Crossing/Conquering/Surfing shifting ground: PI Commitment crossing the boundaries of knowledge

Variables of Commitment and PI performance

Research motivation

- **The new deal in the field of Sciences reveals a new framing of research boundaries…**
  - Emerging new technologies are entailing diverging tracks for research
  - Expanding universe of knowledge challenges ability to cover a field of research or a discipline
  - Increasing number of stakeholders (public laboratories, clusters, private companies, technological platforms, scientific, developers …) with distributed and virtual organisations leads to complexity and uncertainty

- **…& raises new questions regarding Science Management…**
  - Calls for tender create new tension that introduces from the origin the convening of several worlds and actors scientific, economic and social
  - Projects transcend organizations and Project units are temporary premises dedicated to activation and mobilization of resources and skills that gradually draw direction.
  - Continuity is constantly called into play for overcoming uncertainty and find new markets and new applications

- **… and PIs role**
  - If competition for projects and processes are currently structuring actions
  - Project investigators roles remains on shadow whereas they are delegated to research agendas elaboration and implementation of the lines of advancement of science.

Research question

- **In the last decades, project based research policy has delegated to principal investigator the task of anticipating future trends in research.**

- **So it is crucial to improve our understanding of the mechanisms by which principal investigators shape the paths taken by emerging fields.**

- **Because PIs shape and project their vision of science, they deserve special attention:**
  - How do they deal with heterogeneous basis of participants and diverse funding structure?
  - How PIs work on their research theme, defining main orientation, federating people & creating team work?
  - What are their modes of collaboration facing growing complexity, knowledge distribution, sponsorship & fund raising, publication & patenting strategies…

Research question

- **To better understand PIs contribution, we focus their practices and speech in order to characterise PIs in action**

- **In other words serving Science, what are their core practices?**

  ➔ One related to science in the making: experiencing & deducting, publishing or patenting…

  ➔ The other related to science in the sense making in direction to business, industry or public stakeholders: linking technologies, materials, disciplines and fostering connections

Research question

- We intend to demonstrate that PIs practices sheds light on research strategies in emerging fields
  - Creating boundaries between fields and sub-fields
  - Labelling investigation territories to appeal markets and players
  - Transcending institutions and organisations
  - Combining or discriminating technologies and markets they overcome their pure scientific role, in shaping and forming new expectations

- We will show that PIs can deploy 4 sets of practices which are non exclusive and that can be combined one to one
  - *"focusing"* when digging within a trajectory,
  - *"scattering"* when exploiting outcomes for existing makets
  - *"facilitating"* when animating and influencing scientific community,
  - *"exploring"* when shaping new trajectories and new markets.

Research question

- **While "focusing" and "scattering" practices remain close to project management**

- **"facilitating" and "exploring" are reshaping simultaneously boundaries amongst the different subfields and organizations dedicated to nanotechnologies:**
  - To target challenges of nascent or unexplored fields
  - To combine knowledge to deal with uncertainty

Research design

- **Based on the analysis of careers, practices and attitudes (What people say and what they say they are doing, providing narrative and reflexive analysis) of twenty leading researchers, this document proposes a representation of their engagement.**

- **Qualitative process**:
  - In depth interviews with sample of nanotechnology Project leaders

- **PIs sample consist of:**
  - Men & women from 36 to 59 years
  - All involved in nano research programs
  - from various institutions & locations (Paris, Toulouse, Grenoble, LAAS, CEMES, CEA/LETI, LMPQ, LCC, LPN, LFP, IEF…)
  - From different background (engineers, doctors from various disciplines: chemistry, physics, biology…)
  - with different positions & level of experiences (junior, senior scientific researcher, scientific director, head of research group, academic executives…)

Research design

- **Data collection**
  - Interviews – open questions regarding career path, nano-orientation, position within disciplines, project management, PIs main activities & responsibilities.
  - PIs Curriculum and research data

