

Biotensegrity, a didactic tool for osteopathy

by Michèle Tarento

International Forum of Osteopathy - OsEAN
September 2021

Here is my CV which is on my website

Michèle Tarento,

- M.D., ENT, Phoniatriest,
- Osteopath,
- Lecturer in Histology and Embryology - CHU Bichat - Paris
- Osteo awareness[®] conceptor : (Body's Physical and tensegral approach to optimize consciousness and adaptability)
- Practitioner in Bioenergetics (W. Reich, A. Lowen)
- Member of the Biotensegrity Interest Group (BIG) since 2011

www.osteoeveil.fr

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michele.tarento@orange.fr

What is it about?

First of all, **Biotensegrity**

a new vision of the dynamic architecture of the body

which :

- overturns our traditional representations,
- uses innovative and scientifically validated models,
- and which, in addition, provides new keys to understand and perceive our osteopathic gestures.

My objective in the next 20'

I sincerely hope that this presentation will provide you with new answers to these fundamental questions that I have often asked myself as practitioner, passionate about research on posture and movement:

- How does the body adapt to different mechanical constraints?
- What allows the transfer of the osteopathic touch signal from its contact with the body to the nucleus of the cell?

My objective in the next 20'

and also :

- How, from the point of view of biotensegrity is the osteopathic lesion conceived?
- What are the different steps of the osteopathic treatment according to the light of biotensegrity ?

So, what is tensegrity, what is biotensegrity?

Tensegrity is defined as a set of architectural and geometrical principles, derived from the observation of Nature.

Biotensegrity is the concept that applies the principles of tensegrity to living beings.

The structural principles observed in Nature

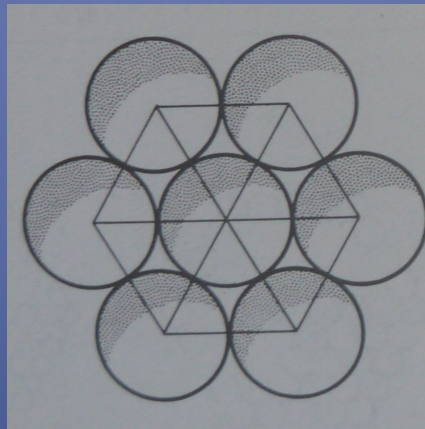


and its dynamic organization,
(closest packing , spirals)
have led...

... Buckminster Fuller (1895-1983)

architect, designer, inventor

- to give up 90° orthogonal reference systems,
- to give priority to triangulated networks in which all the elements are dynamically assembled at 60°,



Buckminster Fuller (1895-1983)

-and to integrate **Geodesic geometry**
in its construction designs.



B.Fuller

After having laid down its essential principles in 1927 as follows :

islands of compression in an ocean of tension,

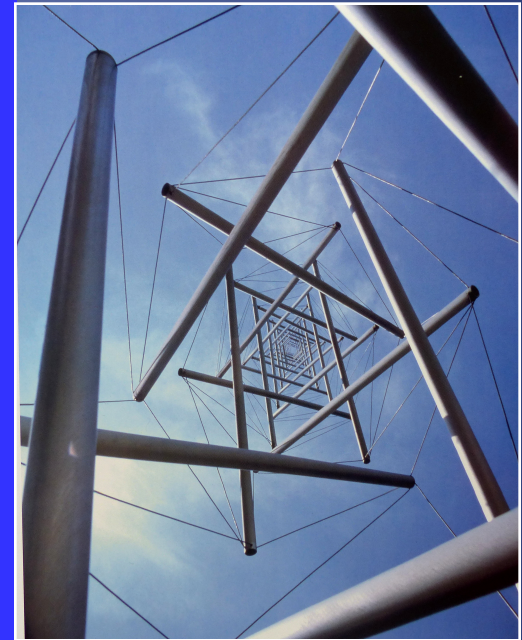
Buckminster Fuller coined the term **tensegrity** in 1950.

.

Kenneth Snelson (1927-2016) and the application of tensegrity principles

The impressive artistic tensegrity towers constructed by K. Snelson show the helical distribution of their internal forces.

The purpose
of their constant reconfigurations
in which
mechanical and vibratory processes
are associated
is
stability.



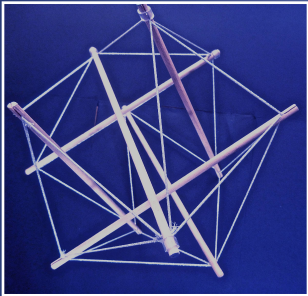
Needle Tower
K.Snelson®-
1968

*A tensegrity system is a system in a stable self-equilibrium state,
comprising a discontinuous set of compressed components,
inside a continuum of tensioned components.*

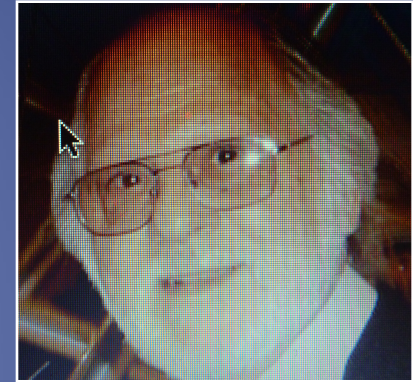
René Motro, Professor and Researcher in Mechanics at the University of
Montpellier (France)

Biotensegrity concept

Steve Levin, an orthopedic surgeon from Washington, D.C., coined this term in 1975. Inspired by the **architectural dynamism of tensegrity constructions**, he first applied it to macro scale and then, to micro scale of fascias.



Tensegrity
Icosaedron

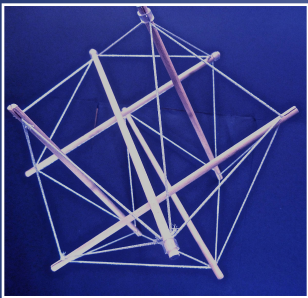


Biotensegrity concept

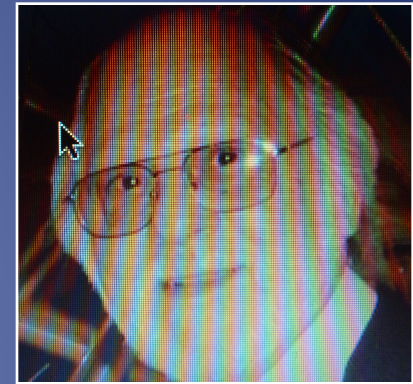
Steve Levin, an orthopedic surgeon from Washington, D.C., coined this term in 1975.

Inspired by **the architectural dynamism of tensegrity constructions**, he first applied it to macro scale and then, to micro scale of fascias.

- the discontinuous solid struts of tensegrity models find their equivalents in : bones.
- the continuous cables find their equivalents in : aponeuroses, ligaments and muscles.



