Biomimétique et biomécanique végétale: recherche et enseignement

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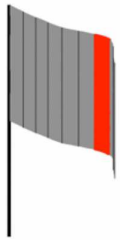
Laboratoire Hydrodynamique (Ecole polytechnique & CNRS)

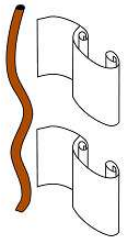
Bioinspiration

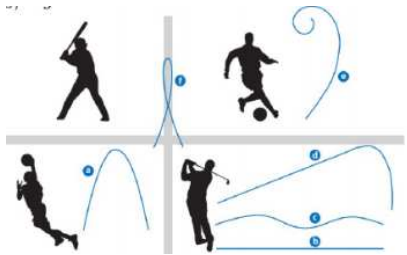
30 permanents

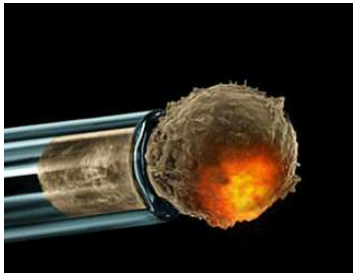
Interactions-fluide Structure

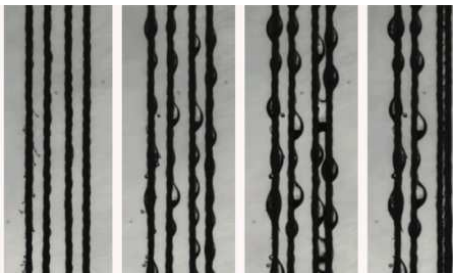
Biomécanique Végétale











Résistance au vent et courant

Dynamique de l'arbre et du feuillage

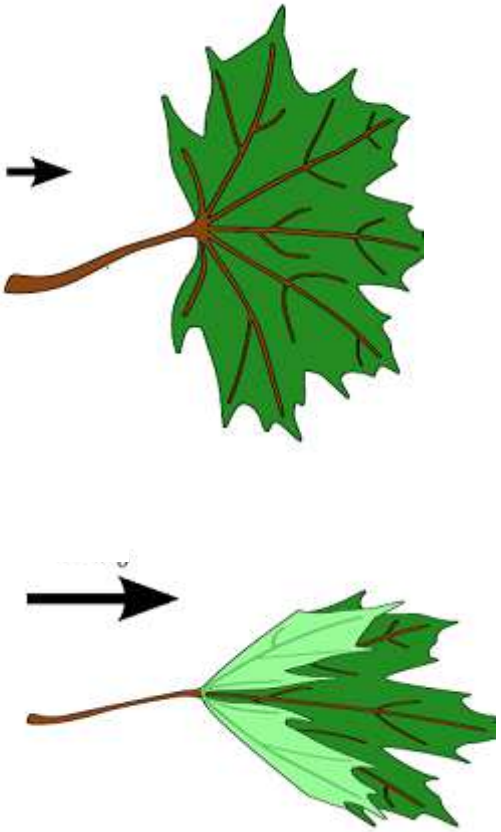
Formations et projets d'étudiants

Bio-inspiration

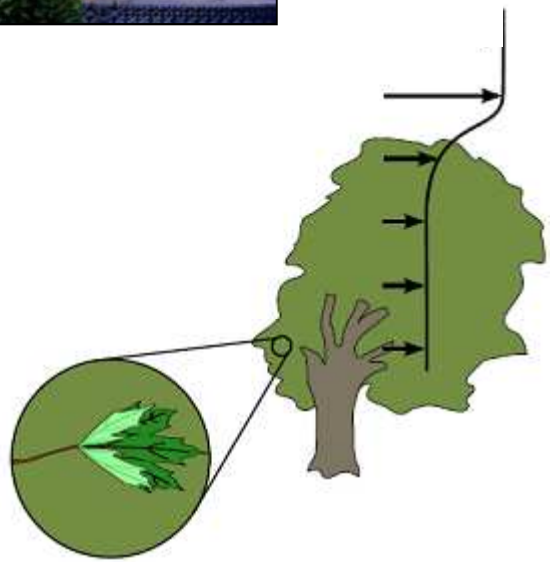
Biomécanique et biomimétique végétale au LadHyX

