POLYTECH°
ORLÉANS
School of Engineering of the University of Orléans

Student Projects Catalogue 2015-16

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Polytech Orléans

Polytech Orléans

Ecole Polytechnique de l'université d'Orléans

Direction management des formations, prospective et innovation pédagogique

☎ : 02 38 49 43 56

🖳 : 02 38 41 73 83

✉ : directrice.formations@univ-orleans.fr

Site Léonard de Vinci
8 rue Léonard de Vinci
45072 ORLEANS cedex 02

Site Galilée
12, rue de Blois – BP 6744
45067 ORLEANS cedex 02

Site de l'IUT de l'Indre
2 rue François Mitterrand
36000 CHATEAUROUX

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Message from the Director

One essential element of the activites of any engineering school is the maintenance of partnerships with businesses and institutions in the local community and beyond. Thanks to its close ties to such organizations, Polytech Orléans can guarantee the employability of its graduates (of which 90% find a first job within three months of receiving their degree), accurately adapt its programmes to respond to the changing needs of the business and scientific community, and acquire the most up-to-date equipment, materials and software.

Our partners also benefit from these exchanges by receiving high-level scientific expertise as they welcome hundreds of our students in internships each year and avail themselves of the educational facilities and equipment we can provide.

To prepare for their entry into the professional world, fifth-year students at Polytech Orléans are required to prepare and complete a project according to the specifications established by an engineer working in the field. For Polytech, these projects validate the body of technical and managerial competencies acquired by students during their years in our programme. For our industrial partners, the students' projects permit them to test systems, confirm new ideas, and create prototypes, among other valuable research outcomes.

Publishing a yearbook that brings together in one volume the overviews of all fifth-year industrial projects is a concrete way of presenting the entirety of the fields of activity in which graduate engineers of Polytech Orléans will work. It is also a way for our business partners to evaluate the assistance which Polytech can bring to them. Our ambition is to highlight the achievements realized in collaboration with businesses and institutions and to encourage development of new industrial partnerships.

Christophe Léger
Director, Polytech Orléans

For further information:
Direction des Relations Entreprises, Stages, Innovation, Formation continue
12 rue de Blois, BP 6744, 45067 Orléans cedex 2
02 38 49 48 48
relations.entreprises.polytech@univ-orleans.fr

Civil Engineering

3D print of the famous Chambord double revolution stair

Civil engineering

PRISME
Laboratoire Pluridisciplinaire de Recherche
Ingénierie des Systèmes, Mécanique, Énergétique

Institution: PRISME Lab

Alexandre GROLLIER / Quentin RAYMOND
Academic and industrial supervisor: X. BRUNETAUD

Selected participant
10th Annual Final Year Projects Forum

Objective/motivation

The project consists of a 3D printing of the double spiral Chambord stairs. The model created at the end can show how these stairs ascend the three floors without meeting. We first did tests that could provide information about cutting (thickness of the helicoid, thickness between floors, and thickness for interlocking). The basis files for this project were different scans of these stairs and all these scans were put together to create a mesh. This mesh was first cut with Meshlab (software) in order to decrease the size of the file and to be manipulated more easily. An operation was done with Blender (software) to decimate the new file and also to decrease the size of the file by ten. With this new file, it became possible to create a closed mesh.

Results

The next step was to divide these stairs into three floors and to cut the two interlaced stairs into distinct parts. It was necessary to create objects in volumes to cut the floors, cubes in volume to create an interlocking between the two floors and a helicoid in volume to divide the two helix stairs. After that, a Boolean operation (difference) was carried out between these volumes and the mesh of the stairs to obtain holes in the mesh where the objects were. Some walks were not really clean due to bad scans so a cleaning was done on every walk. Each floor was printed with a 3D printer at Polytech Orleans for sixty-seven hours per floor, and placed in an acid bath for eight hours to remove support materials. After all the prints of the elements were made, the entire stair was assembled.

Keywords: description, modelisation, impression, Chambord, 3D printer

Contact: a.grollier@live.fr ; raymond.quentin.pro@gmail.com

Agroecology in Barani (Burkina Faso): soil fertility

Environmental engineering

Jean-Laurent CAMLINDIA / Nola JOURNET
Academic supervisor: M. MOTELICA

J-L. CAMLINDIA

N. JOURNET

Objective/motivation

Our fifth-year project deals with agroecology in Barani, Burkina Faso. It's a part of the BIOSOL project, promoting new green agronomic knowledge for Burkina Faso's farmers to improve their living conditions. The aim of the project is to analyse agricultural soil samples from fields of Barani and understand the composition of the soil according to the agricultural practices. The climate change and the development of the area are the reasons why it is necessary to establish a sustainable agriculture there. We have to determine key parameters to evaluate soil fertility: biological fertility with the microorganisms quantity and diversity, physical fertility with the soil texture and water transfer and chemical fertility with the nutrients available to plants.

Results

The results can help to improve the agricultural techniques and yield. The soil is relatively poor according to its physical, chemical and biological characteristics.
> Physical: the soil is mostly sandy with a low water holding capacity. It cannot keep water and nutrients.
> Chemical: the soil has a low quantity of nutrients
> Biological: comprehensive presence and diversity of microflora are the same for each soil.

Keywords: agroecology, soils' fertility, sudano-sahelian soil

Nitrate content of the soils of the different fields
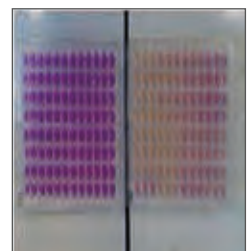
active microorganisms according to

the substrats (MicroResp)

Contact: jlcamlindia@gmail.com ; nola.journet@etu.univ-orleans.fr

Analysis and modeling of $CaSO_4$ fire protective panel damage

Civil engineering

A. DUCATILLON

Q. FALEWEE

C. HANQUIER

Antoine DUCATILLON / Quentin FALEWEE / Corentin HANQUIER
Academic supervisor: D. HOXHA
Industrial supervisor: J. ESLAMI

Company/Institution: PRISME Laboratory, L2MGC

Objective/motivation

This research project presents a numerical study of the thermo-hydro-chemical-mechanical behavior of gypsum panels heated on one side according to the ISO 834 standard. To carry out this study, we used data from the thesis of two PhD students from the L2MGC research lab in Cergy-Pontoise. After having created a conceptual model taking into account all the physics laws and hypotheses regarding the behavior of gypsum boards, we entered the experimental data in FLAC3D (a numerical modeling code for advanced geotechnical analysis of soil, rock, and structural support in three dimensions) in order to compare the experimental results we found in the thesis to the theoretical results given by FLAC3D.

Results

We were particularly attentive to the change in properties during the phase change process caused by the fire. Finally, the influence of the stocking rate on the phase changing properties was studied as well as its influence on the mechanical behavior of the material. The numerical results obtained will be confronted with the multi-scale and multi-criterion database which had already been established.

Keywords: gypsum, passive fire protection, ISO 834, phase-change materials, digital modeling
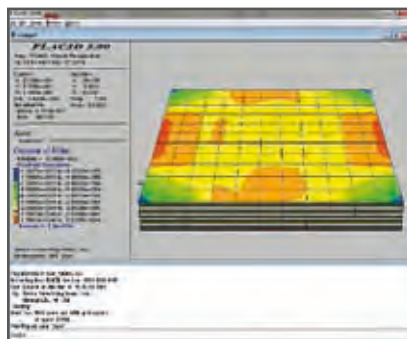
Temperature gradient on the cold face
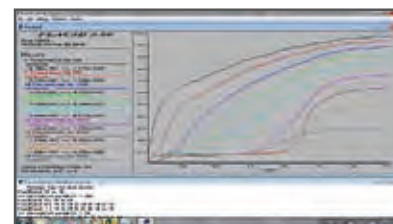
Temperature propagation within the board

Contact: antoine.ducatillon@etu.univ-orleans.fr ; quentin.falewee@gmail.fr ; corentin.hanquier@etu.univ-orleans.fr

Assisted phytoremediation of soils contaminated by metals and metalloids

Environmental engineering

Elisa CHERAMY / Julien LEFEBVRE
Academic supervisors: S. BOURGERIE, D. MORABITO

**Selected participant
10th Annual Final Year Projects Forum**

Company/Institution: Yara, Neodyme, ISTO, LBLGC, University of Orleans

J. LEFEBVRE

E. CHERAMY

Objective/motivation

This fifth-year project was carried out in the context of the RESTOR project with the help of the biology laboratory and the geology institute of the University of Orleans and the firms Neodyme and Yara. This project deals with the requalification of contaminated soils in Issoudun thanks to phytoremediation. The main objective is to define a method to implement an assisted phytostabilization process using willows and biochar (soil-enrichment carbon product). The main thrust was to understand the biogeochemistry and the fate of metals in the soil and highlight willows' phytostabilizsation ability with metals and metalloids present in a contaminated oil from a former fertilizer-producing unit. The soil is currently contaminated by copper, arsenic, zinc and lead. Our different tasks consisted in characterizing the mineralogy and the chemistry of the soil and the microbiology of the rhizospheric soil.

Results

The different measurements of pH showed that adding biochar significantly increased the soil pH. However, we were not able to draw conclusions about soil electrical conductivity. The X-rays diffraction analysis highlighted the presence of hematite, quartz, calcite, jarosite and orthose in the soils. Thanks to our experiments to measure water-holding capacity (WHC), the addition of biochar increased the soil WHC. Our results obtained thanks to chemical sequential extractions highlighted the fact that metals stays in the residual fraction which means that the metals are hard to remove from the soil. Besides, the distribution of the metals in the soil changes with the biochar and the soil TV (mix of compost and sand). For instance, when the soil is amended with biochar and TV, there is less pollutant in the residual fraction and more in the oxydizable fraction.

Keywords: phytomanagement, biochar, soil, metals

Organization of the experimental plot

Salix Viminalis

Former buildings of Yara firm

Contact: elisa.cheramy@gmail.com ; julien.pierre.lefebvre@gmail.com

Automation of 3D acquisition process based on photogrammetry

Civil engineering

L. BUDELLI

F. KERMARREC

Laura BUDELLI / François KERMARREC

Academic supervisors: K. BECK, X. BRUNETAUD, R. JANVIER

PRISME
Laboratoire Pluridisciplinaire de Recherche
Ingénierie des Systèmes, Mécanique, Énergétique

Institution: PRISME Lab

Objective/motivation

To achieve the realization of 3D models, laser scanning is the reference technology. Nevertheless, photogrammetry can be considered as a competitive alternative technology thanks to its potentially low cost, its capability of recovering high quality color information, and the fact that it may not require any further alignment by point picking. With this technology, a 3D model could be constituted from pictures successively taken in a same area with different angles. Consequently, research made by the PRISME lab turned towards photogrammetry to assess its relevance. Thus, the aim is the development of an automated protocol used to monitor sample stone degradation from the morphological point of view.

Results

For the 3D acquisition process based on photogrammetry, the sample stone is placed on a turntable and pictures are taken every 15 degrees. For more convenience, the process is automated. Indeed, the turntable is motorized and synchronized with the camera thanks to an Arduino board. The camera parameters have to be optimized for photogrammetric process and used with a light box, in order to obtain a uniform lighting and a sharp, in-focus picture. After having obtained accurate pictures, software programmes are used in order to transform pictures in 2D into a 3D model. This model can be used to show morphological changes due to stone weathering.

Keywords: photogrammetry, 3D-reconstruction, stone samples, salt weathering

3D model of Tuffeau sample after ageing

The resulting prototype of photogrammetric acquisition

Tuffeau sample after ageing

Contact: laura.budelli@etu.univ-orleans.fr ; francois.kermarrec@etu.univ-orleans.fr

BIM-based digital model of the new Darcy Hall

Civil engineering

Mohamed DENNOUN / Maxime DI ROCCO
Academic supervisor: D. HOXHA

M. DI ROCCO

Objective/motivation

The aim of the project is the design of a digital model representing the new Darcy Hall using BIM technology (which stands for Business Information Modeling) thanks to the Revit Software. BIM is a dynamic technology which allows us to gather the different schematics of electricity, telecommunication and pipe networks, HVAC (Heating Ventilating & Air Conditioning) and manage all of the important parameters about the building such as wall covering, building materials, luminosity, sound intensity etc. With this project, we are endeavoring to build links between all the different actors working on the project: structural works, design office, architectural trades... The final purpose is to learn how to use the software and to be able to build the entire digital model in the given time.

Results

First, we started to learn how to use the software and its basics, then applied it to the Darcy building. After that, we tried to contact the architect and the engineering design office to have more information about the bearing structure (mostly to do with dimensions) and details about the design. Then we learnt how to use the other parts of the software to carry out new functions linked to other software; at the moment we're trying to combine the structure calculation software 'Autodesk Robot' to our design in 'Revit Autodesk'. Finally, we would also like to study the impact of the building on the environment using Revit.

Keywords: 3D modelling, building information modeling, structure, HVAC, Revit software
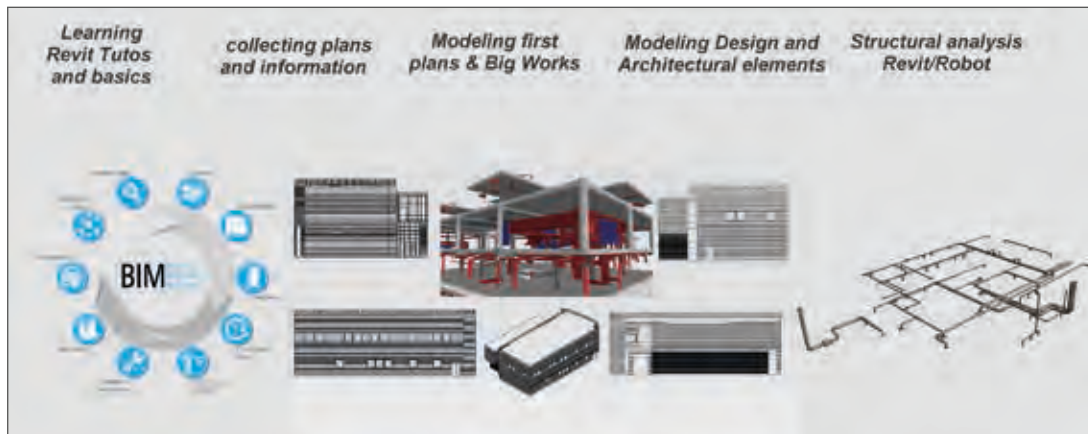
Contact: mohamed.dennoun@etu.univ-orleans.fr ; maxime.di-rocco@etu.univ-orleans.fr

Bitumen/granulate:
a couple under pressure

Civil engineering

Frédéric FAIVRE / Estelle GAILLARD
Academic supervisor: L. JOSSERAND
Industrial supervisors: A. BELKAHIA, A. VAJSMAN

Selected participant
10th Annual Final Year Projects Forum

Company: COLAS

F. FAIVRE

E. GAILLARD

Objective/motivation

Because of the current economic situation in the field of Public Works, the creation of new roads decelerates and is replaced by a big phase of renovation. The goal of our project was to study the behaviour of a coated material put under stress in order to know how it reacts and ultimately be able to revise the formulation of asphalt to make it more efficient in the long term and avoid the recess of granulates. For that we researched the strengths applied by a car or a truck to the road, the different parameters interfering in the problem and the different theories existing about the interface tire/road. The specificity of our project is that the study is focused on the most superficial layer of the asphalt road, while the usual projects are about the entire layer.

Results

At the end of the project we returned a report relating the most interesting theories to use in the study of the interface tire/road. Moreover, we returned an Excel program allowing calculation of the value of the strengths, the area of a tire footprint and finally the stresses. To perform calculations, we suggest that the user input various parameters corresponding to the characteristics of the vehicle (type, tires, weight), the road profile (tilt and turn), and driving parameters (speed and instant acceleration). The quotient obtained by the force and the surface gives the constraints. Determining these constraints are paramount in designing the optimum asphalt road: maximum durability in a given traffic. The designer engineers will then extract the constraints they want and compare them with asphalt formulas at their disposal, enabling time savings and considerable material gain.

Keywords: strengths, tire foot print, stresses, coated material

Variation de l'empreinte de contact avec la vitesse pour le BBSG 0/10 (new)
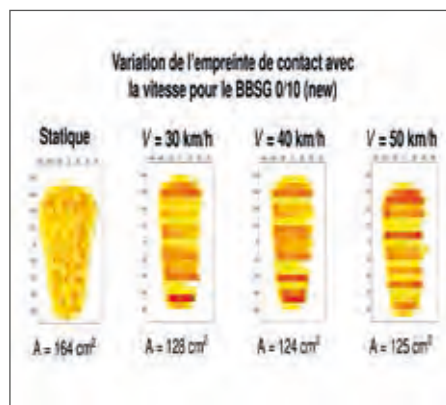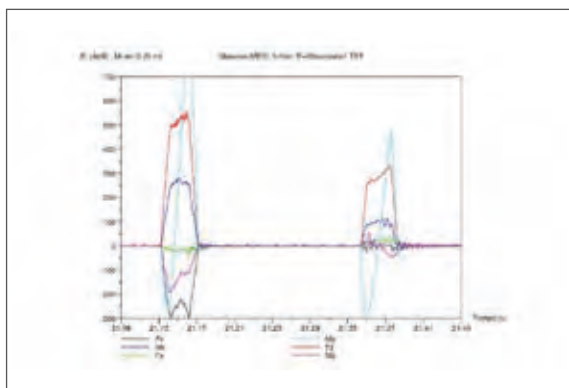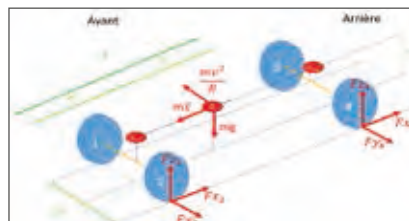
Contact: estelle.gaillard48@gmail.com ; fred.faivre013@gmail.com

Chambord castle: from 3D scanning to architectural documents

Civil engineering

Safia ABOUELFARAJ / Zineb SAIDI
Academic supervisor: X. BRUNETAUD

Institution: PRISME Lab

Objective/motivation

In order to renovate the Chambord Castle, architects can't use their traditional tools. Therefore, the architectural methodology needs improvement. Our project includes two main parts: preparation of as-built drawings based on a 3D scan, and a detailed orthophoto of the external walls of the castle. Thus, our project deals with this issue and we are working on several software programs to meet our goals. The first part includes the following steps:

> Scanning a 3D design using a laser scanner.
> Exporting the results to a software program called "Scene".
> Exporting the results to another software program called "CloudCompare" to have a complete version of the castle.

Concerning the second part, we worked on a graphic software program "QGIS". Indeed, we marked out the architectural elements and the stones of the external walls of the castle by using an orthophoto.

Results

The three steps above were already done last year by other groups. Our mission is to work on the following steps:

> Working on "CloudCompare" and preparing as-built drawings based on the 3D design. The final result is a scatterplot.
> Using "AutoCad" in order to link the several dots of the scatterplot. Therefore, we have a useful result for the architect.

In addition, we marked out the stones and the architectural elements of a wall of the castle called "Aile sud" because it's the main entrance.

Keywords: renovation, 3D scanning, architecture, as-built drawings

Contact: safia.abouelfaraj@etu.univ-orleans.fr ; zineb.saidi@etu.univ-orleans.fr

Construction of a logistic platform "Grand Frais"

Civil engineering

Teuwo LINGET / Jason MILLET
Academic supervisor: L. JOSSERAND
Industrial supervisor: S. CHARRIER

T. LINGET

J. MILLET

Company: Travaux Publics Val de Loire

Objective/motivation

The objective of our project is to professionally answer a call to tender for a logistic platform. In order to fulfil this aim, we need to create a 3D modelling of the project thanks to the blueprints and the software Mensura Genius. With this modelling, we can easily know the quantity of materials needed and the real capacity of the sewage system. Another step of our project will be to list the different tasks to perform on the worksite, to organize them and to estimate their cost and ecological impact. This project has allowed us to get closer to the professional world and see the reality of a project.

Results

At the end of this project, we succeeded in making a 3D modelling of the construction site. We also carried out all the roads, the landscape, the sewage system and the quantity of materials needed. Then, we made an estimation of the cost, the ecological impact and the schedule of the project with the software Excel. We also explained the techniques needed and chosen for the different tasks to complete on the construction site. At last, we suggested a variant about the roadway structures which made a profit of about €100,000. This project taught us a lot about the preparation needed before construction and it will be helpful for our professional life.

Keywords: Mensura Genius, sewage systems, logistic platform, roads, planning and cost of a project
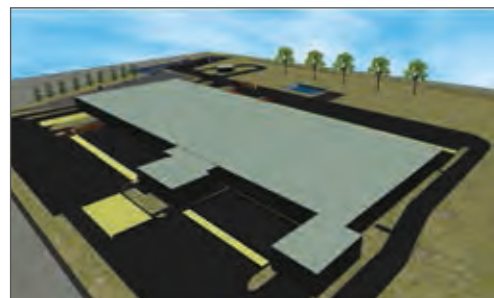
3D modelling of the project
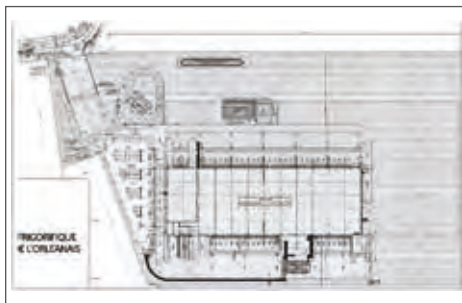
Blueprint of the project
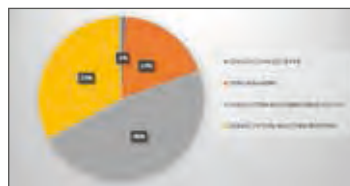
Cost of the project by field
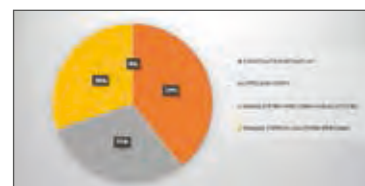
CO2eq. Emission by field

Contact: teuwo.linget@etu.univ-orleans.fr ; jason.millet@etu.univ-orleans.fr

Construction of an agronomic showroom and offices for LEMKEN France

Civil engineering

Valentin BILLAUD / Damien VIEVILLE
Academic supervisor: L. JOSSERAND
Industrial supervisor: S. CHARRIER

V. BILLAUD

D. VIEVILLE

Company: Travaux Publics Val de Loire
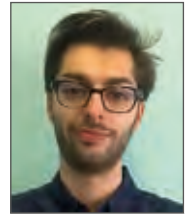
Objective/motivation

The goal of this project is to study the future implantation of Lemken France in Boigny-sur-Bionne (Loiret). This building site is composed of a showroom, offices, roads, and a parking area. All the components of this setting up have been examined by us, except the buildings. The site and the project have been designed on Mensura, a civil engineering software product used in the professional world. In the first place, thanks to it, the rainwater and wastewater networks have been calculated (type of pipes, size), the quantities of materials and their costs have been determined. Moreover, in the second part, the dimensions of the road to access the site have been studied, and each operation and their time have been decided. Finally, in the third part, variations of the project have been looked for in order to reduce the economic costs and/or environmental impacts.

Results

After modeling the project in platforms (building areas, light and heavy traffic load road, green areas and pedestrian areas), we saved their structures in the software. Thus we obtained the quantities of all the materials that the building site needed. Then, we changed the water networks and obtained their dimensions thanks to Mensura. With our estimations for the equipment and time for each operation, we found the cost (€832,389), the time (91 days), and the environmental impact (787,723 kgCO2,éq) of the construction. Finally we suggested changing the materials for the heavy road and adopting another type of platform. Thus we obtained gains of €116,637 and 100,000 kgCO2,éq.

3-D project

Keywords: Mensura software product, economic costs, environmental impact

Map of the whole project
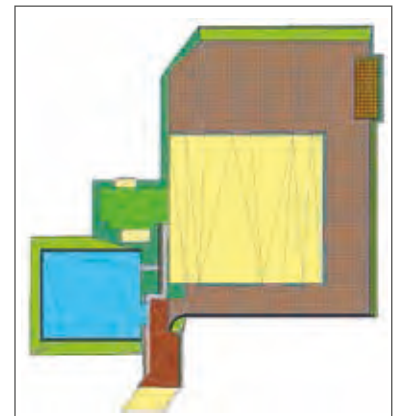
Modelisation of the project in platforms

Contact: valentin.billaud@etu.univ-orleans.fr ; damien.vieville@etu.univ-orleans.fr

Design and modeling of a guarded hot plate

Civil engineering

Alexandre BARBEREAU / Lorena BONFIGLIO
Academic supervisor: Y. BELMOUJAHID

Objective/motivation

The present project aims at the creation of an efficient machine which is able to measure the thermal conductivity of materials. Our model is close to the guarded hot plate system which is here enhanced to miniaturize the machine and fit it to a straw concrete sample. This material is under development at Polytech Orléans and needs an appropriate machine to permit researchers to progress with their hypotheses. First, we had to model the machine thanks to a solid modeling computer-aided design (CAD) software named SolidWorks. Then we had to run thermal simulations with COMSOL Multiphysics, a finite element analysis software. This was necessary to prove that our machine is efficient from a thermal transfer point of view, and also to order the materials to build the machine.

Results

The first part of the project, which is the design of the machine is completed. All the plans and technical details are fixed and ready to be sent to the technician to start the building of the machine. They have also been used to make simulations on COMSOL Multiphysics in 2D and 3D. We did all the research into prices of our products and most of them have been ordered and sent to us. Concerning the results on simulations, we succeeded in having some for the 2D part which are not what we expected from our machine, and we stopped the 3D resolution because our computers are not equipped to solve such problems. Finally, we need to keep running simulations on COMSOL to approach our real model which should not be the case by now.

Keywords: guarded hot plate, insulating, thermal conductivity, straw concrete, research

SolidWorks machine model

2D Model of heat transfer with COMSOL

Sample of straw concrete

Contact: alexandre.barbereau@etu.univ-orleans.fr ; lorena.bonfiglio@etu.univ-orleans.fr

Geotechnical diagnosis of the soil of an individual house
Geotechnics

Adolphe HOUNTONDJI / Rhita JABRI
Academic supervisors: M. AL-MUKHTAR , K. BECK

A. HOUNTONDJI

R. JABRI

Objective/motivation

The aim of our project is to establish solutions to problems of cracking on individual houses in the region of Val d'Orléans, and more particularly in Saint Jean Le Blanc. In order to find those solutions, we need to:
> Start with bibliographic researches about the weather, the soil and disasters in the area for the past 50 years.
> Make some field tests using the dynamic penetrometer and auger, then take samples.
> Make tests in the laboratory with methylene blue, Atterberg limits oedometric test and triaxial test.
All this will help us determine the nature of the soil and the weather, the impact of trees on houses, and find solutions to improve the construction and avoid any further problems of cracking or settlings.

Results

Our researches and tests led us to propose some solutions in order to solve these problems of settlings and prevent their coming back. We have suggested the solutions that follow:
> Get rid of vegetation too close to the construction (with a perimeter of at least one height of the tree)
> Create an anti-root screen
> Consolidate the soil around the foundations using the injection of some resin

Keywords: geotechnics, soil, cracking, settlings, individual house

Cracking through walls

Settlements

Contact: adolphe.hountondji@etu.univ-orleans.fr ; rhita.jabri@etu.univ-orleans.fr

Influence of the anisotropy of the soil on deep tunnels

Civil engineering

Yassine EL MOHANI / Khalil FARAJ
Academic supervisor: D. DO
Industrial supervisor: D. DO

Institution: PRISME Lab

Objective/motivation

Nowadays, due to the need for quick and safe transportation, there are more and more underground constructions. Therefore, since the requirements are higher, the difficulties are more important. The main aspect of these is the anisotropy of the soil. The aim of the project is to analyze the influence of the mechanical and physical properties on the short-term behavior in the case of anisotropic soils. Our project also includes bibliographical studies about the importance of the retaining structure and lining in the final behavior of the deep tunnel. We used both Plaxis2D and Flac3D software to define and simulate the final behavior of deep tunnels in different types of anisotropic soils. Indeed, with these two software products it is possible to develop models in 2D or 3D with different models of calculations.

Results

> The modelisation of a deep tunnel's model where the diameter is negligible in comparison with its depth.

> The final behavior of the construction is not influenced only by the stresses applied to it. It also depends on the mechanical and physical parameters. There are five parameters for the soil: Poisson's ratio and Young's modulus for both directions (horizontal and vertical), and Shear modulus; and two parameters for the joints. All of these define the elastoplastic model that describes the transversely isotropic elastic behavior.

> The necessity of taking into consideration the anisotropy in all the calculation phases to get the final behavior of the construction.

Keywords: deep tunnels, anisotropy, Plaxis2D, Flac3D, elastoplasticity
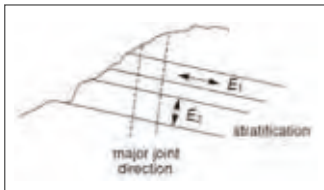
Anisotropy of the soil
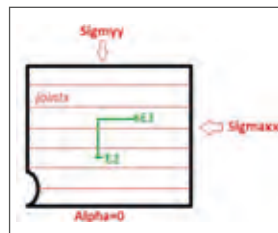
Orientation of joints in the massif
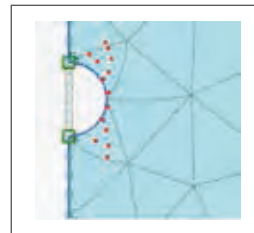
Plastic points in elastic massif

Contact: yassine.el-mohani@etu.univ-orleans.fr ; khalil.faraj@etu.univ-orleans.fr

Life cycle assessment of the Carrefour underground car park near the Orléans train station

Civil engineering

Jamel EL HEDHILI / Pierre HENNECHART
Academic supervisor: C. PROUST

J. EL HEDHILI

P. HENNECHART

Company: Place d'Arc shopping centre

Objective/motivation

The life cycle assessment of the Carrefour underground car park consists in calculating the impact on the environment caused by its construction and its daily use by cars. The car park is located in Orléans city centre, near the train station, under the Place d'Arc shopping centre. It was built in 1988, has two floors, has a surface area of 20,490 square metres, and is used daily by 2,000 cars on average, as it is open every day. Some measurements of the pollution level have been done by the IFSTTAR institute at several places in the car park. The concentration of some pollutants are measured in kilograms per hour of use of the car park. Next, after entering different connected parameters, another software called Ecorce is able to calculate the pollution caused by the car park during its construction.