- **Data analysis:**

  All interviews were prepared from the data available on the Web and ISI-WoS. They were subsequently transcribed and analyzed in particular by using the qualitative analysis software Nvivo in an inductive and deductive approach (Glaser and Strauss grounded theory)

- **Data Set: We track engagement focusing on two sets of analysis**
  - Practices (main activities and related representations)
  - Career path (CV and speech on career, to identify dynamics)

Research design

- Interviews were subsequently transcribed (average of 11,336 words per interview) and analyzed, with particular reliance on the qualitative analysis software Nvivo in an inductive and deductive approach (Glaser and Strauss's grounded theory).
- First we focused on the scope of the field of observations to be made, researching analogies through similarities and differences and finding common elements.
- Our analysis is constructed through observation of what recurs and what is connected and reflects the complexity of things that influence each other.
- We chose to characterise the practices rather than stereotype the researchers. Each practice is developed in reaction to a given situation and allows a better understanding of the system of implementation.

Findings on Practices

Findings

- **First result analysis: Practices of PIs are deployed follwing two main directions**

➔ **<u>Practices focused on scientific output</u>**

- To deliver results
- To explain & comment results

➔ **<u>Practices focused on connections, interactions and meaning output</u>**

- To build meaning,
- To construct perspectives and goals (personal, academic or industrial perspective)

Findings

- **Actions focused on scientific output includes:**
  - The scientific experiments and deductions related to their main research topics,
    - Field of research label & clarity
    - Field of research seniority, broadness and rationale
  - Publications and referees: which describe the level of scientific dynamism and promote the visibility in the academic world (fame)
    - Publication strategy
    - H index
  - Patents: they describe their level of technological dynamism and promote their value in the market for licenses
    - Downstream strategy: Patenting strategy
    - Upstream Strategy: Industrial partnership
  - Strategies for collecting cognitive resources and financial resources to developing their research topic
    - Cognitive resources & skills: PhD students, library…
    - Financial resources: national and international projects (ANR, Cordis, patents royalties…)

