European Project thinkMotion (2010-2013)

GDR Robotique -
GT6 Conception innovante et mécatronique
27 Juin 2011, ISIR
Journée Prototypage de robots

Robotique et bibliothèques numériques de mécanismes :

Le projet européen **thinkMotion**

au service du GDR Robotique
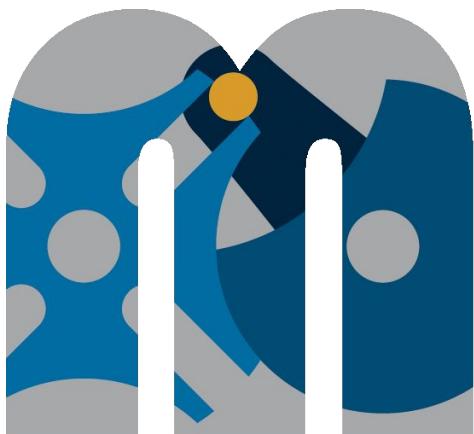
**Jean-Christophe.FAUROUX@ifma.fr**
Clermont Université
Institut Français de Mécanique Avancée (**IFMA**)
EA3867, FR TIMS / CNRS 2856
Laboratoire de Mécanique et Ingénieries (**LaMI**)
BP 10448, F-63000

*think*MOTION

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Présentation du Projet EU thinkMotion

Présentation

## Bibliothèque européenne de machines et mécanismes
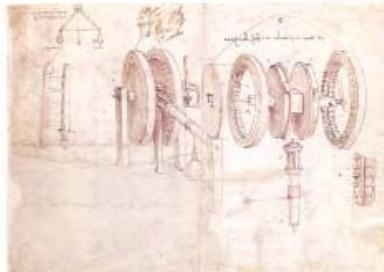
Problématique

- La plus grande bibliothèque numérique libre du monde dans le domaine des machines et mécanismes
- Héritage technique et historique européen
- Numérisation de documents très hétérogènes (textes, photos, vidéos, animations, dessins techniques, notes de calcul, modèles CAO, modèles multi-corps, etc.)
- Archivage multi-lingue et association de méta-données (réseau sémantique)
- Accès interactif pour tous depuis la bibliothèque numérique www.europeana.eu

Partenaires

- Ilmenau University of Technology
- University of the Basque Country
- Politehnica University of Timisoara
- RWTH Aachen University
- IFMA
- University of Cassino
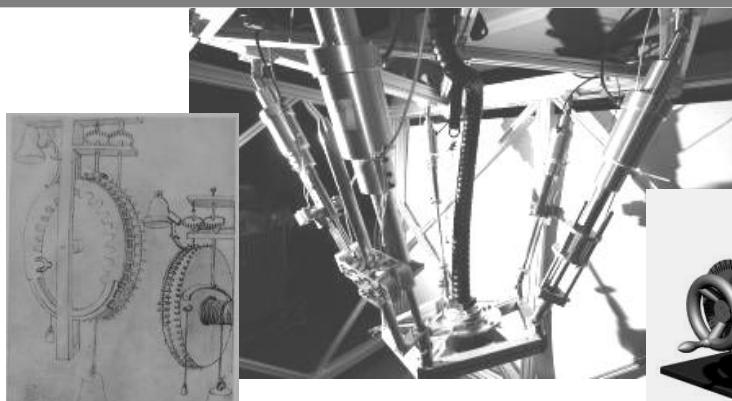
Structuration du Projet EU thinkMotion

Présentation

Juillet 2010 - Juillet 2013 → 3 ans
Digital Mechanism and Gear Library goes Europeana

Structure

- WP1 Coordination, project management and quality Assurance
- WP2 Adaptation of interfaces to Europeana
- WP3 Locating and providing relevant sources and clarification of rights of use
- WP4 Digitising heterogeneous input content
- WP5 Processing of digitised content and integration into DMG-Lib
- WP6 Entering metadata for content
- WP7 Collection and systematisation of information about important persons in mechanism science
- WP8 Multilingual translation of metadata
- WP9 Sustainability and exploitation
- WP10 Dissemination, awareness activities and staff development

Da Vinci

D'Alembert

Contribution FR

Mec. déployables

Portes

Pinces
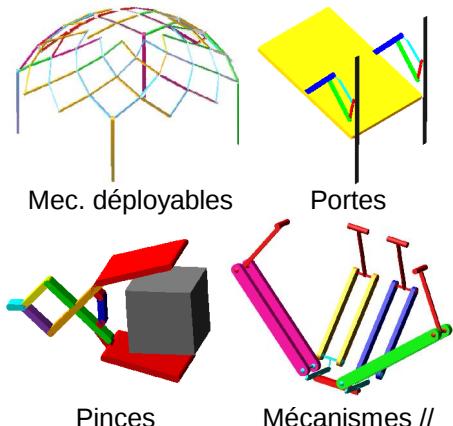
Mécanismes //

- Numérisation de contenu (WP4), intégration dans la base (WP5), saisie de méta-données (WP6) Ouvert à vos contributions
- Intégration et structuration de la base de mécanismes thématique MMS (plus 200 modèles CAO et multi-corps)
- Responsable du WP8 sur la traduction multi-lingue et contribution à l'élaboration d'un réseau sémantique basé sur la terminologie IFToMM
- Réflexion préparatoire sur un format neutre universel de représentation de mécanismes Ouvert à vos contributions

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Données quantitatives

76100 articles en 3 ans

- Texte — 27400
- Image — 37900
- Autre — 10800

Articles de type "Texte"

- Brevets — 20000
- Monographies — 2400
- Notices biographiques — 1500
- Articles de journaux — 1400
- Thèses — 1000
- Notes de calcul — 450
- Rapports techniques — 400
- Journaux — 200
- Notes de cours — 50

Articles de type "Image"

- Dessins issus de documents texte — 25000
- Transparents – Diapositives — 5000
- Modèles physiques — 2400
- Captures d'écran xAO — 2400
- Dessins techniques — 1800
- Photos — 1500
- Machines réelles — 1000

Articles de type "Autre"

- Animations interactives — 6000
- Films — 3600
- Modèles xAO — 1200

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thinkMOTION
DMG-Lib goes Europeana

www.thinkMotion.eu

✔ Site web juste créé www.thinkmotion.eu
✔ Intranet pour documents administratif et base de mécanismes
✔ Première réunion du comité de direction à Ilmenau les 7-8-9 septembre 2010 (Bouzgarrou, Fauroux, Turner)
✔ Prochaine réunion prévue : conférence nationale AIP PRIMECA organisée par l'IFMA au Mont-Dore 30 mars – 1er avril 2011
http://www.ifma.fr/aip-primeca/colloque2011

Projet Européen thinkMotion (2010-2013)

✔ Europeana est la bibliothèque numérique en ligne gratuite européenne (novembre 2008)
✔ Enjeux forts pour l'Europe en terme de rayonnement culturel et scientifique (contrer Google)
✔ Objectif : 10 millions de documents libres en 2010
✔ Nombreux liens vers 25 bibliothèques nationales
✔ Contenu technique déjà présent mais peu détaillé

www.dmg-lib.org

Page d'accueil

Livres animés

✔ DMG-Lib est la base de données de machines et mechanismes (« getriebe ») des universités d'Ilmenau, Aachen, Dresden.

✔ Contenu varié : ouvrages techniques (dont certains interactifs), animations, descriptions de mécanismes, biographies scientifiques...

✔ Langue principalement allemande

www.dmg-lib.org

✔ Les nouvelles fiches seront basées sur le format DMG-Lib

✔ Format évolutif en fonction des besoins (Ex : convoyeurs pôle SIL)

Fiches mécanismes

Notices biographiques

8

Projet Européen thinkMotion (2010-2013)

Aspects linguistiques

WP8

✔ 6 langues : anglais, allemand, espagnol, français, italien, roumain
✔ Chaque partenaire trouve dans sa langue...
✔ … puis les ajoute dans la base et les traduit en anglais

Proposed workflow

Item

Non Localized metadata
General data: Author, Date, Picture, Video,...
Technical data: DOF, degree of overconstraint...

Localized metadata
Title, Summary, Keywords

Metadata (DE) | Metadata (FR) | Metadata (UK) | Metadata (IT) | Metadata (SP) | Metadata (RO) | Metadata (RU) | Metadata (??)