2000

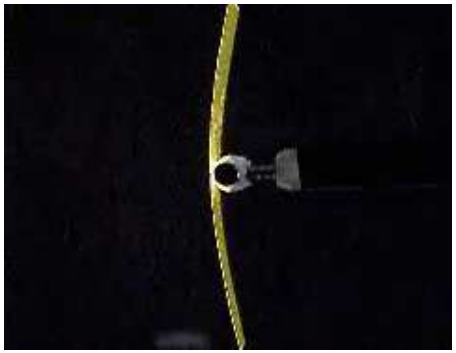
Résistance au vent et courant

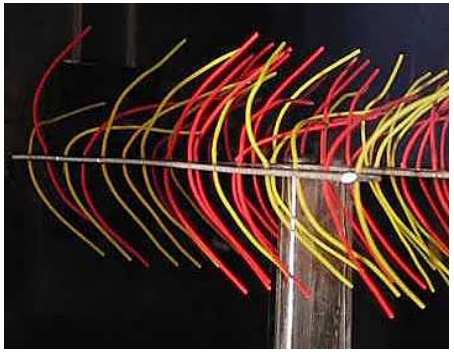


Réduction d'effort
grâce à la flexibilité



Réduction d'effort
grâce à la flexibilité
et la poroelasticité





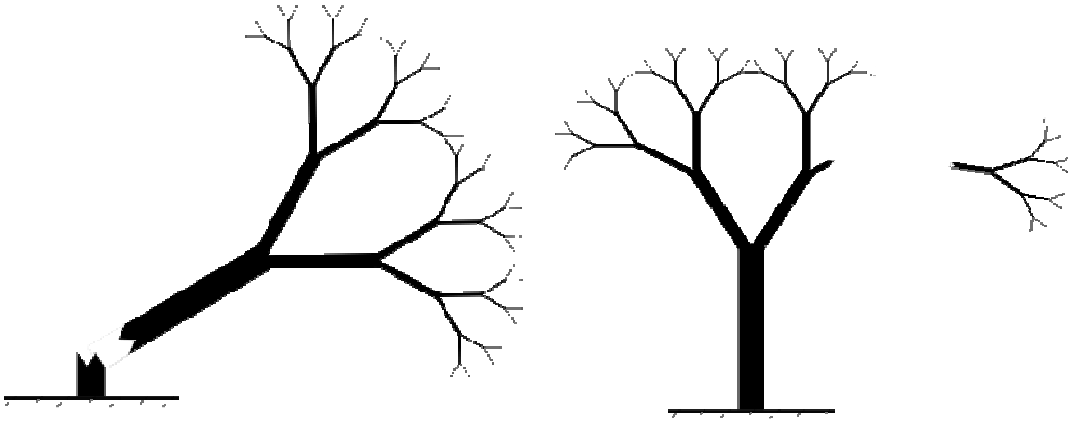
Mastocarpus papillatus