Tensegrity
Icosaedron

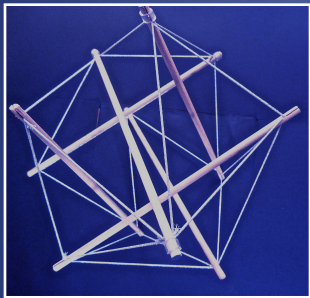


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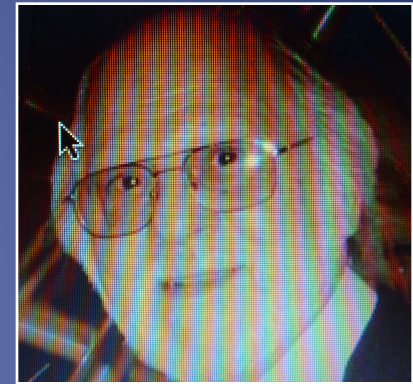
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Tensegrity
Icosaedron

In parallel, Donald Ingber, a researcher in biology at Harvard University, proposed the icosahedron as a model for the organization of the cytoskeleton.

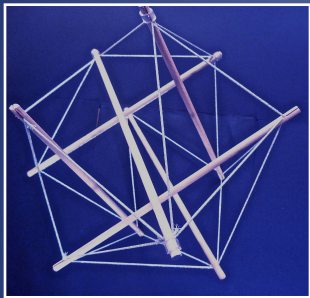
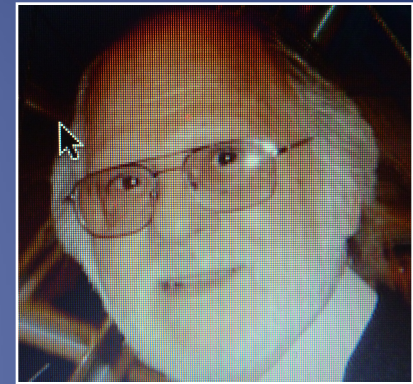


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Tensegrity
Icosaedron

In parallel, Donald Ingber, a researcher in biology at Harvard University, proposed the icosaedron as a model for the organization of the cytoskeleton.

- the discontinuous solid struts find their equivalents in : microtubules
- the continuous cables find their equivalents in : microfilaments and intermediate filaments.





What was decisive for these two researchers was their encounter with Kenneth Snelson's artistic Tensegrity Towers.

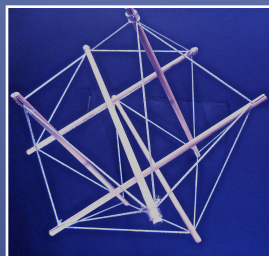
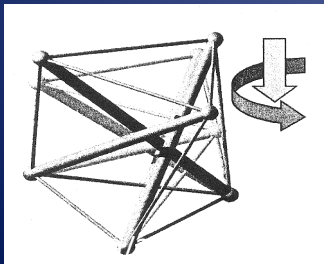
This confirms us the importance of reciprocal research interactions between Arts and Sciences.

Needle Tower;
K.Snelson®-1968

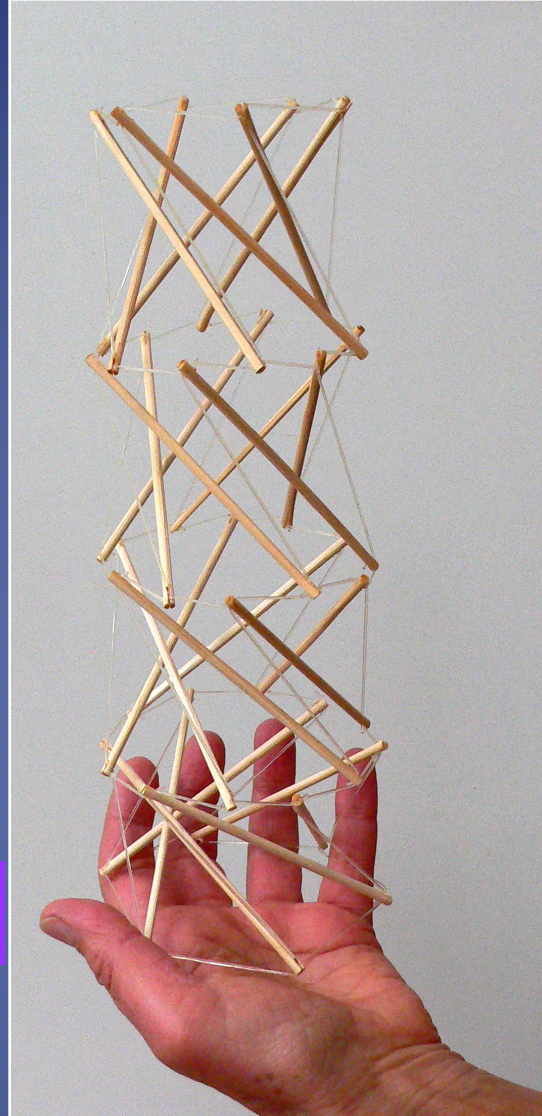
Biotensegrity concept

After having asked engineers to make calculations, Steve Levin showed that **the fascial network of the body is a dynamic triangulated system**, inside which the **constraints are constantly redistributed and balanced** between the rigid elements (bones) and the flexible elements (and reciprocally).

Levin S.M. « The tensegrity truss as a model for spine mechanics : biotensegrity ».
Journal of Mechanics and Medicine in Biology-2- 375-388, 2002



Ostéo éveil® copyright Michèle Tarento

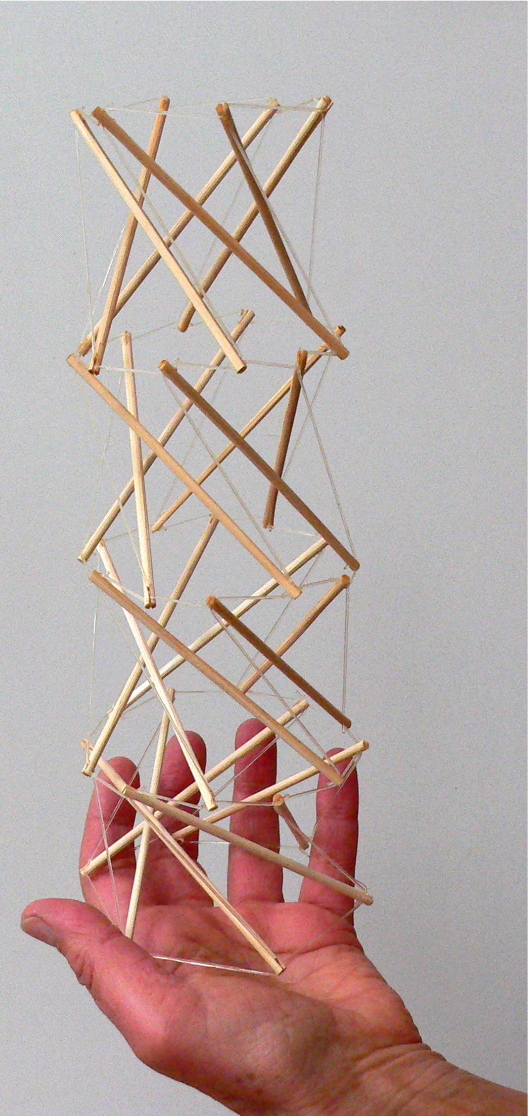
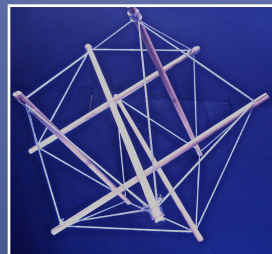
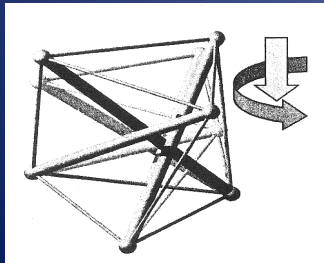


Tensegrity Tower model offered by
Graham Scarr®

Biotensegrity concept

Regarding the spine, it is not the facet joints that bear the stresses, but rather the architectural organization between the rigid and flexible fascias that constantly orchestrates the distribution and balancing of the loads throughout the structure.