Example

Generalization

Links towards parent-concepts

Concept

Non Localized metadata
Links to examples

Localized content
Definition

(DE) | (FR) | (UK) | (IT) | (SP) | (RO) | (RU) | (??)

Links towards son-concepts

1st 2nd

Validation metadata in two stages
1st is critical because having a good english translation from native language is compulsory for quality in other languages

Validation thesaurus
Coherence should be checked first
Translation in a second time
Every 6 months

✔ Gros travail de traduction : S3-Anglais + autres langues
✔ Besoin de prestataires extérieurs

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Partenariats

Partenariats bibliothèques

✔ **Bibliothèque du CEMAGREF** (http://cemadoc.cemagref.fr)
- Ouvrages des éditions CEMAGREF
- Patrimoine machines agricoles (N. Bouton)

✔ **BU Cézeaux**
- Equipe bibliothèque numérique (H. Veilhan + 6 personnes)
- Collecte de documents anciens (P. Rocher)
- Achat scanner à plat pour livres A3
- Mise en place flux BU ↔ IFMA
- thinkMotion parmi d'autres projets de numérisation
  (grand herbier Lecoq, littérature jeunesse)

Partenariats musées

✔ **Musée des Arts et Métiers** (www.arts-et-metiers.net)
- Intéressés pour une aide à la numérisation
- Disposent d'un fond ancien (cnum.cnam.fr)
- RDV jeudi 1er décembre à Paris

✔ **PATSTEC** (www.patstec.fr)
- recensement national du patrimoine scientifique et technique
- le musée Lecoq coordonne ce travail en Auvergne
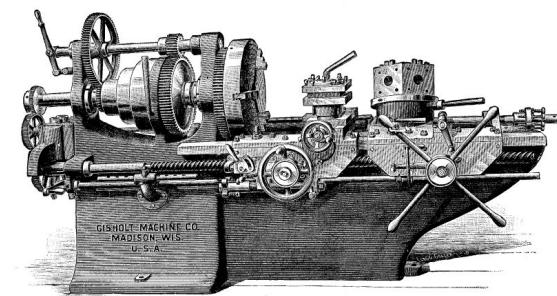
Fig. 230. — Tour à revolver de la Gisholt Machine Company, de Madison (E.-U.).

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The French Team in March 2011

Coordinator FR + Contributor

- IFMA (French Institute for Advanced Mechanics)
  http://www.ifma.fr

Libraries

- BCU Library (Clermont-Communauté Library)
  http://bibliotheque.clermont-universite.fr
- CEMAGREF Library
  http://cemadoc.cemagref.fr
...

Museums

PATRIMOINE scientifique et technique contemporain

- PATSTEC Auvergne
  www.patstec.fr
… (other contacts in process)

Labs

- LaMI
  www.ifma.fr/lami
… your lab ?

Universities

- Blaise Pascal University
  www.univ-bpclermont.fr
… your university ?

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Projet Européen thinkMotion (2010-2013)

People and tasks

- Librarians for selecting books
- A part-time technician for scanning books
- Several projects on digital libraries
- Important collections of old books on mechanical and civil engineering (more than 180000 pages)
- Full text and separate images

DIRECTION

BIBLIOTHEQUE

CLERMONT UNIVERSITE
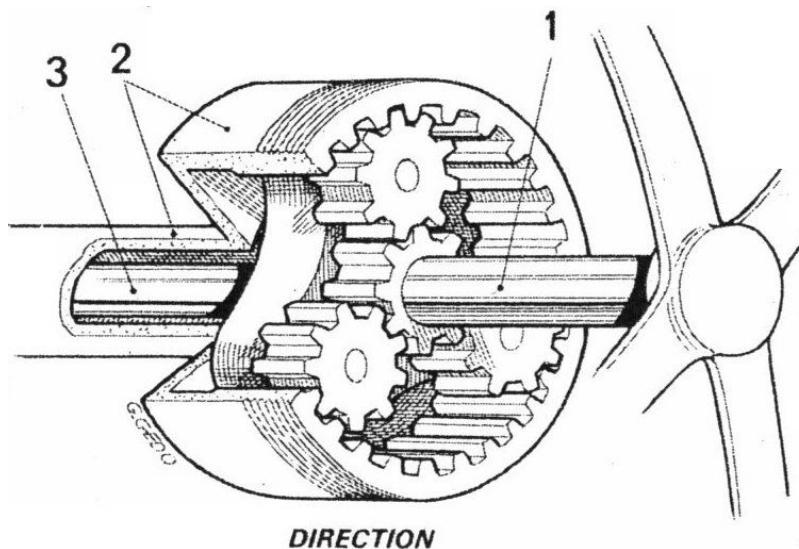
Hardware

- Book scanner Zeutschel OS12000 HQ
- Flat A2 format,
- 15 seconds for A2 Color 600 DPI
- Thickness / curvature compensation

Projet Européen thinkMotion (2010-2013)
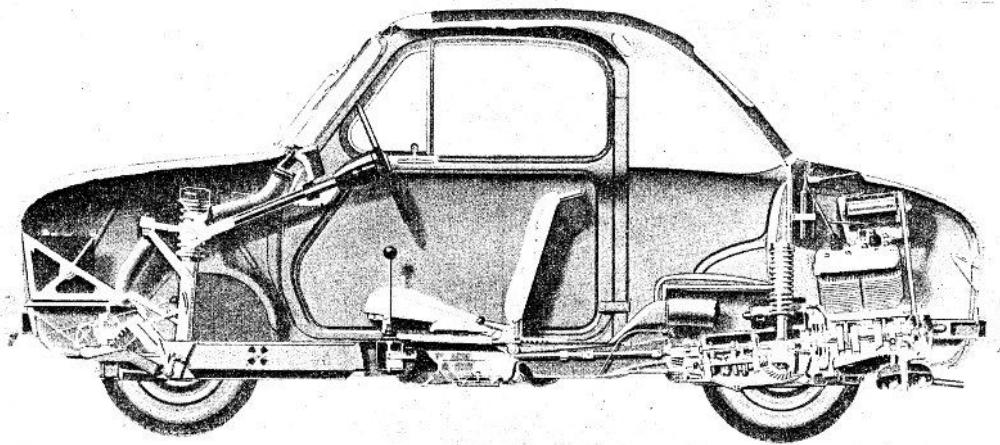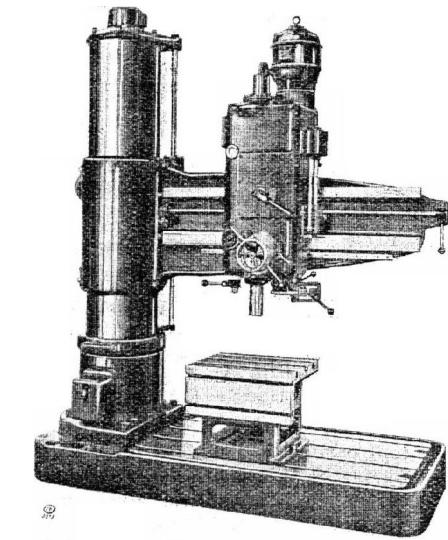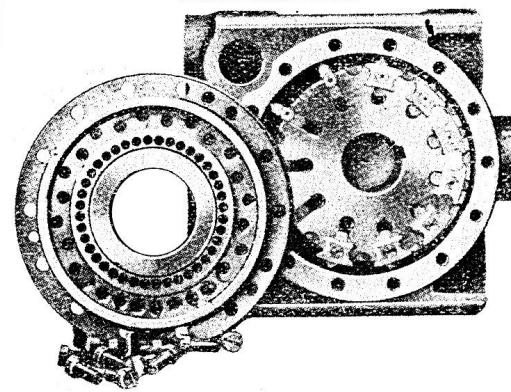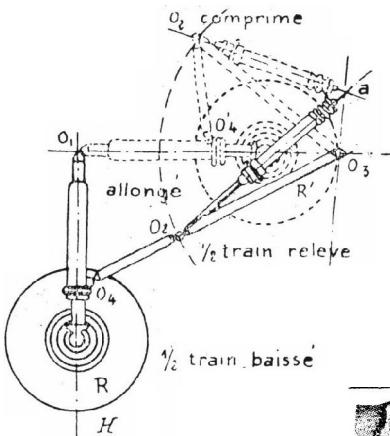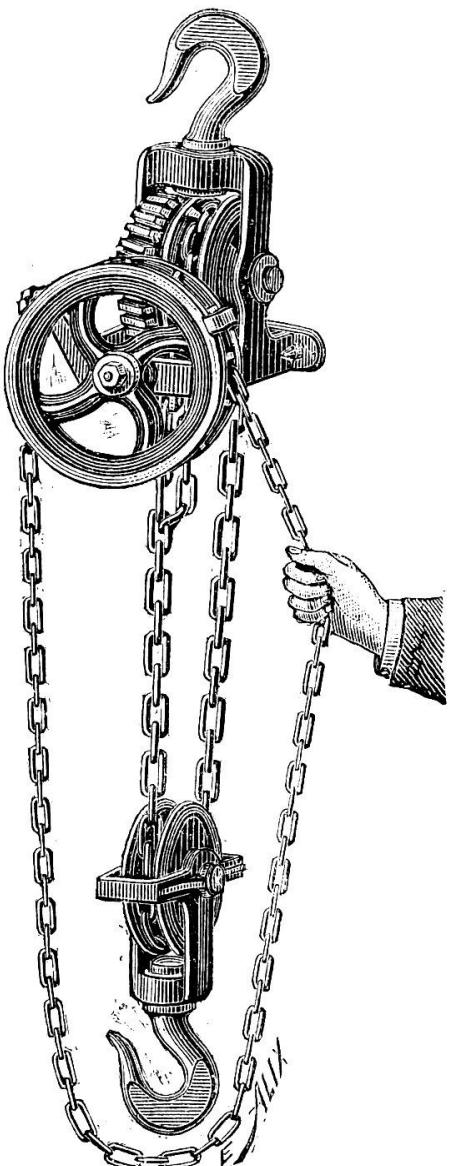
Contribution from the CEMAGREF Library