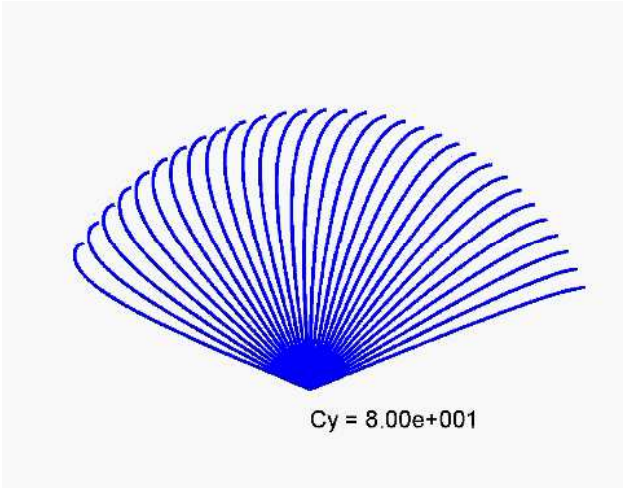
Egregia menziesii

Arundo donax

Pinus sylvestris

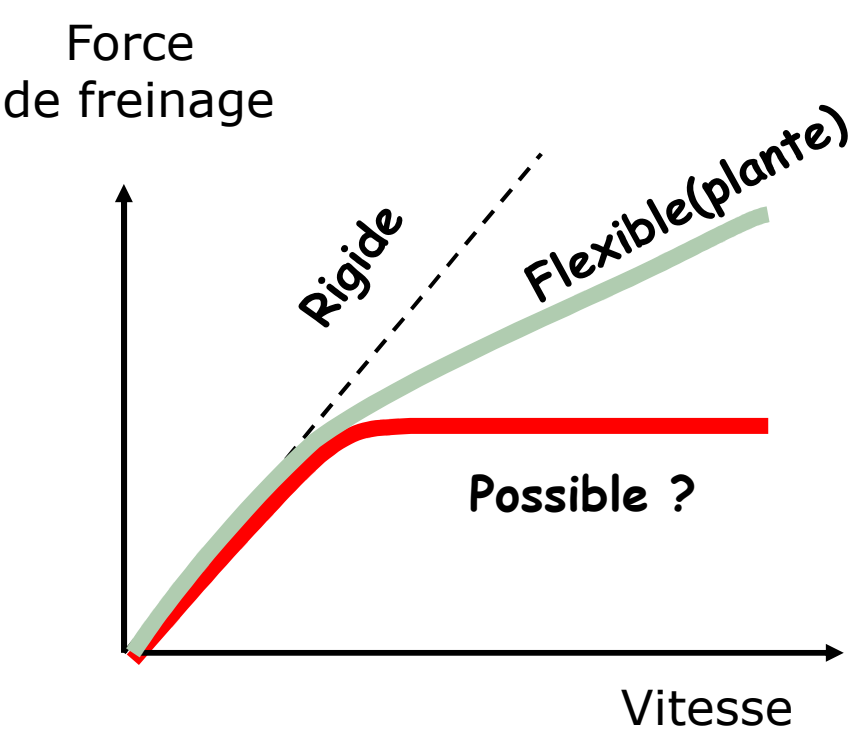
Loi universelle pour toutes les formes

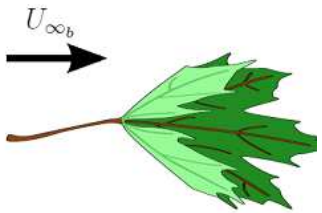


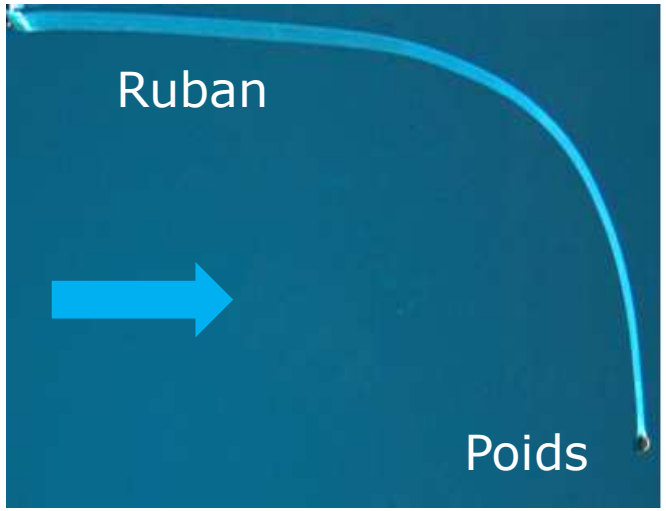


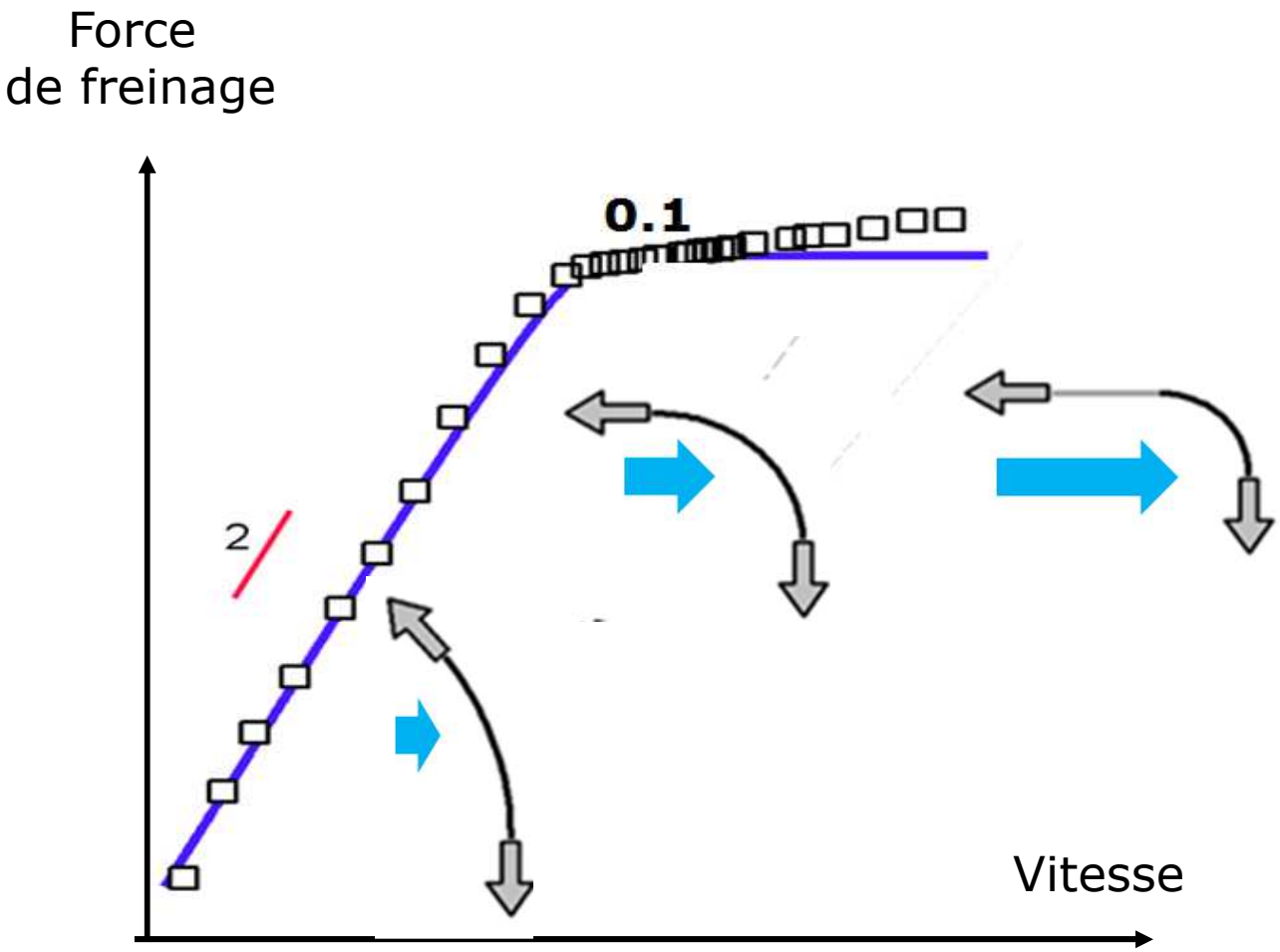