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Biotensegrity concept

Donald Ingber who applied the principles of tensegrity to the cells, has offered us a new approach to mechano-transduction.

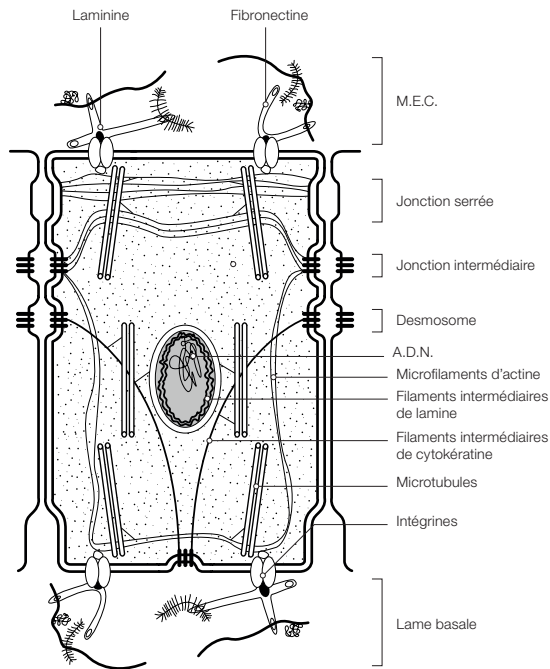
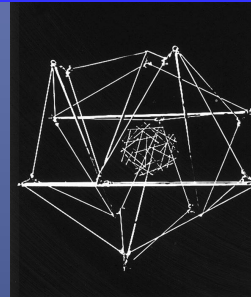


Figure. 9 : Le cytosquelette cellulaire, la M.E.C. et la lame basale

M. Tarento drawing after : *Construire son corps avec l'ostéo éveil et la biotenségrité*- Sully 2016

For him living cells are similar to tensegrity icosahedrons : and their response to constraints gives rise to a **mechanical deformation**.

Transported from the ECM and redistributed by cytoskeletal elements from the cell surface to the nucleus, this mechanical **deformation (=information)** triggers metabolic processes.



After
D. Ingber

Biotensegrity concept

... 'Any deformation applied to the surface of the cell is immediately followed by a reorganization of all the elements of the cytoskeleton'.

D. Ingber

Biotensegrity concept

and also :

...It is the self-constraint of the whole body that allows the transfer of the signal over long distances (from the skin to the heart of the cell).

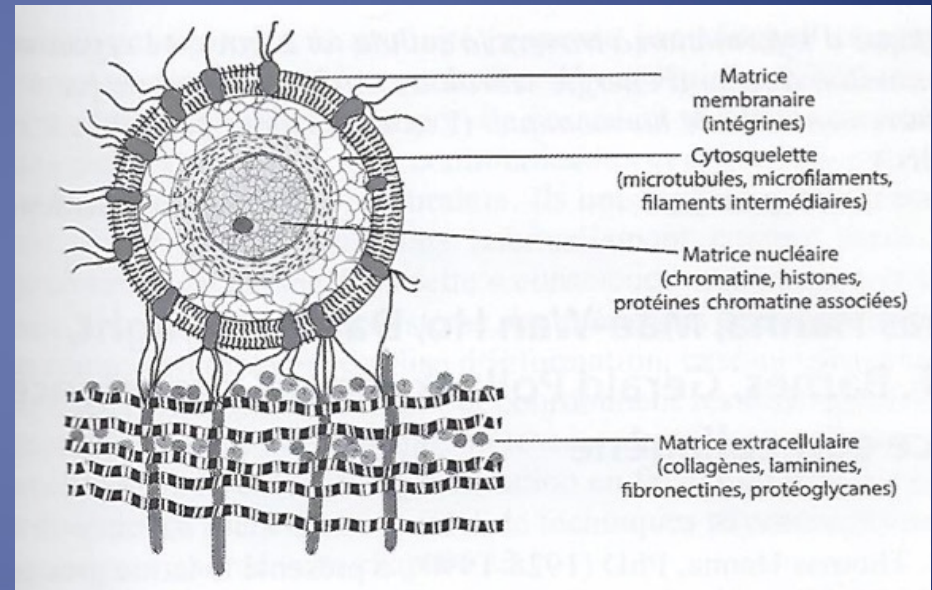
D. Ingber

This allows us to better understand our osteopathic touch dynamism.

Biotensegrity concept

Pienta and Coffey extended Ingber's researches,

and by making quantitative measures with Fourier spectrum analyzers, they showed that the **matrix has oscillatory frequencies**.

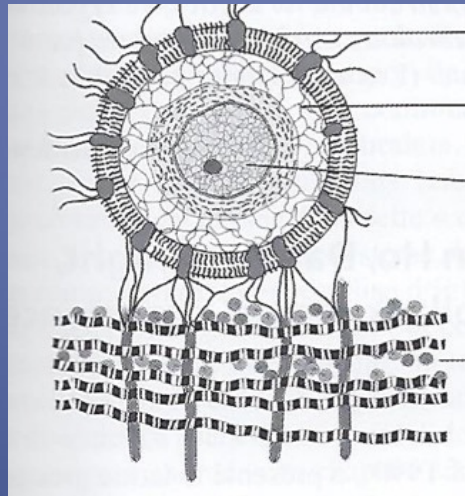


D'après Pienta KJ et Coffey DS

Biotensegrity concept

The vibratory information is transferred through the tensegrity matrix, which acts as a coupled harmonic oscillator, transducing the signal from the cell periphery to the nucleus and ultimately to the DNA.

Pienta K.J. and Coffey D.S. « Cellular harmonic information transfer through a tissue tensegrity matrix system ».
Medical hypotheses- 34 (1) - 88-95), 1991



Thus,
the dynamism of living organisms is correlated to:

- 1- intrinsic synergetic tenso-compressionnal forces,
= **Mechanical processes** expressed by Expansion and Retraction.
- 2- helical organization of the elements of the structure,
= **Vibratory processes** expressed by Winding and Unwinding.