People and tasks

- Librarians for selecting books
- Exchanges with the central CEMAGREF library at Anthony
- Books and journals about agricultural machines

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Contribution from IFMA

People and tasks

- IFMA, French Institute for Advanced Mechanics (1991)
- Around 180 students per promotion x 4
- 3 departments

- Materials and Structures (St2M)
- Machines, Mechanisms and Systems (MMS)
- Industrial Engineering and Logistics (SIL)

- Already working on educational projects about machines
- Software : Adams and Catia V5

- **2003 – Mechanism for a windscreen wiper**
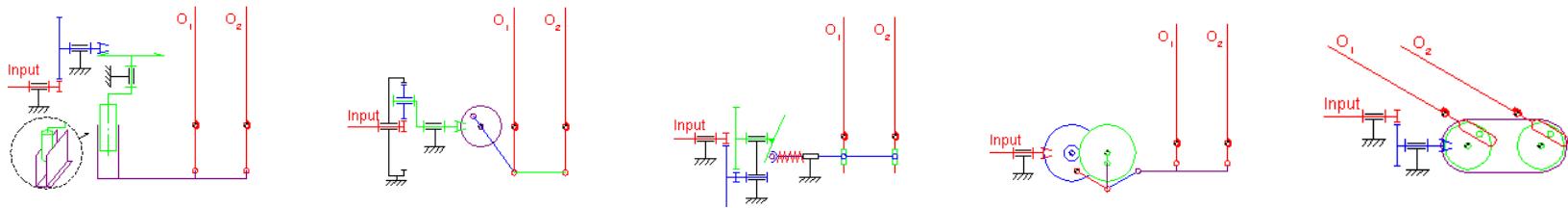
- **2004 – Two-finger robot hands**

Projet Européen thinkMotion (2010-2013)
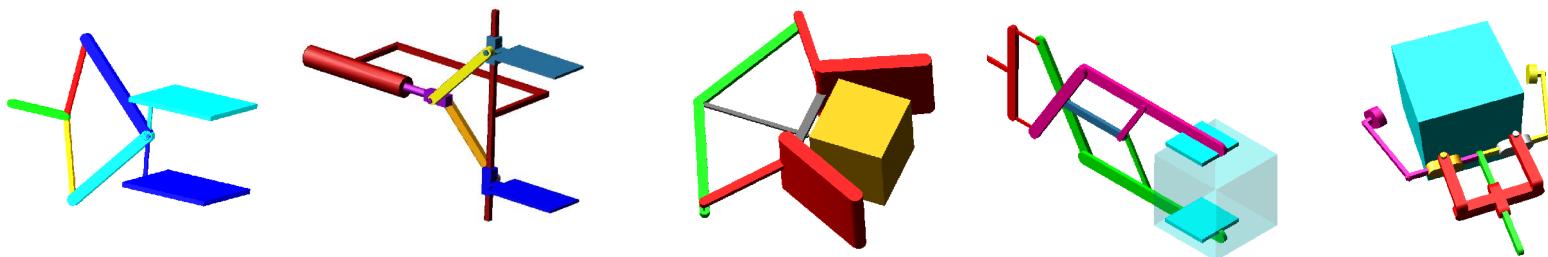
- **2005 – Parallel robots**
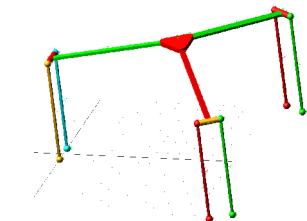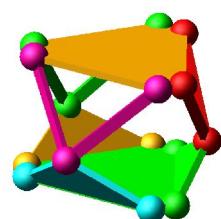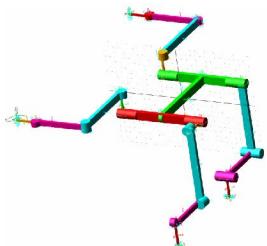
- **2006 – Foldable mechanisms**
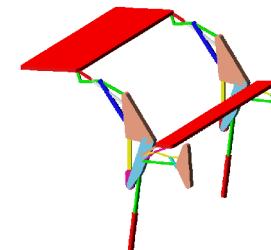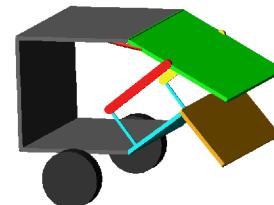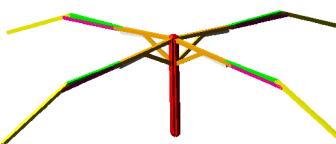
- **2007 – Doors and latches**
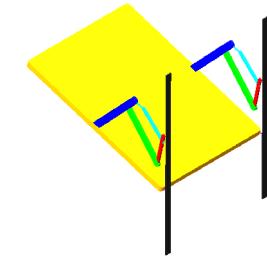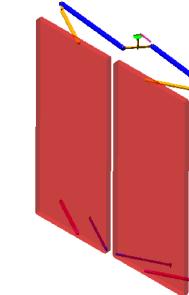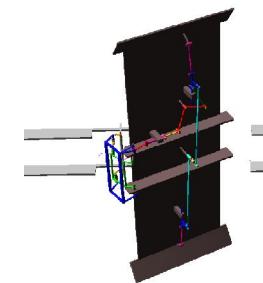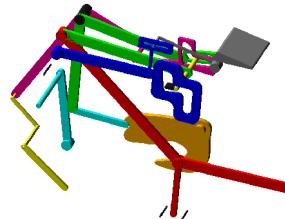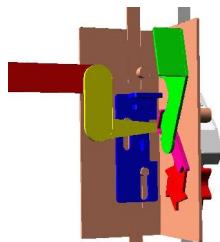
- **2008 – Elements of trucks**

Projet Européen thinkMotion (2010-2013)
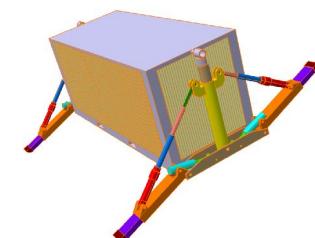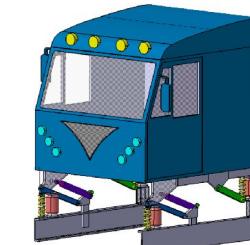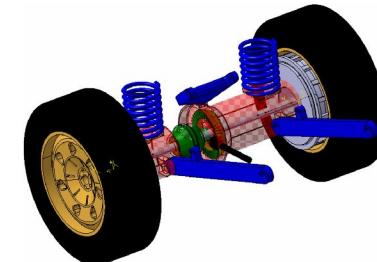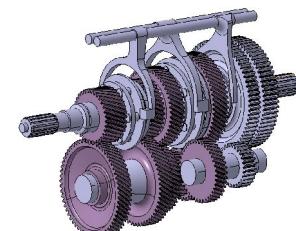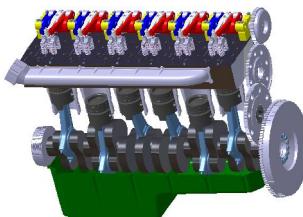
- Contribution 2A MMS
- Encadrement : Fauroux, Couden, Rabany, Guillaume, Touzet
- Provenace : IFMA, collection Ferri
- Mise en forme : Cousturier

