Applying Quantum concepts to systems theory

Toward quantic systems

Yves Chaumette

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The origin of systems theory

- In the beginning of the 20th century great minds puzzled about the problem of the black body
- It gave birth to the quanta of light
- These quanta indivisible units were later recognized as units of action
- Quantum mechanics can talk only about observed objects, according the interpretation of Copenhagen
- The behavior of the system depends on the interaction with the instrument of measurement

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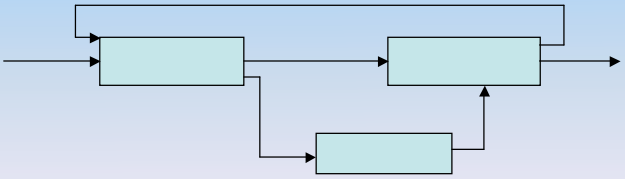
The interaction

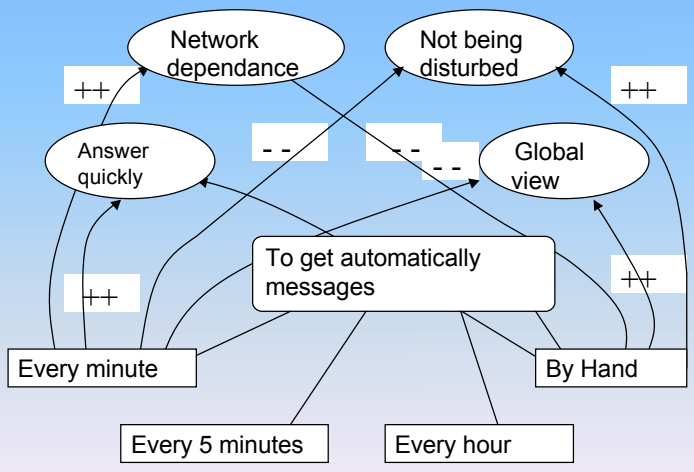
- Objects are known only through interaction
- This hypothesis has been confirmed later by the experiment of Alain Aspect
- Our action upon an object is thus the only means of knowledge
- And the object evolves during that action

Usual systemic modelling

- The interactions between various components are described as flows
- In diagrams of influence, the influence is marked as positive or negative



Influential diagrams



Critics of systems

- The modeler -the one who is drawing these interactions - is not interacting with the other components
- Famous Escher's drawing shows how the picture emerges from the pencil and the hand of the drawer
- Hence a systemic model describes the behavior of an existing system
- Yet does not promote creation of a process
- Systemic modeling is quite ineffective in crisis situation for finding new solutions

Quantization of systems (first step)

- In the 1930's physicists began to quantize classical problems
- The first step is to recognize that flows or interactions are discontinuous
- Positive or negative influence are only trends calculated on small packets or indivisible actions.

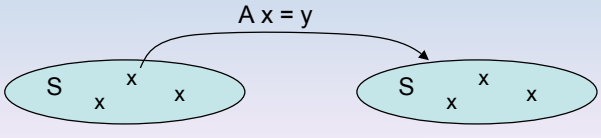
The criteria of action

- Quantum of action
- Observable : operation
- Aristotle : the act before power
- Commuting grandeurs
- Anti commutation

Quantum

- The indivisible unit is not a quantum of light or quantum of energy
- It is a unit of action
- Action in physics is the product of mass with speed with length ML^2T^{-1}

  Or the energy applied during some time
- An action in maths is an external application on a set



Observable

- Any grandeur is assumed to be associated to a linear operator
- It is operating on the linear space of states of this grandeur
- Only eigen states can be observed as one need to compare the initial state with the final state
- Such a grandeur is called an **observable**
- A being the operator, x the state and a the eingenvalue (ie a number) $A\,x = a\,x$
- An operator requires thus an external action

Measurement

- A grandeur can be observed and said to exist only when it is found again through a measurement process
- What is then measured is the probability to get such an eigen value or another
- The length of a table can observed while applying a meter along it and when the table remains in the same state
- The measurement process may be repeated