Biotensegrity: new keys to understand the complexity of life

We will see successively :

- Tension and compression
- Self-stress
- Heterarchy
- Non-linear elastic behavior
- Bones, powerful accumulators and distributors of kinetic energy
- Intertransformability in dynamic geometry

Two aspects are not developed due to lack of time:

- Unpredictability according to synergetics (B. Fuller)
- Auxetism

Biotensegrity: new keys to understand the complexity of life

Tension and compression

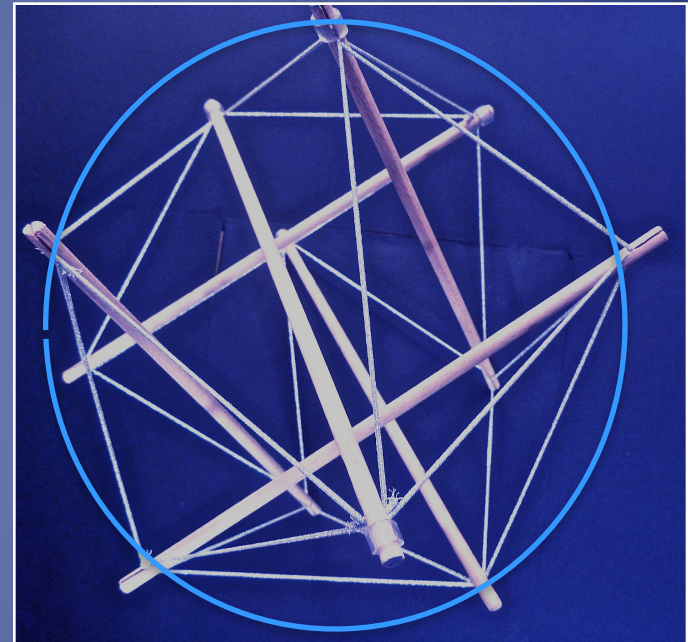


These 2 opposit synergetic forces :

- 1- organize the internal spaces and create **omnidirectional volumes**.
- 2- generate **self-stress** which gives its **dynamism** to the systems,
in particular, their **reactivity** to the constraints.

Biotensegrity: new keys to understand the complexity of life

Tenso-compression synergy



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Biologie de la
reproduction,
Lausanne DR©

Tenso-Compressional Synergy is a constant asset of the human body :

- it underlies pneumatic spheres in its frame of reference.
- and
- it is present from the first fertilized cell.

Biotensegrity: new keys to understand the complexity of life

Self stress

Self-stress is the consequence of :

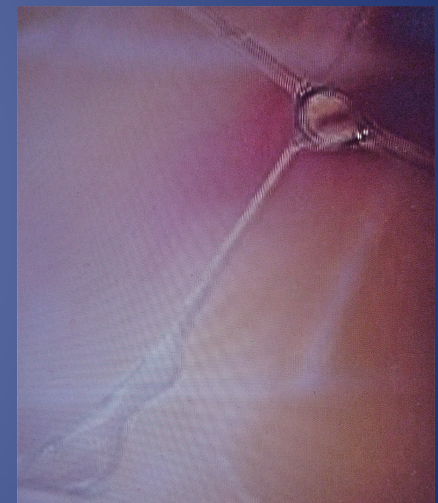
- Tenso-compressional assembly modes at the tissue scale and at the cellular scale
- Hydrostatic pressure, Osmotic pressure
- Turgor effect

Biotensegrity: new keys to understand the complexity of life

Self-stress is generated by the assembly of microfibrils with microvacuoles and the scientific works of J-C Guimberteau show that.



After
J-C. Guimberteau DVD
Endo Vivo®
2012



The microvacuoles are pneumatic systems which provide a lot of micro-supports that allow the body to resist mechanical stress (while the microfibrills redistribute this stress to the entire structure).

Biotensegrity: new keys to understand the complexity of life

Self-stress

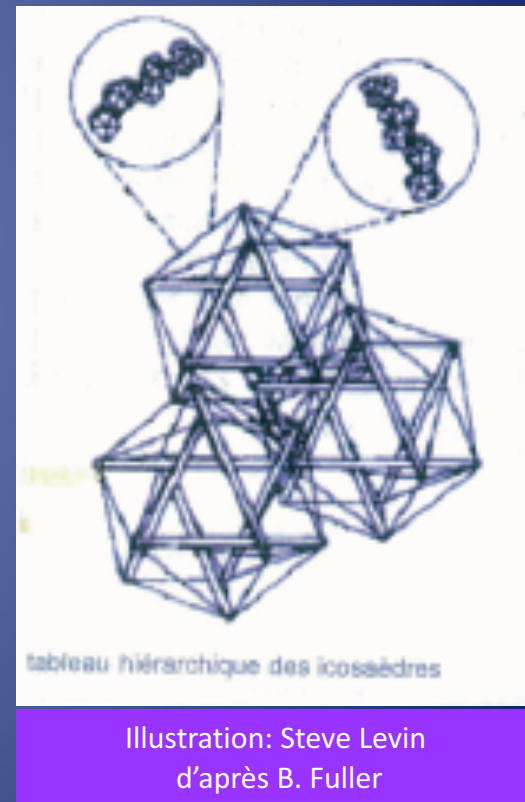
Self-stress is the cause of :

- **reactivity** of the all body's systems which allows:
 - very rapid transmission of informations (mechanical and vibratory)
 - **and** permanent self-regulation of the structure.

Biotensegrity: new keys to understand the complexity of life

Heterarchy of structures

It is defined by the capacity for an organism to self-reproduce its mode of architectural organization, at all it scales.

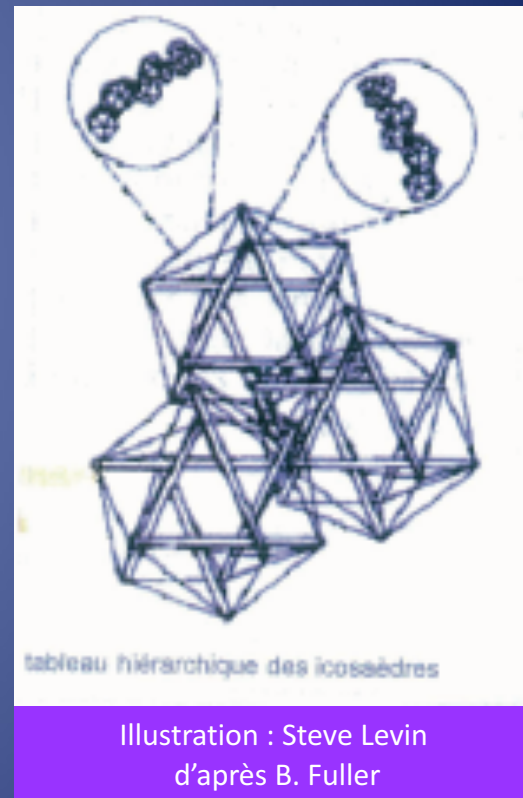


Biotensegrity: new keys to understand the complexity of life

Heterarchy of structures

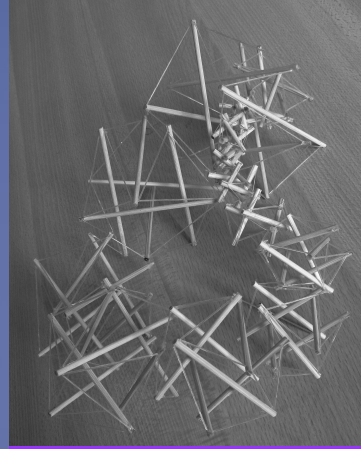
It is defined by the capacity for an organism to self-reproduce its mode of architectural organization, at all its scales.

The body is considered as a whole with subsystems that are interconnected and interact with even smaller systems ; and each of them uses its tensegrity architecture to stabilize the structure through permanent rebalancing...