IFMA
INSTITUT FRANÇAIS
DE MÉCANIQUE AVANCÉE

Batteur-mélangeur

Projet Européen thinkMotion (2010-2013)
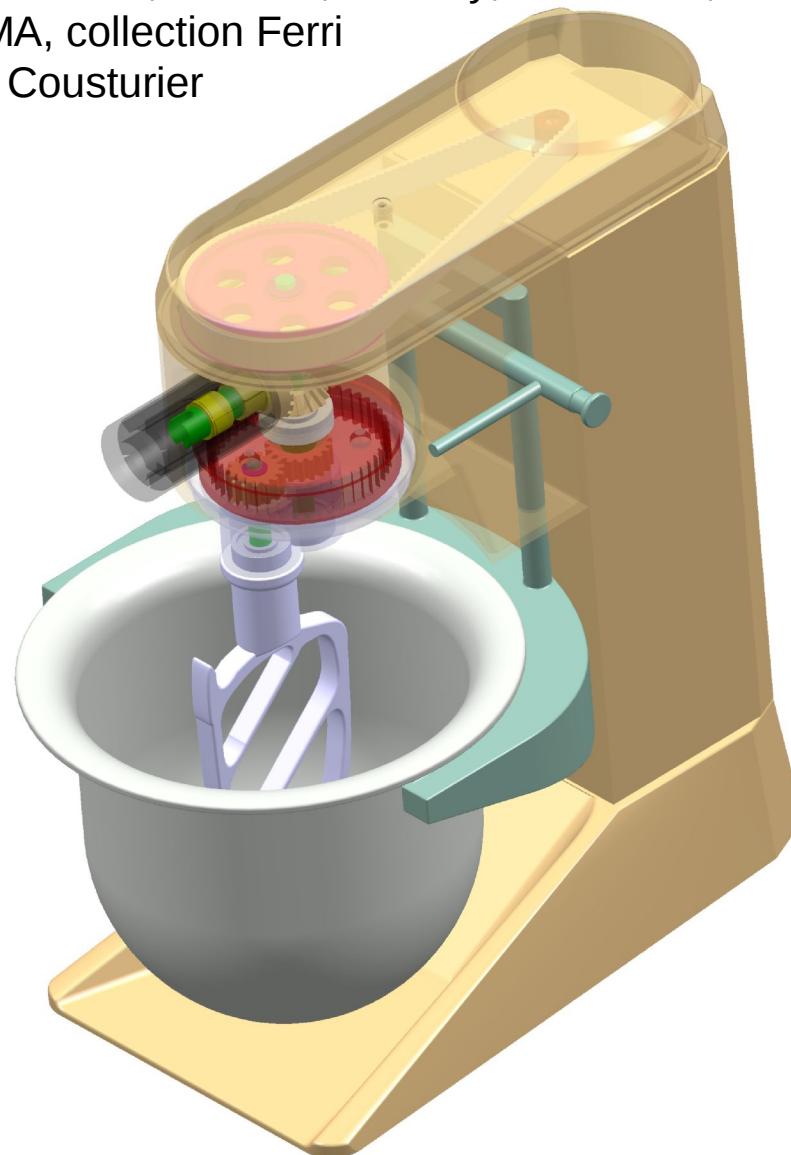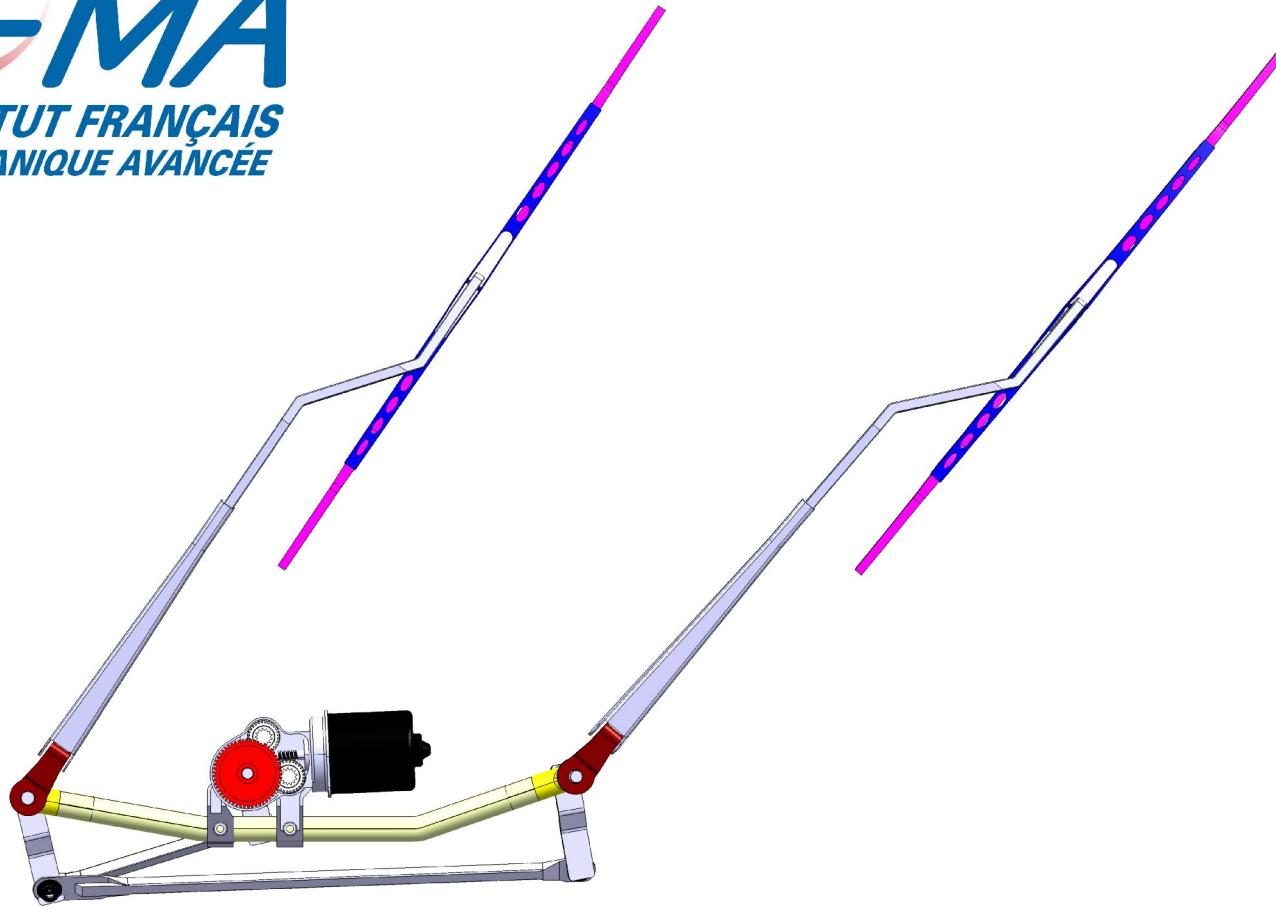
Essuie-glace bi-bras Valeo