Results

We have three types of results: the global warming potential (GWP), the photochemical ozone creation potential (POCP) and the acidification potential (AP). The software Ecorce immediately gave the quantity of those three forms of pollution produced by the car park construction. We got the total pollution caused by cars by multiplying the data measured by IFSTTAR with the area of the car park, its life expectancy which is supposed to be fifty years, and some coefficients given by our supervisor. We finally observed that the greatest natural impact comes from the cars which use the car park, and not from its construction. In fact, the global warming potential is 6 times higher, the photochemical ozone creation potential is 545 higher and the acidification potential is 4652 higher.

Keywords: car park, pollution, software, data, comparison
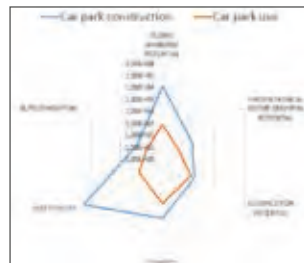
Contact: jamel.el-hedhili@etu.univ-orleans.fr ; pierre.hennechart@etu.univ-orleans.fr

Lifetime estimation of the runways of the Oran Es-Senia airport

Civil engineering

Pape DIATTA / Mohammed EL OUARIACHI / Laura GRIVALLIERS
Academic supervisor: M. TIFOUR
Industrial supervisors: D. HOXHA, M. CHIKHAOUI

Institution: PRISME Lab

Objective/motivation

This project aims to estimate the lifetime of the Oran airport runways. Because of the soil composition and the Sebkha of Oran (a salt water lake), there are the beginnings of cavities which could damage the runways' structure. Our main objective is to model the aircraft undercarriage, finding the location of the undercarriage on the runway. Afterwards, we can determine the impact of landing on the runway. Another goal of this project is to pinpoint displacements, stresses and velocities of the different layers of the runway according to three physical phenomena: static, thermal and dynamic. Especially in the thermal study, the objective is to know if the air temperature has an impact on the pavement structure. These phenomena would be modeled with the FLAC3D software, which study geotechnical problems.

Results

For the static part, we modeled an excavation then the construction of the runway pavement to finally apply the static loads. So, the numerical code allowed to obtain displacements and stresses for each layer which composes the runway. Concerning, the thermal analysis we could observe that the air temperature in Oran doesn't vary from 3 meters above the ground, so that only hydromechanical coupling is considered for full analyses. After modeling the impact and the displacement of the aircraft load, the results collected are essentially the variation of displacements, velocities and stresses in the three directions. The results depend on the depth of the runway and the time of calculation. All collected data could be used to continue the study adding for instance the geogrid or the groundwater flow.

Keywords: runway, landing, temperature, cavities, numerical modelling

Illustration of the landing of an aircraft

Representation of different layers of the runway
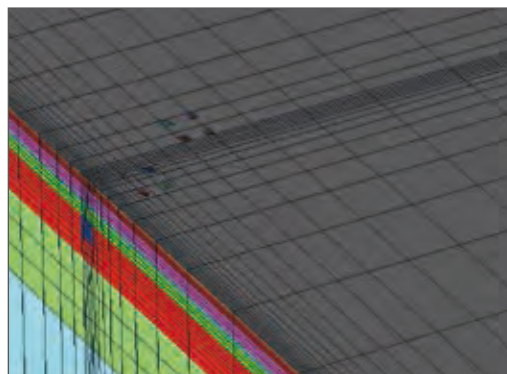
Positions of wheels on the runway at the impact

Contact: pape.diatta@etu.univ-orleans.fr; mohammed.el-ouariachi@etu.univ-orleans.fr;
laura.grivalliers@etu.univ-orleans.fr

Making of a demonstrative session of the triaxial test for 3rd-year students

Civil engineering

Aida BA / Basma IRAMDANE
Academic and industrial supervisors: K.BECK, M. AL-MUKHTAR

POLYTECH®
ORLÉANS
École d'Ingénieurs de l'Université d'Orléans

Institution: Polytech Orléans

A. BA

B. IRAMDANE

Objective/motivation

As a part of the 5th year project, we have been asked to create a two-hour session of practical work for 3rd-year students. The triaxial test allows us to determine the main mechanical properties of a sample of soil. These characteristics are much used in every geotechnical study. That's why it is important to show the students the way to manipulate the triaxial machine. The challenge was to shorten the test duration which usually last from one to two weeks. We had to be present during the five sessions of two groups each. We taught these sessions under the supervision of one of our tutors.

Results

As a result of our work we have:
> Excel spreadsheets of the results of the Atterberg's limits mechanical test
> Test results of the methylene blue mechanical test of different samples of soil
> A GDSLab file of the test that we have carried out in order to make the video
> A two-page written protocol about the progress of the triaxial test
> An explanatory teaching video of how to use the machine
> Teaching ten groups of 3rd-year students
> A 40-question quiz to evaluate the students at the end of each session

Keywords: soil, mohr's circles, 3rd year lab sessions, mechanical properties, shearing

The triaxial machine

Mohr's circles of the unconsolidated-undrained test

The soil sample

Atterberg's limits mechanical test
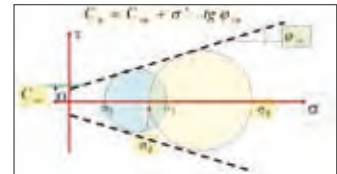
Mohr's circles of the consolidated-drained test

Contact: aida.ba@etu.univ-orleans.fr ; basma.iramdane@etu.univ-orleans.fr

Modelling of the evolution of the temperature of bituminous concrete from fabrication to application

Civil engineering

Kevin ROUTIER / Jérémie SAROMSKY
Academic supervisor: L. JOSSERAND
Industrial supervisor: E. LOISON

K. ROUTIER

J. SAROMSKY

Company: COLAS

Objective/motivation

The company COLAS, particularly their Campus for Science and Techniques, wants a device simple enough for a work manager to model the evolution of temperature of bituminous concrete all along its circuit for any construction site. The major requirement is to know well the fabrication and implementation of bituminous concrete in order to visualize the behavior of the product and its environment. We organized a visit to the production plant and a construction site to gather all the necessary data in order to improve our model. The final file will ensure that the temperature of bituminous concrete will be correct to compact the product at the end of the process. It will be a way of adjusting the temperature of fabrication at the production plant in order to reduce the energy used for consumption and preserve the quality of aggregates.

Results

After comparing different products and theoretical calculations, the EXCEL file is created and different data (such as wind, distance, initial temperature, heat capacity and conductivity, type of truck, weather conditions...) are factors taken into account in the loss of the temperature of bituminous concrete. The circuit of bituminous concrete includes several steps (such as transport, application, compaction...) which have an impact more or less important in the total loss of temperature. And the heat exchange between the bituminous concrete and its environment at each step is represented by one mathematical expression in order to have the input and output temperatures. For a better comprehension, the EXCEL file includes several graphs showing how the temperature of bituminous concrete varies over time.

Keywords: bituminous concrete, losses of temperature, circuit, evolution

Thermal Imaging data
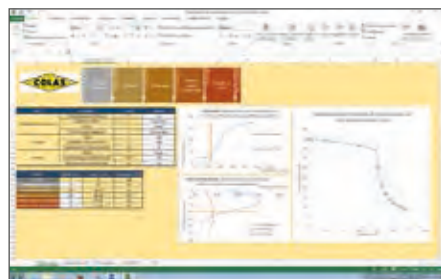
User interface (EXCEL file)

Production plant of bituminous concrete

Implementation of bituminous concrete

Contact: kevin.routier@hotmail.fr ; jeremie.saromsky@yahoo.fr

Office building rehabilitation
Civil engineering

L. CARLES

L. DITTE

Laetitia CARLES / Lucille DITTE
Academic supervisor: N. BELAYACHI
Industrial supervisor: G. LECOEUR

Company: Bouygues Bâtiment Centre Sud-Ouest

Objective/motivation

This project carried out by Bouygues Bâtiment Centre Sud-Ouest is the rehabilitation of Crédit Mutuel headquarters. Our mission consists of establishing a technico-financial analysis, a step which occurs during the preparation of a construction site. Its goal is to define the best construction method for each structural element modified or added, based on their ease of implementation, duration and price. Once we have done that for each building of the operation, we draw execution methods, make a risk analysis and, at the end, we establish a global planning.

Results

During the 8 weeks of our project we were able to:
> Identify new elements and establish several construction methods
> Make a financial analysis for one building
> Compare and choose the best construction methods
> Establish execution methods and develop a risk analysis
> Construct the final planning

The project was very interesting because it was closely related to our future jobs and we did not experience this kind of work in class. Therefore, it completed very well our training and we acquired new skills. Additionally, it was helpful for us to clarify our future careers advice.

Keywords: rehabilitation, construction, destruction, anchorage bond, building
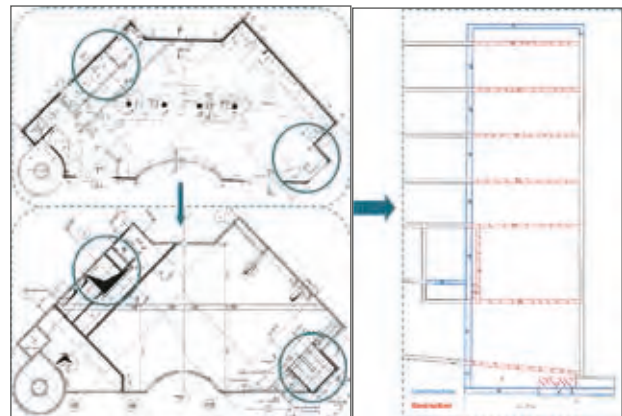
Identification of new elements

Sequencing of the construction method for a lift

Crédit Mutuel headquarters buildings

Contact: laetitia.carles@yahoo.fr ; lucille.ditte@hotmail.fr

Orsay dormitory project

Civil engineering

Salam ISMAIL / Marion LAIZE
Academic supervisor: N. BELAYACHI
Industrial supervisor: S. DUPUIS

S. ISMAIL

M. LAIZE

Company: EBI (EGIS group)

Objective/motivation

For our final project, we wanted to put into practice what we had learned throughout our studies at Polytech Orléans, so we decided to choose a subject that would be very useful for us for our industrial project. We had the opportunity of working with EBI-EGIS Group on one of their starting projects, which consisted of designing one of the eight buildings composing the "Orsay Dormitory Compound" in the south of Paris. Through this industrial project we worked as real engineers, studying technical documents and reports, making some assumptions, proposing technical solutions to various problems, sizing different elements with a well-known software and comparing them with our own manual ones, and learning to look at our results with hindsight. During these 8 weeks, we worked with different persons (structural engineers, draughtsmen, designers and professors) and we discovered how things work daily in a design office.

Results

Our results are the following:
> Calculating the load carried to the ground for the entire building
> Defining the loads distribution on each element
> Making the steel work plans for 2 beams, 2 columns, concrete walls, slabs and piles foundations
> Modeling our building on Arche software
> Making the comparison between manual and software results
> Understanding our courses better
> Sizing new elements such as retaining walls
> Managing to put to use what we learned throughout our studies at Polytech
> Having the chance to work with real engineers
> Learning the working methods of a design office

Architectural photo of the project

Keywords: dormitory, sizing, steel working, arche software, reinforced concrete
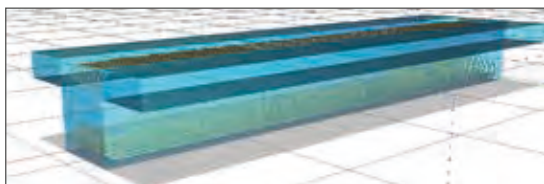
Beam's 3D model made by Arche
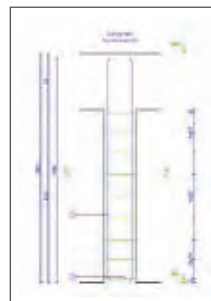
Steel column working plan
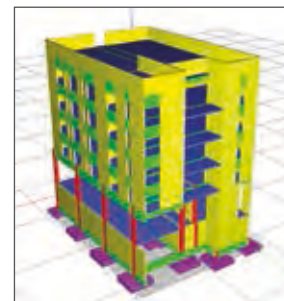
Arche model

Contact: salam.ismail@etu.univ-orleans.fr ; marion.laize@etu.univ-orleans.fr

Practical application of artificial tracing for water management

Environmental engineering

Mathis NEIMARD
Academic supervisor: C. DEFARGE
Industrial supervisor: N. JOZJA

Institution: University of Orléans (CETRAHE)

Objective/motivation

Artificial tracing of underground water is a quick and practical way to determine underground flow. It is an experimental procedure which makes visible the pathway of underground water in aquifers between different places. Artificial tracing in a region can highlight underground links between losses of rivers and resurgences so that we understand local hydrography and we are allowed to manage water better. In this project, artificial tracing was applied in three different situations: in Argent-sur-Sauldre, on flinty clay, to determine geological parameters near a drilling site for water supply; in Sainte-Montaine, on sands and clays of Sologne to determine if a quarry can impact negatively a spring which is used for drinking water; at the Perche near Vendôme, on karstic limestone, to attest to the hypothesis of the links between two rivers and a spring in Morée.

Results

The three parts of this project are distinct, two of them will not be completed at the end of the project. The artificial tracing in Argent-sur-Sauldre was analyzed with the software TRAC and provided geological information such as soil porosity, dispersivity and speed of underground water. Calculation and tracer preparation were done for Sainte-Montaine by using the software TRAC but the injection was postponed, waiting for the approval of the regional public health authorities. Meanwhile, we studied the hydrogeology of the region to determine superficial geology, the localization of a fault and water quality concerning pesticides. In Morée, we prepared two tracers by using formulae for a karstic system. The tracers ware injected but, after one week, they were not found yet in the spring. The latter two projects will be continued by 4th-year students.

Keywords: artificial tracing, water management, hydrogeology

River after injection (sulforhodamine)

River after injection (uranine)

Tracer injection (uranine)

Tracer preparation

Contact: mathis.neimard@etu.univ-orleans.fr

Realization of an automated database on Excel for coated cold-cast on Colas construction sites

Civil engineering

Meriam BELKHADIR / Mouhamadou SY
Academic supervisors: L. JOSSERAND, J. FANTINI
Industrial supervisors: M. DURDILLY, E. GERVAIS

M. BELKHADIR

M. SY

Company: COLAS

Objective/motivation

For our last project at Polytech, the company Colas asked us to create a totally automated database under Excel, based on a file they gave us, so as to use it by cross-checking and static analysis. Our work will enable the future users to compare different construction sites on which coated cold-cast have been used, in order to see what is to be improved. We also managed to improve the file given by the company by making it interactive and more user-friendly for the future.

Results

As expected, we created a database whose purpose was to gather information from different copies of the given file (each copy representing a construction site). We also added a button which will give the user access to a visualization sheet, to see easily each site's specifications. Most importantly, the user will have the possibility of downloading and updating information whenever and as often as required.

Keywords: coated cold-cast, database, excel, VBA

Contact: meriam.belkhadir@etu.univ-orleans.fr ; mouhamadou.sy@etu.univ-orleans.fr

Renovation of a detached house to increase the users' comfort

Civil engineering

Clémentine BRINON / Océane GABETTE
Academic supervisor: C. PROUST

C. BRINON

O. GABETTE

Association: APPROCHE-Paille, 1-TERRE-ACTIONS

Objective/motivation

The purpose of our project is to establish the renovation designs of a detached house which will be serving both as a workshop (top floor) and as an office space (ground floor). Our work covers a study of the house and a thermal analysis of the building in order to come up with solutions to improve the users' comfort. In order to carry out the analysis we had to achieve certain tasks and figure out ways to attain our objectives. Thanks to the thermal diagnosis and heat loss measurements, we acquired all the necessary data. Then we used it to model the initial building with Revit software and to check the compliance with the environmental standards (like the RT2012) with Perrenoud software. This project allowed us to work on a real structure and to have a better approach of the civil engineering profession. Renovation would increase the users' comfort and decrease the energy consumption, thus helping people to live in a pleasant place and save money at the same time.

Results

Our results met our expectations. We were able to successfully create a 3D digital model of the building using the software Revit. Also, the numbers given by the software Perrenoud displayed promising results as they coincided with our handmade calculations of the house's heat loss. Thanks to that, we were able to offer a solution for the insulation and the transformation of the building order so it would meet the norms and the requirements regarding energy consumption and efficiency. One of our final achievements was the financial study and the return of investment showing the coherence of our solution.

Keywords: renovation, comfort, thermal insulation, perrenoud, Revit
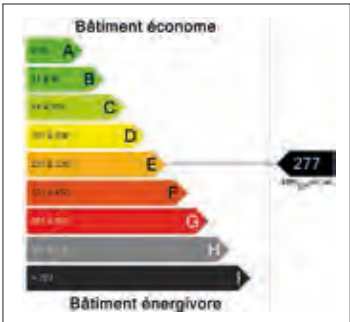
Energy label of the house before renovation
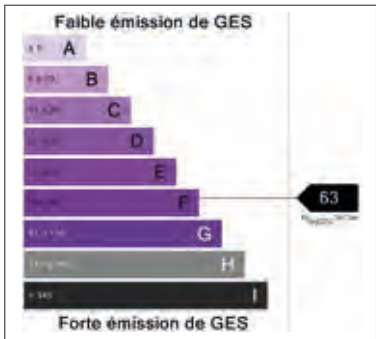
Carbon label of the house before renovation

Model of the first floor before renovation

Model of the first floor after renovation
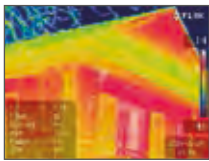
Infrared thermal camera image

Contact: clementine.brinon-rebuffe@etu.univ-orleans.fr ; oceane.gabette@etu.univ-orleans.fr

Roland Garros: structural design of the new Greenhouse stadium

Civil engineering

R. ASSARDIER

M. LE TOUZIC

Ramy ASSARDIER / Marine LE TOUZIC
Academic supervisor: N. BELAYACHI
Industrial supervisor: S. DUPUIS

Selected participant
10th Annual Final Year Projects Forum

Institution: EBI
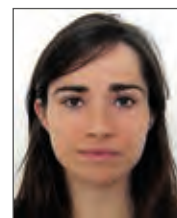
Objective/motivation

Since we are both interested in working in a structural design office after our degree, we were fortunate to work with EBI on a project that has most certainly introduced us to this field. The purpose of this project is to do the sizing of the reinforced concrete structural elements of the new Roland Garros Greenhouse Stadium in Paris. Our work consisted in hand-calculating the vertical loads applied on the structure by determining each element's weight thanks to the architect's blueprints. This will enable us, through several equations and verifications, to deduce the reinforcement needed for the concrete elements. One of the engineers at the firm taught us to work on "Arche Ossature", which is a special software intended to help engineers design the reinforced concrete structural elements literally at the push of a button after they have finished the numeric modelling.

Results

After reading and comprehending the architect's blueprints, the following is what we achieved:
> We created a number of Excel spreadsheets allowing us to lighten the hand calculations
> We calculated the vertical and horizontal loads on each structural element
> We established a number of hypotheses and simplifications which allowed us to create a numeric model on Arche Ossature, the structural engineering software
> We designed and reinforced the concrete elements according to Eurocode and BAEL and drew their plans
> We worked on AutoCad, which is another engineering software, to draw the reinforcement plans
Collaborating with EBI was definitely rewarding. We believe that working on a real project with experienced engineers who were pleased to share their knowledge with us was thrilling. The best results we got were our improved skills as future civil engineers.

Keywords: design, structural elements, Roland Garros, greenhouse stadium, concrete
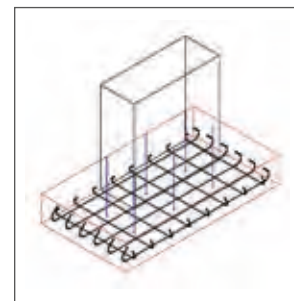
A foundation's reinforcement drawing on AutoCad
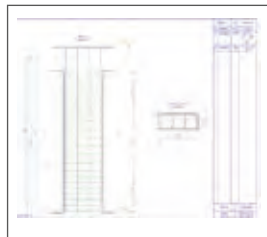
A column's reinforcement drawing on Arche Poteau
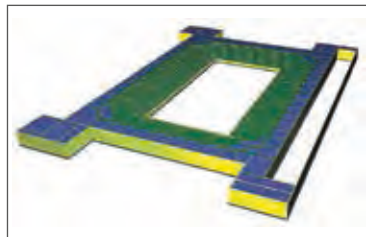
Numeric model of the Greenhouse Stadium on Arche Ossature
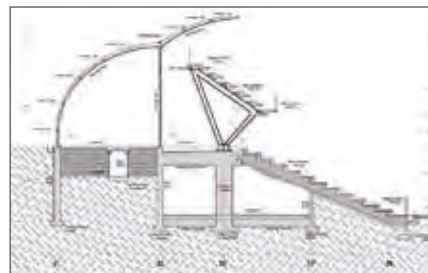
Cross-section of the west tribune

Contact: ramy.assardier@etu.univ-orleans.fr ; marine.le-touzic@etu.univ-orleans.fr

Straw concrete : a promising material
Civil engineering

Julien GOMA-CROUZET / Eloi MARTHOUD
Academic supervisor: N. BELAYACHI

J. GOMA-CROUZET

E. MARTHOUD

Objective/motivation

For a few years, some research professors have been working on a project, PROMETHEE, about a new insulating material: straw concrete. This promising material made of straw has the advantage of being both cheap and lightweight. It is also an interesting material for sustainability. Our work, supervised by Mrs. Belayachi, research professor of PRISME laboratory, consists in making hydrothermal studies on the building walls of a sample construction in order to understand and characterize the abilities that straw concrete can have. Located in the countryside near Orléans, this sample construction consists of four walls as a closed square. To have optimal conditions, as if it were a usual residential dwelling, there is an internal heating system inside the construction. The building walls composed of cinderblock and plasterboard have been externally rehabilitated with the addition of straw concrete and some protection coating.

Results

For the calculations we used a software product called WUFI which has the capacity to model hygrothermal transfers. By comparing measured data made with a sensor in the building wall and WUFI calculations, the goal is to get the two data curves as close as possible. Indeed, it would help to anticipate the reaction of the added material without making any measurement. First, we determined the correct value for the resistance of the building wall outside and inside to get the same behaviour for both curves. Then, to fit the curves, we changed some characteristics of the straw concrete model with the addition of sorption curve which describes the material behaviour towards humidity and the modification of the factor resistance to water vapour. Finally, our goal is now to study the suction phenomenon and water redistribution in the wall.

Straw Concrete
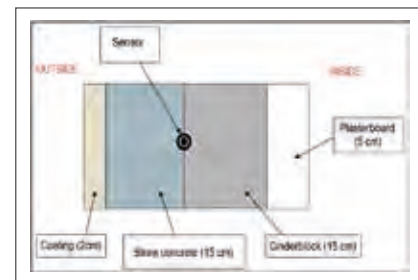
Components of the studied building wall

Demonstrator used as a sample construction

Location of the demonstrator

Sensors between straw concrete and cinderblock

Contact: gomacrouzetloic@yahoo.fr ; eloi.marthoud@outlook.fr

Study of thermal renovation for a 1970's detached house

Civil engineering

Fernando IBARLUCEA / Chloé PROUTEAU
Academic supervisor: N. BELAYACHI
Industrial supervisor: J. BOULNOIS

F. IBARLUCEA

C. PROUTEAU

Company: BHPR

Objective/motivation

In a world where ecology is becoming more and more important, construction has to find new processes to respect the environment. Our project combines the thermal analysis of a house renovation and a new material developed in the PRISME laboratory, straw concrete. We are studying a detached house and its heating losses in order to propose several insulation solutions. Thus, we use three softwares: Perrenoud, PHPP and U-wert. The first two permit us to define the energy class according to the current thermal rules RT2012 (Effinergie +) and the future RT2020, which forbids the use of a heating system. The objective is to choose the best process when refurbishing, taking into account the costs, the environmental impact and the implementation.

Results

The majority of the heat loss comes from the windows and walls. To reach the label, which must not be higher than 25kWh/m²y for the need of heating, we added straw concrete insulation or expanded polystyrene for the walls and floor. We also changed the windows from simple glazing to triple glazing. A dual-flow ventilation has been installed to regulate temperature inside the house. These changes reduce consumption of primary energy and provide a comfort for the inhabitants.

Keywords: thermal analysis, straw concrete, renovation
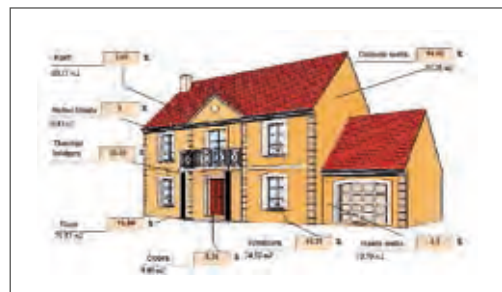
Sources of heat loss for a detached house on Perrenoud

North facade of the 1970's house in Artenay
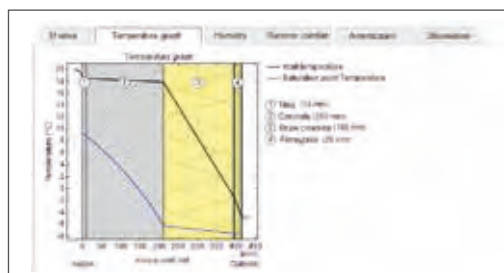
Temperature graph inside floor components

Contact: fernando.ibarlucea@etu.univ-orleans.fr ; chloe.prouteau@etu.univ-orleans.fr

Technical and economical study of roadworks and main networks for the headquarters of the IEE Company

Civil engineering

Guillaume PUYHAUBERT / Laï RATOVOSON
Academic supervisor: L. JOSSERAND
Industrial supervisor: S. CHARRIER

G. PUYHAUBERT

L. RATOVOSON

Company: Travaux Publics Val de Loire

Objective/motivation

TPVL Company proposed to realize the counter-study of one of their projects. It deals with roadworks and the main networks for the future headquarters of the IEE Company located in Champ Rouge Street, SARAN. The objective is to put a cost on the construction site regarding the public works part. The first step is to create the modelling of the whole project using Mensura Genius. It is a software programme which is also used to calculate certain quantities like the cut and backfill volume, the dimensions and number of pipes for the sewer drainage system and the road materials (asphalt mixtures, gravel, etc.). Thanks to these measurements, costing can be established. This takes into account all the equipment and human resources that the company needs. A schedule is also provided including all the tasks of the construction site. Finally, technical variants must be studied in order to improve the construction site, such as decreasing its cost.

Results

The cut and backfill calculation with MENSURA points out that backfills are more voluminous than cuts. This is due to the fact that the building platform is higher than the natural ground. Consequently, an important provision of new materials must be ordered. So, among all the works of the project, earthworks is the most expensive one as it is more than 36% of the whole costing. Moreover, the rainwater network is a big part of the project because an underground retention pond must be installed. This takes over 80% of the rainwater network costing. So, the sewer drainage system part costs almost 36% of the total price. The roadworks represents only 16% because the thickness of the layers are thin. To sum up, the construction site for the public works part costs almost €555,000. The proposed variants consist in lowering the building altimetry and replacing the underground retention pond with an outside one. These solutions save €261,000 of the total budget of the construction site.

Keywords: public works, roads, networks, costing, Mensura Genius software
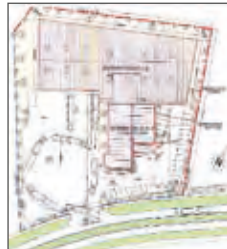
3D modelling with MENSURA GENIUS

Plan of the project
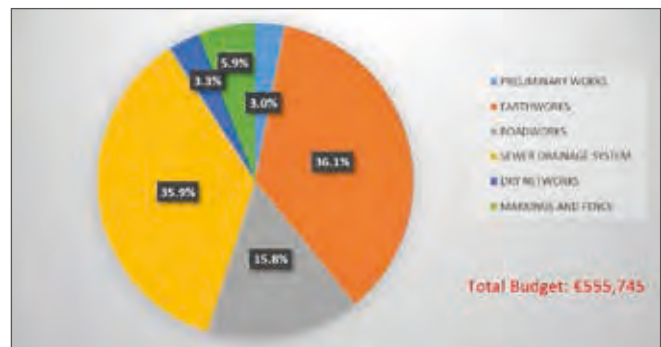
Budget distribution per works

Contact: guillaume.puyhaubert@etu.univ-orleans.fr ; lai.ratovoson@etu.univ-orleans.fr

Technology supporting engineering studies

Civil engineering

Nathan HAGUENAUER
Academic supervisor: A. REKIK

Company: Brézillon

Objective/motivation

For a few years now, BIM technology is becoming more and more important in the construction field. Due to the progression of regulations and design methods, 3D models represent the buildings and infrastructures of the future. This revolution is concerning all collaborators working on the same project— not only the architect but also structural engineers, climatic engineers or economists. The main goal of this project is to gain in situ engineering experience by working on a thermal study of a residential building through a 3D model. The simulation is divided into several steps, starting with the establishment of the building model using the software Revit. It is also important to designate heated spaces and parameters of the project. Finally, the thermal study can be done thanks to a plugin creating a bridge between Revit and Thermal Studies and Perrenoud software. Since 2012 in France, according to the rule RT 2012, every new residential building should observe a maximum energy consumption limit and some equipment's requirements like solar panels. For this project, I have to follow this regulation.

Results

I carried out the establishment of the model thanks to 2D plans supplied by the company Brézillon. Two weeks were necessary to complete an accurate 3D model of the considered 5-floor building. In a second step, I focused on the thermal study of this building. By exporting my file with an .IFC format and thanks to the ThermBIM plugin, I was able to open my work in Perrenoud software in order to undertake the thermal simulation. Because of some bugs during the importation, it took me more time than expected to obtain final results. But finally the following satisfactory results were obtained:
> Primary Energy Consumption : CEP = 73,8 kW/m²/year < CEP max = 83,1 kW/m²/year
> Bioclimatic needs : Bbio = 69,3 < Bbio max = 72
These results are consistent with the thermal rule RT2012 (thermal regulation).