Biotensegrity: new keys to understand the complexity of life

Heterarchy of structures



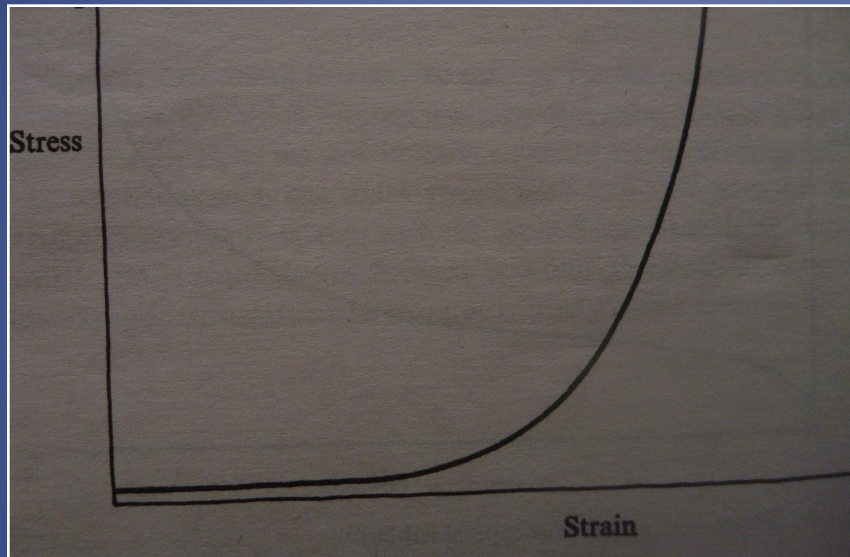
Modèle :Graham Scarr-
Image: Michèle Tarento

This allows osteopaths to understand better that any restriction of mobility or rigidification of one part of a system will have an impact on all the systems and sub-systems.

Biotensegrity: new keys to understand the complexity of life

Non-linear elastic behavior

stress



strain

The J curve : under stress, in a first time, the deformation is very important ; in a second time the deformation is less important while the system stiffens.

Gordon J.E. *Structures or why things don't fall*. Penguin books, 1978

The non-linear elastic behavior of biological structures
is a physical manifestation of their tensegrity,
that's to say : of their synergetic opposit tension-compression forces.
and it is important to get used to their perception.

Biotensegrity: new keys to understand the complexity of life

Non-linear elastic behavior

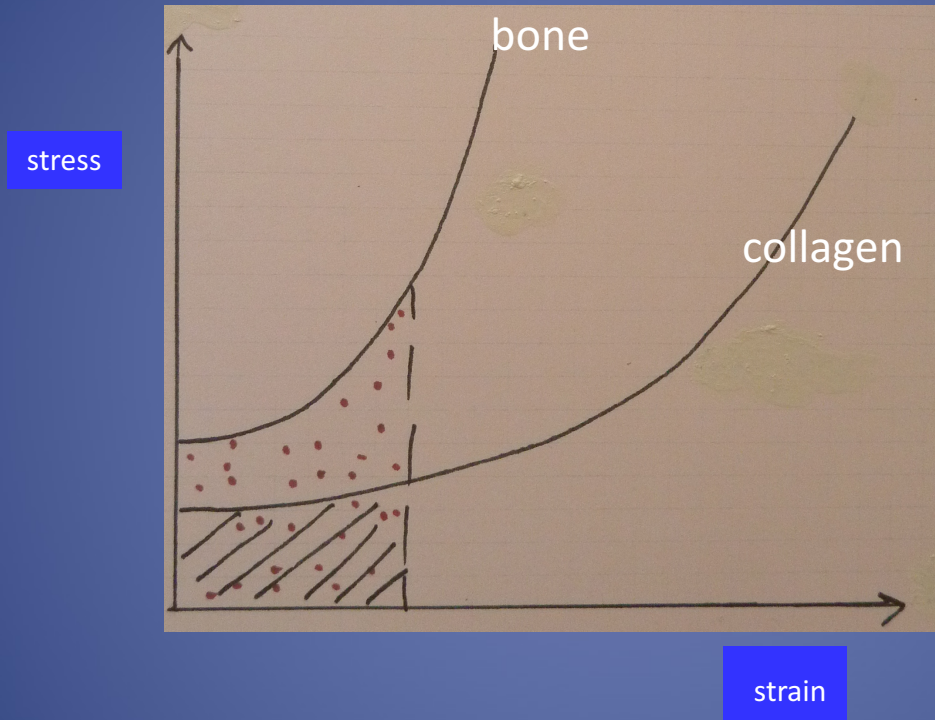
The understanding the J-curve invites us to address **the tenso-compressional reactivity** of the structure during our osteopathic manual practices.

Getting in touch with the **tenso-compressional reactivity** :

- gives us a status of the physicality of the structure: rigidity, density.
- allows us to evaluate the adaptability and comfort in the posture.

Biotensegrity: new keys to understand the complexity of life

Bones are powerful accumulators and distributors of kinetic energy.



When comparing the energy accumulated in bone under stress (surface in red dots) with that of collagen (surface in hatched lines), we can see that the energy accumulated in bone is much more important.

Biotensegrity: new keys to understand the complexity of life

Bones are powerful accumulators and distributors of kinetic energy.

Bones are fountains of energy» S. Levin

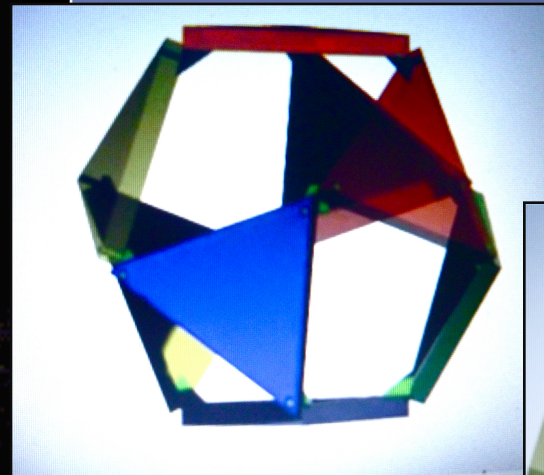
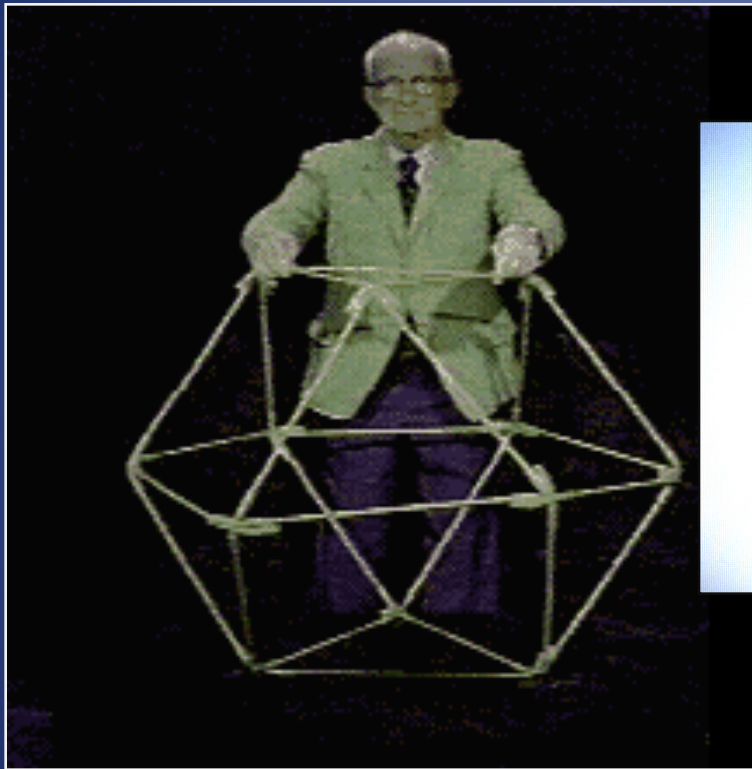
This strongly encourages us to systematically address the bones (rigidified fascias) during our osteopathic practices :

and it is what I do in my personal research in osteo-awareness® and biotensegrity (www.osteoeveil.fr).