Stratégies d’autoélagage

Biomimétique : un système de freinage évolutif



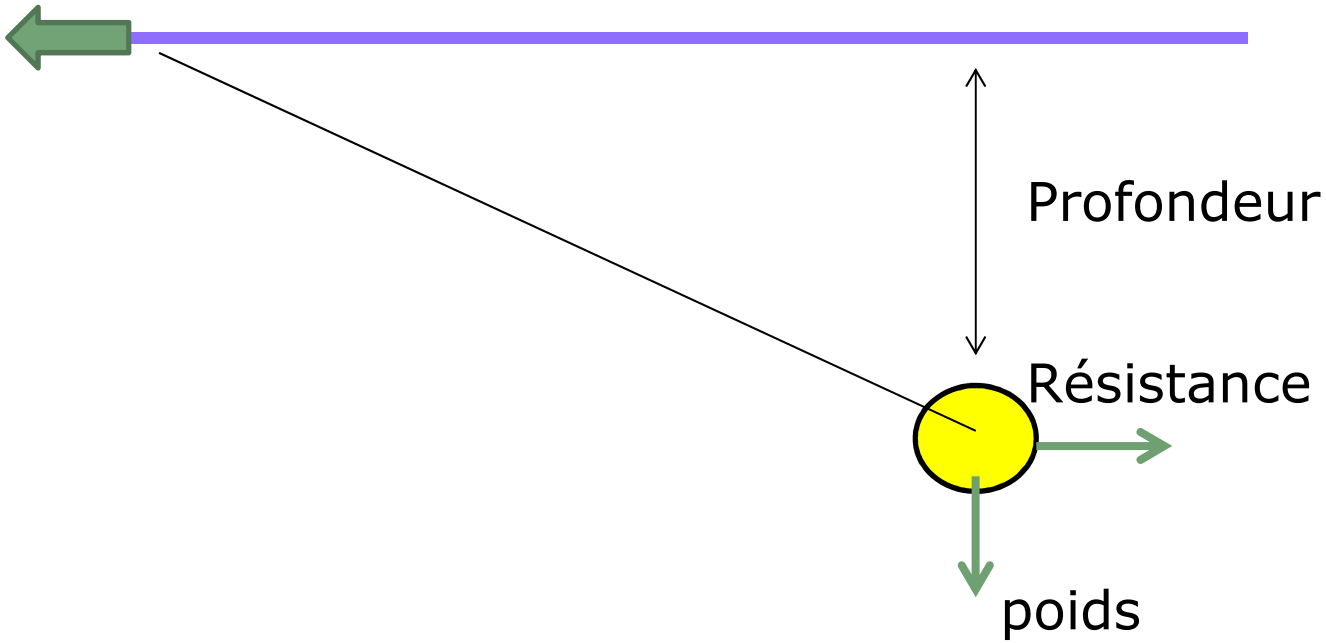






Brevet, 2014

Barois, T., & De Langre, E. (2013). Flexible body with drag independent of the flow velocity. *Journal of Fluid Mechanics*, *735*.