Keywords: building Information modelling, 3D model, thermal study, RT2012
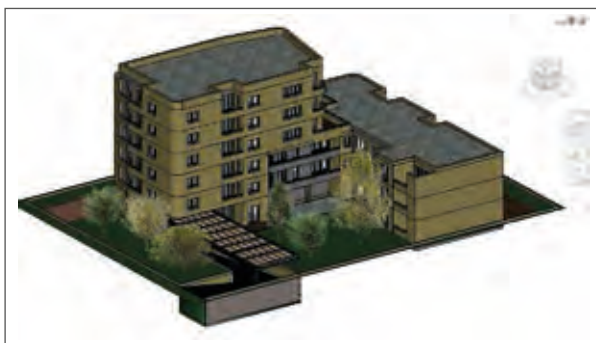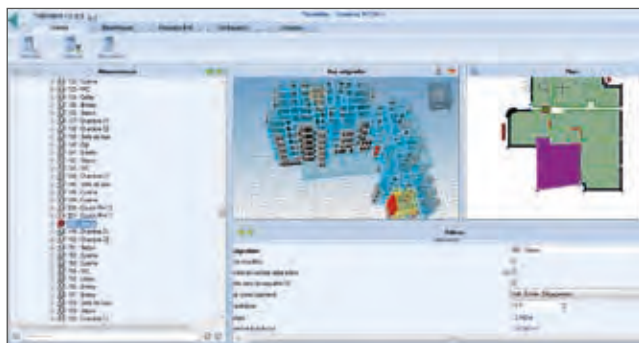
The reuse of La Source treated water: a lean and green initiative

Civil engineering

Loïc LE LAN / Sara SEGTEN

L. LE LAN

S. SEGTEN

Company: AGGLO Orléans Val de Loire

**Selected participant
10th Annual Final Year Projects Forum**

Objective/motivation

The project that we are dealing with is the water reuse of the water treatment plant in La Source in order to supply the floral park, the plant and the town with purified water. Our concern is the establishment of an additional treatment inside the water treatment plant in La Source and the distribution of this water to the different beneficiaries. We are working on behalf of the Agglomeration of Orléans. We defined the context of the project thanks to a document retrieval and a benchmarking of the projects of water reuse that have been done all around the world. We also had to consult the numerous laws in the sector of water reuse.

Results

We identified the needs and constraints to meet the quality requirement of the floral park and of the water treatment plant. Then we chose the technology to set up a tertiary treatment for the water inside the plant. Finally after a technical ('an energy efficiency') and a financial comparison, we chose a pressurized sand filter, UV disinfection and chlorination as the solution for our needs. Next, a dimensioning and an implementation plan was done for the water storage tank, the processing space and the technical room. We also had to draw up a plan following the existing pipe plans and create new ones between the water treatment plant and the floral park. We also did a geotechnical study of the former clarifier and a costing of the project.

Keywords: water reuse, irrigation, water treatment plan, Orléans
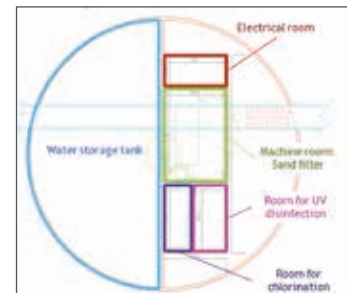
The layout of installations

Beneficiaries of the water reuse project

Water reuse projects in France

Thermal analysis of an energy-efficient building and optimization to passive building certification

Civil engineering

Maxime JAFFEUX / Ashish SAUBA
Academic supervisor: A. REKIK
Industrial supervisor: A. MAHDJOUB

M. JAFFEUX

A. SAUBA

Company: BREZILLON

Objective/motivation

This project consists in making a thermal analysis on a standard multi-unit building and suggesting energetic improvements to get a passive or a positive energy building certification. The major aim is to reveal the most economical and efficient solutions to foresee the requirements of the next French thermal regulation (RT2020). Models are made through Perrenoud, a thermal calculation software, and are based on the current regulation (RT2012). This regulation defines the calculation method, the values of heat loss and thermal bridges. Research will also be done in order to compare a few different regulations in Europe and therefore anticipate the changes in the 2020 French regulation.

Results

The most reliable energy-saving building was obtained by adding each solution onto the model and testing them one by one. At the end of the project, the positive energy building was hypothesized on the software. Among all the improvements, the heat pump, triple glazing, double flow mechanical ventilation and photovoltaic panels were the most efficient. According to the current certification, the improved project would cost no more than +12% of the standard project to become an eco-aware building.

Keywords: thermal, design, certification, building, energy

Example of thermal bridge
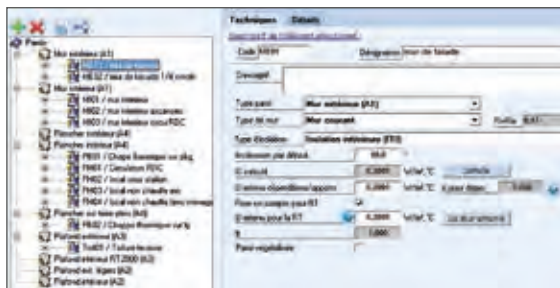
Screenshot of Perrenoud - thermal calculation software
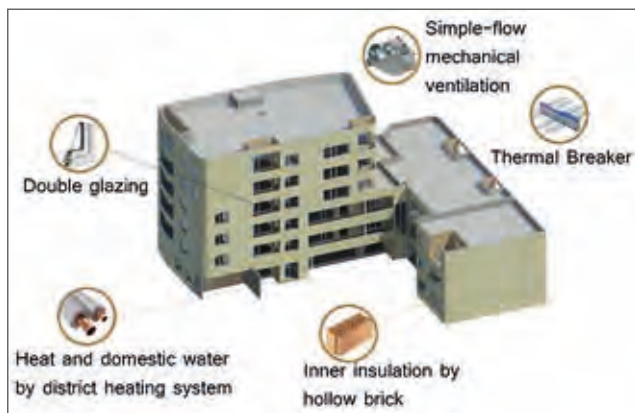
Initial project

Contact: maxime.jaffeux@etu.univ-orleans.fr ; ashish.sauba@etu.univ-orleans.fr

Thermo-elastic behaviour of masonry structures

Civil engineering

Mohamed HAJOUJI IDRISSI / Léonard KRAUS
Academic supervisor: A. REKIK

M. HAJOUJI IDRISSI

L. KRAUS

Objective/motivation

The aim of our project is to predict the thermo-elastic behaviour and strength of a masonry structure under climatic variation of the exterior temperature. Accordingly, we have modelled the masonry and thermal boundary conditions using finite elements method (FEM) by means of the numerical software Cast3M. This project allowed us to vary different factors (external temperature - internal temperature is assumed to be constant equal to the comfort temperature 19°C, use of homogeneous or heterogeneous materials constituting the considered structures (a column and a wall) thermal conductivity of the brick and mortar, thickness of the structure, etc. In addition to this numerical study providing temperature, stress and strain fields in the masonry column or wall, we have investigated thermal rules of the RT2012, thermal performance of the building and the linear thermo-elasticity.

Results

The variation of the different factors quoted above show the influence of each of them on our results (variation of the temperature inside the structure and its induced strain and stress fields) and supports the explanation of the theoretical part of our project. For homogeneous material, the evolution of temperature is exactly the same throughout the structure. For heterogeneous material, because the material is different, the thermal conductivity and dilatation of each is also different, and the decrease of the temperature will be faster in the material which has the lower thermal conductivity. For a single material, the thicker is the structure, the more the temperature progresses.

Keywords: linear thermoelasticity, masonry, temperature, stress, strain, Cast3M

Progression of temperature inside the column
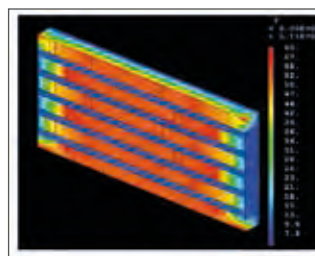
Progression of temperature inside the wall
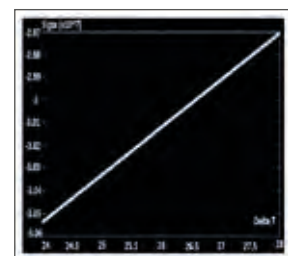
Yield strength as function of temperature

Contact: mohamed.hajouji-idrissi@etu.univ-orleans.fr ; leonard.kraus@etu.univ-orleans.fr

Thermo-mechanical multiscale model showing natural building block behaviour under the effects of fire

Civil engineering

Clément ROBIN / Steve TCHOUANTE
Academic supervisor: H. DASHNOR
Industrial supervisor: J. ESLAMI

C. ROBIN

S. TCHOUANTE

UNIVERSITÉ de Cergy-Pontoise

Institution: University of Cergy-Pontoise

Objective/motivation

During a fire, the temperature increase may be prejudicial to building structure. Indeed, building blocks may be subject to different problems like fissuring or flaking, for example. Our project is based on this kind of problem. We based our work on Nassim Yazbeck's end-of-degree project. After analyzing the experimental trial data provided in his probation report, we drew up a bibliography on the fire resistance of construction stones in order to understand the mechanisms involved and the modeling approaches. Once this task was completed, we made numerical models of two stones: Migné and Saint Maximin. These models allowed us to carry out the thermomechanical calculations required in order to study the evolution of the properties of these stones depending on the porosity and temperature.

Results

The thermomechanical calculations allowed us first to see that when porosity increases, the mechanical characteristics of the two stones are significantly affected, their Young's modulus and Poisson's ratio decrease along a straight, the thermal conductivity of the Saint Maximin stone decreases with porosity whereas Migné stone is substantially constant. This difference is explained by the fact that the Saint Maximin stone is composed of 90% calcite and 10% quartz, whereas Migné stone is pure Calcite. On the other hand, the increase in temperature has no great influence on the porosity and mechanical properties of the Migné stone, while Saint Maximin stone is greatly affected. It loses mechanical resistance due to high heterogeneity.

Keywords: numerical modelling, thermomechanical, young's modulus, poisson's ratio, thermal conductivity
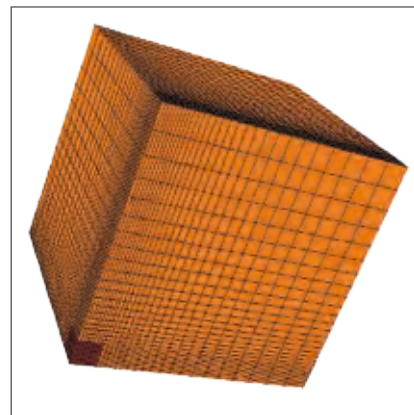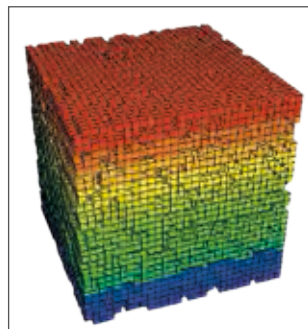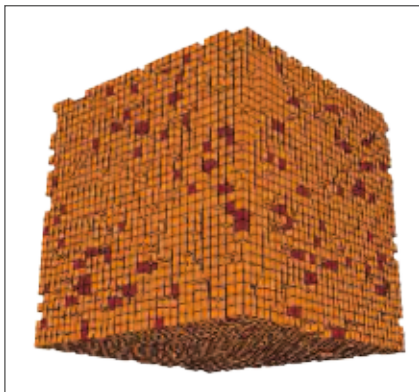
Contact: robin_clement@hotmail.fr ; steve.tchouante-mba@etu.univ-orleans.fr

Transfer of micropollutants by urban runoff in Orléans
Environmental engineering

Jordan GONÇALVES / Camille JONGY
Academic supervisors: M. MOTELICA, C. DEFARGE

J. GONÇALVES

C. JONGY

Institution: ISTO, University of Orléans (CETRAHE), Région Centre-Val de Loire, AgglO

Objective/motivation

The aim of this project was to determine the contribution of human activities to urban surface runoff in the basin of Ormes-Saran-Ingré-La Chapelle-Saint-Mesmin near Orléans. The sources of pollution in an urban area and the spreading of contaminants after climatic events like storms have to be studied to improve the quality of the water rejected into the natural system so as not to affect the aquatic ecosystem too much. Pollutants accumulated during dry weather conditions and coming from different human activities (industry, cars and erosion of metal parts) can be conveyed by urban surface runoff to the Loire. Indeed, after heavy rains or storms, the runoff is more abundant and the water is likely to collect contaminants on its way to the river.

Results

The presence of contaminants in the retention basins and also in the catchment area of Ormes was revealed by several analyses. The contaminants found in the samples were for example PAH (Polycyclic Aromatic Hydrocarbons) and heavy metals (Cd, Cu, Cr, Pd). Moreover, a link between the contaminants in the water and the highway was detected. Another important result is that the concentration of contaminants is higher during dry weather conditions than during wet weather conditions. The urban surface runoff from all our basins was estimated to be richer in pollutants (COD, BOD, Total Suspended Solids, N, P) than the sewage outfalls of the municipal wastewater treatment plants. These results also confirm the studies on the right side of the Loire conducted by Mohammed Al-Juhaishi and the ISTO. Therefore, a control of rain water is necessary upstream from the discharge in the Loire.

Keywords: contaminants, urban runoff, water quality

Traces of PAH in Azin basin

Azin basin

In situ sampling and measurements

Contact: jordan.goncalves@etu.univ-orleans.fr ; camille.jongy@etu.univ-orleans.fr

Valorization of the Moroccan archeological site Volubilis

Civil engineering

Alicia BINET / Julien DUBUET
Academic supervisor: M. AL MUKHTAR, K. BECK

A. BINET

J. DUBUET

Institution: PRISME Laboratory, Centre-Val de Loire

Objective/motivation

Our project consists in enhancing the archeological site of Volubilis which is located in Morocco between Meknès and Fés. Volubilis is a Roman city located on an old Berber city. During this project we had to work on two major parts of the valorization of the site. The first one is a tree structure and the design of a new website and the second part is the creation of an interactive map of Volubilis. We also had to suggest circuits for different types of visitors and also to create flyers to explain these different circuits. This project is part of a three-year mission of the Centre-Val de Loire region. They worked with Polytech Orléans for the valorization of the site but mainly for the research and the diagnosis of the constructions and stone restoration.

Results

At the end of this project, we created the new tree structure and design of the website with complete information about all the archeological site that we could find. We also created an interactive map of Volubilis with the available information based on the current website. It could help users to discover the site and to more easily plan a visit with a geographical view. We have used software like Microsoft Office® (to explain the website structure), Google Earth® and Google Maps® (to create the interactive maps of Volubilis). To complete this project we also worked on some informative flyers, a new logo for the 2015/2018 project and on some circulation maps that suggest circuits to the visitors in regards to their interests. All our work could be used for the Val de Loire mission and the person in charge of the site to valorize Volubilis with the objective of having more tourists for the coming years.

Keywords: valorization, archeology, communication
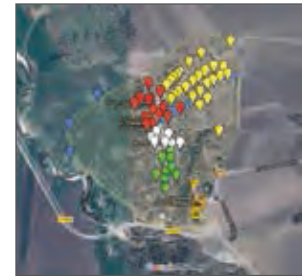
One page example of the website model

Final suggestion of logo

One of the famous mosaics of the knight's house

General view and picture of Volubilis site

Contact: alicia.binet@etu.univ-orleans.fr ; julien.dubuet@etu.univ-orleans.fr

Ecotechnologies

3D characterization of osteocyte cells using automatic skeletonization process

Electrical engineering

Gauthier MARCEL
Academic supervisor: R. JENNANE

Objective/motivation

Osteoporosis is the common cause of broken bones among the elderly, especially among women. The mechanism of bone generation is well understood, but not the mechanism of bone destruction. To understand the mechanism of bone destruction, 3D scans of bones and osteocyte cells are used. These scans lead to a huge amount of data needing to be processed to extract usable information. Skeletonization is a process that helps simplifying the data for a better characterization. The objective of this project is to implement an easy-to-use skeletonization algorithm, adapted for bones micro-architecture and osteocyte cell 3D scans, to simplify the process of identification and characterization.

Results

During the project, test vectors have been produced to test the algorithm. The skeletonization process speed was increased by 10, which significantly reduces the time to process huge 3D scans. An other version of the code which use less than 2GB of RAM memory was also released. A version without interface and visualization window was released to save RAM memory. All provided versions of the code are able to read binary files of almost any size.

Keywords: skeletonization, huge data
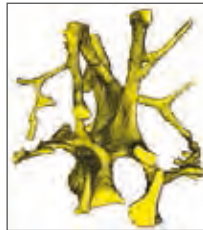
Bone micro architecture before skeletonization
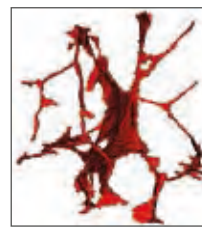
Bone micro architecture after skeletonization
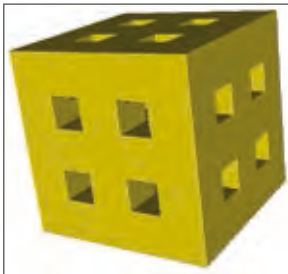
Test vector before skeletonization
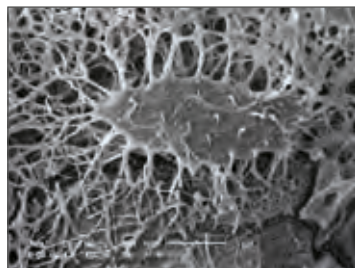
Osteocyte cell
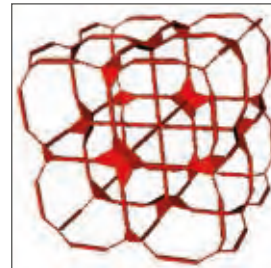
Test vector after skeletonization

Contact: gauthier.marcel@etu.univ-orleans.fr

3D printed volume from 2D functions

Computer science

Loïc BOURDAIN
Academic supervisor: R. CANALS
Industrial supervisor: F. DAUBIGNARD

Company: ALGONA

Objective/motivation

To materialize a 2D function, you can either draw it on a board or display it using, for example, the Matlab software program. But to enhance the experience, it is possible to print the function in 3D to give it a new dimension. The goal of the project is to create an STL file which would use some given parameters to turn a 2D function into a 3D printed volume. The software needs to be free and allow advanced parameters to apply different filters or modifications to the function.

Results

The first step was to check the feasibility of the project with the most complete software, Matlab. Then, the software must be chosen between Octave and Scilab as they are free. After some tries, Octave seems to be the most adapted with the different current libraries and it could work with the same files as Matlab. The most difficult was to recreate a function which can find the free edges of the surface to create the volume. Finally, the program works but for the program to be used by everybody, it must have a great number of dialog boxes. The user can choose the dimension, whether he keeps the entire surface or just a part, etc.

Keywords: 3D printing, octave, simple GUI
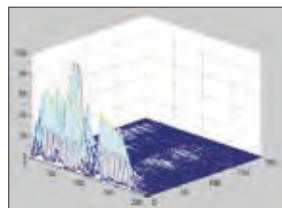
2D function displayed with Octave   3D volume created with Octave   Tyrannausaurus in 3D
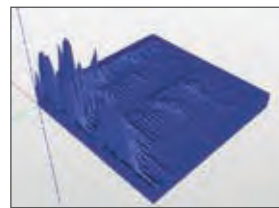
Contact: loic.bourdain@etu.univ-orleans.fr

Acousto optical spectrum analyzer

Electrical and optical engineering

Victor LOGIE
Academic supervisor: T. GIBERT

Objective/motivation

The main objective of this project is to develop an acousto-optical spectrum analyzer which can be used in astronomy for radio frequency analysis. By programming an electronic card, it will generate and transmit a random radio frequency signal to the Bragg cell. The latter is an optical component crossed by a laser beam which, once a radiofrequency is applied to its terminal, will diffract the laser beam. The acquisition of the diffraction figure is made thanks to a CCD camera. According to the frequency applied to the Bragg, the distance between the zero order diffraction and the first order of diffraction will be unique. Therefore it is possible to determine the frequency by measuring precisely the distance between these two orders.

Results

A deflector driver generates random frequency between 57MHz to 103MHz. A polarizer is used between the Bragg cell and the CCD camera in order to decrease the intensity of the laser beam. The calibration of the Bragg cell is made with an external generator in order to determine the extremum distance between the two orders of diffraction. The CCD camera is used with the software Caliens which offers two opportunities: either to determine the distance with the graphical user interface or to export data for further analysis. By measuring the distance between the two orders, we can determine the frequency applied to the Bragg cell.

Keywords: acousto-optical spectrum analyzer
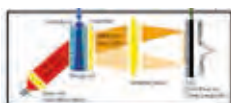
Acquisition
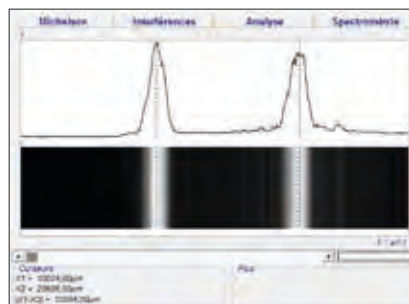
Optical setup

Contact: victor.logie@etu.univ-orleans.fr

Automatic segmentation of identity photo background in an industrial context

Electrical engineering

Yacine DRIES
Academic supervisor: R. HARBA
Industrial supervisor: F. ROS

Company: Gemalto

Objective/motivation

As this industrial project is an integral part of a 5th-year internship, it mainly consists in preparatory work. In order to improve security in the identity field, Gemalto needs to develop new processes. The project consists of creating an algorithm capable of separating the background from the person in an identity photo with the intention of reinforcing its security. Thus, it would be possible to replace the background colour or simply suppress it from an ID-card/passport photo. The innovation brought by the project is the automation of the process. Indeed, Gemalto has already started such a process but it currently needs a technician to manually separate the background from the person. With the purpose of making the production profitable, it needs to be done automatically, with the complexity residing in the high requirements of the company: over 99% accuracy.

Results

The difficulties of this project reside in several points: the background intensity variation that saturation phenomena could introduce, the weak textural aspect of the hair and the confusion that could exist between the clothes of the person and the background. Thus, a simple segmentation would not be efficient (cf. Figure 2). This project was started last summer (June to August 2015) as a 4th-year internship proposed by Mr. Ros, researcher and professor at Polytech Orléans. The feasibility study as well as the first algorithm components (cf. Figure 3) have been achieved by Mr. Ros and the trainee during the internship. My role has been to resume the project, finish the algorithm and conduct a series of tests on the FERET database. The final database will be provided by Gemalto during the internship.

Keywords: computer vision, segmentation, identity photo

Fig1: Original Photo

Fig2: Simple Segmentation: Non-Robust

Fig3: Adaptive Segmentation: Robust

Contact: yacine.dries@etu.univ-orleans.fr

Creation of a smart and wakeup-friendly alarm clock
Smart buildings

Teddy CHAPILLON / Mathieu DESIRE / Mickael PAÏS
Academic supervisor: J-Y. CADOREL
Industrial supervisor: F. FOURREAU

Company: Don't Worry Be Healthy

Objective/motivation

Our goal was to think about a new alarm clock. The alarm clock is to be innovative and smart. Indeed, the user wants to be awakened in the best manner possible. Thanks to a sensor and some calculations, the sleep cycles of the user can be analyzed and used to determine a perfect time to wake up. Moreover, the waking-up of the user must be optimum. This can be made possible thanks to a growing luminous glow and a specific music defined by the user. The result of the project will be a prototype of our alarm clock system. It will have two buttons on it and everything will be set up using an Android app. For ecological concerns, a specific communicating technology, Bluetooth Low Energy, will be used to communicate between the app and the mobile phone.

Results

As this book went to publication, the app is working but still needs some adjustments. The electronics part of the system is governed by an Arduino Mega. The portability of the data sent and received by the app from Arduino is still being improved. In addition, all the sleep data captured by the sensor won't be sent directly to the Android because this would imply continuous communication and electric consumption. Moreover, the plans of the model have been made with CAO software and we are waiting on an estimate from the Fablab Orléanais. After the estimate is accepted by Polytech, the FabLab, with the help of our team, will be able to produce the model.

Keywords: alarm clock, innovative, smart, friendly
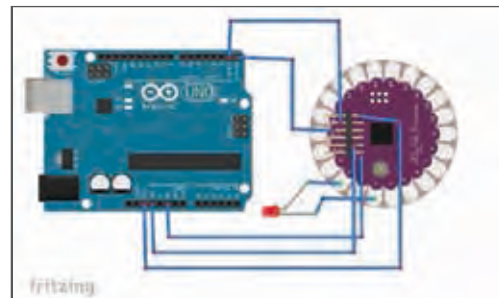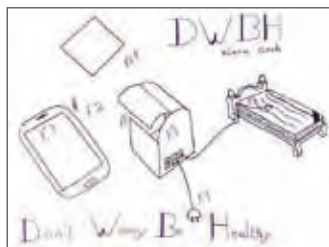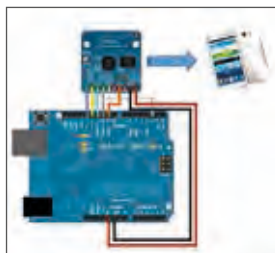
Contact: teddy.chapillon@gmail.com ; desiremathieu@gmail.com ; mickael606@gmail.com

Design of a photo-goniometer

Electrical optics engineering

Nicolas GOLFIER / Valentin GUERY
Academic supervisor: C. CACHONCINLLE

POLYTECH
ORLÉANS
École d'Ingénieurs de l'Université d'Orléans

Institution: Polytech Orléans

Third Place
10th Annual Final Year Projects Forum

N. GOLFIER

V. GUERY

Objective/motivation

For the quality of lighting in our homes, in the streets and all kind of other public places or environments likely to be illuminated, the luminaire manufacturers and sellers need to have high-quality systems in terms of performance but also in terms of respect of many standards. Our project is one of the major tools in obtaining these required qualities. This industrial project is implies the design of a photo-goniometer, which is a tool able to establish an illumination map of a lamp and also give parameters such as the dominant wavelength, visible spectrum and Correlated Color Temperature (CCT). The main constraint of this project is to take into account the weight of a lamp because it can range from a few hundred grams to 30kg. That is why the structure and the motors must be sufficiently strong.

Results

This tool will be designed to be used by students in future practical work and also for Polytech to respond to companies' needs. The photo-goniometer must sweep the lamp around a virtual sphere. It turns 360° on vertical and 180° on horizontal axes. The movements are controlled by an Arduino card that sends the impulsions to the different stepping motors. The frame is treated against rust and the whole system is mounted on wheels. The final system is approximately 1.40 meters high with a surface of about 2 square meters. The measures are done automatically and a sensor is placed several meters of the goniometer.

Keywords: goniometers, optics, electronics, informatics, luminaires

LED Light distribution
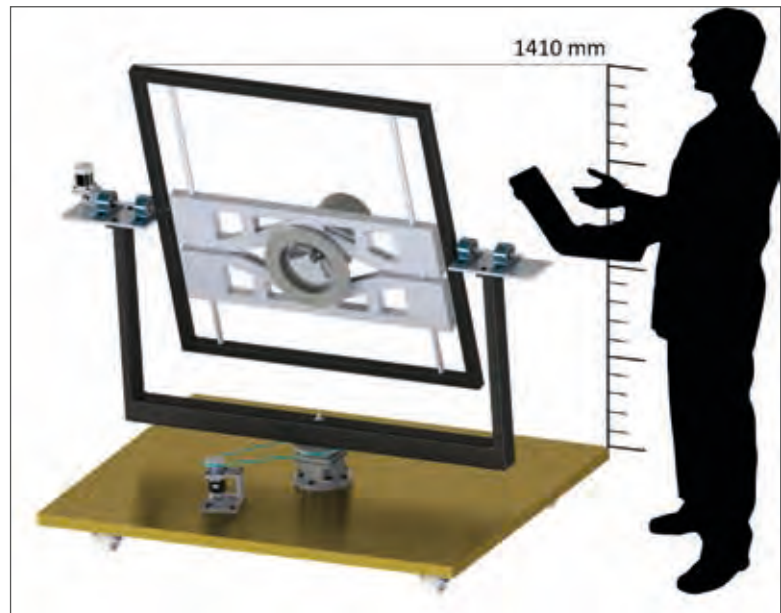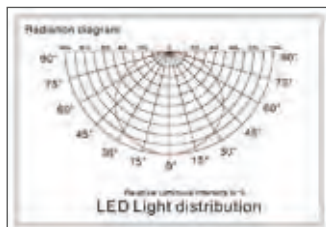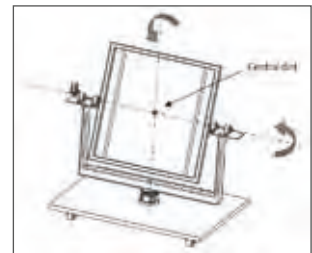
Contact: nicolas.golfier@etu.univ-orleans.fr ; valentin.guery@etu.univ-orleans.fr

Detection and prioritizing the pieces of art in the Louvre museum with Bluetooth Low Energy

Electrical engineering

Dounya BENDAHHOU
Academic supervisor: J-Y. CADOREL
Industrial supervisor: J-B. CLAIS

Company: Louvre Museum

**Selected participant
10th Annual Final Year Projects Forum**

Objective/motivation

Museums in general can face an enormous danger in an emergency situation. Firemen can have a hard time knowing which artwork should evacuate first, even though they have a numerical file that has all the necessary information for that purpose yet with many lines that only can be considered as a waste of a precious time. This project, in collaboration with The Louvre museum, tries to incorporate a fast, simple way to know the order of artwork priority in seconds by using a Bluetooth Low Energy (BLE) sensor and developing an Android application.

Results

Basically, the application can detect a BLE sensor and display a picture of the piece of art with a number of evacuation priorities. This project has the ability to be continued and expanded to another level. The features of the app can be limitless since we can always think of ways to improve every option.

