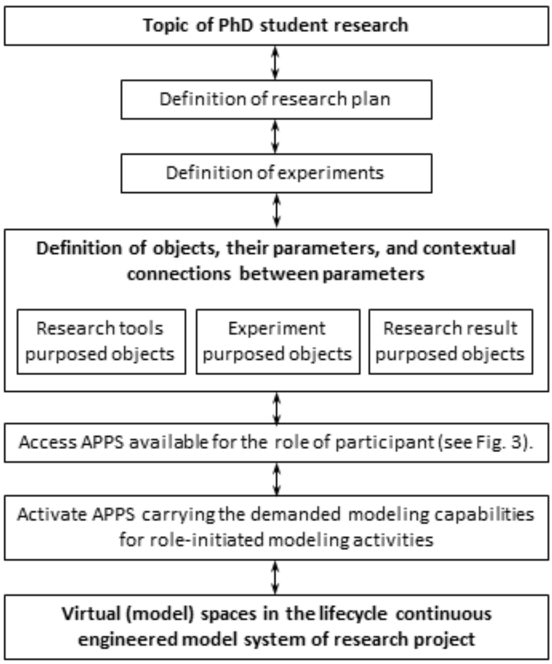

Fig. 4. Research for PhD degree under the scope and management of professional modeling platform.

Next tasks are definition of research plan and elaboration of plan of experiments. These serve research in VRL specific configuration. Future research is needed to find and elaborate methodology which allows replacing the currently used passive documents by active models. Requirements level modeling from system engineering (SE) is available in the modeling platform for this purpose.
Definition of the required model objects, contextual connections between object parameters and research specific represented procedures are done. Objects represent and describe developing set of research results during the lifecycle of a project. Other objects serve as research tools in the modeling environment of research in the experimental

model system. Experiment purposed objects are also included for experiment plan, virtual execution of model, organized structures of simulations, etc. Object classes are initially available and are defined by participants in the platform

Access to APPS is critical to ensure modeling capabilities as it is allowed for assigned roles of participant. On the other side, role-controlled access to APPS prevents unauthorized activities on any experimental model system. This is increasingly important in case of group work on a research project [16]. Model system consists of virtual (model) spaces. Continuous engineering methodology [15] serves safe modification of model system at its any point with organized propagation of modification throughout the whole model system and its related environment along chains of contextual connections. PhD research can utilize this recent methodology in software and modeling technology.

6 Conclusions and Future Research

Recently implemented new scientific and technological developments in industrial technologies dramatically changed thinking, curriculum, research, teaching content, and methodology in higher education for engineering and other areas. Industrial engineering and equipment control activities are moving into cloud computer systems where advanced smart model system provides lifecycle activities for an achievement such as product, experimental equipment, prototype, artistic configuration, etc. Change for construction of these new achievements using collaborating systems thoroughly transforms engineering activities in these days and has great impact on higher education processes. The main concept in this paper is moving course and research activities into purposeful model systems and developing and maintaining these model systems in professional modeling platform available as program product service in professionally managed cloud. Change for the modeling proposed in this paper is advantageous at handling of knowledge, at active knowledge based response of model system, at integrated theoretical and experience based teaching and PhD research, and at active model supported assessment, and updating and upgrading of teaching and research content.

In addition to future research issues above this paper, future work is planned to provide continuous development of VRL regarding system related achievements, algorithms, procedures, intelligent computing methods, object structures, and context connected knowledge representations.

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