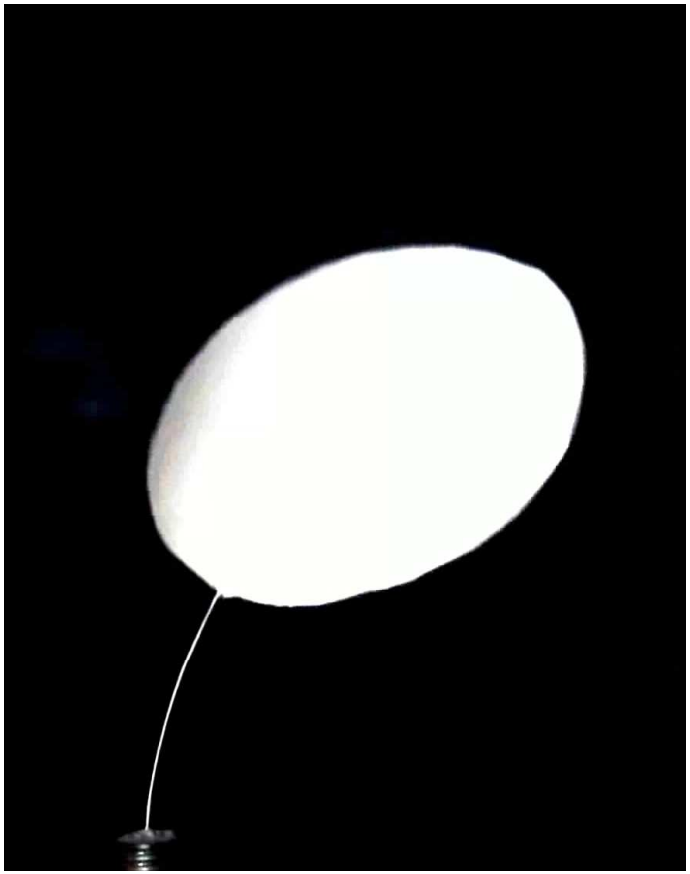
Application : immersion à profondeur constante des objets tractés

Brevet, 2014: dispositif de freinage d'un mouvement dans un fluide

WO 2014/207713 A1

Dynamique de l’arbre et du feuillage

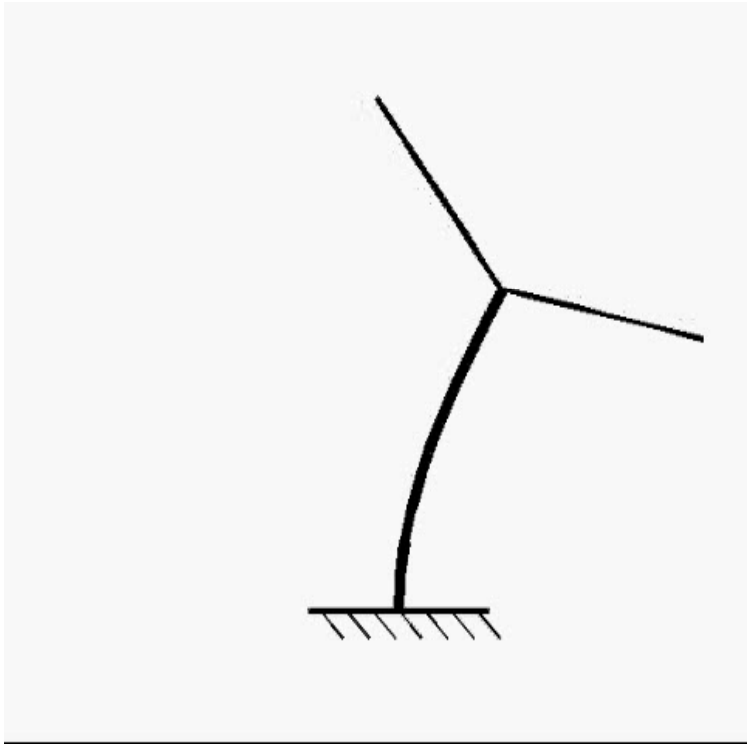
Lien entre architecture et modes de vibrations