Findings

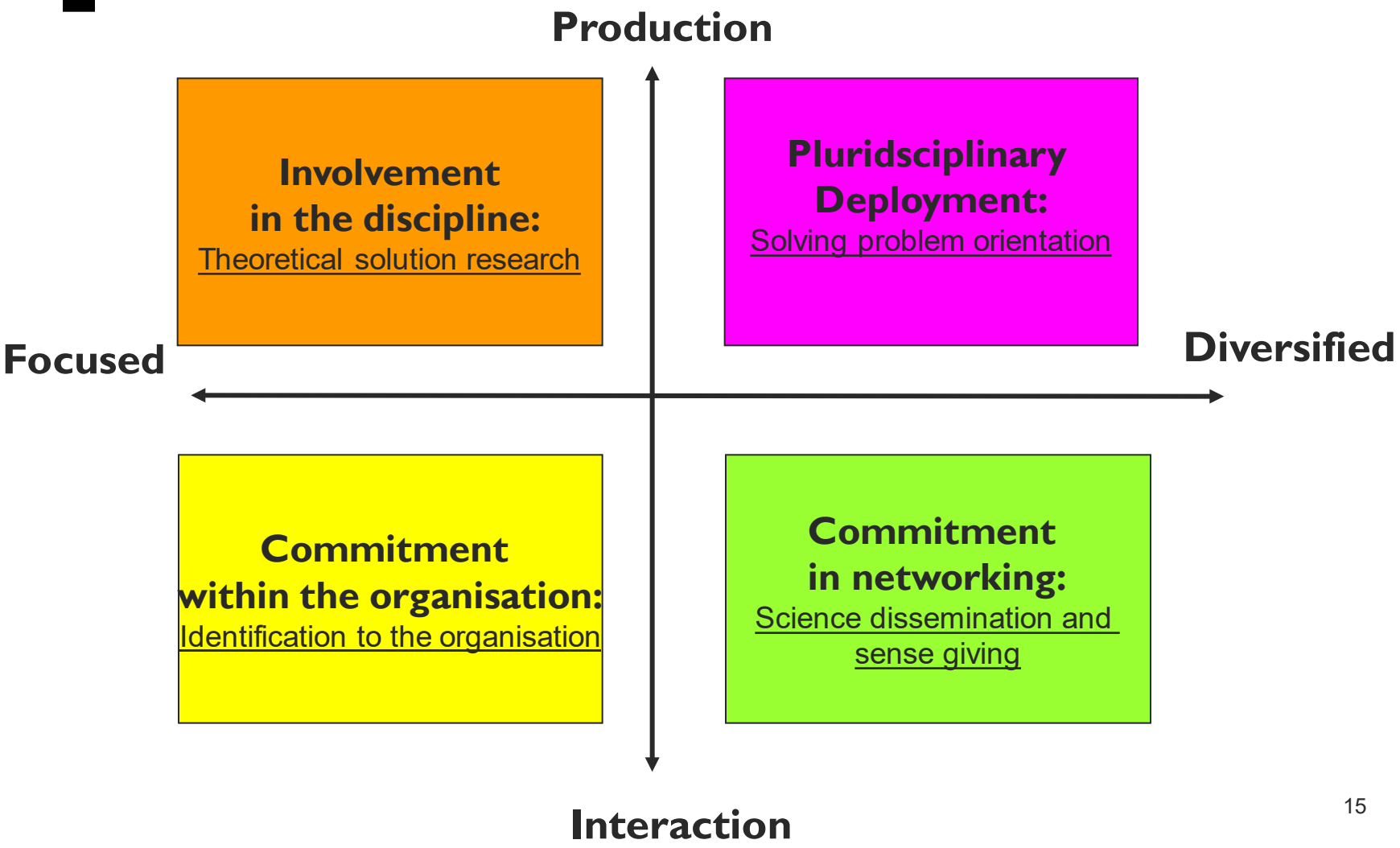
- **Practices focused on interactions and meaning output**
  - Relations within the host institution: laboratories, public research structure..
    - Position, latitude and perceived support from the institution
    - Geographical and scientific environment of the institution
  - Relations within the field & within the scientific community
    - Conference attendance & invited presentations
    - Initiation of collaboration, research team, partnership into projects or institutions
    - Coordination of scientific networks & multi-disciplinary interactions
    - Peer Recognition and depth of network (Position, Awards, Honours…)
  - Relations with the business and industry (technology platforms, industrial partnerships, technology transfer infrastructure ...)
    - Partnerships with industry, Consulting activities…
    - Knowledge of markets and competition
  - Relations within projects:
    - Orientation and /or generation of projects
    - Promotion and management of projects and teams.
  - Teaching and mentoring students master, doctoral and post-doc.