Keywords: Bluetooth Low Energy, beacon, Android, application, smartphone

Applications

Contact: dounya.bendahhou@etu.univ-orleans.fr

E-cockpit project: external perception

Electrical engineering

Romain DUPUIS
Academic supervisor: A. CHETOUANI
Industrial supervisor: C. ESCANDE

Company: Altran Technologies

Objective/motivation/results

In order to prepare my 5th-year internship at Altran Technologies in Vélizy-Villacoublay, the company asked me to do a preliminary draft concerning the state of the internship project. They are currently working on a project which is called E-Cockpit. Because of the confidentiality of the specific goals and the innovative results, I am not going to explain it in detail. What is E-Cockpit? It is a project regarding a new concept of vehicles concerning two main aspects. The first is that the vehicle will be modular. In other words, it can be as small as a city car, but also as big as an SUV model, for example. Moreover, an advantage to the modularity is that the drive can be powered either by an electric motor or heat engine. The second aspect is the smartness of the vehicle. Actually, this refers to several points: driver surveillance, information system, external perception, road traffic management. The long-term objective is to transform this intelligent vehicle into an autonomous vehicle. In accordance with my studies in EEO, with the VE ("Vision embarquée") specialty, the project and the internship deal with the external perception. This part of the E-Cockpit consists in obtaining the maximum amount of information concerning the vehicle with a minimum need of financial resources. The whole project, including my work, will be presented in early October 2016 at the "Mondial de l'automobile - Paris" show.

Illustration of the modularity of the vehicle

Contact: romain.dupuis@etu.univ-orleans.fr

Echosonder: implementation of a system for measuring ultrasonic sedimentary layers

Electrical engineering

Bangzhao WU / Yuwen XIAO
Academic supervisor: R. NEDJAI
Industrial supervisor: J-Y. CADOREL

Company: CEDETE Laboratory

Objective/motivation

The purpose is to improve an existing echo sounder system that allows the identification of components of sediment in the marine environment. The functioning principle of the system is not difficult, so the main task is to study an existing solution to determine its capabilities and limitations. The regular equipment of echo sounder detection that is used in the laboratory is quite large and heavy. The problem with the existing solution to detect sediment is that it has limitations in terms of measures in shallow areas. The next task is to design an embedded solution by using an ultrasonic system with a drone. The idea behind this solution is to allow researchers to make measurements with a remote control system instead of using heavy equipment.

Results

In order to design an embedded echo sounder system that can be installed in a drone, the microprocessor and sonic-sensor must be smaller and lighter. The sonic frequency and measurement distance of the sonic-sensor also need to be considered. So far, we have already created a system with Raspberry Pi, jointed in an electric card which is 15cm (large) *20cm (long). The sensor has a 4800Hz frequency and the effective distance is within 10m. When connected with a personal computer, it can draw a graph that shows the number of layers and the distance between each layer. The next step of our project is to test our system outdoors. We need to know how long the system can last with batteries, furthermore, in order to get a remote-controlled system, a wifi interface is needed to connect with the computer and system.

Keywords: geography, ultrasonic, analog signals, embedded

Each layer detected by the system

Sensor used in system

Schematic of the echo-sonic system

Contact: bangzhao.wu@etu.univ-orleans.fr ; yuwen.xiao@etu.univ-orleans.fr
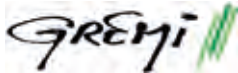
Etching in microelectronics: STiGer or Bosch

Electrical engineering

Ying CUI / Chengkun TU
Academic supervisors: R. DUSSART, T. TILLOCHER
Industrial supervisors: R. DUSSART, T. TILLOCHER

Y. CUI

C. TU

Institution: GREMI Lab

**Selected participant
10th Annual Final Year Projects Forum**

Objective/motivation

The principal objective of this project is to develop an etching process on the substrates of silicon 6'' with a thickness of 400-500 µm, which can achieve an aspect ratio that is higher than 10. The two basic processes of plasma etching that we will use are the cryogenic STiGer process and the Bosch process. This project aims to compare these two etching processes and find a better way to obtain a deep etching with anisotropic profile and less etching defects. It will suggest a new solution to industry. Moreover, with further studies, it will contribute to improving the etching quality and reducing the product cost.

Results

For this project, we have tried different parameters to get a better etching result for each process. With the help of a SEM (scanning electron microscope), we found that the highest etch rate we have for the STiGer process is 2.53 µm/min, while for the Bosch the process is 2.50 µm/min. As a widely used method in industry, the Bosch process has two main advantages: it works at room temperature and is robust. However, as a new method, the STiGer process also has a great advantage compared to the Bosch: it does not need any cleaning steps, leading to a higher throughput for production. The improvement of this performance reduces the cost of semiconductor fabrication industries. For those who have a higher requirement for etching depth, STiGer process is an optimized choice.

Keywords: silicon deep etching, Bosch, STiGer, cryogenic, plasma etch
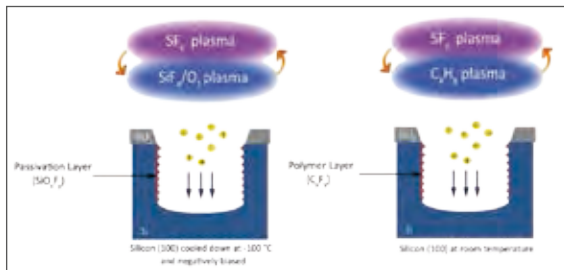
Profile of STiGer process

Profile of Bosch process

Contact: ying.cui@etu.univ-orleans.fr ; chengkun.tu@etu.univ-orleans.fr

GaN Light Emitting Diode (LED) fabrication processes

Electrical engineering

Faisal RAHMAN / Marie YANG
Academic supervisors: A. STOLZ, F. LEROY, R. DUSSART

POLYTECH
ORLÉANS
École d'Ingénieurs de l'Université d'Orléans

Institution: Polytech Orléans
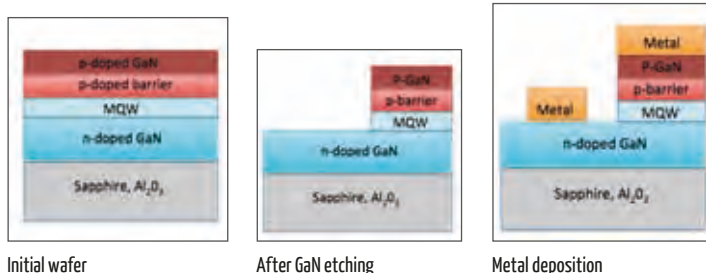
F. RAHMAN

M. YANG

Objective/motivation

The objective of the project is to obtain optimized GaN LED Fabrication processes and LED functionality. GaN is a III-V semiconductor with a high band gap that gives it special properties for optoelectronics applications. GaN has been commonly used in LED fabrication in recent years. A LED is typically a p-n junction diode that emits light as a result of recombination of the electrons with the holes when voltage is applied between these junctions. This project will also enable the replacement of existing practical work for 4th-year EEO students in Micro-Nano Technologies. From a student's point of view, we could apply our theoretical knowledge acquired during courses at Polytech in order to develop competences and skills in micro fabrication processes thanks to the industrial project approach.

Results

Currently, we have found optimized processes for GaN etching by using $CHF_3/SF_6/Cl_2/Ar$ chemistry at 15°C and 20mTorr. With this chemistry, the estimated etch rate for GaN is about 60nm/min. If we want to obtain 300nm of etched GaN, about 5 minutes is required to reach n-doped GaN. However, GaN etching using photoresist as a mask with this process gives a bad selectivity with a ratio GaN/Photoresist of 0.11:1 meaning that the etch rate of photoresist is much higher than the etch rate of GaN. A thicker photoresist mask must be used with this recipe. We have also found optimized processes for SiO_2 opening on SiO2/ GaN surface by using CHF_3/Ar chemistry at 20°C and 3mTorr that serves as a mask for GaN Etching.

Keywords: LED, GaN, etching, lithography, metallization

Initial wafer

After GaN etching

Metal deposition

Contact: faisal.rahman@etu.univ-orleans.fr, marie.yang@etu.univ-orleans.fr

Image processing for stones segmentation of a monument facade

Electrical engineering

Adrien AUVERNOIS
Academic supervisor: S. TREUILLET
Industrial supervisor: X. BRUNETAUD

Institution: Polytech Orléans, PRISME Lab

Objective/motivation

On Chambord facades, alterations of stones are present and can take different forms: chromatic alterations in biological colonization (lichens, mosses) or loss of material (cracks, impacts, detachments). The detection of alterations has already been done by experts: they have an orthoplan created from a series of color images, on which they manually added the type of alteration, stone by stone. This work of visual examination and annotation is very tedious. Two main steps are required to detect alterations on the stones: first, it is necessary to segment the image in order to get each stone separately without the joints and then analyze the texture to see if the stone is altered and define the kind of alteration. The goal of my project is focused on the segmentation part.

Results

To get each stone separately without the joint, image processing is applied on an orthoplan. Functions from OpenCV library are used to automatically extract horizontal and vertical lines and reveal the irregular orthogonal tiling of stones. Then, Canny filter allows detection of the real contour of each stone. As the stone texture varies greatly, algorithm parameters have been adjusted by testing the quality of results against the ground truth provided by the expert on a database of 20 image samples selected throughout the facade. The finalized C++ software provides the expert with a segmented image he can correct if necessary, which displays each stone with a different color. Future work will focus on color texture analysis to recognize the kind of alteration automatically.

Keywords: image processing, stones segmentation

Contact: adrien.auvernois@etu.univ-orleans.fr

Intelligent power switch

Electrical engineering

Thomas PALMADE
Academic supervisor: F. FOURREAU
Industrial supervisor: J-Y. CADORE

Company: 3zaintech

Objective/motivation

The objective of this project is to create a power switch capable of receiving and sending information through a wireless connection. It will have to detect any abnormal heating and make adjustments to operate safely. An optional measure of the current will be made to supply various information about charging and consumption. A light sensor will also be made available as an option, allowing a functioning on threshold. Autonomous functioning will be planned from the configuration of an internal schedule (for example, cut off at noon). The configuration and the sequencing will be realized from a compatible browser html 5. Functioning with a smartphone will be also demonstrated. An Android App and a website will be created.

Results

This project was divided into three parts. The first part was the technology watch because wireless products already exist, but they're not interoperable and are not orderable directly by a smartphone.

The second part was the communication with smartphone and browser. The last part was the electronics and security. Indeed, the product has to be secure because the user must not be electrocuted when he touches the switch. Wireless communication will be in 433 MHz, a Raspberry PI will be used with a transmitter. The switch will be a wall switch situated at 1m of height.

Keywords: switch, smartphone, WiFi communication, home automation

Raspberrypi model b

433mhz-rf-transmitter

Interrupteur sans fil

Contact: thomas.palmade@etu.univ-orleans.fr

Internet of things

Electrical engineering

Benoit VAILLANT
Academic supervisor: R. WEBER
Industrial supervisor: F. DAUBIGNARD

Company: Algona

Objective/motivation

The main goal of this project is to establish a new market position in the internet of things field. Today there are more than 15 billion connected devices and this number keeps growing quickly. These devices can be in very different fields, for example, a watch, a fridge or surveillance systems. The product being developed uses Sigfox technology which is the simplest communication solution and the most optimized for low energy consumption which is really important for avoiding frequent maintenance. It will help the user as it will be time-saving: the customer will be warned almost instantly by text message.

Results

The developed product can detect objects with different properties (weight, size, and thickness) to comply with the specifications with a simple and cheap solution. With the Cortex M-3, one of the best microcontrollers in the world for embedded application, the device will be very power efficient. In cities, the user can be warned 140 times a day over more than 15 kilometers' distance thanks to the Sigfox network. Service is a little less in the countryside.

Keywords: cortex M3, sigfox, IOT

Laser sintering of metallic powder onto ceramic

Simon DELALANDE / Stélie GIRARD
Academic supervisor: S. KAYA BOUSSOUGOU
Industrial supervisor: S. DESPREZ

Company: GD Laser
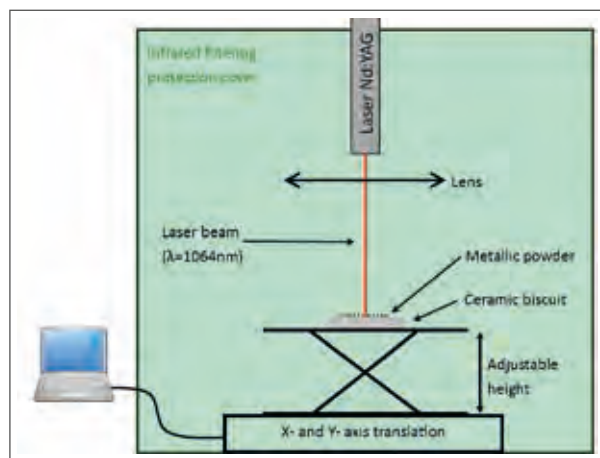
S. DELALANDE

S. GIRARD

Objective/motivation

Our project consists of the bonding of a magnetic and metallic powder on ceramic by using the principle of laser sintering. In other words, heating up the material just before it melts in order to glue the two materials together via a laser. Consequently, it is easily possible to stick the powder onto specific places to create patterns. This might be used to stick ceramic components on a magnetic object/wall. It is to be used in the luxury industry. Indeed, companies in this field need complex processes that are difficult to reproduce in order to fight against counterfeiting. Moreover, this allows higher quality and better precision.

Results

The right set of parameters has to be found to glue the powder onto the ceramic. Indeed, a lot of things can influence the results and the aim of the project is to determine if it is possible to develop this process. After some initial experiments, the best results were obtained with the company's laser which has parameters that cannot be set up on the GREMI laser. Even with close parameters, much less powder was glued onto the ceramic. For instance, the GREMI laser spreads the powder and digs the ceramic with the same fluence (Joule per cm²) as the company's laser. There are two problems: the impulse of the GREMI laser is shorter (the thermal effects are less favoured) and the energy per pulse is higher.

Keywords: laser, sintering, metallic powder, ceramic

Optical bench scheme
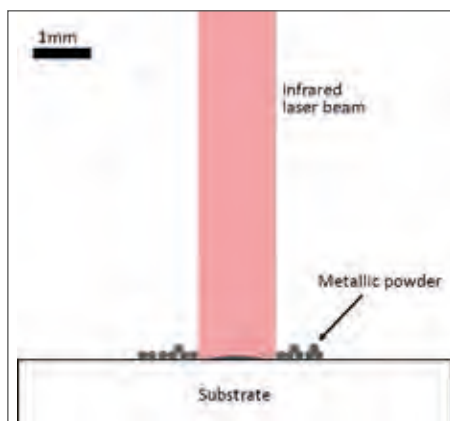
Laser sintering principle

Contact: simon.delalande@laposte.net ; stelie.girard@gmail.com

Lean, presence list's management allowing energetic optimization of a building

Smart buildings

Julien FELICIANO / Yann GIMENEZ
Academic supervisor: J-Y CADOREL
Industrial supervisor: F. FOURREAU

POLYTECH
ORLÉANS
École d'Ingénieurs de l'Université d'Orléans

Institution: Polytech Orléans
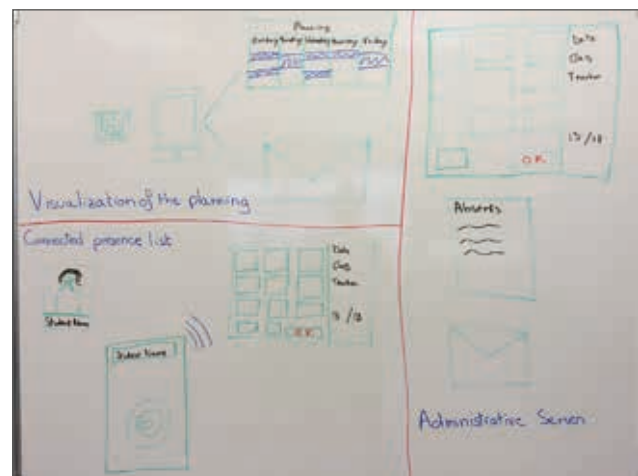
J. FELICIANO

Y. GIMENEZ

Objective/motivation

The purpose of the project is to automate the presence list to increase the liability and to better use administrative time currently devoted to this task. This project is divided into two parts: the visualization of the planning of a classroom and the presence list. The understanding of administrative work is necessary for this study. For the visualization of the planning, the objective is to simplify the access, for teachers, to the timetable of a class. For the second part, the presence list will be dematerialized using student cards and a tablet App. This new dispositive allows a real time control of students and teachers with an increased liability.

Results

After a methodic study of solutions, we chose four main parts to realize these objectives. The first part represents the reading of student cards: a screen displays the name of the student as confirmation and a Bluetooth connection sends the information to the second part, a tablet App. This App is composed of the student picture and useful data of the present course. After validation of this presence list by the teacher, a query is sent to the administrative server to regulate absences. The next part represents the database of absent students per courses and days on the previous server. Students concerned will receive an automatic email for a better presence monitoring. To finish, an Android App shows the planning of a specific room and allows the teacher to ask for a reservation.

Keywords: Lean, arduino, student card, apps, presence list

Contact: : julien.feliciano@etu.univ-orleans.fr ; yann.gimenez@etu.univ-orleans.fr

Leather engraving by laser

Materials

Thomas BONASSI / Jérôme PAUC

Academic supervisor: E. MILLION

Industrial supervisor: S. DEPREZ

Company: GD Laser

Objective/motivation

The project was to engrave leather by laser to get a suitable aspect for the client. The project was carried out with a designer. Several tests using different parameters were made. The aim was to obtain parameters that could fit and that could be used in a process such as the one in GD Laser. To achieve the project, there were different kinds of leather such as natural, brown, varnish, black and yellow. Concerning the laser, three different wavelengths were used: an ultraviolet (266 nm), a green (532 nm) and an infrared (1064 nm). Therefore, the parameters were the wavelength but also some other such as the distance between two points and the number of times the laser was impacting the leather. The goal of the project was also to carry out scientific characterizations such as measurements of the depth and the width of the engraving according to the experimental parameters. The measurements were made by using a numerical and optical microscope.

Results

The results were classified by doing square and line engravings on the leather sample. Each engraving was different from another by a change of parameters. All of the tests were repeated for each kind of leather. Then, the designer chose what the best engravings were according to her visualization. The best results were with the wavelengths 532 nm and 266 nm. The parameters which were suitable to obtain a good aspect were: weak laser energy values and a high enough number of times in which the laser impacts the material. The results with the wavelength of 1064 nm were less interesting due to a more significant presence of the thermal effect on the material. The scientific characterizations were made for the interesting engraving chosen by the client. Microscopic visualization of some line engravings showed the influence of the experimental parameters.
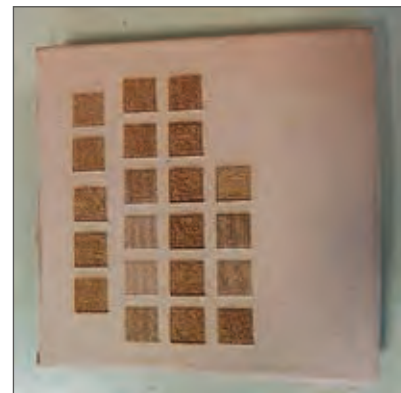

Characterization of a line engraving on a black leather sample

Keywords: leather, laser, etching, wavelength, tests
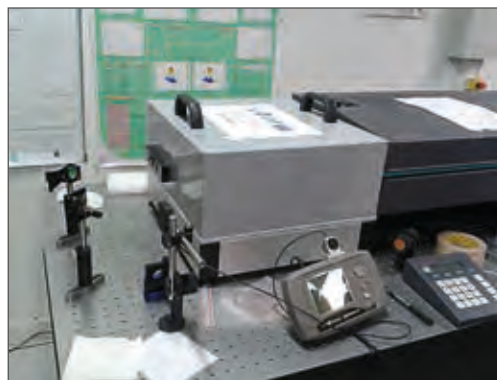
Laser used for the project

Natural leather engraving with a wavelength of 266 nm

Contact: thomas.bonassi@etu-univ.orleans.fr ; jerome.pauc@etu-univ.orleans.fr

Lighting design of the new Philippe Chatrier Court at Roland Garros

Electrical engineering

Mathieu GUILHEN / Hugo SERUS-DELOFFRE
Academic and Industrial supervisor: J-M Bauchire

M. GUILHEN

H. SERUS-DELOFFRE

Objective/motivation

Roland Garros is one of the oldest and most prestigious tennis tournaments in the world. Yet tradition is not enough for a Grand Slam, and the French Open needs to evolve. This is why the French Tennis Federation (FFT) is working on a modernization project. One of the biggest challenges of this project is to build a retractable roof over the Philippe Chatrier Court. Such a roof would allow the matches to be played regardless of rain or time of day. The objective of this project is to design the lighting of the court in order to hold evening and night sessions. The proposed solution must respect lighting and TV broadcasting standards.

Results

The first step of the project was the bibliography and state of the art to determine the performance to attain. In order to respect the standards and to match what is done in other tournaments it has been decided to light the court with 3125 lux horizontally and vertically with a uniformity of at least 65% and a glare rating inferior to 50. In the meantime, a 3D model of the stadium was created on autoCAD. The 3D model was then imported into DIALux to realize the lighting design and calculate the performance of the installation. With 212 projectors, the proposed solution respects the requirements set during the first step.
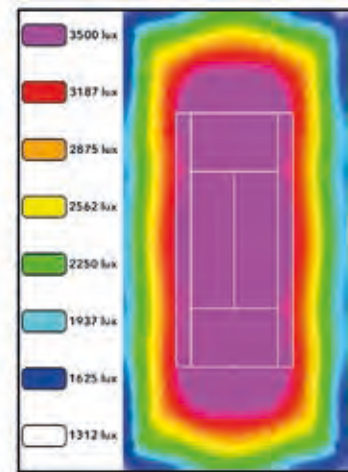
Keywords: sports lighting, tennis, Roland Garros

3D model of the stadium
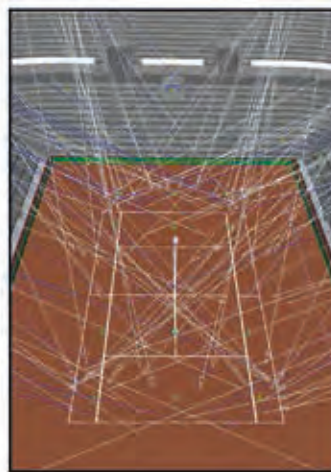
Projectors aiming map

False color illuminances maps

Contact: mathieu.guilhen@etu.univ-orleans.fr ; hugo.serus-deloffre@etu.univ-orleans.fr

Medical vision and Eye Tracker

Image processing

Sophie HAMELIN

Academic and Industrial supervisor: A. CHETOUANI

Institution: PRISME Lab

Objective/motivation

The aim of this project is to analyze the doctor's visual behavior during the observation of an X-ray radiography using the Eye Tracker. These data are later meant to create an algorithm able to detect anomalies in an X-ray radiography. The final goal is to reinforce the doctor's observations and thus the medical diagnostic. The participants selected for the experiment will be persons working in the medical field. The participants who are taking part in the experiment are both doctors from the Regional Hospital Center of Orléans (for expert observation) and some students from Polytech Orleans (for novice observation).

Results

As this is a new project, few previous studies on this subject have been done. Some technical surveillance has to be done in order to know if a project having the same goals has been conducted and what kind of research has already been done. A procedure has to be set up to record participants and acquire data. Finally, an analysis of data has to be carried out with the tutor and to be classified in order to contribute to the algorithm. At the time of publication, the technical surveillance is done and the procedure is almost finished with the tutor. Getting samples of X-Ray radiography from the hospital is quite difficult, and other ways to acquire them must be found.

Keywords: X-Ray radiography, Eye Tracker

Tobii Eye-Tracker

Tobii Studio

First experience with Eye-Tracker

Medical vision sample

Contact: sophie.hamelin@etu.univ-orleans.fr

Optimization of laser-matter interaction applied to chemical analysis by mass spectrometry

Environmental engineering

Océane CONTOUR / Sigolène COSTES
Academic supervisor: T. GIBERT
Industrial supervisors: L. THIRKELL, L. SELLIEZ-VANDERNOTTE, C. BRIOIS

**Selected participant
10th Annual Final Year Projects Forum**

Company: LPC2E

O. CONTOUR
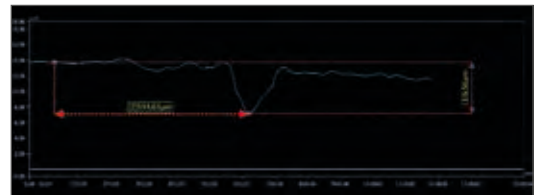
S. COSTES

Objective/motivation

The team of the LPC2E laboratory that has welcomed us is working in collaboration with a Japanese laboratory on comet samples analysis. This study involves identifying chemical and organic species that make up the samples. The French laboratory decided to use a laser that ionizes the particles they want to study which will permit us to identify them through a mass spectrometer. Our project concerns the optical level of this study: we must optimize the laser in order to have the best ionization possible. In order to do this, we worked on the following three points:

> The optimization and characterization of an optical system for a UV laser
> The reducing of the green interference component for a good visibility of the UV beam
> The perfect alignment and a sufficient energy to ionize

Results

The optical material (laser, mirrors, filter and lens) was installed on the same axis and at the same height. It was adjusted for the beam to remain parallel to the optical axis and to keep the same path after passing through each optical component. We succeeded in obtaining the strongest value at the laser output and verified this value after the crossing of each component. We also analyzed the shelf samples used for the tests of laser shots with a numerical microscope. The installation was moved from Polytech to the LPC2E laboratory. We dismantled our installation as little as possible so as not to lose the adjustments we had made. We are currently optimizing the optical part to have the best ionization conditions.

Keywords: space mission, UV laser, chemical species

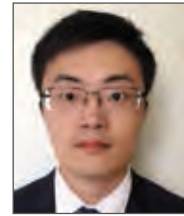Measure of the impact depth

Aluminium sample shelf

Final installation

Microscope picture of a laser impact

Contact: oceane.contour@etu.univ-orleans.fr ; sigolene.costes@etu.univ-orleans.fr

RFID valve

Electrical engineering

Yubo RUAN
Academic supervisor: F. FOURREAU
Industrial supervisor: J-Y CADOREL

POLYTECH
ORLÉANS
École d'Ingénieurs de l'Université d'Orléans

Institution: Polytech ORLEANS

Objective/motivation

The main object of this project is to develop an electronic counting system for the asthma inhaler. The idea is to use the RFID (Radio Identification) technology by attaching the tag to the valve. Consequently, we will be able to measure and count each interaction. Before this project, a mechanical counting system already existed. However, an electronic system with longer lifetime works better. There is also the possibility of developing a smartphone application which matches the counting system.

Results

Because of the size of the valve, both tag and reader are limited. After several comparisons using different marks, the smallest UHF (Ultra high frequency) tag from Murata and its reader from AMS were chosen. However, the communication distance remains very short due to the size and the power of the tag. So two methods will be tested. The first will be to try to change the power of the antenna or its size by creating another antenna or adding an amplifing system to it. The second will be to change the communication firmware of the reader to see if it can communicate with a weaker signal.

Keywords: rfid, uhf, tag reader

Contact: yuboruan@gmail.com

Segmentation of phono-cardiogram signals through the Teager-Kaiser Energy Operator

Electrical engineering

Nicolas MARTINEZ
Academic supervisors: M. JABLOUN, R.LEDEE
Industrial supervisor: L-D. NGUYEN

Company: CHRO (Orléans Region Hospital)

Objective/motivation

The objective of our project is to capture different heart sounds in order to detect pathologies. The presented work is embedded in a collaboration between the PRISME Laboratory (Pluridisciplinaire de Recherche Ingénierie des Systèmes, Mécanique, Energétique) of the University of Orléans and the cardiology department of CHRO (Orleans Region Hospital, France). The aim is to develop phonocardiogram processing tools in order to provide a computer-aided method for heart pathology diagnosis. My contribution to this project consists of the implantation of a phonocardiogram (heart sounds) segmentation method recently developed by the researchers R. Oweis et al. (2014). This segmentation method is based on Teager-Kaiser Energy Operator. Its implementation has been done on Matlab environment and a graphical interface for phonocardiogram segmentation issue is provided. This interface has been used and tested with synthetic signals and real pathological phonocardiogram signals acquired at the CHRO by the cardiologist. Results show that whatever the patient pathology is, the algorithm is able to segment the audible heart sounds S1 and S2. For the future steps of the project, the exploitation of the multichannel acquisitions can be investigated in order to improve the segmentation of inaudible heart sounds S3 and S4 which are of great interest for pointing out heart sound pathologies.

Results

We are able to auto detect S1 and S2, but the signals are too noisy for S3 and S4.
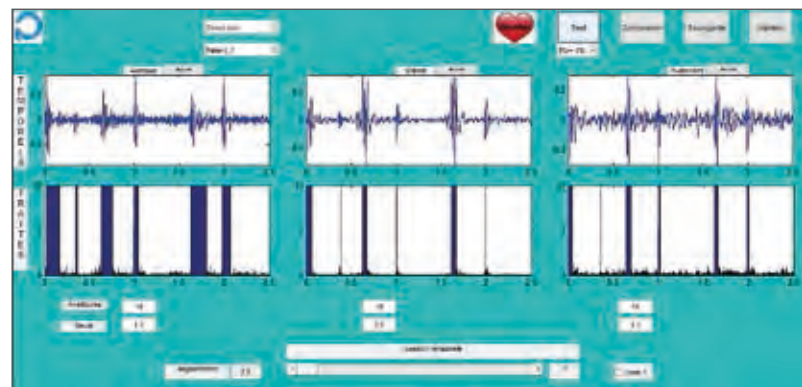
Keywords: segmentation, Teager-Kaiser energy operator, TEO, Matlab, heart sounds
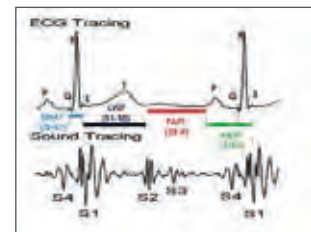
Analogy between ECG and PCG signals

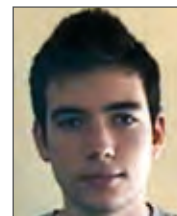Material used to acquire phonocardiogram signals

Interface developed for this project

Contact: nicolas.martinez@etu.univ-orleans.fr

Semi-automated image processing to create a record of works of art

Software engineering

Julien BADEROT
Academic supervisor: J-Y. CADOREL
Industrial supervisor: J-B. CLAIS

Company: Louvre Museum

Objective/motivation

In order to reduce the time spent on creation of records, a web application will be used. This application needs to be easy to use and require the fewest interactions possible from the user. To do so, a web application is a good tool as every computer has a browser. The purpose of the application is to crop different documents and gather all the pieces together in order to create the record. The different steps are the following: loading documents, cropping regions of interest, gathering all the regions on a separate document, reorganising the elements and finally saving the record. The gathering also requires taking into account the other elements in order to minimize reorganisation so the elements should be placed in a certain disposition by default.