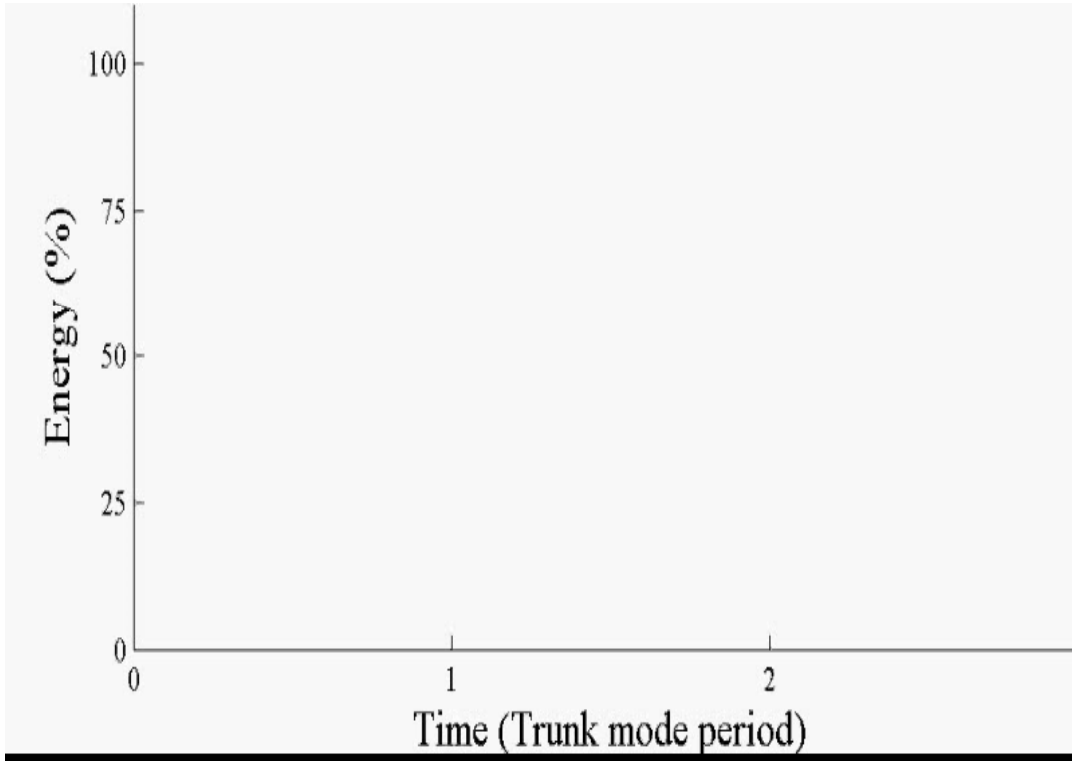


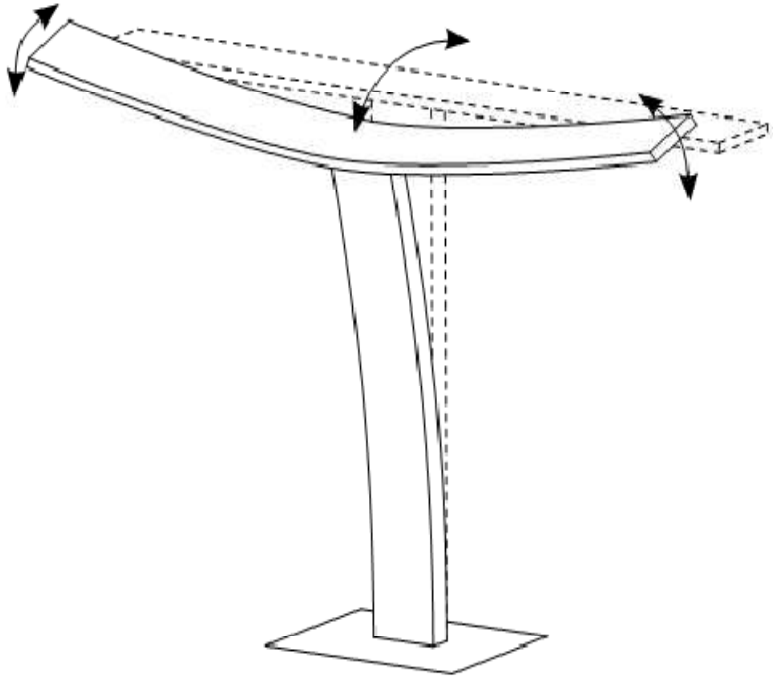
Caractéristiques du mouvement en fonction de la vitesse du vent

Biomimétique : un amortisseur branché

Transfert d'énergie

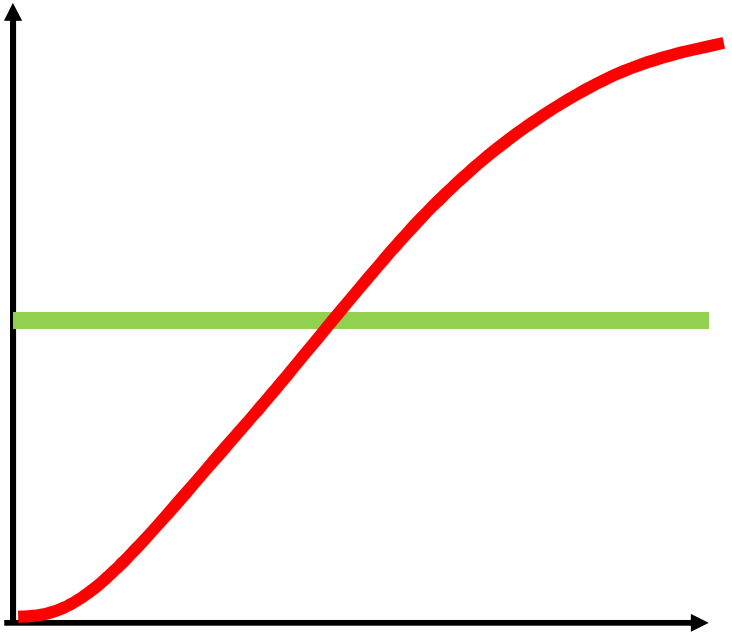



Energy (%)
100
75
50
25
0
0
1
2
Time (Trunk mode period)