Exemples : IFMA 2009
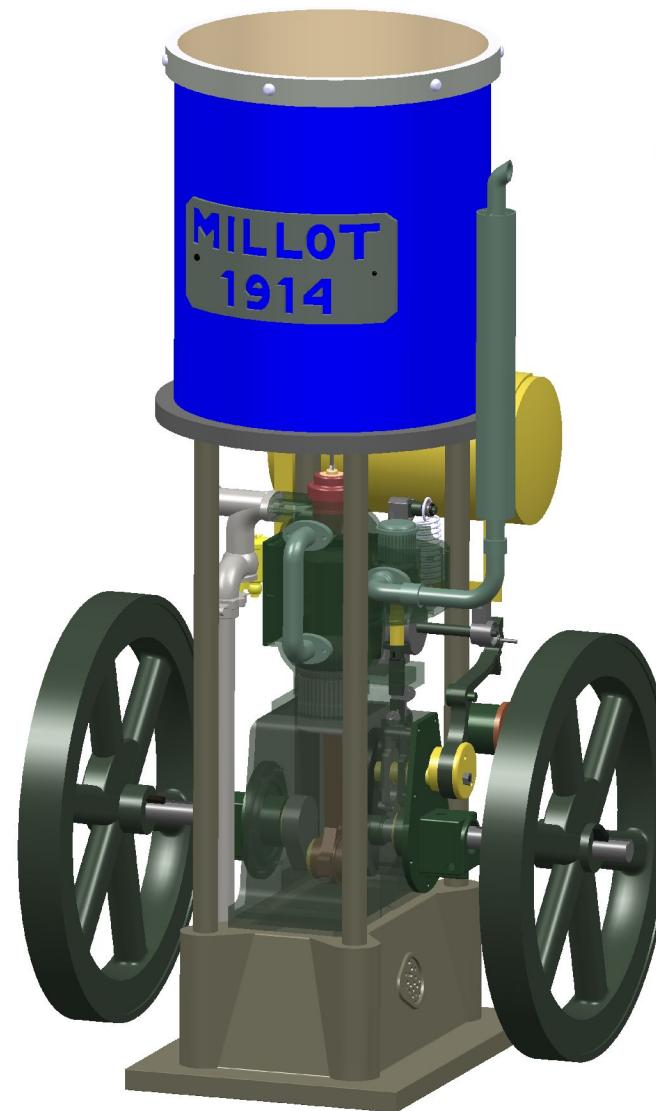
Moteur à poste fixe mono-cylindre Millot

Projet Européen thinkMotion (2010-2013)
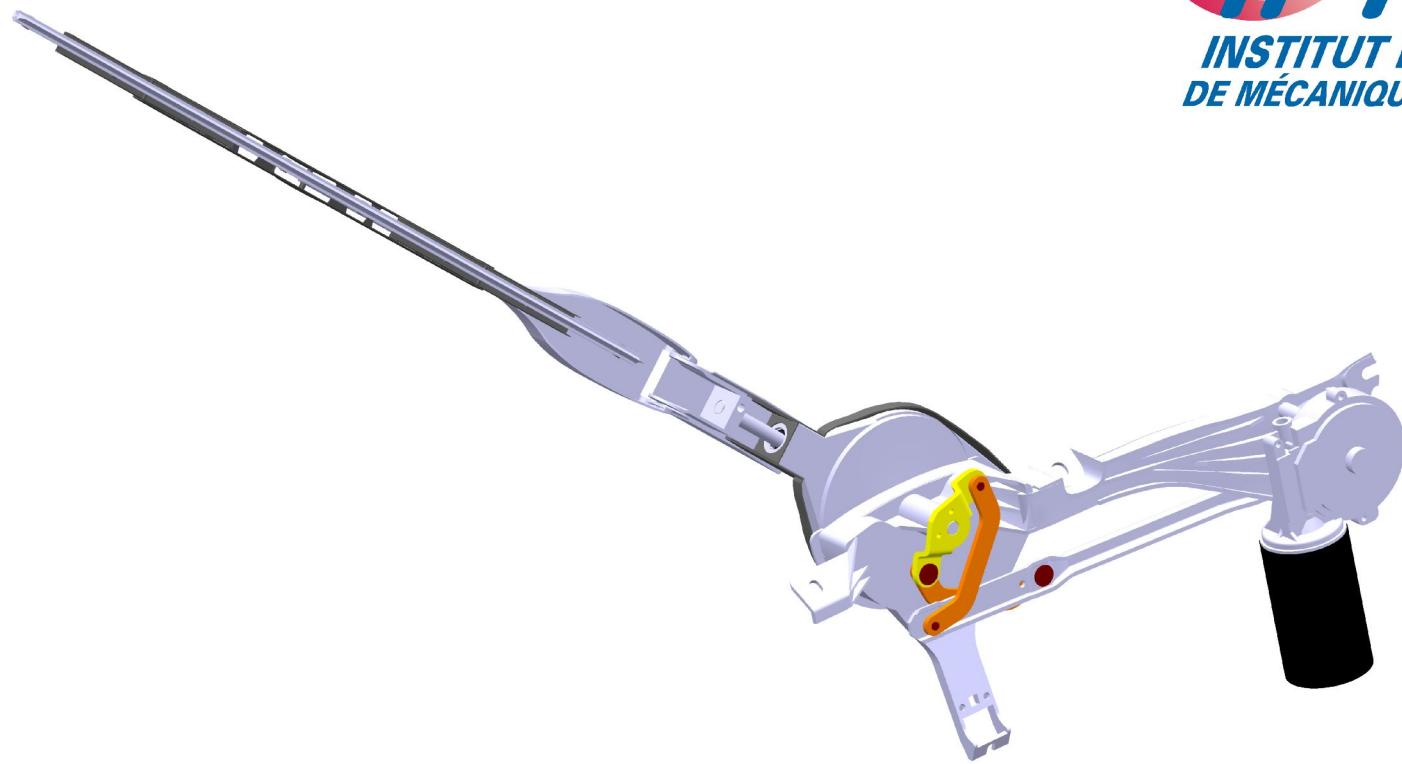
Essuie-glace mono-bras Bosch

Projet Européen thinkMotion (2010-2013)

- Contribution 2A MMS + PST
- Encadrement : Fauroux, Dréan, Bouzgarrou, Couden, Gogu
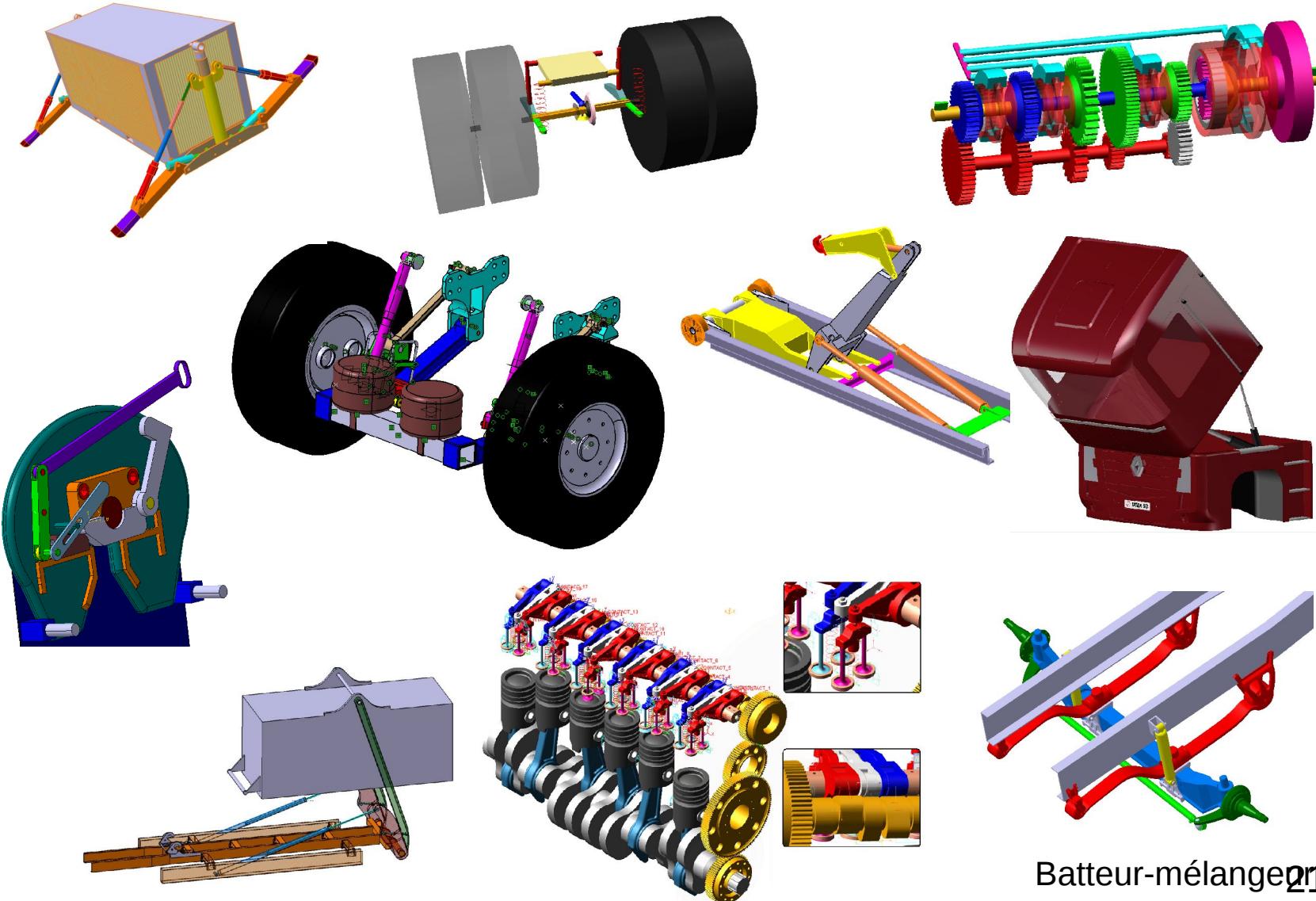
Batteur-mélangeur