The necessity of action

- A measure - or any knowledge - requires thus an action
- Without action, the system does not exist for the observer
- This (inter) action relates the object and the instrument
- More generally, the subject is acting on the object
- The subject meaning the process, its design and the instrument

Independent observables

- Some observations do not disturb the observation of other variables.
- For instance, the measurement of position along one axis does not alter the position along other axes.
- These variables or observables are independent and may be done in whatever sequence
- They are commuting

Position x ∘ Position y = Position y ∘ Position x

Operating observables

- So far we have only described a way of describe a mechanical system.
- We may say that we are acting when measuring the length of a table
- However its length does not change whether we measure it or not.
- Reality is said objective, independent of the observation

Anti commuting observables

- Some observables are altering the system measured along other observables
- The measure of position of an electron alter its wavelength (thus its impulse)
- One measurement assumes the system to be a corpuscle while the impulse assumes it to be a wave

Anti commuting 2

- Observables which anticommutes are said complementary
- Their antiproduct is equal to identity up to a scalar

  Position ∘ Impulse - Impulse ∘ Position = i h 1
- This scalar h is a typical grandeur of Quantum Mechanics

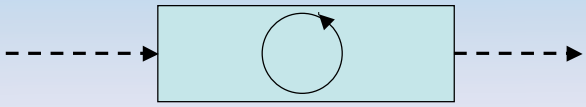
  (here h is the Planck constant divided by 2 π called h bar)
- There are several complementary observables

Identity

- Identity is appearing in the antiproduct of complementary observable
- This fact can be interpreted as such:
- **Identity is an action**
- Indeed, A = A requires to compare the left member with the right member
- The system does not exist without an action = it can't be observed

Quantized system

- As a conclusion, a system does exist only thorough an action, be it a move, a change or an act of perception
- It could be modeled as such, if we assume that all features require an interaction



Permutation object-instrument

- Contra variance and covariance
- Permutation in classical physics
- Permutation in quantum formalism (real and imaginary part)
- Instrument or subject

Contravariance

- In the night a car is turning to the right,
- The beams of light are turning to the right, while the objects in the country side a returning to the left
- That which goes along the instrument is covariant (the light beams):
- That which goes in the opposite way is contravariant: an object
- The etymology of Ob-ject is ‘thrown before’

Measurement Form

- The measure in Quantum Mechanics has this form
- <Instrument | Object> = Amp Probability <Covariant | Contravariant>
- Amp Probability is the amplitude of probability: a complex number
- Its square gives the probability to get the result: an eigen state of the object

Permutation Object - Instrument

- An object can be used to measure “back” an instrument

  $\overline{\text{<Instrument | Object>}} = \text{< Object | Instrument>}$

- The bar above the expression means complex conjugates
- This gives

  Real part = 1/2 <Instr | Object> + <Object | Instr>

  Imag part = 1/2 <Instr | Object> - <Object |Instr>

Reality

- This expression gives a clear meaning to Reality
- Is real what is constant when the object is used back to measure to instrument
- If we are walking 2 meters toward an object, the object should see the distance decreasing of 2 meters
- If this is not so, the move is partly imaginary

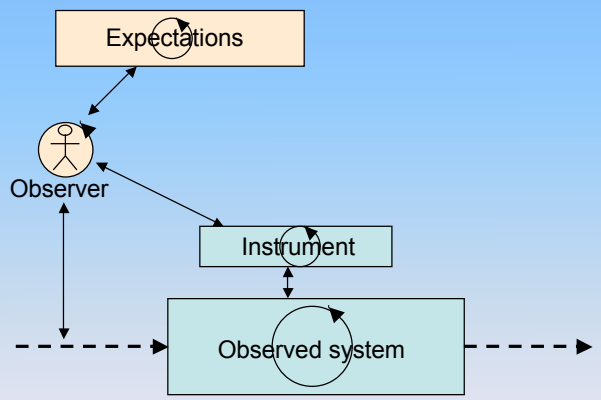
Reality 2

- The example given above addresses to the observed values themselves.
- In QM, the formalism addresses to amplitude of probability
- The probability concerns the fact of some instrument observing in the right direction when some event is happening
- Both the event and the observer are playing in that probability of observation