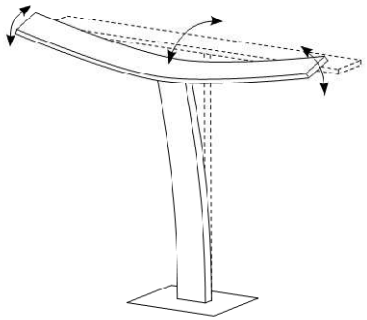


Amortisseur par branchement

Amortissement



Branché

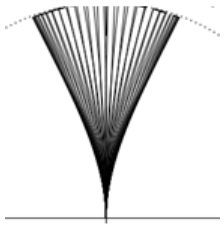


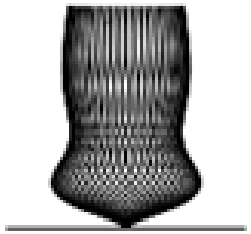
Classique

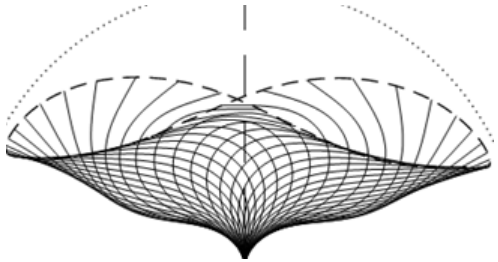
Amplitude du mouvement

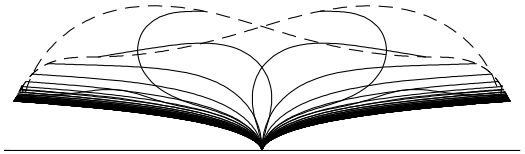
Theckes, B., De Langre, E., & Boutillon, X. (2011). Damping by branching: a bioinspiration from trees. *Bioinspiration & biomimetics*, *6*(4), 046010.