Contribution from IFMA (cont.)

A federating project at IFMA

- Various contributors
- Adaptation to each type of lecture
- **First** :   Educational content
- **Second** :   Interest for thinkMOTION
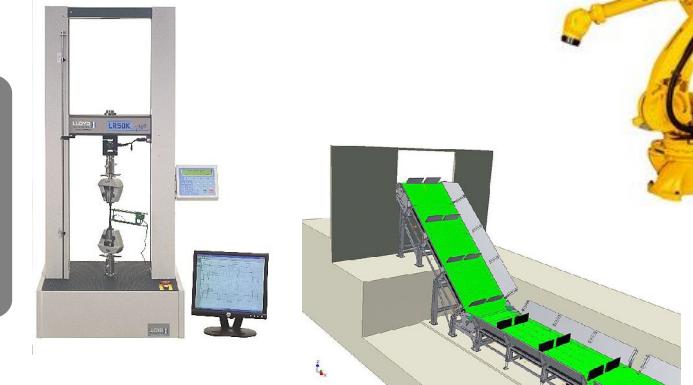
Tous pôles	Flux	Sujet
S3-Conception et Fabrication Assistée par Ordinateur	160 élèves	Dessin/Cinématique
S1-S2-S3-Anglais (CIME)	160 élèves	Traduction (machines, biographies)
Projet 2A	160 élèves	Etat de l'art (cassage noix, joug rugby...)
PIFE	160 élèves	Etat de l'art selon sujet

Pôle ST2M	Flux	Sujet
S4-Dimensionnement des structures et assemblages	24 élèves	Dimensionnement de parapluies

Pôle MMS	Flux	Sujet
S3-Ingénierie Assistée par Ordinateur	72 élèves	MEF / Optimisation de mécanismes
S3-Modélisation des Robots	72 élèves	Robots manipulateurs anthropomorphes
S4-Analyse et Synthèse de Mécanismes	48 élèves	Mécanismes parallèles hyper/isostatiques
S4-Analyse de Brevets	72 élèves	Machines

Pôle SIL	Flux	Sujet
S3-Robotisation et Automatisation	48 élèves	Robots industriels, convoyeurs
S3-Industrialisation et Mise en Production	48 élèves	Transitique

Creating a CAD exercise for thinkMOTION

CAD Exercise Rules

- Choose a patent (patents are free of copyright)

  - Understandable and **interesting**
  - Not too complex (≈10-20 parts)
  - With realistic shapes (for CAD interest)
  - From a European inventor

- One mechanism / One student → uniqueness → public claim on a Moodle forum + checking the thinkMOTION database
- Modeling / Parametrizing / Assembling / Animating
- Output :
  - CAD assembly (.ZIP)
  - Screen capture (.PNG)
  - Video (.AVI)
  - Mechanism description (form)
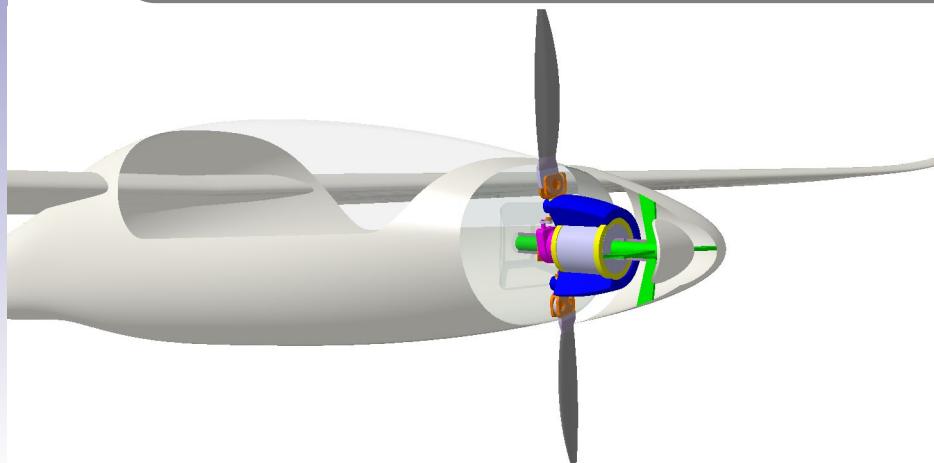
Re: Forum Travail de TP et projet thinkMotion
par LOUIS Nicolas, samedi 13 novembre 2010, 10:55

N° Brevet : US6550719B2

...ive device for aircraft
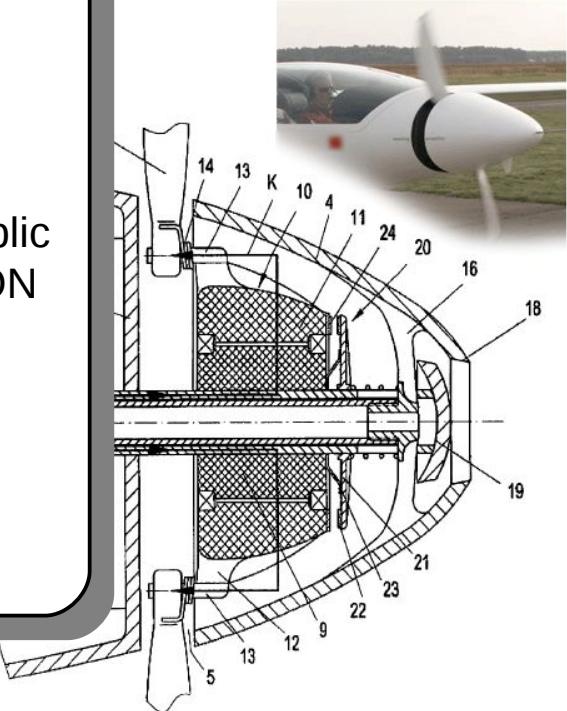
Niveau supérieur | Modifier | Supprimer | Répondre

Re: Forum Travail de TP et projet thinkMotion
par COUSTURIER Richard, lundi 6 décembre 2010, 16:45

validé

Niveau supérieur | Modifier | Supprimer | Répondre

Re: Forum Travail de TP et projet thinkMotion
par MENAND Alexis, samedi 13 novembre 2010, 18:18

MENAND Alexis, MMS3B
N° Brevet : FR2602474A1
Titre : Windscreen wiper unit for vehicle

Design project

- Ex : design project in 2nd year → 12 students
" Creating a crushing machine to extract argan nut " (K. Kouiss)
- Study of **existing crushing machines**
- **Patent research** on nut crackers / Market study
- Output :
  - Picture (.JPG)
  - Kinematic chain (vector format)
  - Mechanism description (form)