Testing the observer

- One consequence is that the observation is real if one is able to permute the instrument (the observer) and the object.
- Are we able to do that?
- One main hindrance of systemic theory is the expression of our own knowledge and hypotheses

Model of a quantic system



Quantized system commented

- The identity of the observer is not taken as granted: it is an action
- The instrument as well as systems are not taken as granted : they have an id
- The expectations - intention- of the experiment are taken into account, as much as knowledge is concerned
- Any interaction is taken into account as it may disturb the observation or the state of the interacting system

In-tension

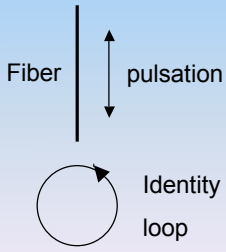
- Creation and annihilation of particles
- Founding stimulus
- Fiber on a variety
- Dynamism: renewal of identity
- Cohesion: spatial impact of the foundation

Creation and annihilation

- The creation and annihilation of particles have been observed in the 1950s
- A couple proton antiproton can be annihilated giving 2 photons
- It can be created by the meeting of two high energy photons
- This is a second term conclusion of QM

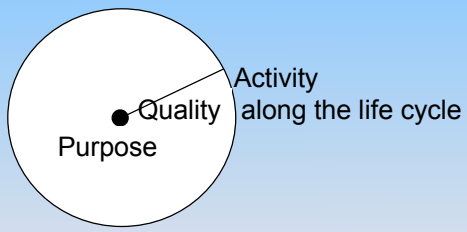
Founding stimulus

- As identity is an action, on e may see this action as a pulsation along a fiber
- This fiber can be viewed as an hidden dimension



Intensional quality

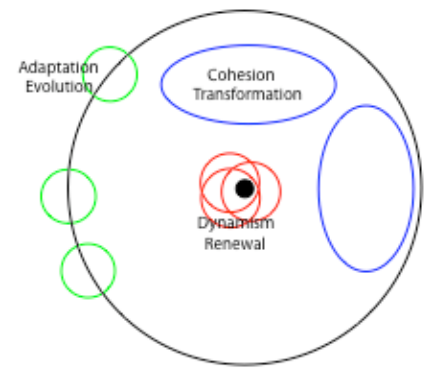
- Quality may be defined as the rapport between purpose and activity



This definition is most useful in complex systems and in crisis situations

3 basic qualities

- From the intensional definition, 3 qualities emerge “naturally”
- At the center
- Along the radiuses
- At the periphery



Dynamism

- Dynamism can be defined as the frequency of the renewal of identity
- Within a period of pulsation, the system is not defined as the identity can’t be observed
- This idea joins with phenomenologists, these philosophers are talking about life and intentionality
- We can observe that many social systems are making effort to assert their identity, through advertising, meetings, names and logos

Cohesion

- Cohesion can be defined as the impact in space of the inner tension
- As this tension is renewed, the impact goes backward from the periphery to the core
- Thus cohesion is the outreach of identity as it is expressed in activities
- In the life cycle, it is the several radius as they express the purpose and the activity is revealing the purpose

Perspectives

- Spin or intrinsic rotation
- Fracta - quantic hypothesis: scale invariance of the quantum of action
- Applications in social and biological systems

Spin in space of values

- Any particle has an intrinsic momentum called the spin
- Can we observe an rotation in any system?
- In social systems, it could be that the life cycles revolve around a main value which is the social purpose (raison sociale in French)
- This would mean that all values are explored and the aim of that organization is reasserted regularly
- Can we observe such a fact?

Fracta quantic hypothesis

- One will have to test whether the unit of action is equal to all scales
- Form physical atoms to living cells, to social cells, to society and organizations
- However if several orders would have various quanta of action - several values for the indivisible unit of action - , the principle of a quantum for an order may remain valid.

Applications

- Social systems such as organizations are usually strongly interacting with the object of the experiment and with its objectives
- For example,
- UN observers of an election
- Human Rights watch on an educative program
- Biological research during an epidemic

Short bibliography

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