Autre piste : résistance aux vagues



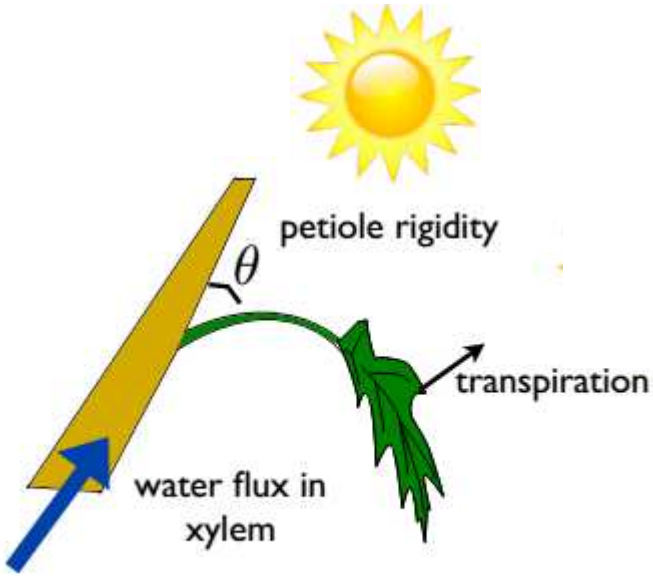


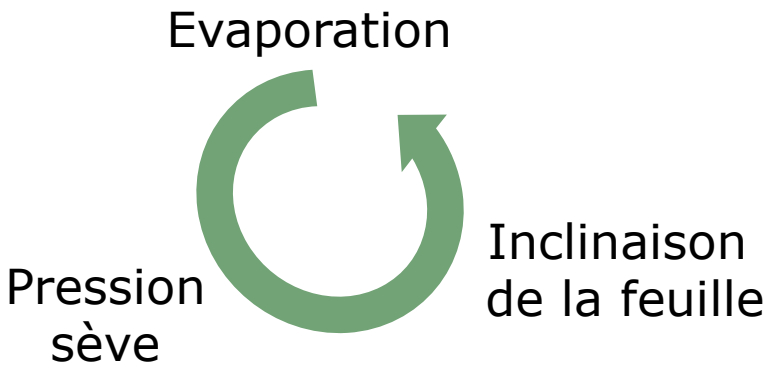




Plusieurs façons de réduire les efforts alternés

Autre piste : résistance à la sécheresse en fanant





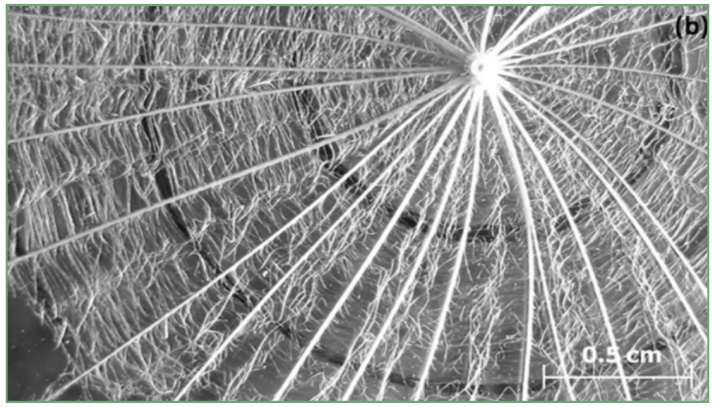
Formation et projets étudiants

Cours de biomimétisme à l'Ecole polytechnique (2017-)

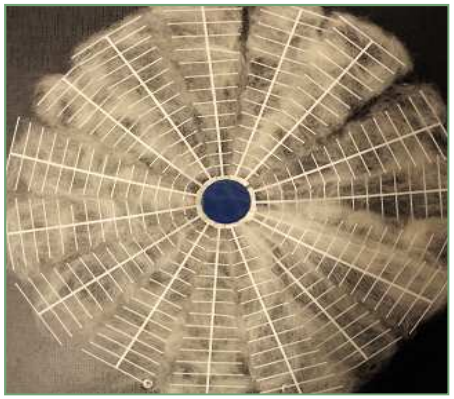
Etudiants polytechnique & Etudiants Master : 36 heures (12 étudiants)
Formation continue : 1 journée dans « master of executive education »

Projet étudiant : Parachute bio-inspiré du Salsifis des prés

pickers

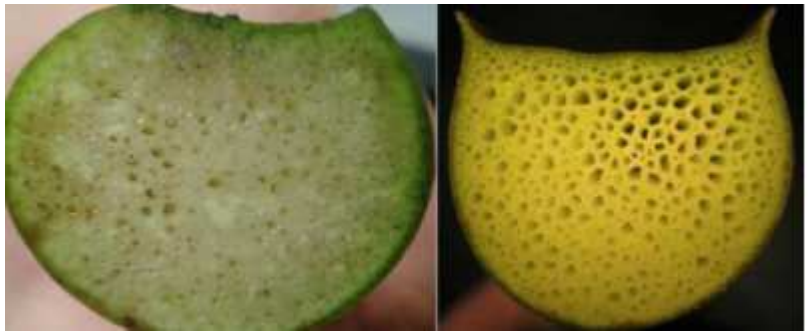


Casseau 2015



Wormser & Lilin
Etudiants cours Biomimétisme 2017

Projet étudiant : Valise souple/rigide par effet de turgescence



Pression d’eau

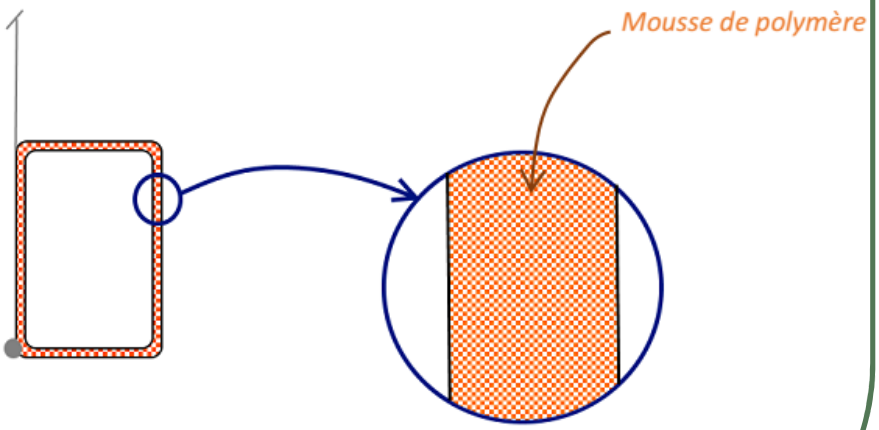


Schéma de la constitution de la **Dualise®**

Un GdR

BIOMECANIQUE ET BIOPHYSIQUE DES PLANTES

(2017-2022)

25 laboratoires en France

Thématiques scientifiques

Le programme scientifique se décline en 4 thématiques allant des échelles microscopiques cellulaire tissulaire aux échelles macroscopiques de la plante, de l'arbre et des écosystèmes :

- mécanoperception
- morphogénèse, croissance et mouvements
- interactions fluide-solide
- écologie, évolution, développement et biomimétisme

Conclusions

Robustesse du végétal

Champ biomimétique très ouvert

Emergence d’une communauté biomimétique végétale en France