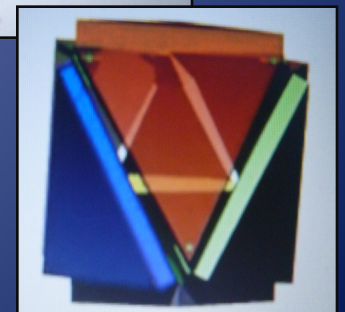
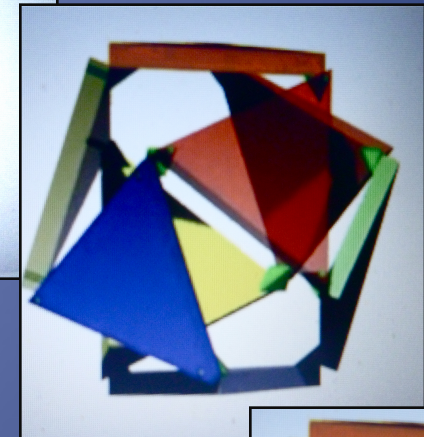
- Levin S.M. « L'os est du fascia ». traduit par Tarento M. et Néplaz I. Site d'ostéo4pattes, mai 2019
- Tarento M. *Construire son corps avec l'ostéo éveil et la biotenségrité* - Sully -2016
- Tarento M. « La tenségrité, la biotenségrité et l'Ostéopathie » - *Revue du Site d'ostéo4pattes* Hors série N° 1-3 Avril 2018
- Tarento M. *Biotenségrité, Fascias, Ostéopathie vers une perception consciente de l'architecture dynamique du corps* – Sully, 2021

Biotensegrity: new keys to understand the complexity of life

Inter-transformability" in dynamic geometry



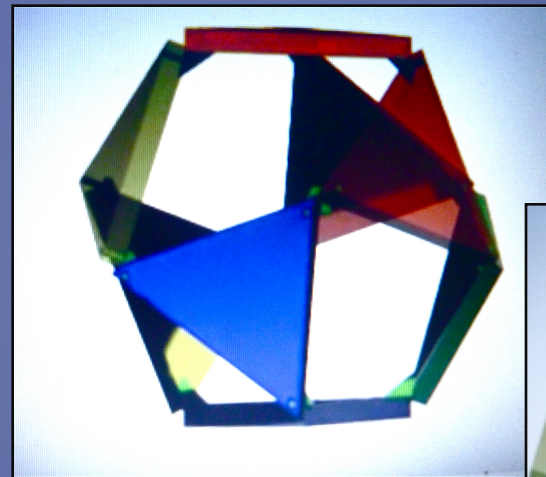
*The Jitterburg
and Buckminster Fuller*



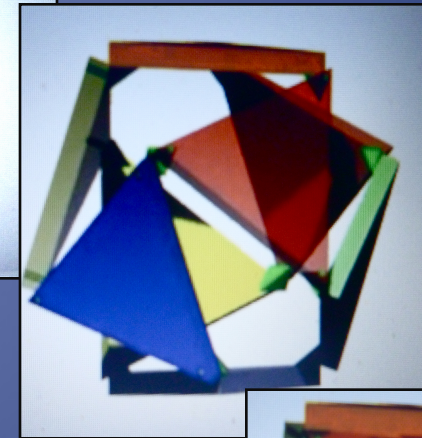
The **jitterburg** is a geometric transformation process .

Biotensegrity: new keys to understand the complexity of life

Inter-transformability" in dynamic geometry



*Jitterburg
et Buckminster Fuller*



This process resonates with the changes of phase (gel-sol) of soft matters: colloids, polymers, liquid crystals, glandular secretions, etc., which occur under the effect of mechanical, thermal, piezoelectric or electromagnetic constraints. These changes of phase are reversible.

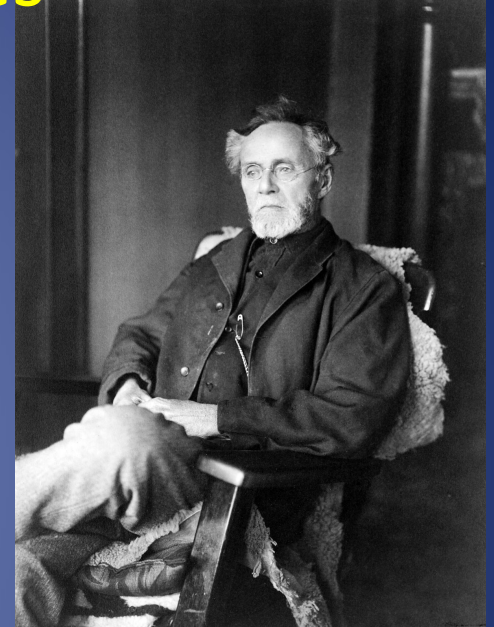
Action and perception in osteopathy, in the light of Biotensegrity

We will see successively :

- Fascial architecture, homeostasis and self-healing processes
- The osteopathic lesion
- Osteopathic treatment

Fascial architecture, homeostasis and self-healing processes

AT Still (1828- 1917), founder of osteopathy, put the architecture of the whole fascial system and the perception of its continuum in the hands of his successors to establish their diagnosis and their treatment.



AT Still fondateur de l'ostéopathie,

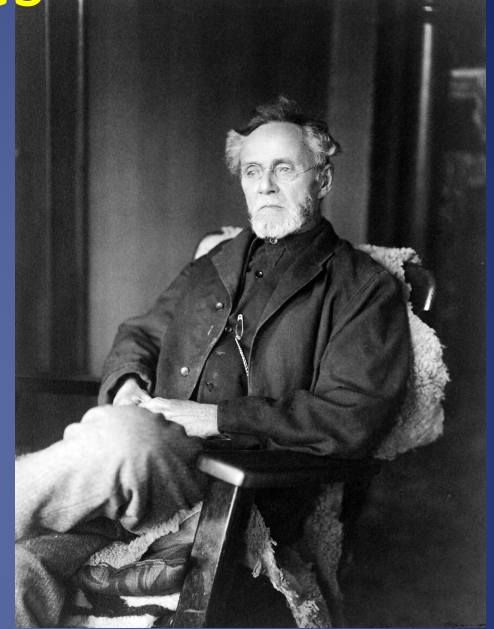
Still A.T. *Philosophie de l'ostéopathie*. Traduction française par P. Tricot -Sully, 1999

Still A.T. *Ostéopathie : Recherche et pratique*. trad. Tricot P- Sully - 2001

Fascial architecture, homeostasis and self-healing processes

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For AT Still, the laws of Nature has to be respected otherwise the processes of auto-regulation (homeostasis) which lead to self-healing will be impeded.