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Projet Européen thinkMotion (2010-2013)
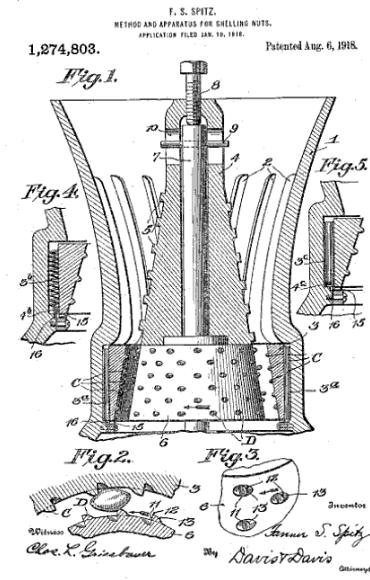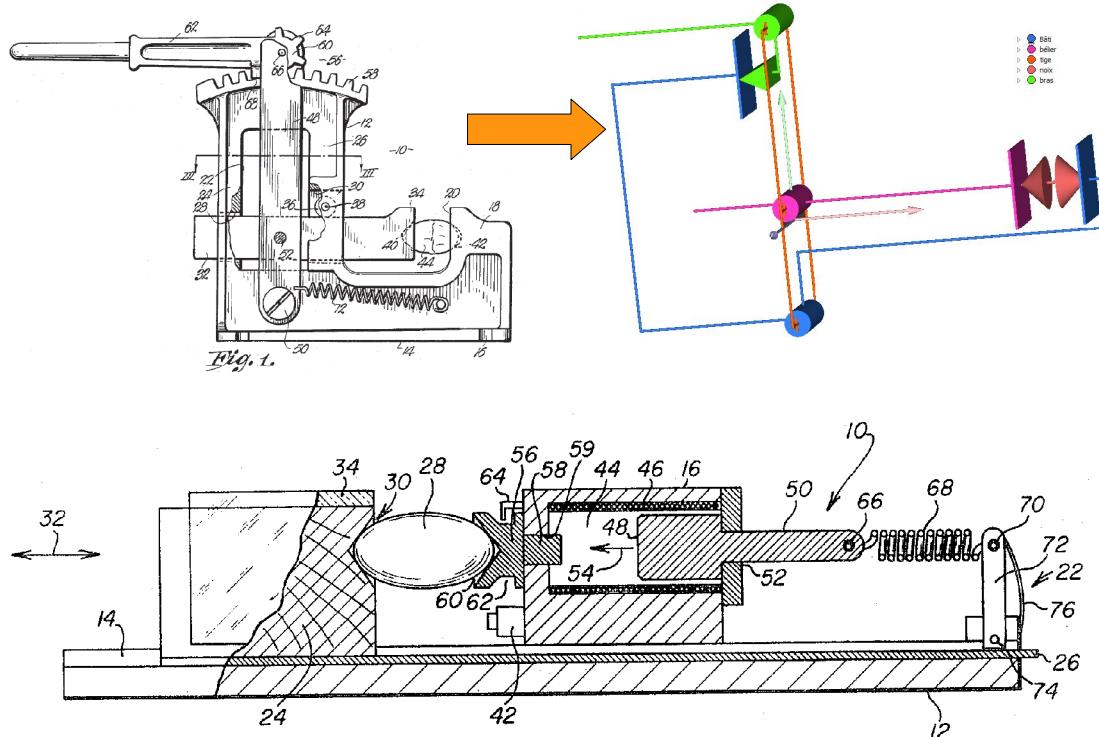
Rules

- **Input:**
  - Your prototypes
  - Your machines / mechanisms / robots
  - Your patents

- **Output:**
  - Text of patent (.PDF)
  - Mechanism description (form)
  - CAD image (.PNG)
  - CAD video (.AVI)
  - Photo of prototype (.JPG)
  - Video of a real demo (.AVI)
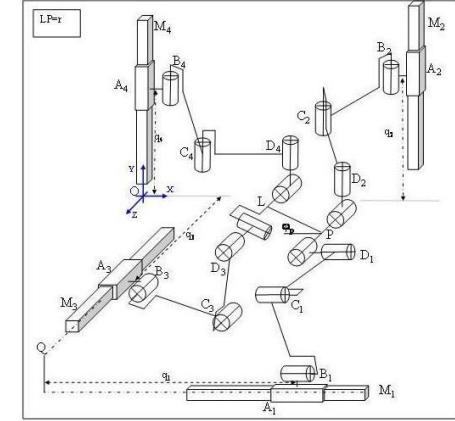
Ex : Isoglide parallel robot
IFMA/LaMI
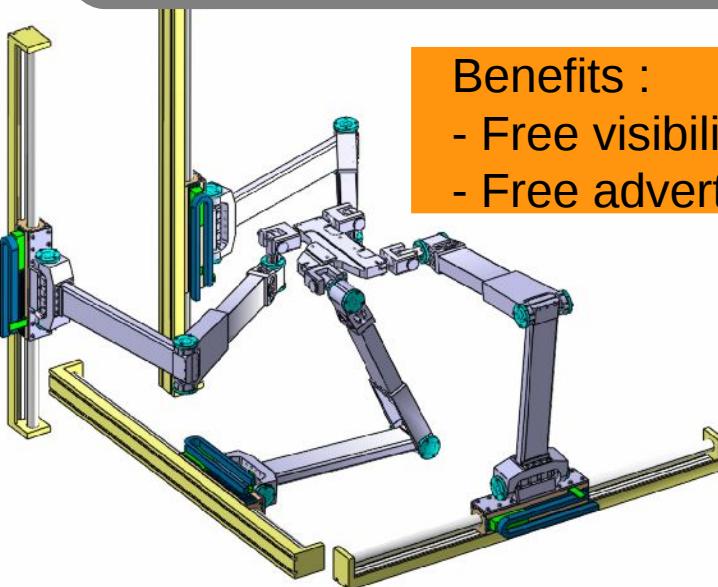
Benefits :
- Free visibility for your research work
- Free advertisement for your lab
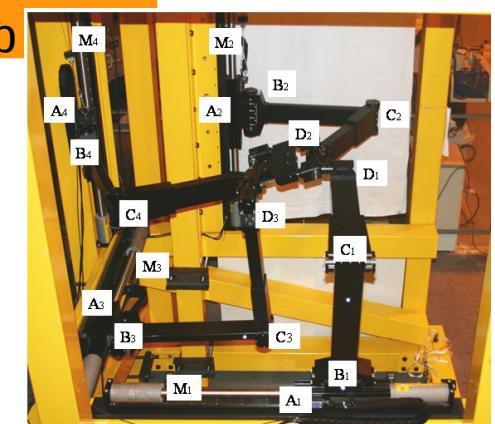
Contributing as a school or university

Rules

- **Input:**
  - Patents
  - Documents without copyright (old or free)
  - Documents with copyright describing machines that you re-model with the students

- **Output:**
  - CAD model
  - Mechanism description (form)
  - CAD image (.PNG)
  - CAD video (.AVI)
  - Photo made by you (.JPG)
  - Video made by you (.AVI)

| 2626 | THREE-SLOT INVERSE GENEVA WHEEL MECHANISM | FG GW |

Driver *I* rotates about fixed axis *A* and carries pin *a* which consecutively engages straight radial slots *d* of Geneva wheel *2*. Geneva wheel *2* rotates about fixed axis *B* and its slots *d* are located symmetrically at angles of 120° between the axes of adjacent slots. Driver *I* has concentric locking surface *b* which engages concave locking surfaces *e* of Geneva wheel *2* during its idle periods. When driver *I* rotates continuously at uniform velocity, driven Geneva wheel *2* rotates intermittently at nonuniform velocity and has three rotation periods t_r and three idle periods t_i. Locking surfaces *b* and *e* prevent unintentional rotation of Geneva wheel *2* during its idle periods. The time of one revolution of driver *I* is

$$T = t_r + t_i.$$

The angles of rotation of driver *I* corresponding to an idle and to a rotation period of Geneva wheel 2 equal $\varphi_i = 60°$ and $\varphi_r = 300°$. The angle of rotation of Geneva wheel 2 to each revolution of driver *I* is $\varphi_G = 120°$. The rotation and idle factors are $p = t_r/T = 0.8333$ and $q = t_i/T = 0.1667$. The working time coefficient is $k = p/q = 5$. The transmission ratio from the Geneva wheel to the driver is

$$i_{21} = \frac{\omega_2}{\omega_1} = \frac{\lambda (\cos \varphi_1 - \lambda)}{1 - 2\lambda \cos \varphi_1 + \lambda^2}$$

where $\lambda = R/L$, *R* is radius $\overline{AD}$, *L* is centre-to-centre distance $\overline{AB}$, φ_1 is the instantaneous angle of rotation of driver *I* measured from line *AB*, and ω_1 and ω_2 are the angular velocities of driver *I* and Geneva wheel 2. The maximum value of the transmission ratio is

$$i_{21} = \frac{\omega_2}{\omega_1} = 0.464.$$

Coefficient χ characterizes the angular acceleration ε_2 of Geneva wheel *2* at the instants when pin *a* begins and ends engagement with slot *d*, and equals

$$\chi = \frac{\varepsilon_2}{\omega_1^2} = 1.729.$$

Driver *I* and Geneva wheel *2* rotate in the same direction.