Results

As a result, the application has different parts: a space on the top of the page where you can import documents on the application, crop regions of interest and export the record when it is finished. Below it are two frames: the right one is the space where cropped documents appear and are ready to be dragged or exported. The left one is the space where imported documents are loaded and a frame can be used to select the region of interest to be cropped. All of these elements are interactive using buttons or tools like "drag and drop" to make the application more user-friendly, thanks to Javascript which makes this application use only the browser to be run and does not require any other supports like a server.

Keywords: ergonomics, website, Musée du Louvre
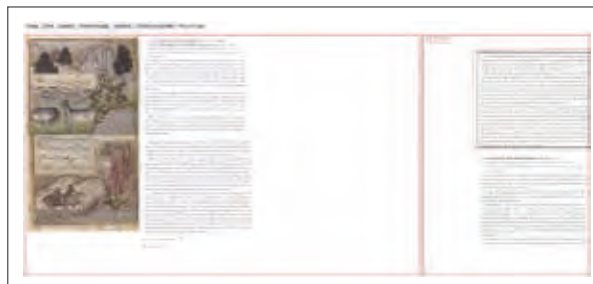
Contact: julien.baderot@etu.univ-orleans.fr

Very High-Speed data acquisition from plasma sources

Electrical engineering

Jérémy BRINGAULT / Jeff DESTRUMELLE
Academic supervisors: M. HENAULT, L. BOUFENDI

J. DESTRUMELLE

Institution: Gremi Lab

Objective/motivation

The project consists of very high-speed data acquisition. These kinds of plasma sources are excited with a 13.56 MHz electrical generator and the phase changes once powder is inserted in the gas. Currently, to get this useful information, high-speed sampling cards are used but the sampling rate does not suit the need. The aim is to find an adapted sampling rate, develop an electrical card to get the waveform and find a method to extract the phase. The measure of the phase is used to follow the growth of nanoparticles in the plasma reactor. The success of the project is crucial because many companies are interested in this field of research.

Results

The first result is the sampling rate. To respect the Shannon theorem, the sampling rate should be superior or equal to the double of the maximum frequency. Because of the electrical source, the maximum frequency is around 13.56 MHz. To get all the signals, the sampling rate chosen is 40MHz. Concerning the hardware, a powerful Rigol oscilloscope was used to acquire 1.4 second of the signal. Then a Matlab program has been developed to calculate the phase based on the Hilbert function. This program was checked and the Cramer-Rao Bound was determined to be sure that the result is close to the real phase.

Keywords: plasma, sampling, acquisition card
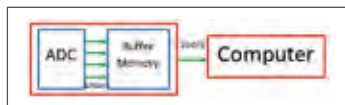
First approach to developing the electric card

Second approach to developing the electric card

Technical solution to developing the electric card

Contact: jeremy.bringault@etu.univ-orleans.fr ; jeff.destrumelle@etu.univ-orleans.fr

Visitors counter for the Musée du Louvre using infrared cameras

Electrical engineering

Jérémy BETHUNE
Academic supervisor: J-Y. CADOREL
Industrial supervisor: J-B. CLAIS
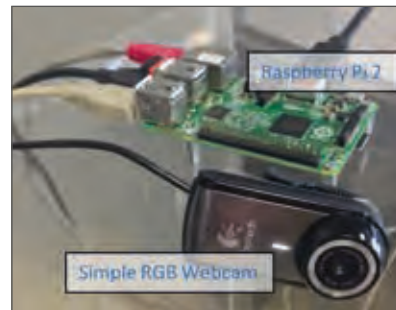
Company: Louvre Museum

Objective/motivation

This project has been proposed by Jean-Baptiste Clais from the Musée du Louvre in order to know the number of visitors in the museum in real time. The museum proposed to work with new methods using standard and infrared cameras. There are existing devices (e.g.: geo-trackable tickets) to gather information on visitors, but these solutions are not efficient and accurate enough to know the exact number of visitors in each room. The goal is to use standard and infrared cameras to experiment with people detection and counting using image processing methods. We realized these tests in order to know if this new solution could be suitable for a museum and consequently for counting a large amount of people in a crowd. The developed project has to be cheap, discreet and work in real time.

Results

To carry out this project we used a Raspberry Pi 2, a simple micro-computer of the size of a credit card, and we worked with only one standard camera (webcam) to experiment with image processing methods for people-counting with RGB images. To experiment with infrared image processing, an infrared filter was added on the standard camera to get a thermic image of people. The adding of infrared cameras doesn't seem to substantially improve the performances of the system because of problems linked to clothes that people can wear. The system remains inaccurate unless people in the room wear light clothes and therefore leave some parts of their skin visible. However, the device works well with the RGB camera, counting people with a 100% precision and 96% recall with a low-density crowd. The data collected by this device is then sent wirelessly to a broker then a server that can display and record the number of visitors in each room in real time.
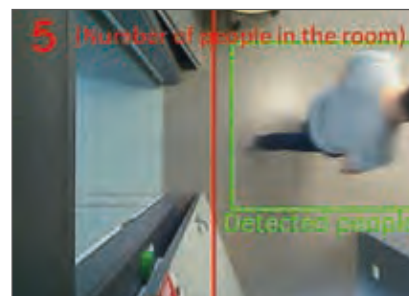

Whole device (camera and micro-computer)

Keywords: computer science, image processing, people detection, embedded systems
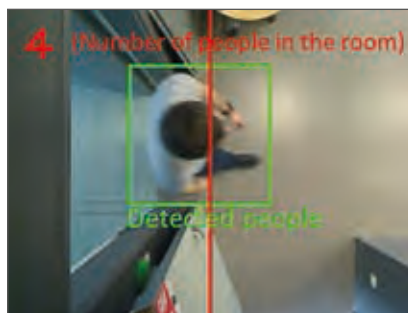
Counting people when crossing the red line

Counting people when crossing the red line

Contact: jeremy.bethune@etu.univ-orleans.fr

Innovations in design and materials

Design an industrial application to establish coherency between luggage and transport system

Mechatronics engineering

Jorick LOCHET / Bruno TUROWSKI
Academic supervisors: B. BONHEUR, J. GILIBERT
Industrial supervisor: J-M. DEDISSE

J. LOCHET

B. TUROWSKI

ALStef

Company: Alstef

First Place
10th Annual Final Year Projects Forum

Objective/motivation

Nowadays the customer's satisfaction is one of the main concern in the airport industry and to respond more and more to clients' satisfaction challenges, airports are looking for industrial solutions to avoid flight delays. Even though high speed transport applications have been already developed, all of them have some required luggage positions to successfully work. In collaboration with Alstef automation SA, an industrial company working among others on this problem, we are working to develop an industrial process to center and orient luggage following the main conveyor running direction opening new market perspectives for Alstef. Even if some competitors have already designed different luggage conditioning systems, none of them are able to meet the high treatment cadency needed: 1200 luggage/h. This is our goal.

Results

The results of a deep analysis of existing systems and after testing and characterizing different technologies, we finally chose and offered the right association allowing the system to reach our cadency goal. Using a new type of 3D images acquisition we are able to fully know the luggage characteristics in our system input. Based on the acquired information, the code that we have developed will control our chosen actuators. Those actuators have been chosen by functions: centering and rotating. The centering function uses the Activated Roller Belt™ technology provided by Intralox which can center luggage without feedback loop. The orienting function is based on the simple principle of two semi-conveyors driven at two different speeds directly calculated by our code with the luggage characteristics from the 3D camera. According to our first estimations we have good hopes to reach a treatment cadency of 1200 luggage/h.

Keywords: luggage, conveyor, orienting, centering, control system
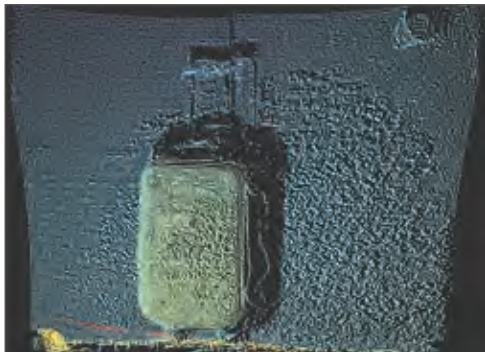
3D image of a baggage from an industrial 3D camera

DCV : Destination coded vehicle, a high speed transport system

Contact: joricklochet@free.fr ; turowski.bruno@gmail.com

Design and manufacture of a solar tracker demonstrator

## Electrical/mechanical engineering

Angéline BOUIN
Academic supervisors: J-M. AUFRERE, B. BONHEUR

POLYTECH®
ORLÉANS
École d'Ingénieurs de l'Université d'Orléans

Institution: Polytech Orléans

Objective/motivation

The objective is to build a solar tracker for a small-scale Engineering school. The photovoltaic panels have a poor performance. In order to increase this performance, a solar tracker will be used. The tracker allows the panel to follow the sun's path according to two perspectives: azimuth (rotation of the mast) and elevation (inclination of the panels). The human influence is stamping out with an automated control system. In addition, this project will permit making a submission to the specialty ICM / MCS in the context of internal and external communication. This project requires looking for suppliers on upstream work. From there, we will select azimuth components and elevation components based upon their technical specifications, their prices and their compatibility. The second part consists of building the solar tracker. For this purpose, we will simulate an association of components on ADAMS software.
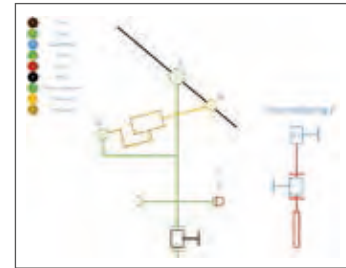

Cinematic model

Results

All the components of the system have been built. The block diagram of the motorization has been designed according to the SysML method. Concerning the mechanical model of the solar tracker, we decided to start with the cinematic model. A complete study of material and permissible stress was realized. The structure was designed accordingly, composed by the mast and jack's carrying arm. The topic was preventing the solar tracker from being extracted from the ground. The control part will be handled by my 4A colleagues whom I had to consult about control requirement. The next step was to decide where the system would be located and to assemble the solar tracker.

Keywords: sustainable development, photovoltaic, sun path
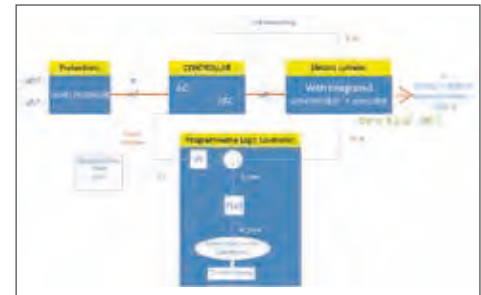
Elevation bloc case 1
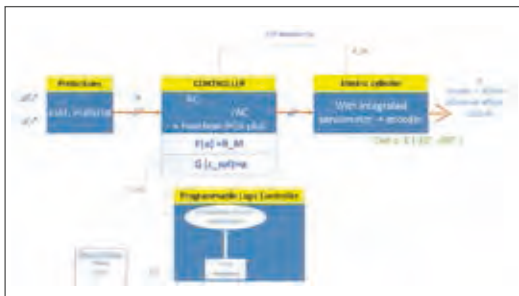
Elevation bloc case 2

Azimuth block

Contact: angeline.bouin@etu.univ-orleans.fr

Development of a strategy of improving the quality of dry fabric draping

Materials processing

Emilien BOISE / Zhen JIA
Academic supervisor: S. ALLAOUI

E. BOISE

Z. JIA

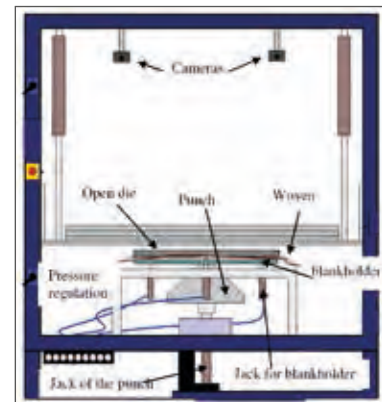Institution: PRISME Laboratory

Objective/motivation

Textile composites materials are widely used in various industries sectors due to their good strength/ weight ratio compared to conventional metals. To manufacture these materials and structures, forming processes are among the best candidates because they offer a good compromise in terms of repeatability and production rates. However, during forming, defects can occur and have to be taken into account because they can significantly affect the mechanical performance of the part. Therefore, our project first consists of finding and validating solutions to avoid or reduce defects appearing during the preforming of multilayered complex parts. When forming multilayered preforms with dry fabric, inter-ply friction has a huge effect on the quality of the preform. For this reason, we also tried to find solutions to reduce the inter-ply friction of multilayer interlock dry fabrics.

Results

In the beginning, a bibliographic study has been made to understand the mechanisms that drive defects during preforming, the strategies used to avoid defects and solutions to reduce the inter-ply sliding of multilayer dry fabrics. In the practical part, we first researched methods to eliminate defects on monolayer fabric, which was positioned in 30 and 45 degree according to the punch. We have found that wrinkles appearing at corners can be eliminated by increasing the blank-holder's pressure in corners as well as by eliminating the gap between blank-holders. Secondly, we have investigated methods to reduce the inter-ply friction effect in position 0°/45°, 45°/0° and 30°/0°, and in the end have found that putting another material between layers could reduce this inter-ply friction.
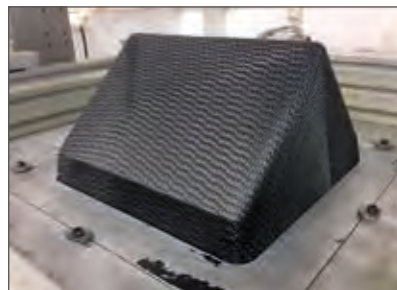

Description of the device

Keywords: composites, carbon fabric, preforming, defects, inter-ply friction
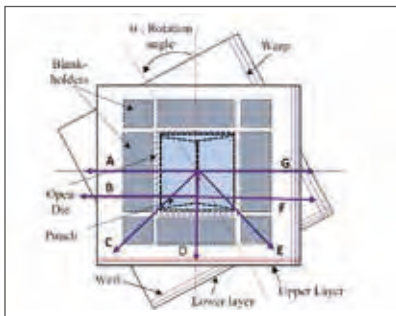
Distribution of blank-holders in our project and position of fabrics

Dry interlock carbon fabric after preforming

Wrinkles appeared during forming test

Contact : emilien.boise@etu.univ-orleans.fr ; zhen.jia@etu.univ-orleans.fr

Discovery of 2 methods (SPH and DEM) in Abaqus

Mechanical engineering

HongXiao DAI / Zi WANG
Academic and industrial supervisor: J-L. DANIEL

H. DAI

Z. WANG

Institution: Polytech Orléans, PRISME Laboratory

Objective/motivation

The purpose of this project is to extend the application of two methods in the software Abaqus. Abaqus is not only a software based on the finite element (FEM). There are also two methods in the calculation code which are called "particle methods". The first, smoothed particle hydrodynamics (SPH), is a method without mesh which is used to simulate the flow of fluids. The second, discrete element method (DEM), is used to monitor interactions between a large number of individual particles. The first task is to discover these two methods in Abaqus, and to learn theoretical knowledge. The second task is to validate these methods and simulate several engineering examples. In the end, we will provide a complete operational process.

Results

The first phase of the project is to learn the theory and principles. The second phase is to simulate in Abaqus 6.13. In the field DEM. at the beginning, we have used Fortran to edit a program, which is to set up the discrete elements. We can import the elements into Abaqus 6.13. Any part of DEM has to be edited manually in the file INP. To validate the method, we have set up one example 'Mixing of granular media in a drum mixer'. In the field SPH, we changed the type of these elements and the condition of the model on the basis of the first method DEM. To validate the method, we have created two examples in the fields of ballistics and fluidics. Through these simulations, we have provided a complete operational process.

Keywords: SPH and DEM in Abaqus

Contact: hongxiao.dai@etu.univ-orleans.fr ; wangzigaetan@163.com

Gas/solid exchange modelling through a dense ceramic membrane

Materials

Noélie FERRANDO / Brice REVERDY
Academic supervisors: E. BLOND, T. SAYET
Industrial supervisor: N. RICHET

N. FERRANDO

B. REVERDY

Institution: Polytech Orléans, PRISME Laboratory, Air Liquide

Objective/motivation

Nowadays, the industry and the energy sector are compelled to use new processes for oxygen production. Oxygen separation from air production may be cited, due to the semi-permeability property of ceramics. Such a technology, combined with the change of people's mind and an ever energy-consuming future, could give an interesting substitute, but it is still at the laboratory stage. Pure oxygen retrieval is a key challenge for the world economy today and in the future. The modelling of the membrane catalytic reactor behavior is required. Therefore, the finite element method can be the best numerical solution to model such process. Our choice is to use the Abaqus software.

Results

Our study consists of modelling the gas/solid exchanges through the surface. It is trivial that such development leads to couple, both thermos-electro-chemistry and thermomechanical physics. From a numerical point of view, this coupling simulation is the main constraint. The association of adsorption, desorption and loads transfer phenomena constitute our main guideline. To solve this problem, we propose to compile simultaneously these three surface phenomena flux. These adsorption and desorption concepts called upon the density of active sites for both association and oxygen dissociation. These exchange laws are implemented in a finite element software called Abaqus, using adaptive subroutines. We use the Fortran language, which is the oldest scientific language used with Abaqus.
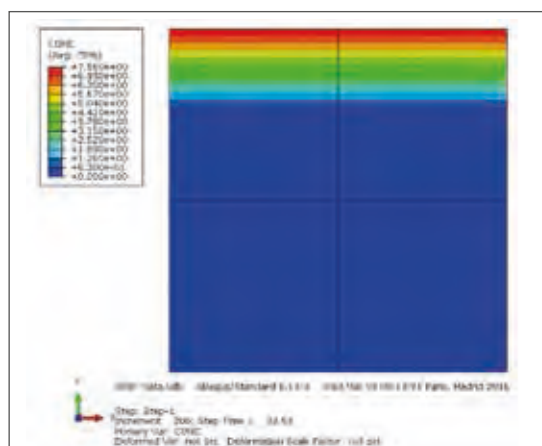
Keywords: oxygen separation from the air, dense membrane, perovskite structure, semi-permeability, modelling

Perovskite structure
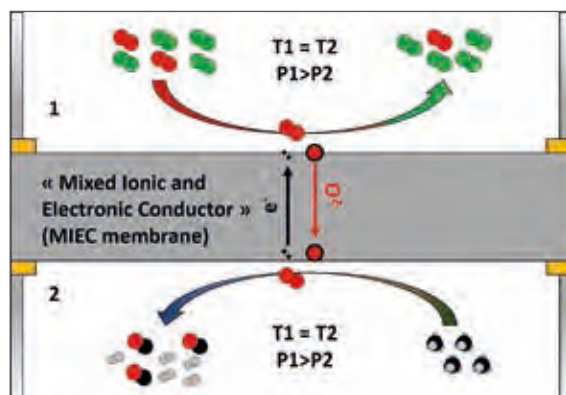
Catalytic Membrane Reactor (CMR) process

Modelling of membrane catalytic reactor – exchange in surface

Contact: noelieferrando@live.fr ; brice-reverdy@orange.fr

Human skin layers characterization
Mechanical engineering

M. EL MOUSS

L. MARIN

Marouane EL MOUSS / Logan MARIN
Academic and industrial supervisor: R. HAMBLI

Institution: PRISME Laboratory

**Selected participant
10th Annual Final Year Projects Forum**

Objective/motivation

Anatomically, the human skin is a complex material consisting of three laminated layers: the epidermis, dermis and hypodermis, of which the thickness and the biological structure are quite different. When human skin is stressed mechanically, each layer will play a role of its own, directly related to the elements that constitute it. Consequently, a 2D modeling of skin behavior requires the development of a biomechanical model to three layers. For simplifying reasons only two layers (dermis and epidermis) were considered. The construction of the geometric model of the skin was made from existing skin sample cup called histology. The mechanical behavior of the skin is described by macroscopic Hyperelastic law. The Ogden law of behavior has been chosen. The parameters of this law have been identified from bibliographical results. The project objective is to develop a 2D numerical model to simulate the mechanical behavior of human skin under the effect of mechanical stress (traction, traction cyclical, etc.).

Keywords: human skin, hyperelastic law, numerical model, mechanical properties
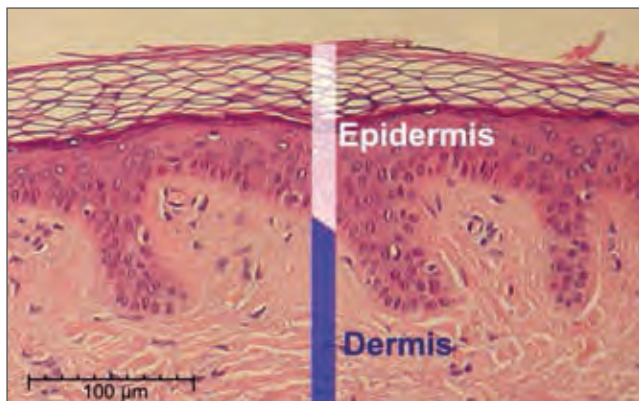
Histology of human skin
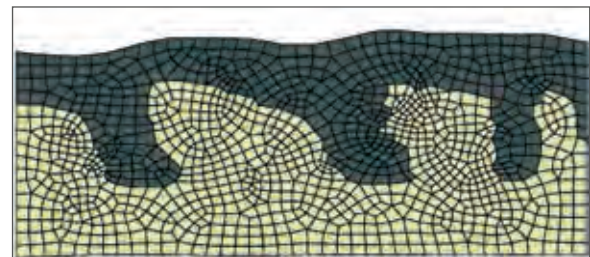
Realized geometric model

Contact: elmouss.marouane@gmail.com ; logan.marin@etu.univ-orleans.fr

Installation and calibration of a new sensor

Guilhem VRARD
Academic supervisor: A. FONTE

Objective/motivation

This project was developed as a part of the renovation and modernization of our equipment for practical works in Polytech. Different solutions have been explored and, since 2015, the integration of new magnetic level sensors has been launched. These sensors will be used to regulate the level of a fluid on a double flux unit. A previous sensor sourcing has been made and my project is now focused on the calibration and adaptation of one sensor to the existing system. My objectives are to verify the adaptability of the sensor and its behavior, to install it, and to modify the code to make the regulation work again.

Results

This project has encountered some difficulties. The sensor was tested with success, and I installed it on the system with some modifications on the float. The next step was to modifiy the code, and without any problem, the code was implemented with few adjustments. By testing the sensor in real conditions, difficulties appeared, some due to the upkeep of the system and others due to the interactions between the sensor and the NI driver. Currently, these problems are solved and the only remaining objective is the modification of the code to extract a numerical curve of what happened during the regulation.

Modeling of a heating wall

Materials

S. MILOT

L. RADIGON

Steven MILOT / Léa RADIGON
Academic supervisor: A. GASSER
Industrial supervisor: M. LANDREAU

Selected participant
10th Annual Final Year Projects Forum

Company: Centre de Pyrolyse de Marienau

Objective/motivation

The aim of this project is to create a thermomechanical model of a heating wall in a coke plant in order to reduce damage to the heating walls. Indeed, with successive heatings (which last about 18 hours), the walls are damaged and are very difficult to repair. Thus, it is necessary to find a solution to limit the cracking of the wall bricks. A thermomechanical model would permit choosing the best geometry and heating temperature to increase the lifespan of the battery.

Results

With the creation of the heating wall geometry, it is possible to apply different boundary conditions to develop a numerical model which is the most realistic. First, a thermal field which shows the rise of temperature in the heating wall is applied. It is introduced in the mechanical model. Then mechanical loads are applied: gravity, a swelling pressure which represents the contact between the heating wall and the coke and different pressures to model contact with the other parts of the heating wall. The numerical model shows the deformation of the wall during heating. It is possible to modify different parameters to study their influence on the simulation. For instance, it is possible to change the material properties, the size of the wall, the interactions which represent the other parts of the oven, etc. This way, it would be possible to optimize the ovens.

Keywords: modeling, optimization
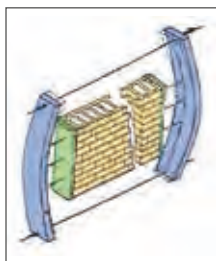
Heating wall
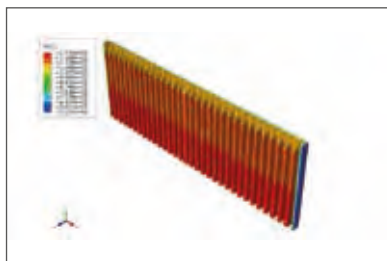
Thermal field
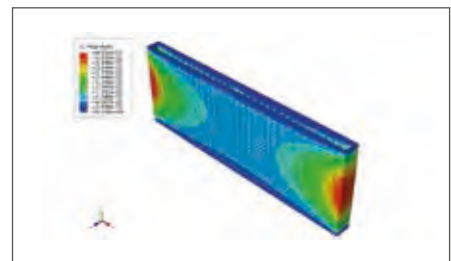
Displacement of the geometry

Contact: steven.milot@etu.univ-orleans.fr ; lea.radigon@etu.univ-orleans.fr

Oscillating wind turbine

Mechanical engineering

S. MACHICOANE

M. MARSAT

Samuel MACHICOANE / Maxime MARSAT
Academic supervisors: G. HIVET, B. LE ROUX, J. GILLIBERT

Company: Dassault Systemes

Objective/motivation

The aim of the project is to model an alternative to a classic wind turbine created by Mr. CREVEAU and studied for several years at Polytech Orleans. This new kind of device uses the force of the wind to generate a movement, oscillate, and finally create electrical energy. The energetic conversion also needs to be simulated. The whole study is carried out with a brand new software from Dassault Systèmes: 3D EXPERIENCE. This software is able to handle every part of the development of a product, from functional analysis to production management. For this project, we will especially use the mechanical simulation applications.

Results

Some of the possibilities of 3D Expérience still need practice, and everything cannot be done yet, particularly concerning the dynamic simulation applications. The comparison between the results provided by the simulation applications of 3D Experience and ADAMS has consequently not been made. However, the shape of the wind turbine has been modeled and the kinematic model is mastered. Several 45-minute long tutorials about creating, generating and simulating have been made and tested. Moreover, a document enumerating all the difficulties that we have encountered has been written, and will be delivered to Dassault Systemes.

Keywords: modelling, wind turbine, oscillating, 3D Expérience

Oscillating wind turbine
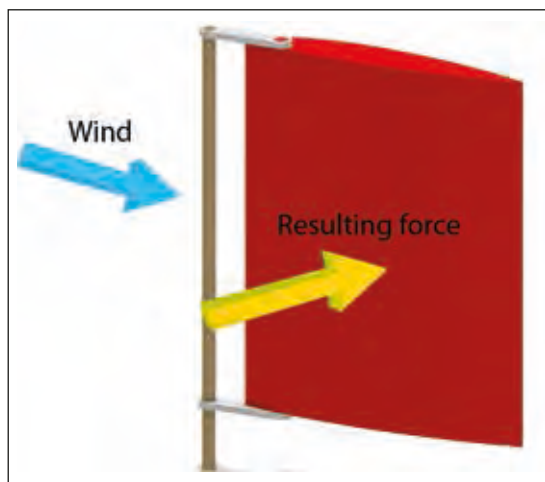
Modeling of an oscillating wind turbine

REDEX gearbox sensor equipment
Mechatronics engineering

Leo JORDAHN / Herve POUJOL
Academic supervisors: J. FANTINI, S. ALLAOUI
Industrial supervisors: J-P. MOZZICONACCI, P. CASANOVA

REDEX
Great achievements start with us

Company: REDEX

L.JORDAHN

H.POUJOL

Objective/motivation

Redex produces gearboxes for big-sized machine tools. They provide a rack and pinion system named DRP to actuate machining tables. Their clients are mostly machine tool builders. During this year project, the company wants to put sensors in these gearboxes to better know their product's working conditions. All the gearbox main parameters must be measured and will be used for two purposes. First, the user will be warned when the gearbox is out of its normal working conditions. The objective is to predict failures before they happen in order to optimize maintenance time. Then, all data will be used to better know how their products are used. It will help Redex engineers to fit their products to real needs and increase the quality of the gearbox. This follows their previous encouraging experience with industrial spindle instrumentation.

Results

This project is following another project from last year when the need was specified. We then worked on understanding it and defining it more precisely. We defined priorities with the engineers. Thus, oil level, quality and torque sensors appear to be the most important for them and their clients. The main issue of this project is to integrate sensors without using too much room. Then we organised our work in four main steps. First, we carried out research to determine available technologies and performances. The second step was to choose the most fitting technologies. Finally, we chose sensors and integrated them into the system. During this project, we've worked as a team in cooperation with Redex engineers who validated every task. This collaborative work is important to make sure we meet Redex expectations and needs. Finally, it also strengthens the link between the school and the local industrial network.