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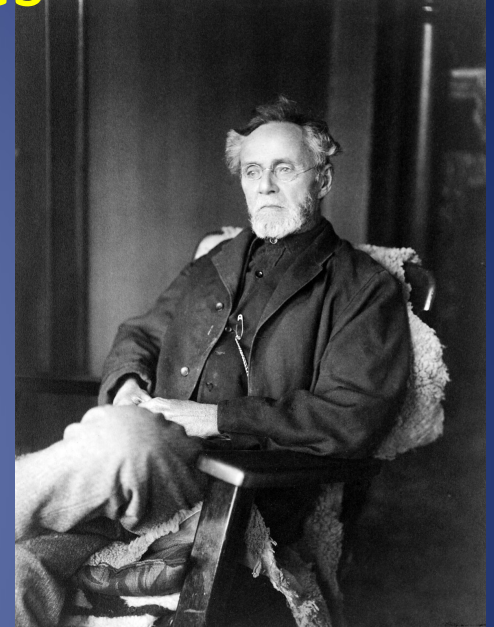
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AT Still fondateur de l'ostéopathie,

Convinced with the vitalist conceptions of his time, he said about the 'primary lesion':

Find it, fix it, and leave it alone : Nature will do the rest.

Still A.T. *Philosophie de l'ostéopathie*. Traduction française par P. Tricot -Sully, 1999

Still A.T. *Ostéopathie : Recherche et pratique*. trad. Tricot P- Sully - 2001

Osteopathic lesion

According to AT Still :

Osteopathic lesion called today 'somatic dysfunction' is the partial or total interruption of the free **flow** in tissues ; and the modifications of the tissue permeability (densifications, rigidifications...) involves gradual dysfunctions.

Osteopathic lesion

According to AT Still:

-Osteopathic lesion called today somatic dysfunction' is the partial or total interruption of the free **flow** in tissues. And the modifications of the tissue permeability (densifications, rigidifications...) involves gradual dysfunctions.

- The word 'flow' includes everything that is conveyed mechanically, neurologically, fluidically (by blood vessels, lymphatic vessels, interstitial liquids) and which participates in the vital principle and in the maintenance of health.

Osteopathic lesion

From the point of view of Biotensegrity :

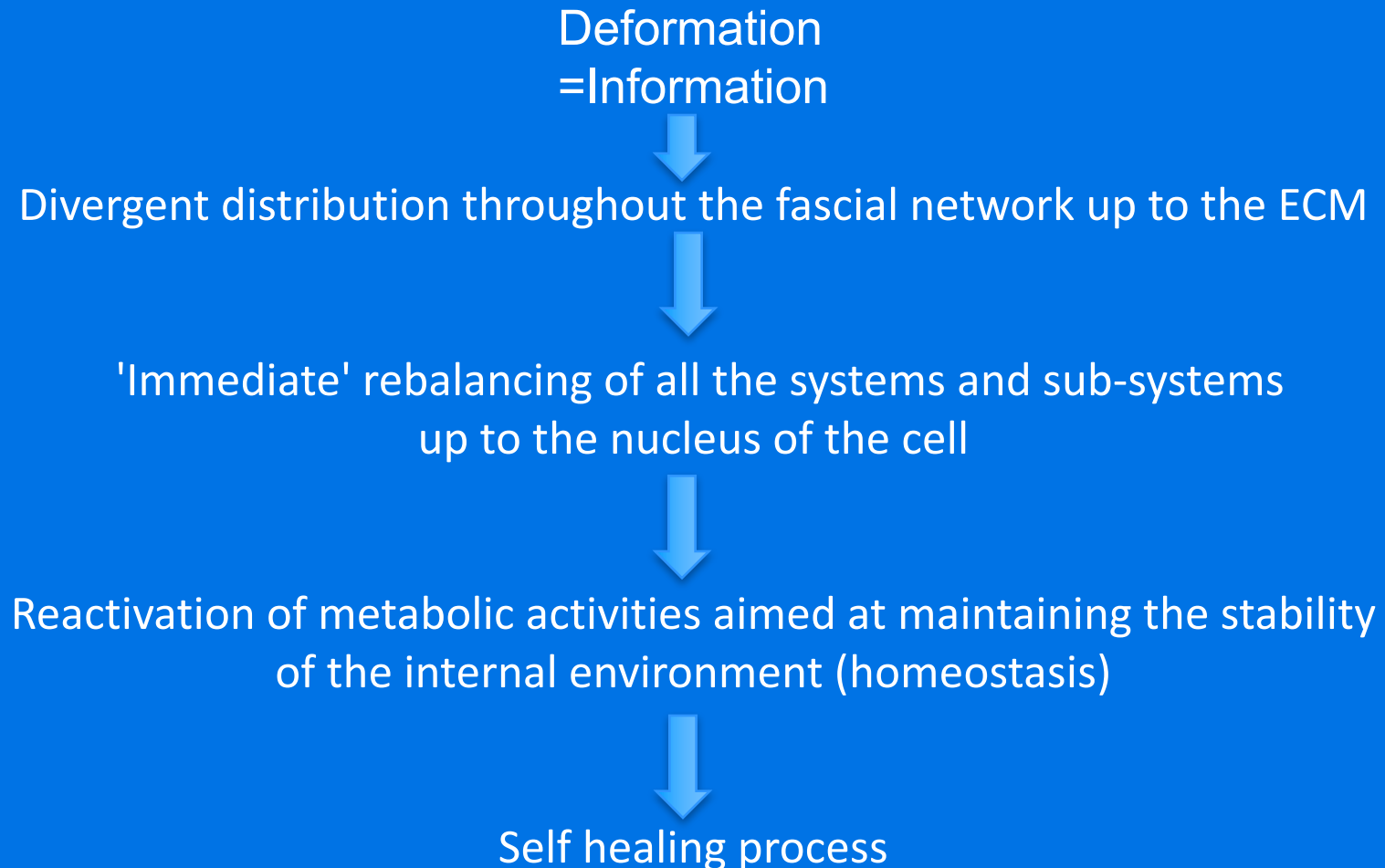
'Osteopathic lesion' could be defined by **organizational disorders** in which **altered patterns of tenso-compressional forces distribution** are accompanied by **inappropriate changes** that occur in the **flow of information and in homeostatic responses**.

Osteopathic treatment

Whatever osteopathic treatment we perform (structural, functional), we apply a constraint (pressure, stretching) to the body, which induces a deformation.