Benefits :
- Mention of each student name → Motivation
- Free advertisement for your university

Ex : Re-modelling all the 6000 mechanisms of the book :
I.I. Artobolevski
*Les mécanismes dans la technique moderne (Mir, 1975, 7 tomes, 5120 pages)*

31st March 2011 : 120 / 6000

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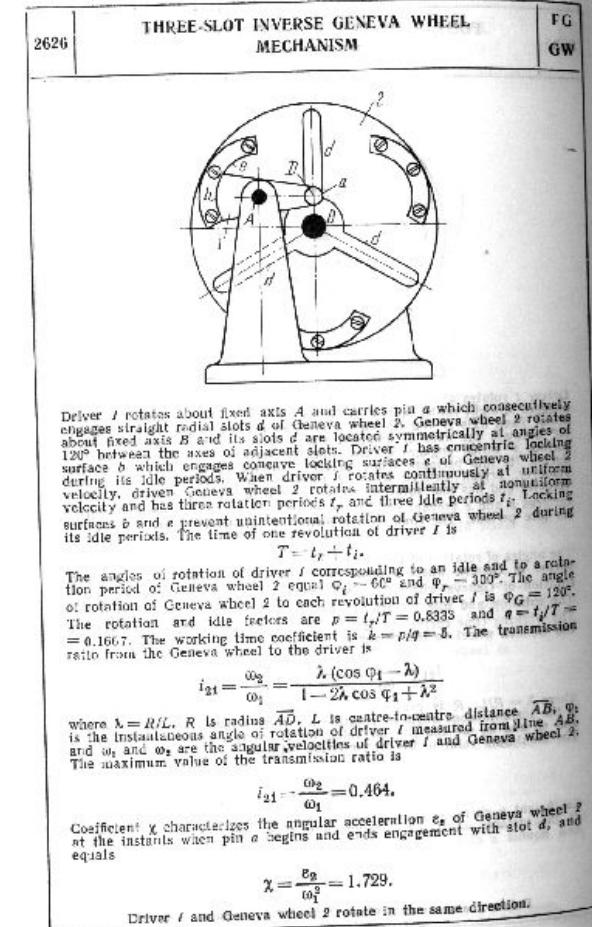
Future extension to Research

- ## Examples of interesting design methods

Approach 1: Serial combination of blocks of mobility m
to obtain a mechanism of mobility m

Example: adding one after the other several stages for transmission movement, such as in CASYMIR software [Fauroux99] [Wahl03] [Fauroux Bouzgarrou Gogu 04]
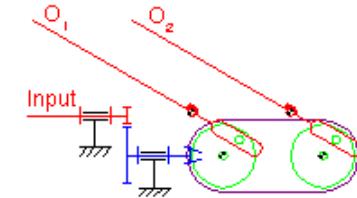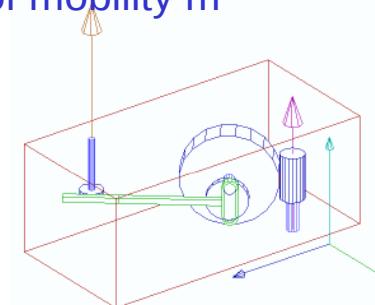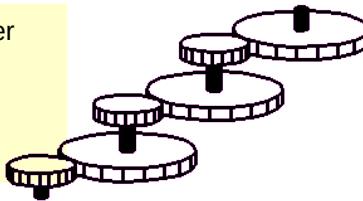
Approach 2: Serial connexion of blocks to obtain a higher mobility

Example: serially adding N x (part with a joint) to generate all the anthropomorphic robot arms of a given DOF. Evolutionist algorithms may be used [Gog07]

Approach 3: Parallel connexion of blocks
to obtain a mechanism with smaller (or equal) mobility

Example: design of parallel robots of n DOF, n € [2,6] by combining legs with DOF >= n [Gogu07]

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Future extension to Research

## • Examples of interesting design methods (continued)

Approach 4: Modification of a few structural parameters

Example: changing the output direction of a transmission mechanism by adjusting only the inter-stage angles [Fauroux 2002]
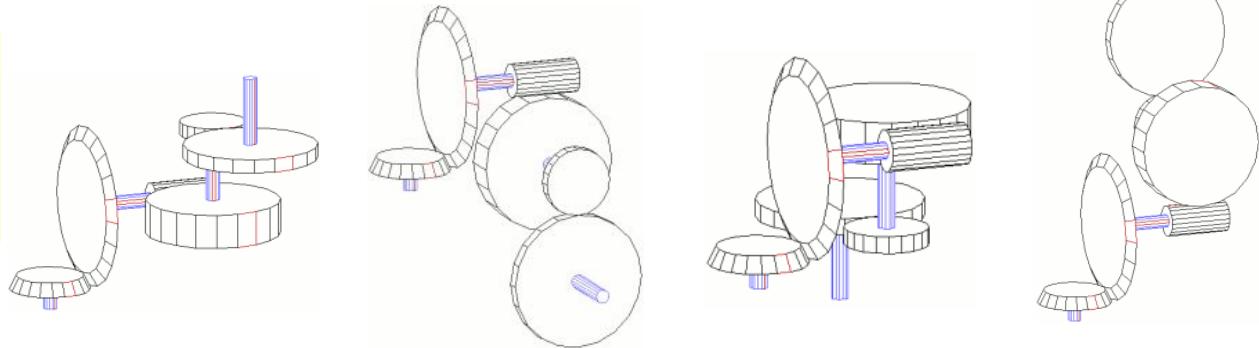
Approach 5: Substitution of a part of a mechanism

Example: replacing a folding leg by a prismatic leg of the same mobility in a parallel robot of the Isoglide family
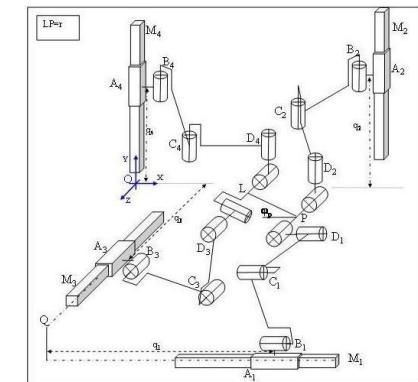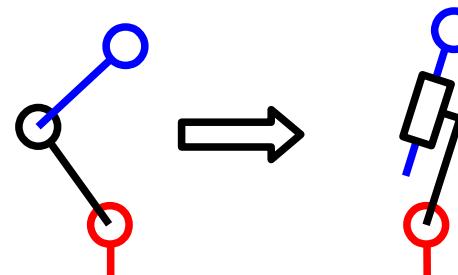
Approach 6: Inference based on existing mechanisms

Example 1: from {Mechanism M1 with property P1, Mechanism M2 with property P2}, it is possible to design M3 with both P1 and P2

Example 2: from {Mechanism M1 with property P at level L1, Mechanism M2 with property P at level L2}, it is possible to design M3 with property P at level L1+k(L2-L1) with k € [0,1] (level interpolation)

Approach 7: Changing the input link / output link in a mechanism ▪▪▪

Conclusion : thinkMOTION...

...has Educational objectives

- **Digitizing** and **organizing** a huge content on machines an mechanisms
- Technical and cultural **heritage** from Europe
- **Free access** for all from the digital European library www.europeana.eu

*think*MOTION

...has long term research potential

- Reflection on a **neutral file format** for mechanisms
- **Taxonomy** of machines
- Innovative **design methods** by intelligent re-use of knowledge (methodology and CAD aspects)

think MOTION !

...needs you !

- As a **teacher**, with your **students**
- As a **researcher**

Every contributor will be cited by name/URL

- Because it is a huge and ambitious goal that requires help from every volunteer and **will be continued** after this project

www.thinkmotion.eu
French contact : thinkmotion@ifma.fr

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