Keywords: instrumentation, sensors, gearbox, torque, oil

The gearbox with an additional angular gearbox

The gearbox with only electric motors
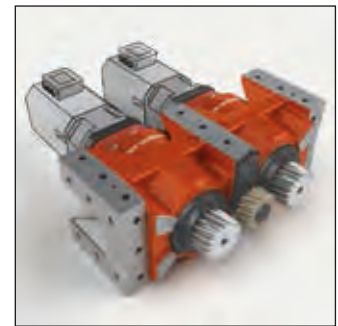
The gearbox horizontally positioned

Contact: leo.jordahn@etu.univ-orleans.fr ; herve.poujol@etu.univ-orleans.fr

Reliability of a rotating machine with a rotor in a polymerization resin oven at a temperature of 190°C

Mechanical engineering

Warren LASSEY / Thibaut LEFEBVRE
Academic supervisors: J-M. AUFRERE, S. ALLAOUI
Industrial supervisor: G. RODRIGUEZ

W. LASSEY

T. LEFEBVRE

Company: Leroy Somer

Objective/motivation

This project takes part of the company's quality policy on products that are "recognized for their high level of performance and reliability in demanding applications and harsh environments." The products affected by this project are alternator massive rotors used, for example, in central power generations. During one phase of production, a number of problems arise that may affect the quality of this product. The objective of this project is more reliable or better cooking rotators. The aim of this project is to make a study of the device in order to target the failure modes in the first phase. Then, will follow a research for technical solutions to solve these problems.

Results

Our project consists of reliability of a rotating machine with a rotor in a polymerization resin oven at a temperature of 190°C. After a failure mode, effects, and criticality analysis, we're able to identify and order the main failures. In order to address these failures, we established several technical solutions. These solutions were submitted for agreement at each Supervisor (Industrial and Academic). The project is still in study phase, and it will be the subject of an end-of-study internship. During this internship, we have to develop the technical solutions, and then we will test them first in laboratory, and, if they succeed, will carry out other tests in full-scale. The aim is to obtain a perfectly reliable device.

Keywords: reliability, process, transmission, motorization

Contact: warren.lassey@etu.univ-orleans.fr ; thibaut.lefebvre@etu.univ-orleans.fr

Stamping simulation
Mechanical engineering

Anthony DUHAMEL
Academic supervisor: J-L. Daniel

Objective/motivation

Within the framework of the ICM education reform, several practical works will be provided. Indeed, for the coming final-year students, a sheet metal stamping machine will be made. Stamping is a sheet metal forming process in which a metal sheet is formed by the mechanical action of a punch. The aim of this project is to simulate several tests with different punch shapes in order to choose one of them and to calculate the forces needed in designing the motor. The tool used is Abaqus software, which is used for finite elements analysis and computer-aided engineering.

Results

Several trials have been made such as the Nakazima and the Marciniak, a stamping test with a prism-shaped punch, a triangle-shaped punch and a cone-shaped punch. In this project, the main experiment is to vary the distance between the die and the binder and to draw the Forming Limit Curves which are useful in order to know if the metal sheet will crack or tear during the stamping test. To conclude, the deep drawing quality depends widely on the pressure applied on the binder and the distance between the die and the binder.

Keywords: sheet metal stamping, finite elements, Abaqus, Marciniak, Nakazima
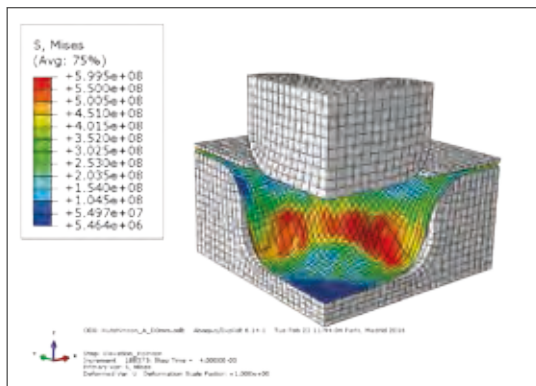
Mises stress of the cross-shaped punch test
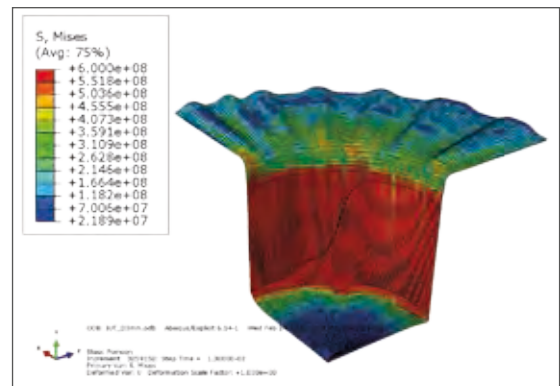
Mises stress at the end of the test

Contact: anthony.duhamel@etu.univ-orleans.fr

Thermomechanical simulation of refractory brickwork

Material and mechanical engineering

Han-Sol RO / Martin SAGREDO
Academic supervisor: A. GASSER

H. RO

M. SAGREDO

Institution: PRISME Laboratory

Objective/motivation

The project deals with the creation of a model calculated from infinite element methods to study the thermomechanical behavior of an entire steel ladle. The point here is to study in particular the effect of refractory lining on the steel shell while it is carrying molten steel at a temperature of 1000°C. In this study, three designs (fish bone, parallel and radial) and two types of joints (dry or mortar joint) are investigated using simulation.

Results

To do calculations with such a complex model, we use two different way for the material. For mortal joints masonries, homogeneous equivalent material props are calculated using the periodic homogenization method. Dry joints should be simulated with a Fortran subroutine which simulates joint closure. As of now, each are taking effect from the temperature's evolution which bring the model nearer than before to a real ladle. The results for each design and joint will allow us to see which case has the lower stress.

Keywords: thermomechanical, refractory materials, masonry, dry joint, modelling, simulation
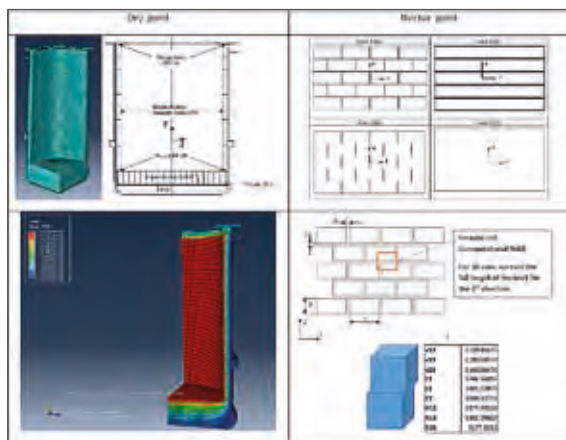
Topological optimization technique with Abaqus software

Mechanical engineering

Mohammed AMMOR / Noé BEAUPERE

Academic and industrial supervisor: J-L. DANIEL

N. BEAUPERE

Institution: PRISME Laboratory

Objective/motivation

Nowadays, numerical simulation using computers is very often used to design prototypes, thus avoiding the cost of construction of real prototypes. The aim of this project is related to one of the numerical simulation softwares, Abaqus, and its optimization module, Tosca for Abaqus. It will focus more precisely on the topology optimization of numerical structures with this software. This optimization is used to decrease the weight of a structure whereas the resistance remains constant. Complex geometries are developed, creating new holes in the material where matter is not required for the global resistance of the structure. The topology optimization differs from shape optimization which can just modify the shape of a hole, and sizing optimization which can just change specific distances (thickness, height, etc.).

Initial control arm

Optimized control arm

Results

However, the optimization process is something new in numerical simulation software. Therefore, an explanation was required from our teachers in order to know how to use this software. The topological optimization methods for Abaqus' numerical simulation will provide some design part. The goal of the project is to explain how the optimization process can be used with Abaqus. The study of different examples was done to visualize the influence of the different Abaqus' optimization parameters on the final optimized design. Optimization of specific structures was realized, including a car control arm and a bridge. The optimized shape of the bridge will be used by further students to build a composite bridge in the framework of the competition SAMPE FRANCE.

Optimized arched bridge

Real arched bridge

Keywords: topology optimization, Abaqus, numerical simulation
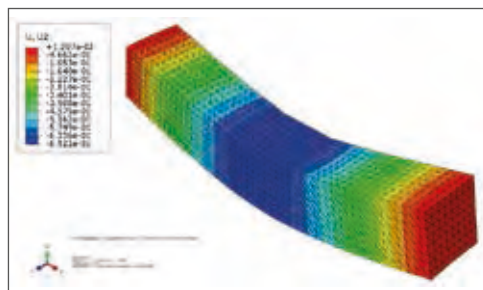
Initial bridge
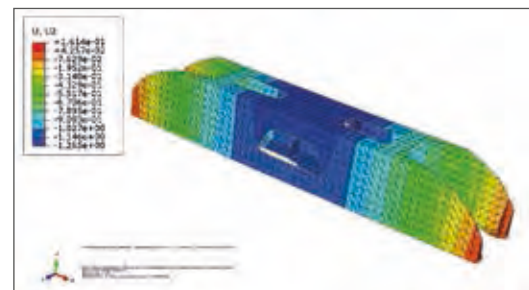
Optimized bridge

Contact: mohammed.ammor@etu.univ-orleans.fr ; noe.beaupere@etu.univ-orleans.fr

User manual of the software 3D Experience

Mechanical engineering

Christophe CHA / Benoît GUEHERY
Academic supervisor: B. LE ROUX

C. CHA

B. GUEHERY

Company: Dassault Systèmes

**Selected participant
10th Annual Final Year Projects Forum**

Objective/motivation

Our project consists of testing the functional analysis applications from the new software "3D Experience" by Dassault Systèmes. As a result, we will be able to determine if it's possible to create a SysMl diagram on the software. To properly test it we used the SysMl diagram of the previous project: "HandiPode", which is a project of the design of a gyropode for disabled people. Our first test was to find how to translate a SysMl diagram on the software and analyze whether it respects its norms. The second one was the simulation of the system, and the third one was the creation and the simulation of the 3D model. At the end of our project, each test will lead to a document which will be sent to Dassault Systèmes to recap the difficulties we encountered and a tutorial which will be used to train the student on how to create a SysMl diagram on 3D Experience.

Results

In order to make the SysMl diagram with 3D experience we used an application composed of three parts: requirement & functional, logical & behavior and physical (RFLP application). The use of this application starts with the description of the system and finishes with the simulation of the 3D model. We found and explained with a tutorial how to make the first two parts. To finish this project we have to find how to link the 3D objects to the logical & behavior. Next year, the instructor of the ICM specialty will use our tutorial to explain to the students how they can use 3D experience to make a better conception.

Keywords: Dassault Systèmes, 3D expérience, sysMl, handiPode, simulation
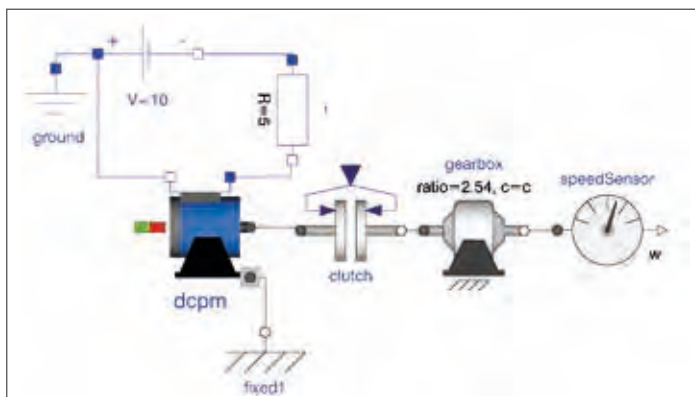
Applications

Multiphysics simulation

Contact: cha-christophe@laposte.net ; benoit.guehery@gmail.com

Using the generalized contact method and application to refractory masonry

Materials, numerical simulation

Raphael SALLIBARTAN
Academic and industrial supervisor: J-L. DANIEL

Institution: Polytech Orléans, PRISME Laboratory

Objective/motivation

The study of refractory structure appears among the various team activities of the Heterogeneous Material Mechanics Laboratory PRISME. We find these structures in industry sectors such as steel or energy. The very large number of blocks present in these structures makes their study, by the finite element method, complex, due to the multitude of contacts to be considered. The generalized contact method could be an alternative to the pair element method. The aim of this study is to simulate the closing of joints between each brick submitted to a thermomechanical load, and thus to validate the generalized contact method by comparing it to experimental results.

Results

In the masonry structure modeling, there are bed joints that are parallel to the brick length direction, and head joints that are perpendicular to the brick length direction. In this project, during load, these roughness peaks can be flattened, which leads to joints closure. Abaqus has enabled us to view its closure by the generalized contact method. Using the generalized contact method allows time savings when modelling the problem, where only friction coefficient is requested. This method could then be validated by relevance closures joints between the brick and the relation to the experimental.

Keywords: materials, numerical simulation, heat, refractory wall
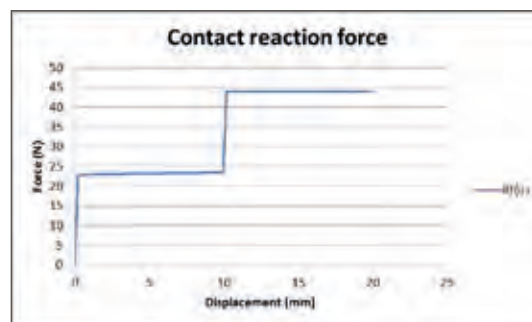
Contact reaction force between two bricks
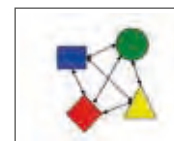
Pair contact method   General contact method
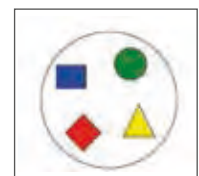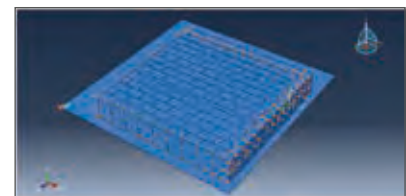
Mechanical load on refractory masony

Contact: raphael.sallibartan@etu.univ-orleans.fr

Production Management

Connecting rod traceability project

Production engineering

Mathieu BELLIER
Academic supervisor: B. ROUSSEAU
Industrial supervisor: E. CAMPOS

Company: John Deere

Objective/motivation

My main motivation is the challenge brought about by this project. First, the plant in Saran updates its processes to carry out John Deere's strategy, which is to have a distinctive quality. All machining parts must be traced. Second, to integrate new equipment in the old machining line considering the constraints of this line (old technology machine, environment, manual operation, cycle time and so on). Third, to support this project (investment, choice of technology and so on) near to the company and to be close to industry 4.0. This project has all the elements of project management and represents a good experience for me. The main objective of this project is to integrate a traceability system for the machined parts to align the processes to the company strategy and to acquire data on strategic points of the machining line. This project will be done in three main steps:

> The first step will be to understand the different needs (quality, production and machining manufacturing needs, etc.) and to identify the machines to equip

> The second step will be to share our needs with different suppliers and choose the equipment in function of several criteria (prize, technology, service, etc.) with the goal of integrating different equipment necessary to have traceability on the machining line (marking system, rereading system, IT materials, etc.)

> The third step will be to manage the teamwork (IT, production, buyer, supplier and so on)

Keywords: traceability, vision, industrial IT, integration, management

Contact: mathieu.bellier@etu.univ-orleans.fr

Development of an industrial heating coating for railway glazings

Electrical engineering

Guillaume AUDEBERT
Academic supervisor: B. LE ROUX
Industrial supervisors: F. TURPIN, E. COCCOLI

SAINT-GOBAIN

Company: Saint-Gobain Sully

Objective/motivation

Replace the current heating layer (based on a thin coating deposited by vacuum systems) of railway glazings produced in Sully sur Loire with a more industrial heating layer already deposited on the raw material. The establishment of this layer requires less expertise than the vacuum-deposited layer. Production of this glazing can be transferred to Italy (in another Saint-Gobain plant specialized in large-sized glass such as that for buses and trucks). This project is divided into two parts. The first is a study of glazing currently produced in Saint-Gobain Sully with the vacuum-deposited layer that can be transferred to the Italian site in Sicurglass South. The second part is a knowledge transfer to Italian colleagues (training directly on the Italian site).

Results

After two weeks of calculation, 71% of studied windshields were found to be compatible with the glazing choice, with some technical changes. I must now study the windshield composition to get the same mechanical resistance between the new windshield and the old. Solutions must be found for low-tension windshields.

Keywords: heating coating, railway windshield, industrial coating development
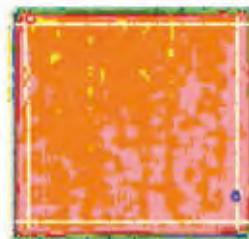
Heating coat mapping for a 500mm x 500mm glass

Contact: guillaume.audebert@neuf.fr

Finishing process steps improvement

Production engineering

Kelly VEZIAT
Academic supervisor: H. LAILHEUGUE
Industrial supervisor: S. VANNIER

Company: Leroy Somer

Objective/motivation

The finishing department, denouncing badly adjusted time ranges, rarely reaches a 40% efficiency rate. Instead of starting revisions of the department's time ranges, it was decided to lead a project on improving the painting and completion processes. My mission, in association with operators, the production manager and the sector method's advisor, consists of managing this project to find, some solutions allowing time savings in the manufacturing process. Having to meet a precise end-of-project's deadline, I first have to plan suitably the various milestones corresponding to the end of each analysis phase of current processes. After that, I will have to pool improvement solutions with the project team and finally implement the reserved solutions.

Keywords: painting, improvement, process, efficiency, time

Contact: kelly.veziat@etu.univ-orleans.fr

Implementation of a data management software in John Deere's machining area
Production engineering

Félix FITZNER
Academic supervisor: E. COURTIAL
Industrial supervisor: Y. LARMIGNAT

Company: John Deere

Objective/motivation

John Deere (Saran), a company of the world group Deere & Company, develops, builds, and commercializes diesel engines with 3, 4 or 6 cylinders and 48 to 275 hp. Reaching distinctive quality is one of the primary objectives of John Deere. After the implementation of data acquisition devices in the machining area, John Deere needs to manage this quality data. They will allow John Deere to drive in real time the quality of the machined features and to analyze the causes of its defects. To reach its quality goals, John Deere chose a unique global SPC software solution. To start the implementation of this new data management solution, John Deere has decided to set up the software on four pilot areas on the Block machining line.

Result

The main goal of this project is to improve the Process First Pass Yield (scrap/rework rate) in this area through:
> a better reactivity between the metrology and the machining
> displaying in real time the CMM reports to the operator and the set-up operator;
> a reduction of the time to search quality data, thanks to a central common database which allows for a quick and efficient response to the customer
> the removal of control charts (no human error possible)
This area has to be in production by the end of June, 2016. In the meantime, we will define the next areas where the software will be implemented in 2017 and work on the associated budget.

Implementing continuous workflow in production workshops

Production engineering

Aboujihad AMAR
Academic supervisor: J-M. AUFRERE
Industrial supervisor: R. GAZE

Company: LOEUL et PIRIOT

Objective/motivation

The food industry sector is undergoing important technological and organizational changes. For that, Loeul et Piriot will have to adapt to these changes in order to increase productivity and performance. For this to happen, we will incorporate and apply a new organizational method to eliminate the non-value added in their processes and to reduce product lead time. In this context, the project aims to create a continuous flow of value-added operations between the slaughterhouses and the production workshops, more precisely the GD line, which represents the greatest volume of activity for the company.

My project consists of designing and deploying a new solution to supply line production using raw material directly, without prior storing.

Results

Continuous process improvement is one of the key points considered by Loeul et Piriot. This project's objectives are the improvement of operational performance, the achievement of higher levels of quality, a reduction in costs and completion times, and finally the end customer's satisfaction. The aim of my project is to reduce the product lead time, which allow us to reduce production costs, to limit the frequency of logistics operations and finally to save direct labour costs.

Keywords: supply chain management, cost control, continuous improvement
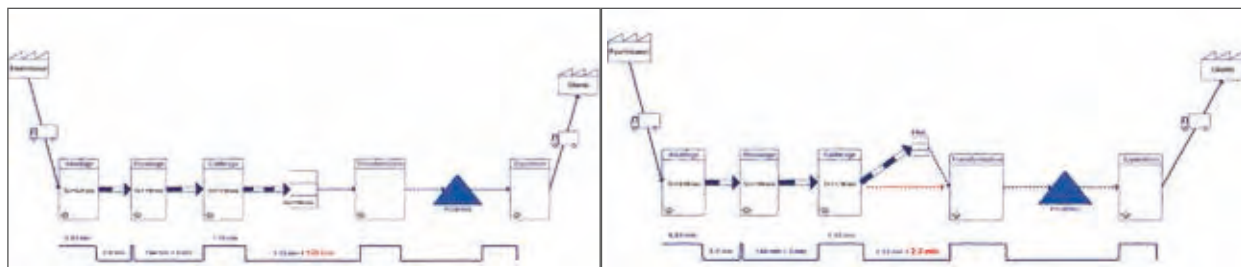
Current state value stream mapping process

Future state value stream mapping process

Contact: amar.aboujihad@gmail.com

Improving the process of sorting nuclear waste in nuclear areas
Production engineering

Romain ABRIOUX
Academic supervisor: S.ROUSSEAU
Industrial supervisor: J-D. HEVIN

Company: EDF

Objective/motivation

With the Great Refit project of the nuclear power plants of the French fleet, we have to prepare the future. Sorting waste is essential to extend the operation of our nuclear power plants. The maintenance projects which will be carried out during the Great Refit will be dimensioned according to what EDF agents know, and nuclear waste production will seriously increase. Nuclear waste sorting is complex and must be done with regard to environmental standards. Poorly sorted waste carries a risk of losing permission to send our waste to the various channels of treatment or storage. If it is not possible for a nuclear power plant to ship waste, its operation must stop, which is inconceivable in the current economic and political climate. The project called "waste sorting simplification" must be finished for the next unit outage planned for June, 2016. It is based on the development of DMAIC (Define – Measure – Analyze – Improve – Control) method in which we have integrated a SIPOC method (Supplier – Input – Process – Output – Client) to precisely define all the process and its weaknesses. After that, we will work to remove these weaknesses to get a simpler, more reliable and more robust system. The objective is to reduce sorting deviations of nuclear waste to zero by the end of the year. To succeed, stakeholders should be able to know perfectly the new waste sorting management process. Detection barriers of dangerous sorting errors must be 100% reliable. Finally, the ultimate objective is not to incur a delay in the restarting of the next reactor because of a backlog in the nuclear waste sorting chain.

Nuclear power plant of Belleville sur Loire

Nuclear waste sorting area

Nuclear wastes storage area

Contact: romain.abrioux@etu.univ-orleans.fr

Increase the production rate of an assembly production line

Production engineering

Geoffrey GALLES
Academic supervisor: S. LEROUX
Industrial supervisor: S. DAVOUT

BOSCH

Company: Robert Bosch Automotive Steering Vendome

Objective/motivation

This project's objective is to improve the production rate of an assembly line composed by a steering column, made of assembly components, for Mercedez Benz. The project integrates the Safe Launch Production, a standard tool of Bosch, in order to integrate the transition between the Start Of Production (SOP) and the full ramp-up of the line (Gate G). This project enables an increase in the value added of the product and improves productivity. The main aim of this project is to reach a targeted PPOH (Pieces per Operator Hour), instant cycle time and OEE (Overall Equipment Effectiveness) for the production assembly line while ensuring safety and training of the people working on it. The next target will be to implement all documents of the line (Standardized Work, Organisation sheet and Procedure documents). Finally, the last goal will be to implement the followed actions and the PDCA methods with the solving of technical problems through the intervention of each man's job and machine supplier. All things have to be accomplished and the objectives reached before a certain date.

Keywords: production, lean, management, assembly, automotive industry
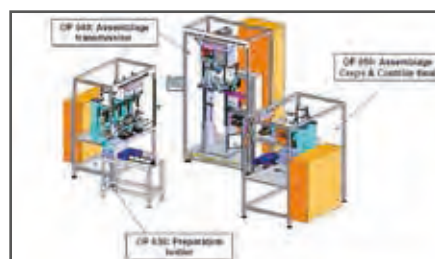
Contact: geoffreygalles@gmail.com

Industrialization of a new product made by injection of composite resin

Production engineering

Jonathan GAMBY
Academic supervisor: E. COURTIAL
Industrial supervisor: R. PECHEVY

Company: Faurecia Automotive Composites

Objective/motivation

This project's objective is to ensure the industrialization of a new product, made of composite resin using an injection press, for PSA and Opel. This project takes place in the Program Management System, a standard tool of Faurecia, and, more precisely, on the Production set-up and the Launch steps. It covers actions from costing to mass production of the new part with two Gates Reviews, which are the main milestones of the project: Production Part Approval Process (PPAP) and Start Of Production (SOP).

Results

The main aim of this project is to reach a targeted scrap rate, cycle time and OEE (Overall Equipment Effectiveness) for the new production line while ensuring safety, training of the people working on it and reaching a level of Quality through a Validation Plan. The secondary goal will be to create the full body of documents of the line (Standardized Work and Maintenance documents). The project has to be finished and implemented for January, 2017.

Keywords: industrialization, management, composite, automotive industry

Fat BCUV

Production zone
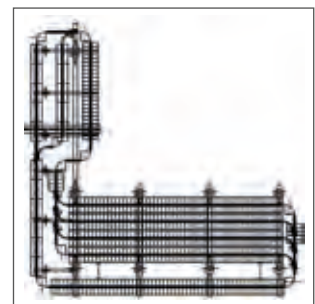
Shopstock

Contact: jonathan.gamby@yahoo.fr

Integration process IT in a management of information systems

Information systems

Robin SIVIGNON
Academic supervisor: B. BONHEUR
Industrial supervisor: M. BOURNAZAUD

Company: EDF

Objective/motivation

The project I was entrusted with in Grade 3 deals with the transition of services including the improvement process "Release and Deployment Management". I have contributed to the definition of the process for maintenance, performance and production support implementation of information systems. In the fourth year, I was assigned to accompany the operators operating the new software tool carrier operating process (named POGS tool). The project I was entrusted with during this fifth year is to increase the "Release and Deployment Management" processes within an operating tray application services (human resources applications). I will support and operate to control their application portfolios to the incidents, requests, changes and especially deployments of versions and new applications.

Results

The project objective is to become the referent of drivers operating on this process and the associated tool to drive change POGS of this new organization on the user population.
For this it is necessary to:
> identify gaps between the current organization and the organization to come,
> write descriptive and instructions sheets (procedure)
> make risk analyses regarding compliance process,
> propose solutions to the risks found,
> establish action plans and follow them,
> train and support stakeholders in the new procedures,
> propose changes to the process in the framework of continuous improvement,
> communicate with different people (MOE operating and development EOM)
Getting into skills on the new "Release and Deployment Management" module POGS and intervene in support of the operational team.

Keywords: IT, digital, information systems

Contact: robin.sivignon@etu.univ-orleans.fr

Management of a continuous improvement project on the establishment of a pull and smooth flow on a production line

Production engineering

Fabien THILLOU
Academic supervisor: P. GRILLOT
Industrial supervisor: S. BARRE

Company: Thales Avionics

Objective/motivation

The product is an embedded visualization (human-machine interface) for a military aircraft. Production rates have increased significantly (300 products in 2016 versus 50 products in 2015). Initial Lead Time of the product is 20 days. The Lead Time variation seems important. This project has several constraints: supply problems of three sub-items and three different types of flows: production/non-conformity output LRU/Avionnage. The objectives of the project are to ensure stable production taking into account the various constraints in order to meet customer demand following the increase; to reduce and stabilize Lead Time, and to develop Lean maturity of the project team.

Results

The project is divided in two parts. First, we have to respect the customer demand without further delay. To satisfy this condition, I need to manage Human Resources and production means, create production plans and integrate a manufacturing line of sub-item for the finished product in the project. Second, we need to implement a continuous improvement project to establish a pull and smooth flow on the production line. I need to analyze all of the input and output flows, the overall layout of the production line and put in place an implementation for better visibility of flows and implementation of visual management in parallel. Improving workflows and reducing product defects, improving workstations to avoid the risk of repetitive strain injury and allow better flexibility, operator training allowing flexibility within the production line and establishment of an approach "Kaizen" in the production island to problem-solving through autonomy as a team.

Keywords: lean manufacturing, supply chain management, production management

The product

Contact: fabien.thillou@gmail.com

Optimize the time of change of series

Production management

Sadqi BOUCHAÏB
Academic supervisor: J-M. AUFRERE
Industrial supervisor: G. DUCROCQ

Company: NEXTER MUNITIONS

Objective/motivation

My objective is to optimize the time of change of series and known regulation in a unit of production of medium caliber. To be able to reach my objective, I have to set up a tool of calculation and follow-up of the TRS. Secondly, I am going to create and to set the standard procedure of regulations of production lines. Thirdly, I have to optimize the organization and the process of the changes of series to decrease the times of non-value added. To finalize all this, I will develop the documentation describing the starting up manufacturing of medium caliber ammunition to formalize all that.

Results

I developed a tool for calculating and following the TRS. The operators and the line leader used this tool daily, and it was used at least once a week by the pole methods lines and the methods industrialists. Further, meetings were held weekly to plan, perform, check and act on the preventive and corrective actions. These actions aim at improving the productivity of production lines. The standard procedure of regulations used by the production staff allows a great flexibility from the point of view of human resources. In addition, I improved the times of regulation of production lines. I introduced a work SMED and divided the number of tools by two.

Keywords: quality, maintenance, production management, continuous improvement, industrialization

Reducing waste cream
Production management

Sylvain PERRIN
Academic supervisor: S. TOUTAIN
Industrial supervisor: F. DAVAL

Company: LSDH

Objective/motivation

The dairy of Saint Denis de l'Hotel packs all types of liquid food (fruit juice, milk, cream, elaborate products). Within a specific economic context, the dairy of St. Denis de l'Hotel has to control and reduce waste (products, packaging). Having no technological means of controlling these losses, I have to organize, coordinate and direct a working group. In addition, the company currently has no traceability losses. It is important to be able to act quickly and effectively. From the ordering of raw materials to the unloading of the tank, until the packaging and export of finished products, information of each of these services must be reliable and validated.

Results

The objective is to analyze the progress of the entire process to identify each step where we may lose significant amounts. Installing multiple sensors will be useful to measure losses accurately. Then, work will be conducted on the recycling of the product. Indeed, in the food industry, products have an end date of validity, so it is important to act intelligently on the recycling of products so that they can be rapidly reused. The goal is to reduce losses on the year 2016 by 30%, and each department will have to review its organization. The organization of personnel and the introduction of Lean manufacturing are important steps in the work carried out under good practices.