Mégret J.F. « La tenségrité, vers une biomécanique ostéopathique -Mémoire d'ostéopathie »- 2003

The different steps of the osteopathic treatment according to the light of biotensegrity



Osteopathic treatment

Understanding with the J-curve

what we do and perceive during osteopathic treatment :

The example of the Recoil

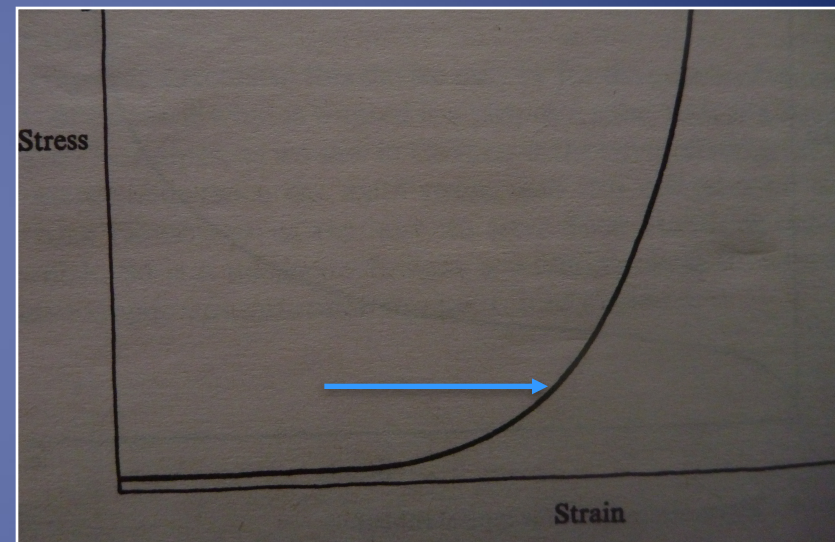
Recoil is used to tissues strong rigidity.
in :

a-Self Adjusting Technique (SAT)

by Tom Dummer and Parnel Bradbury

and in:

b- Mechanical Link by Paul Chauffour and Eric Prat.



The practitioner applies a pressure (deformation) that leads him to reach the **tissue barrier** that is located at **the beginning of the verticalization of the curve** and it is where the recoil will be carried out.

Let us now share 3 recent testimonies
about **biotensegrity**
from French osteopaths

For Ildiko Somody Néplaz, osteopath, teacher and recently member of the BIG,
biotensegrity scientifically enlightens my osteopathic touch whose message spreads to the cell. Biotensegrity as integrated into Michèle Tarento's «osteo- awareness», widens my adjustments possibilities, giving back to the bone its essential role.

Personal communication 2021

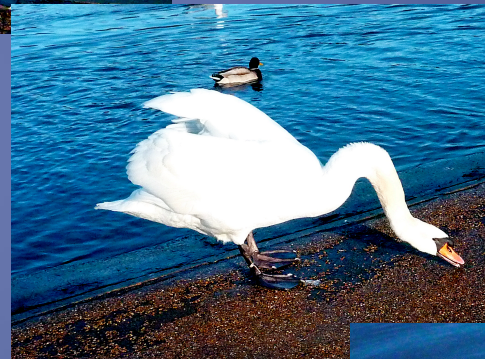
For Bernard Schmidt, osteopath, teacher, *biotensegrity is a new science of systems'*
- Conference at compared Osteopathy Meeting- 2021

For André Ratio, osteopath, founder and director of the CSO, Toulouse, Nanterre,
this concept appears as a real opportunity offered to our senses, especially to touch, to support our perceptions and gestures.

Ratio A. *Utopias - From the perineum to the brain, through the breath and the hand.* Editions André Ratio, 2018



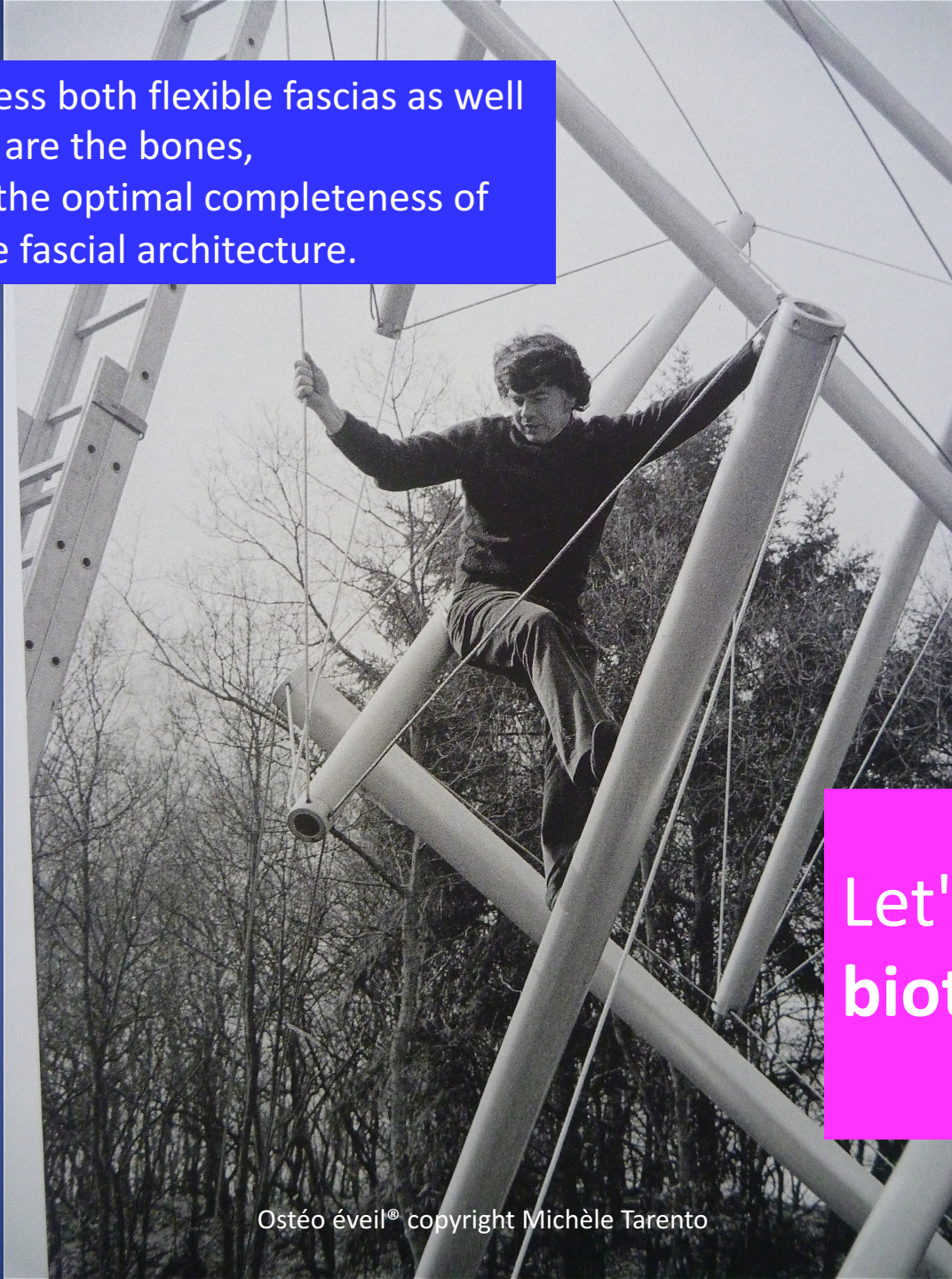
However, a particular attention to the dynamic organization of the living matter awakens inside oneself...



...this image of
Kenneth Snelson
practicing the art
of tenso-
compressional
adjustments of one
of its sculptures...



...invites us to address both flexible fascias as well as rigid fascias that are the bones, in order to restore the optimal completeness of its dynamism to the fascial architecture.



Let's dare
biotensegrity!

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