Keywords: milk company, agrifood, industry, waste

Contact: syperrin@gmail.com

Reduction of rejects caused by dust in assembly cleanroom

Production engineering

Marie FRASNIER
Academic supervisor: B. LE ROUX
Industrial supervisor: A. GUYON

SAINT-GOBAIN

Company: Saint-Gobain Sully

Objective/motivation

Most products made at Saint-Gobain Sully go through an assembly step in a cleanroom before baking. Yet, the accumulation of dust in the different layers of glazing is the main cause of waste and non-compliance. To solve this problem, we have launched a 5S project in the cleanroom to fight the causes of dust and get the room back to the standards of the group in terms of WCM (World Class Manufacturing). The implementation of correctives and preventive actions will allow us to standardize the best practices and to detect any future drift.

Indicators

To manage this project, I will examine the number of non-compliances on a pareto every week with the project team in order to know which type of impurity to deal with first. We will analyze the results on a graph. I will put in perspective the amount of re-baking and reject compared to the number of windows made. This will be done every week at first and then only every month until the end of the project.

Keywords: decrease, dust, waste, clean room, 5S
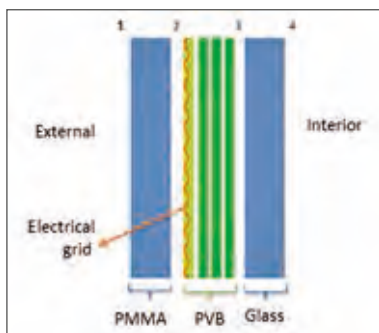
Example of laminated window composition

Uniform required for going into the cleanroom

Contact: marie.frasnier@laposte.net

Setting up an inventory management for the maintenance spare parts

Production engineering

Solène DUCLOS
Academic supervisor: A. FONTE
Industrial supervisor: S. ROGER

Company: Wilo Intec

Objective/motivation

For the last project at my company, WILO INTEC, I have set up an inventory management for maintenance spare parts. Currently, each technician has to place an order when he needs a spare part. The company now wants to automate this system. I have to create a system which can define our order (when to order and how many pieces). The main objective is to incorporate the maintenance inventory management into the company system. I have to create a "proper basis" to achieve this objective. Moreover, since 2012, the company has implanted 21 production lines. A lot of new items will be added to the inventory so the company needs a good inventory management system to ensure the equipment efficiency.

Results

First, I analyzed the current situation in the maintenance department. Second, I made a situational analysis of spare parts to define the different types of items. In function of those different items, we need to define different methods to place an order. Currently, we are in the development phase for the items which are more regularly used. In the meantime, we are creating a method to determine if a spare part must be stored. This method is based on the quantity for one item in the company, the type of the item and the criticality of this same item.

Keywords: maintenance, spare parts

Automatic inventory management

Spare parts

Contact: solene.duclos@etu.univ-orleans.fr

Smoothing of internal flows of production

Logistics engineering

Damien BENIGUEL
Academic supervisor: S. ALLAOUI
Industrial supervisor: M. BOURCHEIX

Selected participant
10th Annual Final Year Projects Forum

Company: Faurecia Automotive Composite

Objective/motivation

In order to reach the FES objectives of Faurecia System Excellence, the plan aims at standardizing flows of production. To achieve this, the Production Control and Logistics department is setting up systems of management of Lean Manufacturing like pull system. Tools are deployed such as kanban, leveling board, the launcher and small train. This system requires a new organization and staff training to adapt to a new mode of production. Indeed, the purpose of this system is to satisfy the customer while meeting his need but also that producing parts according to need. My project is to level flows by collecting finished parts with a small train. This will be coupled with a sequenced system, leveling board and kanban cards. This aims to collect the parts regularly at the same rhythm so that production manufactures the parts as needed.

Keywords: flow, kanban, small train
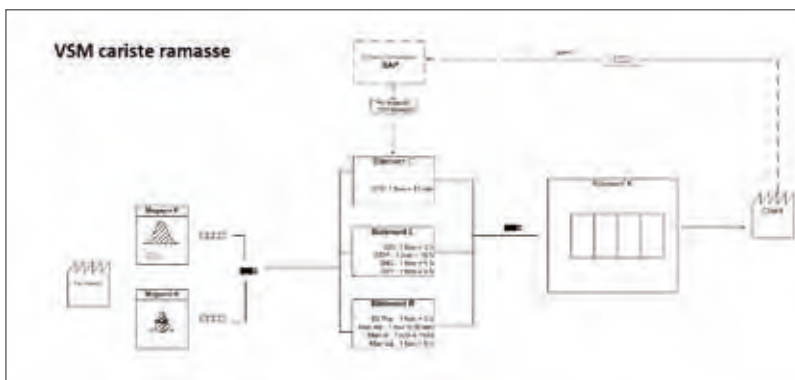
Contact: damien.beniguel@etu.univ-orleans.fr

Smart Building

Design a house responding to the RT 2020

Energetics

Mathieu POULAIN
Academic supervisor: G. LAMARQUE
Industrial supervisor: R. FIGOUREUX

Company: BATI'CONCEPT

Objective/motivation

Because of increasing global temperatures, attention has been clearly focused on renewable products and ecologic buildings for some years. One of the results of this is the creation of regulations, such as building rules. Today, the thermal regulation applied to building is regulation 2012 (RT 2012). But thanks to recent progress, we will soon be using RT 2020. As professionals, it's necessary for us to be prepared for future rules. With this in mind, and to develop my knowledge, I have to carry out a mission: prepare my company for the RT2020, with designing, feasibility study, costing, and results analysis. The first step is to collect all the information related to the regulation. Second, I have to find solutions like triple-glazed windows, dual-flow ventilation coupled with heating system, positioning of the building and other solutions to obtain the best thermal and economic performance possible. If the price and the feasibility are appropriate, I have to request a study of the project by a thermal studies board to validate the project.

Keywords: RT2020, Smart Building, Passive House, BPos, innovation

Contact: math.poulain@gmail.com

Designing a tool for analyzing and planning the availability of a set of systems

Electrical engineering

Alban AZEMA
Academic supervisor: P. VRIGNAT
Industrial supervisor: F. MASSIAS

Company: EDF

Objective/motivation

The operation of a nuclear power plant has many requirements regarding regulations and safety instructions. It is sometimes difficult to anticipate when limits might be reached or surpassed. If detected too late, these kind of situations can lead to the shutdown of the plant and cause security risks. The goal of the project is to improve the monitoring of some systems by checking some physical parameters. This can be done using a tool which can analyse and plan the availability of a set of systems. To achieve this, I will rely on the extraction and the analysis of a lot data available on the internal computer system. The project is divided in three parts:

1. Creation of an availability analysis tool
2. Development of a data extraction tool
3. Design of an availability planning tool

Keywords: improvement, anticipation, analyzing, planning
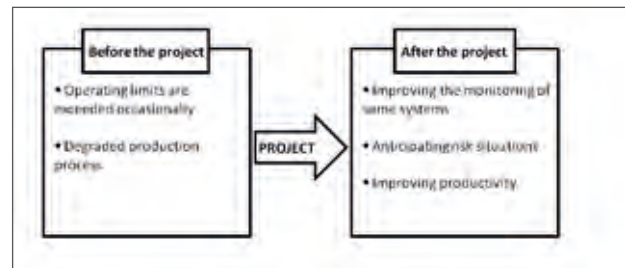
Objective of the project

VBA code
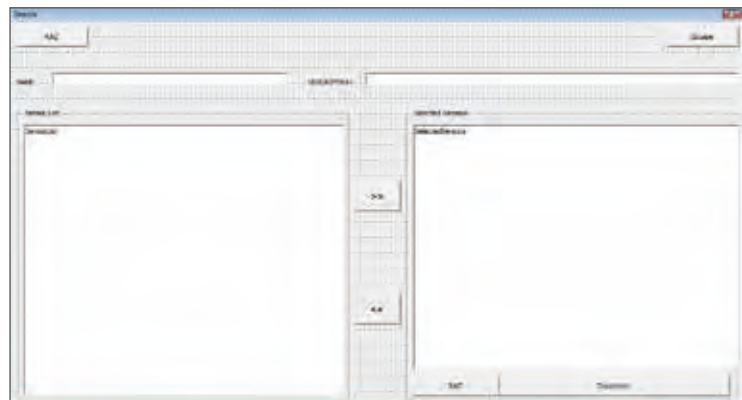
Human-machine interface

Contact: alban.azema@etu.univ-orleans.fr

Electric vehicle

Smart building

Hind BACHINI
Academic supervisor: B. EMILE
Industrial supervisor: P. PREVOST

legrand®

Company: LEGRAND

Objective/motivation

Within the framework of a project on Smart grid experimentation and energy efficiency, Legrand is developing new solutions enabling measurement, display, analysis and control of loads in buildings, as well as communication between all of the players in the electric value chain to allow for transparent determination of when, how, and at which price electricity is produced and consumed. During my last year, I am working on the part concerning electric vehicles, in particular improving flowcharts of electric vehicle load and bookings in the commercial sector, so as to make it possible to better adapt the distribution of electricity to this new challenge. These flowcharts are necessary to continue modernizing electricity networks by making them increasingly "smart", but also to decrease our electricity bills.

Keywords: smart grid, energy efficiency, flowchart, electricity, commercial sector

Contact: hind.bachini@etu.univ-orleans.fr

Indoor lighting systems
Smart buildings

Nada AMINE
Academic supervisor: J.-M. ROUSSEL
Industrial supervisor: B. PUNELLE

Company: Philips Lighting France

Objective/motivation

Smart building is an apprenticeship course that allows us to work in a company whilst following our studies during our three years at Polytech. At Philips, my job consists of conducting indoor lighting studies using lighting software such as Dialux and Calculux. These lighting studies, together with the salesmen's commercial offer, come as a technical support to the final report that we give back to our clients. The major purpose of lighting studies is to help us optimize lighting designs and calculations by respecting mandatory lighting standards. Some of the other most important factors that we have to keep in mind while doing our projects are the clients' budget and environmental constraints.

Keywords: lighting, efficiency, visual comfort
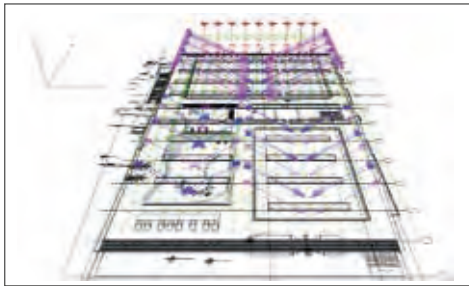
3D simulation of a swimming pool on Calculux

AutoCAD overview drawing
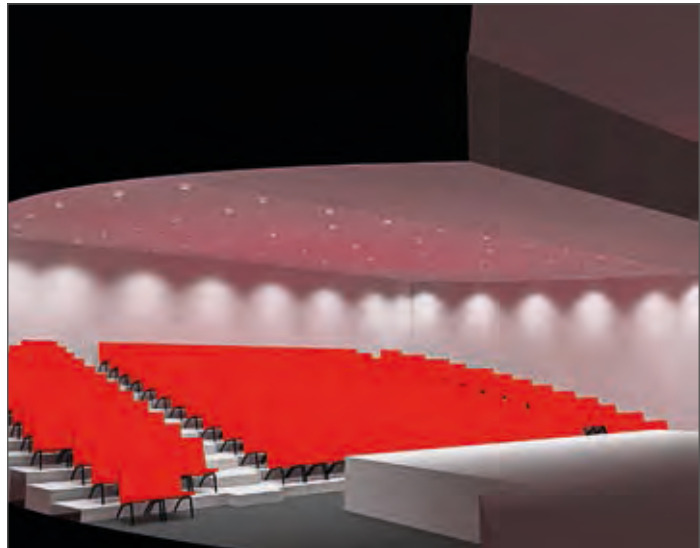
3D simulation of a theatre on DIALUX

Contact: nada.amine@etu.univ-orleans.fr

Intelligent skylight

Smart buildings

Sami Nezar BELLA
Academic supervisor: G. LAMARQUE
Industrial supervisor: J-M. CAOUS

Institution: HEXADOME

Objective/motivation

My project is a part of a development approach which aims for complete autonomy of a skylight. Indeed, with the Sunlite Control, a series of rotating blades is used in order to ensure a significant and stable daylight contribution. We have set up a computer algorithm which simultaneously controls the ventilation and shading functions. The aim is to offer a stand-alone device which provides comfort to the user and reduces electrical energy consumption. The perfect integration of the skylight into its environment is also guaranteed by the project.

Results

For now, the algorithm is almost finished. The tests step are in progress. Results will be announced later.

Keywords:

skylight,
autonomy,
shading,
natural ventilation,
algorithm

The blades allow the device to follow sunlight phases in order to keep the room/office illuminated stably.

Intelligently controlled natural ventilation and shading provide to the user thermal comfort and electric power consumption saving.
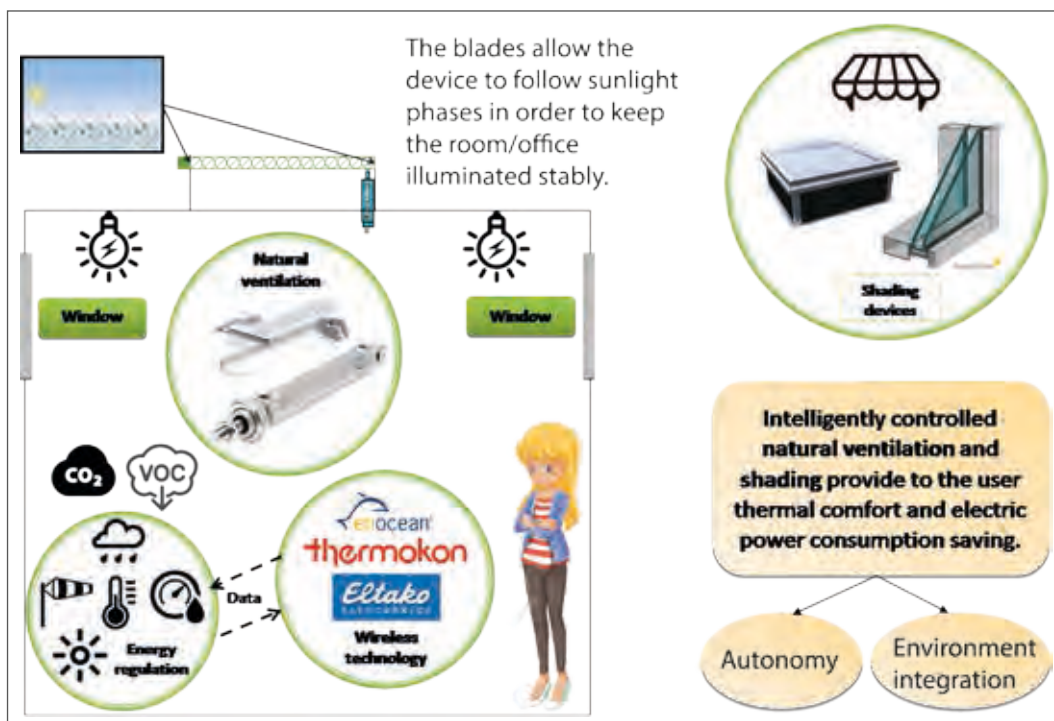
Contact: sbella@hexadome.com

Modification of the Building Management Systems

Smart buildings

Justin BERNARD
Academic supervisor: M. AVILA
Industrial supervisor: P. DESSERPRIT

Company: FPT POWERTRAIN TECHNOLOGIES

Objective/motivation

The objective of this project is to install a scalable Building Management System (BMS). Currently, we have a Heating Management Systems (HMS) which is obsolete, a Lighting Management Systems (LMS) which we are installing progressively, and a Counting Management Systems (CMS) which doesn't support all counter buildings that are installed. The heating represents one third of energy consumption for the factory. After comparing the ambient temperatures to the set point temperatures, the extra cost of the heating have been calculated.

Results

In the short term, the BMS will manage the heating, the lighting, the counting (building) and the monitoring (machine). In the long term, this system will have real-time monitoring of production and will manage the position of Automatic Guided Vehicles (AGV). All our heating Programmable Logic Controllers (PLCs) will be replaced, connected to the factory's Ethernet network and a supervision DESIGO INSIGHT V5 will be installed. A part of counters (buildings) and of monitoring (machine) will be connected, too. The best heating management should enable a return on investment of less than three years.
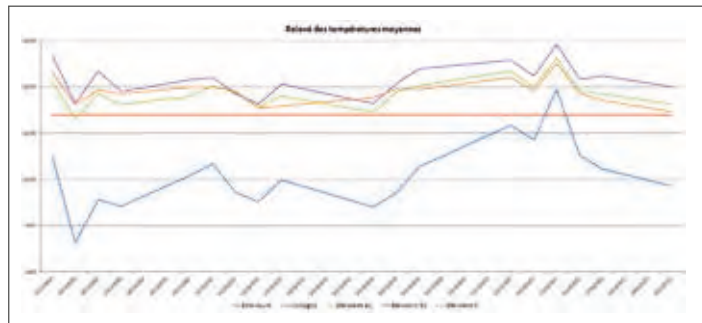
Keywords: smart buildings, energy saving, Building Management System

Contact: justin.simon.bernard@gmail.com

Plans of heavy and low current installations

Electrical engineering

Soa BEMANANA
Academic supervisor: C. FOUQUET
Industrial supervisor: S. COURLIT

Company: SNEE

Objective/motivation

The main goals were making plans of heavy and low current installations in apartment buildings, and updating these plans and schematics according to technical specifications. I also had to make equipment lists and low current synoptics. As part of a project, I made the electrical layout plans of the building "TOUR LUMIERE" in Tours (département 37 in France), created by the architect Jacques Ferrier and composed of 89 apartments. The project managers were the SNI Group, the social landlord in France. The goal of this project was to learn every norm in collective housing (NF C 14-100, NF C 15-100, etc.) as well as computer tools (AUTOCAD, OLYMPE and DIALUX) needed to do the job properly. During this coming year three themes will prevail. First, I will have to learn about analytics management, costs planning and project assessments. Then, I will need to develop my communications skills toward the internal and external personnel (project owner, the prime contractor, site manager, etc.) on my upcoming projects. Finally, I will work on delegating responsibilities and offering new ideas to my department.

Keywords: heavy current, low current

Contact: soa.bemanana@etu.univ-orleans.fr

Securing the drinking water supply of SIVOM Rive Gauche du Cher and the conurbation of Montluçon

Electrical engineering

Alexis COUSIN
Academic supervisor: T. FAU
Industrial supervisor: T. CAGNAT

Company: ACTEMIUM BOURGES

Objective/motivation

As an apprentice engineer in the water management service of ACTEMIUM Bourges, I started my 5th year project in November 2014 (response to a call to tenders) and it will be over by July 2016. Our tasks are to set up the equipment needed to secure a drinking water supply for two public authorities. The cost is about 1.2 million euros, excluding tax. The tasks involve several sites and include the installation of hydraulic equipment (pumps, motorized valves, flow meters), the construction of a pumping station and manhole, designing and installing electrical cabinets, and modification of the supervision to control all equipment remotely. I participated in all steps of the project (consultation of suppliers, making quote and technical brief, creating electrical diagrams, hydraulic and civil engineering, selection and procurement of equipment, site supervision).

Keywords: electricity, hydraulic, supervision, design

Pumping station of Buffon
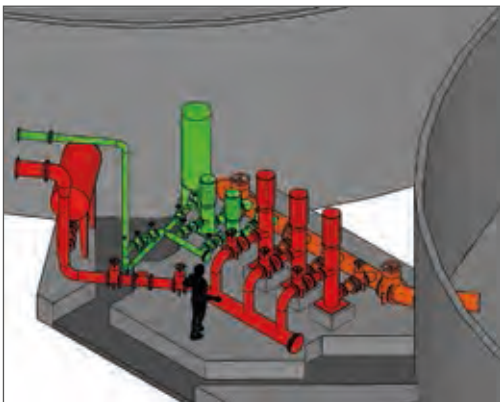
CAO with Plancal Nova software

Pumping station of Saint-Jean

Contact: alexis.cousin@etu.univ-orleans.fr

Supervision of operations in contracting owner

Civil and environmental engineering

Thibault CONSTANTIN
Academic supervisor: S. TREUILLET
Industrial supervisor: S. GAY

Company: Conseil Régional du Centre - Val de Loire

Objective/motivation

The new laws and standards related to the environment affect many sectors, in particular both public and private construction sectors. To cope with this, the Région Centre Val de Loire set up many projects aiming at making its heritage more respectful of the environment. Forming an integral part of the regional heritage, high schools are also concerned with these environmental challenges. As an apprentice in charge of operation at the Direction des Lycées of the Région Centre Val de Loire, my role is to follow from an administrative, financial and technical point of view one or several operations (construction, rehabilitation, restoration) being carried out in the high schools of the region, in regard to the respect of the environment. This last year, my presence during an operation was more important than before. For example, I have been supervising, from its beginning to its reception next August, an operation of demolition and of reconstruction of educational workshops at the Becquerel High School in Tours, costing about 7M€. All the details are important: the selection of the teams, the respect of deadlines, the coordination, methods and choice of construction, etc. But it is also very important to anticipate the environmental impact of the construction: respect of environmental standards, assessment of carbon and grey energies, choice of renewable energies, lifetime of the building, etc.

Keywords: environmental impact, operation, energies

Contact: constantin.thibault@gmail.com

The improvement towards an energy policy

Smart buildings

Paul ABORD-HUGON
Academic supervisors: J. BORDERIEUX
Industrial supervisors: D. NIEDERLANDER

Institution: University of Bourgogne

Objective/motivation

The University of Burgundy has always been eager to follow its consumptions of energy and to optimize the management of buildings in terms of heating and ventilation. Since the 1980s, the technical service has deployed a SCADA system (Supervisor Control and Data Acquisition) in Dijon. This is a system for remote monitoring and control that operates with coded signals over communication channels. My project is to follow the consumption and set up a threshold for each type of energy for each building. It is therefore necessary to identify a consumption profile. However, this work is complex because it depends on a lot of variables like the number of students, the weather, review periods, or holidays. In case of excessive consumption, I have to create some procedure or action to return to the average. My other mission is to inspect the SCADA system to discover the deficient point and organize modifications and optimize it as much as possible.

Results

With reference to the SCADA system, I have to redraw the historic event to establish the weak and obsolete point to set up a schedule. This work has three objectives: to delete useless points in the database, to restart points stopped by a previous subcontractor, and to plan the replacement and the optimization humanely, financially and technically to assure comfort for students and employees. I have already done twenty-five percent.

Contact: abordpaul@gmail.com

Technologies for energy, aerospace and engines

Aerodynamic study of EXERGIE prototype vehicle

Mechanical engineering

Mickael BRUNET / Florian CASAURANG
Academic supervisor: N. MAZELLIER
Industrial supervisor: A. DENIS

M. BRUNET

F. CASAURANG

Company: EXERGIE

Objective/motivation

Due to an increasing energy consumption, sustainable development is one of the most innovating sectors. Each one of us should contribute in their own way and within their means. The members of Exergie, a student association of Polytech Orléans, want to participate in the Shell Eco-marathon, which will take place in London this year. Around 200 teams of students will compete to see how far their ultra-efficient vehicle is able to travel with a single litre of fuel. In order to assess the performances of the vehicle, our project consists in studying the aerodynamics of the car via Computational Fluid Dynamics (CFD) simulations. The main goal is to emphasize potential improvements of the aerodynamic performances. The simulation is divided into several steps, starting with the vehicle geometry (Computer-Aided Design, CAD), then the workspace can be divided into small elementary volumes (the mesh, to apply the method of Finite Volume Analysis), and eventually we will be able to analyse our results.

Results

We carried out two different simulations: 2D and 3D. The idea is to start with the less consuming case (2D) in order to get a first idea of the aerodynamic performances. We focused our results on two important variables in aerodynamics. The first one is the drag coefficient (a dimensionless quantity which is used to quantify the resistance of an object in a fluid environment, n.b. air): the lower the coefficient, the better the aerodynamic performance (figures 1&2). We also have to observe the impact of eddies at the rear and how the geometry of the vehicle may force them to change (figures 3&4). The project targets a more efficient vehicle by reducing the drag coefficient by means of flow management solutions.

Keywords: aerodynamics, simulation, drag coefficient, eddies
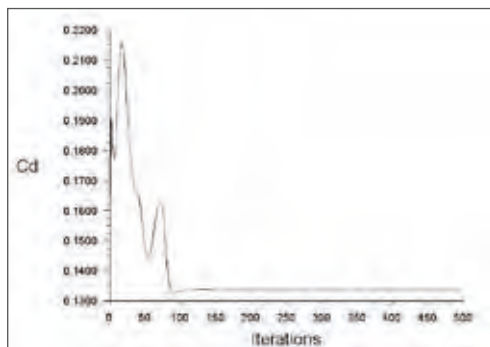
Eddies (3D)

Eddies (2D)
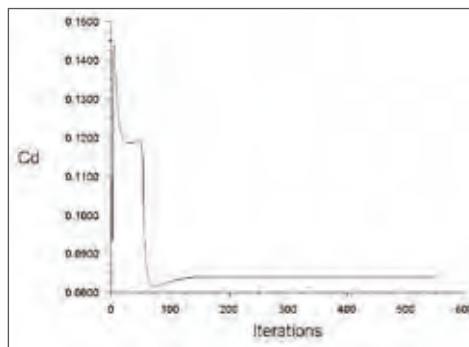
Drag Coeficient (2D)

Drag coefficient (3D)
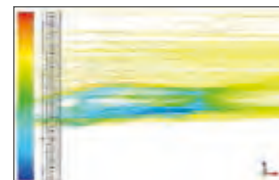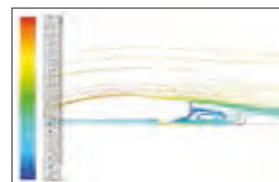
Contact: mickael.brunet@etu.univ-orleans.fr ; florian.casaurang@etu.univ-orleans.fr

Analysis of local non-equilibrium on heat transfer exchanges in porous media

Mechanical engineering

Julie CARDIN / Florian ERMACORA
Academic supervisor: I. FEDIOUN
Industrial supervisor: M. BOUCHEZ

Company: MBDA France

Objective/motivation

For several years in Europe, intensive research has focused on the study of Mach 6 civil aircraft (Paris to Sydney in 4 hours). A challenging issue is the cooling of the nozzle and of the wall of the combustion chamber of the engine. A possible technology is to use a porous panel for wall transpiration, hence reducing the wall temperature. The aim of this project is to analyze the flow and heat transfer across a porous medium by numerical simulation and to study the impact of thermal non-equilibrium between the solid phase and the fluid phase inside the porous material. The prototype flow is taken from an experiment by Ouamar Rahli (PhD thesis, University of Aix-Marseille, 1997).

Results

The Ansys/Fluent software was used to simulate a porous medium as designed in the thesis. A 2D model was set up in which a liquid (pentane) was flowing through two layers of heated porous medium (bronze or glass). As a first step, the simulation was held in thermal equilibrium so we can obtain the same results as in the thesis but it was inconclusive. The second step consisted of doing the simulation in thermal non-equilibrium and studying the difference of results between the first and second steps. No significant difference could be observed since the flow velocity was rather low.

Keywords: porous medium, heat transfer, fluid mechanics, numerical simulation
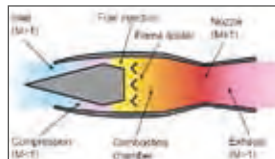
Ramjet engine
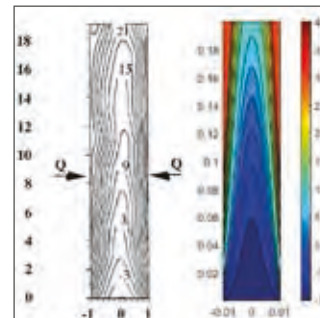
Comparison of the temperature fields between the thesis and our simulation
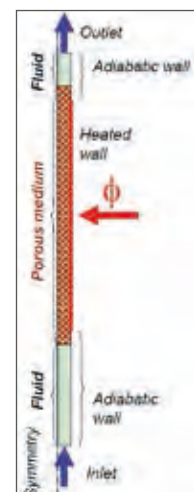
Experiment

Contact: julie.cardin@etu.univ-orleans.fr ; florian.ermacora@etu.univ-orleans.fr

Characterization of ramp (or flap) flow separation and its control

Mechanical engineering

Xavier LACHAIZE / Valentin MARTINEZ
Academic supervisors: A. KOURTA, N. MAZELLIER
Industrial supervisor: J-P. ROSENBLUM

V. MARTINEZ

Company: GDR 2502, Dassault Aviation

Objective/motivation

Companies are looking for ways to improve their products' fuel consumption. One of the many research fields involves characterization and control of flow separation to reduce drag. To improve aerodynamic performances, a synthetic jet was used to control flow separation on a ramp. A conventional jet sucks in air, accelerates this air, and exhausts the air out of a different opening, maintaining an airflow. In contrast, a synthetic jet alternates sucking in and blowing out air through the same opening at high frequencies. Thanks to a CFD software, Fluent, we will be able to simulate and model it correctly and then the reduction of the consumption will be assumed.

Results

Thanks to a script used as a model for the synthetic jet, we were able to choose the right frequency and amplitude to find the most effective case. These simulations will then be used by PRISME laboratory to do a preliminary work for their research. Nevertheless it is the simplest modeling for this jet. Therefore to obtain more accurate results it will be necessary to improve it and use a finer definition of this jet such as a moving piston or even better, a membrane that will oscillate like a real synthetic jet.

Keywords: CFD (Computational Fluid Dynamics), modeling, simulation, synthetic jet

Contact: xavier.lachaize@etu.univ-orleans.fr ; valentin.martinez@etu.univ-orleans.fr

Cooling of a combustion chamber for a hypersonic aircraft

Mechanical engineering

A. BETHRY

S. BLANCHARD

Alexandre BETHRY / Simon BLANCHARD
Academic supervisor: I. FEDIOUN
Industrial supervisor: M. BOUCHEZ

Company: MBDA France

Second Place
10th Annual Final Year Projects Forum

Objective/motivation

For several years, the European Research program ATLLAS-II has been ongoing. Its aim is to study and develop technologies in order to build a Mach 6 civil aircraft, which will be able to fly from Paris to Sydney in three hours. MBDA and ONERA (the French aerospace lab) are involved in this project, with the task of finding a process to cool down the walls of the combustion chamber for this future hypersonic plane. Indeed, such high speeds lead to high temperatures and the walls of the engine could melt. MBDA Bourges has been collaborating with Polytech Orléans since 2008, proposing projects on this issue to students. This year's work is strongly linked to the previous ones. The aim is to build and analyze by numerical simulation the cooling of the engine thanks to cold nitrogen flowing through a multifunctional porous material customized sandwich structure.

Results

The ANSYS-Fluent® multi-physics software has been used to simulate an experimental panel developed and tested respectively by MBDA and ONERA. The first two weeks were dedicated to getting familiar with the topic by simulating some simple cases, mainly with the porosity configuration. Then, a spheres cluster has been built and simulations have been conducted in order to simulate the "real" porous material. It has been shown that it is possible to reproduce it numerically. Finally, a small part of the industrial hypersonic METHYLE (Moyen d'Essais de Technologies Hypersoniques Longue Endurance) test facility used at MBDA Bourges-Subdray to test the panel has been reproduced on the software and good tendencies have been obtained.

Keywords: scramjet, propulsion, fluid mechanics, numerical simulation, porous material
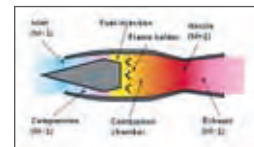
Scramjet functioning
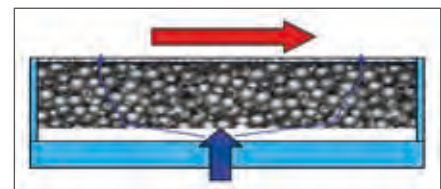
Cooling process
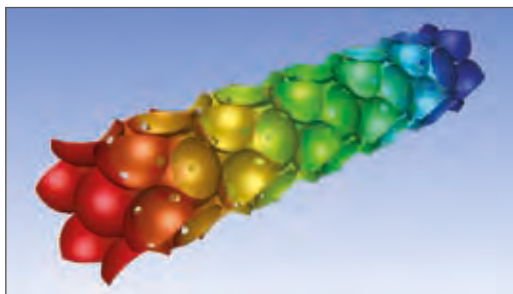
Pressure field through the porous material
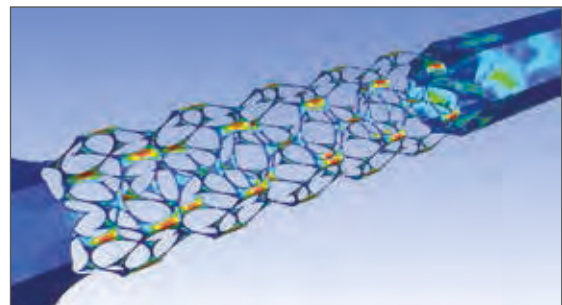
Velocity field through the porous material

Contact: alexandre.bethry@etu.univ-orleans.fr ; simon.blanchard1@etu.univ-orleans.fr

Eco-driving: comparison simulation and experiment

Mechanical engineering

Thomas FOLLAIN / Arnaud GLORIAN
Academic supervisor: G. COLIN
Industrial supervisor: K. GILLET

T. FOLLAIN

A. GLORIAN

Institution: PRISME Lab

Objective/motivation

Today, CO_2 emissions are a topical issue and are mainly emitted by the transport sector. Car manufacturers are thinking about designing new technologies that allow vehicles to reduce their consumption in order to meet the standards decreed by governments. One solution to reduce fuel consumption is to use new technologies (e.g. engine downsizing or hybrid electric vehicle). As a complement to these norms and these technologies, every driver has to adopt an eco-friendly driving behavior. Eco-driving involves travelling the same course in the same time while consuming as little fuel as possible. In order to this, an algorithm, developed by PRISME Lab, allows generation of vehicle speed cycles that enable the lowest consumption of the vehicle on a given course with distance and time constraints. The aim of our project is to study the complexity of implementing this algorithm output on an engine test bench.

Results

The eco-driving cycles from the algorithm (figure 1) are run on the test bench (figures 2 and 3) and reveal fuel savings of around 10-15 %, by using the engine braking (engine is still clutched when decelerating, and the friction inside the engine brakes the vehicle). During the phase of constant speed, a phenomenon named "pulse and glide" appears (figure 1), which is an alternation of acceleration and deceleration in order to take advantage of the inertia of the vehicle. These accelerations must be close to the full throttle in order to reach the best efficiency and reduce fuel consumption (figure 4). In order to get coherent results and to have a convergence between the results of the algorithm and the test bench, we worked on the acceleration phases to compensate delay because of the dynamics of the engine, and modified the road law of the vehicle in order to correct the engine braking decelerations.

Keywords: eco-driving, engine, gasoline, consumption, algorithm
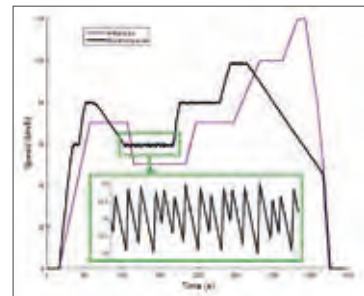
Figure 1 : Comparison between eco-driving speed cycle and initial speed cycle

Figure 2 : High dynamics engine test bench with a 250 kW generator

Figure 3 : Group of students working on the engine test bench console
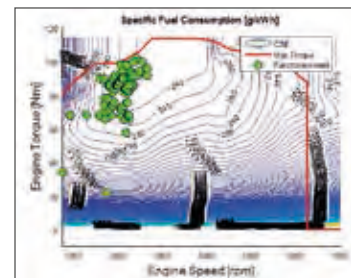
Figure 4 : Specific Fuel Consumption map with operating points of the eco-driving cycle in green

Contact: thomas.follain@etu.univ-orleans.fr ; arnaud.glorian@etu.univ-orleans.fr

Energy optimization in a building

Energetics

Nicolas BERTHOLIER / Hermann KUETAT NGADJA
Academic supervisor: J-M FAVIE

**Selected participant
10th Annual Final Year Projects Forum**

N. BERTHOLIER

H. KUETAT NGADJA

Objective/motivation

Today, the world has to face environmental problems such as global warming, biodiversity losses, reduction of fossil fuels stock, and increase of greenhouse gas emissions. In order to take up those challenges, an energy transition is inevitable. This means changing both human habits in terms of energy consumption and imagining an environmentally responsible way to produce energy. In the framework of the European policy related to environment known as "agenda XXI", a pedagogical house is going to be built in Chateauroux. The main purpose of this construction is, first, to show the differences between existing habitats and upcoming buildings in 2020 in terms of thermal comfort and energy management. Second, it will make the public aware of the concept of energy efficiency. Finally, it will provide real-life experiments for students and teachers.

Results

To reduce the energy consumption of the building, walls have been insulated using bio-based materials like wood fibre, cellulose wadding, hemp and straw. These materials allow the heat requirements to be reduced to 18.75kWh/m²/year. To reach the comfort temperature inside the building during the whole year and to fulfil the electrical needs, energy has been produced thanks to thermal panels coupled with a geothermal heat pump and a stirling engine. Moreover, we used a Canadian well coupled with a double flux CMV. However, because of the intermittency of the solar energy source, inertial storage tools have to be sized to suit our needs. We used a water tank to store thermal energy and also a hydrogen tank to store electrical energy. Finally, our building does not need any external energy supplier during the entire year. Full autonomy has been reached.

Keywords: renewable energy, energy transition, autonomous building, comfort, dynamic control
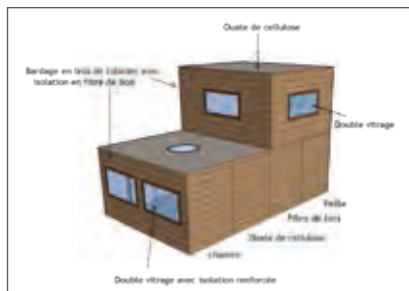
Building located in Chateauroux
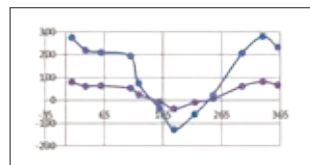
Energy consumption during the year
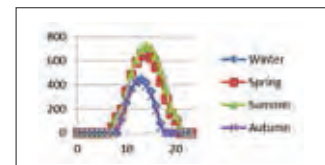
Power of the sun during a day

Contact: nbertholier@yahoo.com ; kuetathermann@yahoo.fr

Helicopters: performance enhancement

Fluid mechanics

Alexis SANJAIME / Guillaume SIROT
Academic supervisors: A. KOURTA, N. MAZELLIER

**Selected participant
10th Annual Final Year Projects Forum**

Company: Airbus Helicopters

A. SANJAIME

G. SIROT

Objective/motivation

This project was requested by Airbus Helicopters after test pilots recorded abnormal amounts of vibration at cruise speed. The point of this project is to highlight the existence of periodic vortices in the wake of a helicopter and their influence on its tail. Once the production area of vortices is identified, new studies will be conducted. Such physical phenomena can be controlled using passive or active aerodynamics systems. In the end, this project will improve comfort and security and also reduce drag, vibration and environmental pollution (sound emissions and pollutants).

Results

Two bluff bodies are used to represent simplified versions of the fuselage. The rotor hub is also simulated using a basic cylinder shape. Both 2D and 3D simulations are conducted. These simulations have provided evidence of different existing structures in the wake of the bodies: vortices areas, tip vortex, horse shoe vortex (as shown in the figures). Depending on the shape of the bluff body, several phenomena appear. In both cases, a massive depression is found in the wake of the body. Depending on the geometry, however, other phenomena can be witnessed. Recirculation areas and vortices appear and reduce aircraft efficiency. These results highlight the initial problem. Now, new studies should be conducted using detailed 3D models and the tail of the helicopter, and these studies should take into account the incidence of the helicopter.

Keywords: helicopters, CFD, vortices, turbulence, wake
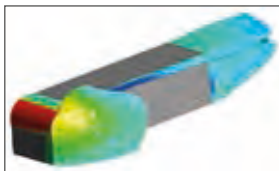
D shape body - Q criterion

Coloration of the Q criterion with the V velocity
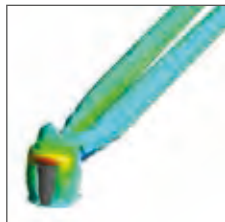
Horse shoe vortex around a cylinder – Q criterion
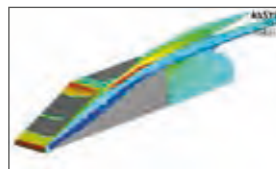
Sharp shape body – Q criterion

Contact: alexissanjaime@gmail.com ; sirotguillaume@gmail.com

Optimal energy management for a hybrid electric vehicle: towards an analytical solution

Mechanical engineering

Jiang CHANG / Edwin SOLANO
Academic supervisor: G. COLIN
Industrial supervisor: S. HADJ-SAID

J. CHANG

E. SOLANO

Company: Renault

Objective/motivation

Renault is looking forward to developing hybrid electric vehicles (HEV). The company wants to assess the impact of the powertrain dispersion on the performance of the energy management law. Therefore, the aim of this project is to take into account the engine dispersion in the energy management law in order to improve its robustness. To provide this strength, the calculation of the sensitivity of the control solution is required. However, this calculation seems to be very complex or even unfeasible for nonlinear models. Hence, the use of simplified and differentiable models in solving the optimal control problem is highly attractive. In this project, the considered vehicle will be a power-split HEV, the Toyota Prius 2 of Polytech Orléans.

Results

Based on data measured on the real vehicle, a simplified model of Prius 2 was constructed which is capable of achieving similar performance on a given mission (here, the standard cycle NEDC). This model contains four principal components: the mission, the Energy Management Strategy (EMS), the vehicle and the measurement. In the EMS bloc, the Pontryagin's minimum principle (PMP) was used to find the optimal control strategy for rotational speed of the motor-generator and for torque of the traction machine. In the end, the consumption achieved in the simulation is very close to that of the real vehicle.

Keywords: Energy Management Strategy, hybrid electric vehicle, power split modelling, Pontryagin maximum principle

Prius II of Polytech Orléans
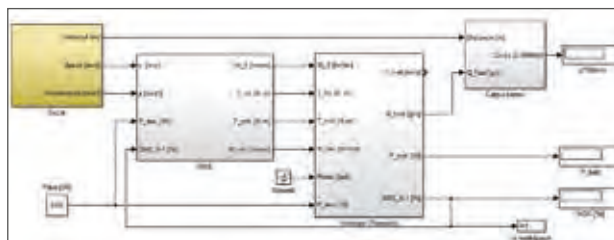
Built model of PRIUS II on Simulink
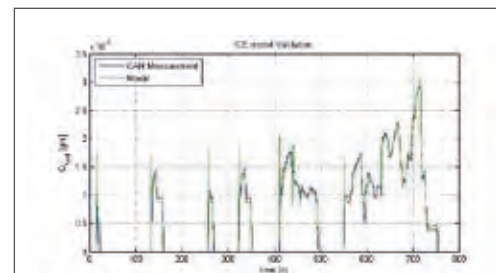
Comparison between model simulation and experimental data for fuel consumption

Contact: jiang.chang@etu.univ-orleans.fr ; edwin.solano-araque@etu.univ-orleans.fr

Study and analysis of technical solutions for thermal and hydric regulation in a production hall

Energetics

Alexandre MAZELINE / William RICHARD
Academic supervisor: J-M. FAVIE
Industrial supervisors: G. CONCHON, G. POCLET

Company: MSL Circuits

Objective/motivation

MSL Circuits (based in Meung-sur-Loire) is a specialist in electronic sub-contracting sectors for the automotive industry, energy management and medical field. To produce efficient electronic circuits, they need some special confines in temperature, hygrometry and suppression. Furthermore, their production chains work around the clock. So in the bill of specifications, the firm set extreme climatic conditions to foresee outside temperature during summer.

Results

To improve their regulation of temperature and hygrometry, we analysed their present energetic and air treatment systems. We made a static balance of power to have the results for the worst situation possible. Then we made it for dynamic simulation which is closer to the actual situation because it takes thermal inertia into account. We provided three solutions to resolve their problem. The first one by adding cold power on rooftop with the AHU, the second one by a better use of their actual equipment and the last one with a zoning implementation. This third solution should be combined with the second solution to have a better power efficiency.

Keywords: AHU (Air Handling Unit), thermic, air treatment, heating pump

Contact: alexandre.mazeline@etu.univ-orleans.fr ; william.richard@etu.univ-orleans.fr

Study of a lean air/gas mixer for cogeneration engine

Mechanical engineering

Jiahao ZHANG / Jingren ZHOU
Academic supervisors: P. BREQUIGNY, F. FOUCHER
Industrial supervisor: E. MOUILLE

J. ZHANG

J. ZHOU

Company: NAODEN

Objective/motivation

Syngas is recognized as a viable energy source worldwide. Naoden, a startup from Nantes created in February 2015, has found a syngas from the thermochemical conversion of wood. Having difficulties in finding the equipment adapted to this kind of syngas on the motor of 30kVA in the market, Naoden is planning to develop its own solution on the basis of petrol engines available on the market. Thus, they are hoping that we will be able to design a mixer which can meet their demands. The target of the project is to identify state-of-the-art equipment in this area (existing products, conducted theses, etc.) and to model a venturi mixer and also carry out a flow simulation.

Results

We decided on a venturi mixer as the prototype to mix air and syngas. First, seven English papers were selected to give to Naoden and different aspects affecting venturi have been considered, such as the pressure inlet and outlet, the flow rate of air, the air-fuel ratio, etc. After that, those parameters in working conditions were calculated via the Bernoulli equation and the Navier-Stokes equation. Afterwards, a 3D model of the venturi has been drawn in Creo and meshed in the workbench and we have carried out the flow simulation in Fluent. After comparing the images, an optimized design of venturi gas mixer has been made, which gives good mixing quality.

Keywords: Venturi mixer, syngas, flow structure, mixing quality, CFD
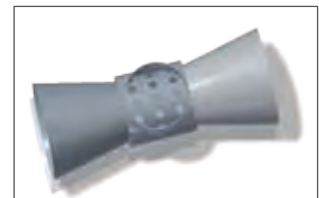
Venturi (92mm) structure
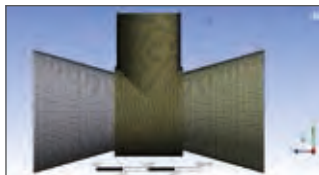
Mehing fluids (D92mm)
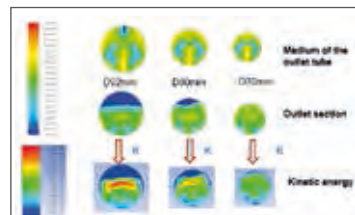
Mass fraction syngas and kinetic energy
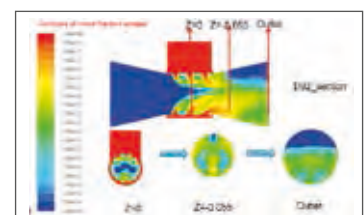
Mass fraction syngas in the venture (D92mm)

Contact: jiahaozhang1990@gmail.com ; chou.bien@gmail.com;

Study of an innovative wind turbine

Mechanical engineering

T. DUBOIS

M. RENOUL

Tanguy DUBOIS / Maxime RENOUL
Academic supervisor: P. DEVINANT
Industrial supervisor: A. CREVEAU

Company: ALTINNOV

Objective/motivation

The aim of this project is to do a feasibility study of an innovative wind turbine using a vertical wing settled on a mast. The concept is to use the flutter create by the wing to create a self-entertaining movement which will be converted into electrical energy by a transformer and a generator. After that, the second objective is to optimize the different parameters of the wind turbine, both mechanical and geometrical, in order to produce at least as much energy as a classic horizontal axis wind turbine. Moreover, this new shape could avoid many flaws of classic wind turbines such as their impact on the landscape, the cost of maintenance, the negative impact on birds and the use of an alternative power source for starting.

Results

The result of this study is a mathematical system of mechanical equations used in an encoded program on Matlab which provide for the behavior of the wind turbine. The oscillations of the wing are then translated into mechanical power as a torque. The parametric study has shown that depending on the value of the friction between the two corps of the wind turbine, the flutter may diverge into larger and larger oscillations or be neutralized as the functioning of a weather vane. However, in certain cases, oscillations of the wing can evolve into an equilibrium state and so furnish a constant source of energy. The next step of this project would be to create a prototype with optimized parameters and study the real behavior in a wind tunnel in order to validate the numerical behavior established previously.

Keywords: aerodynamics, energetics, matLab, simulation, wind turbine
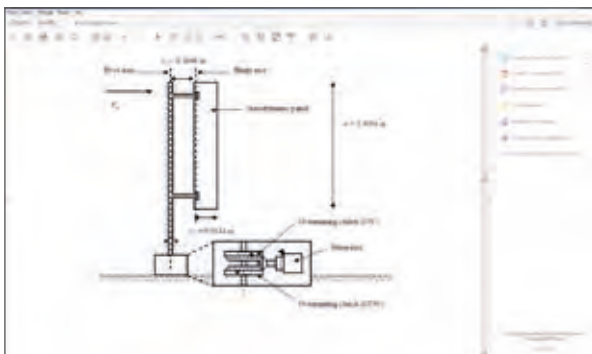
Side view of WF (not to scale)
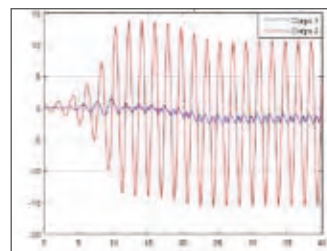
Oscillations of the two corps of the wind turbine

Contact: tanguy.dubois@etu.univ-orleans.fr ; maxime.renoul@etu.univ-orleans.fr

The autonomous building of the future

Smart building

C. GAUDILLAT

C. GAUTHIER

Clotilde GAUDILLAT / Charly GAUTHIER
Academic supervisor: C. CAILLOL

POLYTECH
ORLÉANS
École d'Ingénieurs de l'Université d'Orléans

Institution: Polytech Orléans

**Selected participant
10th Annual Final Year Projects Forum**

Objective/motivation

Nowadays, the use of energy is identified as a major cause of environmental issues and global warming. That is why using new and green energies or more efficient heat producers is essential. Ensuring thermal comfort in buildings represents the major source of energy consumption. Because of that, the aim of this project is to develop a thermal model that can turn current buildings into energy-efficient buildings. At present, energy management systems in buildings, such as home automation, require many sensors and do not take into account the efficiency of heat or cold production systems. The objective here is to develop a numerical tool that can be used to maximize or to limit (depending on atmospheric conditions) heat transfers with the outside of the building, which is a free source of energy. This approach makes use of the indoor temperature measurement as unique sensor.

Results

Thanks to physical equations and to a direct numerical model on Matlab, the way the external elements impact the indoor temperature evolution can be simulated. To control the indoor temperature, the available energies have to be known. For that, theoretical curves of temperature evolution are computed in all the possible configurations, and compared with an experimental measurement from a physical model of a building. When numerical results match with experimental data, the external elements and how they impact the physical model are determined. This solution only requires one indoor sensor. Furthermore, the physical model can be used as a practical course for Polytech in which students will be able to control the effects of external sources of heat. When the impact of elements is known, the shutters or windows can be controlled to take advantage of the natural sources of power, or to stop their contributions.

Keywords: autonomous building, energy saving, reverse model, computer model
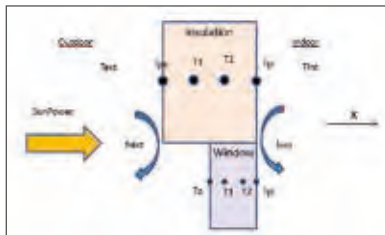
Representation of the thermal computer model
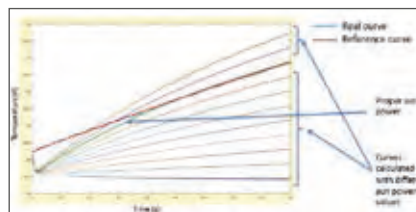
The determination of correct sun power

The physical model of building thermic behavior

Contact: clotilde.gaudillat@etu.univ-orleans.fr ; charly.gauthier@etu.univ-orleans.fr

Thermal modelling of a Heat Energy Storage System (HESS)

Energetics

Nicolas D'AURIZIO / Songqian LIU
Academic supervisors: C. CAILLOL, M. SIMONETTI
Industrial supervisor: C. DUMAND

N. D'AURIZIO

S. LIU

Company: PSA Peugeot Citroën, PRISME Lab

Objective/motivation

The main objective of this project is to recover wasted heat energy in internal combustion engines by using a HESS (Heat Energy Storage System). This work deals with the study of different HESSs of which the operating principle is to store thermal energy from hot gases, as close as possible to the cylinder exhaust exit, and to restore heat to a cold flow. Temporarily storing thermal energy through the augmentation of the internal energy of the solid requires a particular attention to the thermal inertia response of the HESS system. In partnership with PSA, some experimental tests have been conducted at PRISME laboratory. The first step of the project was to analyze pressure measurements on the test bench. The second phase corresponded to the heat transfer analysis, performed using Matlab software. Finally, according to numerical results, an assessment of storage efficiency was realized for all types of storage systems in order to identify the optimal geometry.

Results

A well-performed efficiency of the HESS corresponds to both a minimum pressure drop and a maximum thermal exchange between air flow and mass storage. First, according to experimental data, we classified all of the storage systems in terms of pressure drop. Second, we developed a thermal model in Matlab. Thanks to this model, we ran simulations by adjusting the model parameters in order to fit the numerical results with temperature measurements. The obtained temperature profiles indicated that the majority of the energy contained by the air flow is stored into the storage system. Finally, we hope that this project will help to design a better storage system and will lead to an industrial application.

Keywords: numerical simulation, thermal transfers, heat energy storage system, internal combustion engine.
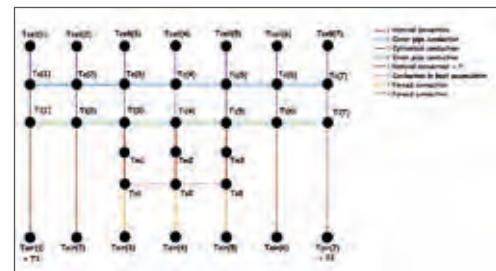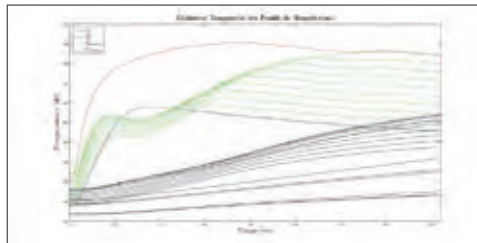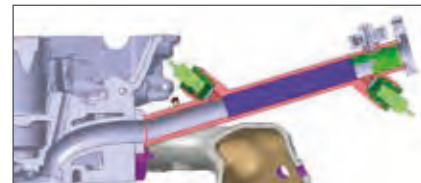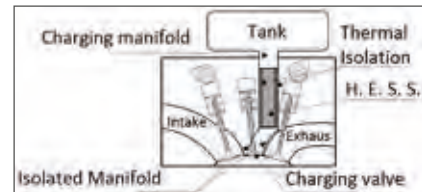
Contact: nicolas.daurizio@etu.univ-orleans.fr ; songqian.liu@etu.univ-orleans.fr

Vehicle model simulator improvement: model part

Mechanical engineering

P. PICOCHE

T. THIERION

Paul PICOCHE / Thomas THIERION
Academic supervisors: G. COLIN, A. CHARLET
Industrial supervisor: H. DUARTE

Company: John Deere
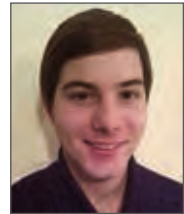
Objective/motivation

We have been working on this project jointly with John Deere. The aim is to develop a model to carry out most of the experiments on a high frequency engine test bench instead of on a tractor itself. This should result in a less expensive way to develop an internal combustion engine and its control. The proposed work is first to look at how the engine power is drained by accessories and the road itself and find out how to implement them with equations in a Simulink model. Then, this model, which represents the resistive forces all along the road we want to simulate, is compiled and run into a unit that drives the high dynamic test bench. Once the experiment is done, it will allow us to understand if the engine can drive the vehicle in all the required conditions and, if not, retune the engine control parameters.

Results

Our main goal is to improve the torque losses estimation, especially rolling resistance and hydraulic losses. The previous estimation of the rolling resistance was done with a simplified equation which is not adequate for a tractor. Hydraulic losses were simulated with a constant, which is false because it fluctuates with the engine speed. Our estimations will be completed with tests on a real vehicle. It was not possible to proceed to these tests, so we have prepared some files in order to help with future work. Meanwhile, we added a grip control depending

Result of a simulation with changing speed and road profile

on the slope of the road. The vehicle was able to move on a road with a steep slope, which is not real. Finally, this project will be very important for our careers because modeling will gradually replace tests, so it is a plus for engineers.

Keywords: engine, modelization, tractor, simulation.

Simulation model representing the tractor

The tractor to modelize

Contact: picoche.paul@live.fr ; thomas.thierion@etu.univ-orleans.fr

The Final Year Projects Forum

Each year, students who are completing their final year of studies at Polytech Orléans compete to participate in the Final Year Projects Forum under the direction of Jean-Jacques Yvernault. Students may present their projects individually or in groups, after which a selection is made by each department head of those projects which will compete before a jury of knowledgeable professionals from businesses and institutions in the wider community. During the Forum, each student or group of students presents the project over the course of an entire day, beginning with a general assembly during which a brief oral description and PowerPoint® presentation is made. This is followed by in-depth discussions with each jury member at individual stands constructed by the students, where they are able to give a more detailed explanation of their work. The jury selects and makes an award to each of the three best projects of the Forum.

The Final Year Projects Forum promotes the relationship between the school, its students and the business community and allows students to make direct contact with those companies who might wish to recruit graduates in their field.

For a list of all participants in the Final Year Projects Forum of 2015, please see page 143
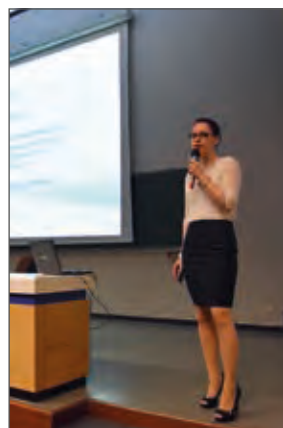
Our remarkable equipment

Wind Tunnel

The Lucien Malavard wind tunnel of the PRISME laboratory is used by Polytech Orléans students for aerodynamic systems studies typical of the automobile, aeronautics and environmental industries. Those who specialise in these fields have the opportunity to do their practical work and projects in this exceptional environment.

Clean Room

A class 10,000 clean room of 100m^2 is in service at the GREMI laboratory of Polytech Orléans. Students working in the Ecotechnologies, Electronics and Optics specialty carry out their practical work study projects in micro/nano-technologies and plasma processes in this facility.

Engine Test Benches

The engine test benches of the PRISME laboratory are used by Polytech engineering students and by students of the international Master's degree "Automotive Engineering for Sustainable Mobility" for projects and practical work in the fields of combustion, energy efficiency, pollutant formation and engine control.

Computer science labs and WiFi network

Polytech Orléans provides twelve self-service computer science labs with 300 computers and all necessary software for the use of its engineering students for lessons, projects, and personal work. WiFi access points are available in Polytech facilities and on campus for internet connection using laptop or tablet computers and smartphones.

Robots

Polytech Orléans has both industrial and domestic robots for use as part of the robotics coursework.

Material Mechanics Hall

Experimental devices in the Material Mechanics Hall of the PRISME laboratory are used by our engineering students during their projects to determine the mechanical behavior of innovative materials. This equipment may also be used to test materials such as woven composite reinforcements for aerospace and medical applications (biaxial tensile benches, benches to test shear, bending, wear and shaping) and materials in extreme conditions, such as ceramics for high temperatures with applications in new energies (mechanical test furnace for traction, compression, bending, and creep, under controlled atmospheres (nitrogen, argon, air) from ambiant temperature up to 1600°C).

Index of students

Index of participants in the Final Year Projects Forum

1st place
2nd place
3rd place

Index of participating businesses