Findings

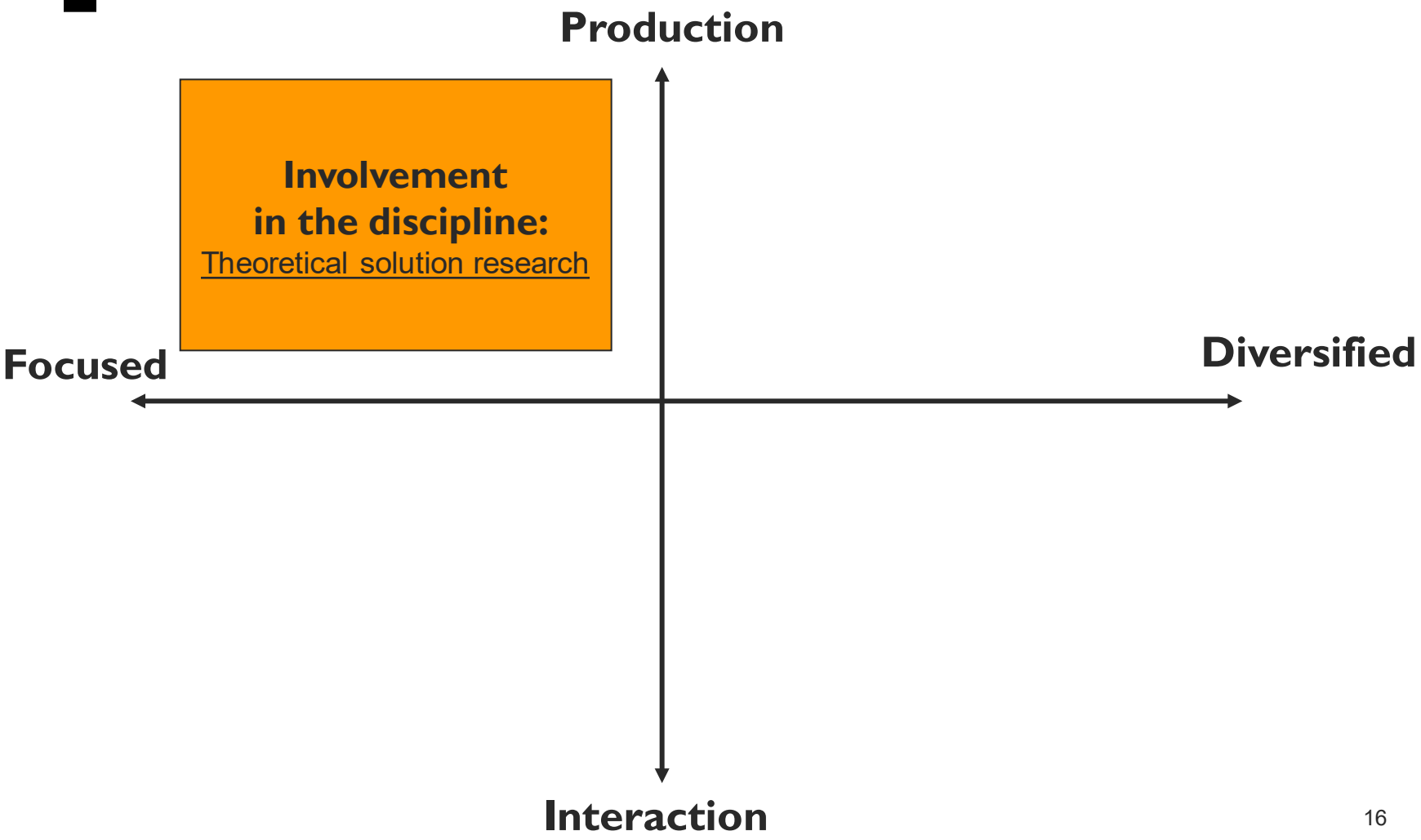
- **We subsequently been able to characterised the different types of practices on a matrix:**
  - An axis specifiying practices type (production / interaction)
  - An axis characterising deployment modes (focalised / diversified)

- **The practices sets are identified and contribute to clarify the wide variety of commitment styles:**
  - Involvement in the discipline: theoretical solution research
  - Commitment within the organisation: identification to the organisation
  - Pluridsciplinary deployment: solving problem orientation
  - Commitment in networking: science dissemination, sense giving

Practices Types



Practices Types



Involvement in the discipline
Practice type: theoretical solution research

- Practices are centred on scientific production in a disciplinary field.

- Activities are focused on the scientific production of the discipline. There are few contacts with other communities. “I am a physicist, my formal training is in quantitative physics and I stay within this subject. I must preserve my knowledge and expertise”.
- As the field evolves (change of theme, laboratory…), the researchers express discomfort (they feel uneasy): “I have to make a big leap to change subject – that’s difficult for me” with often a parallel obligation to overcome an unsatisfactory professional situation.

- This focalisation reduces possibilities to anticipate. The projection of self in the future is vague, and to the question “where do you see yourself in ten years” the responses are uncertain: “it’s a good question….I don’t currently think ten years’ ahead.”

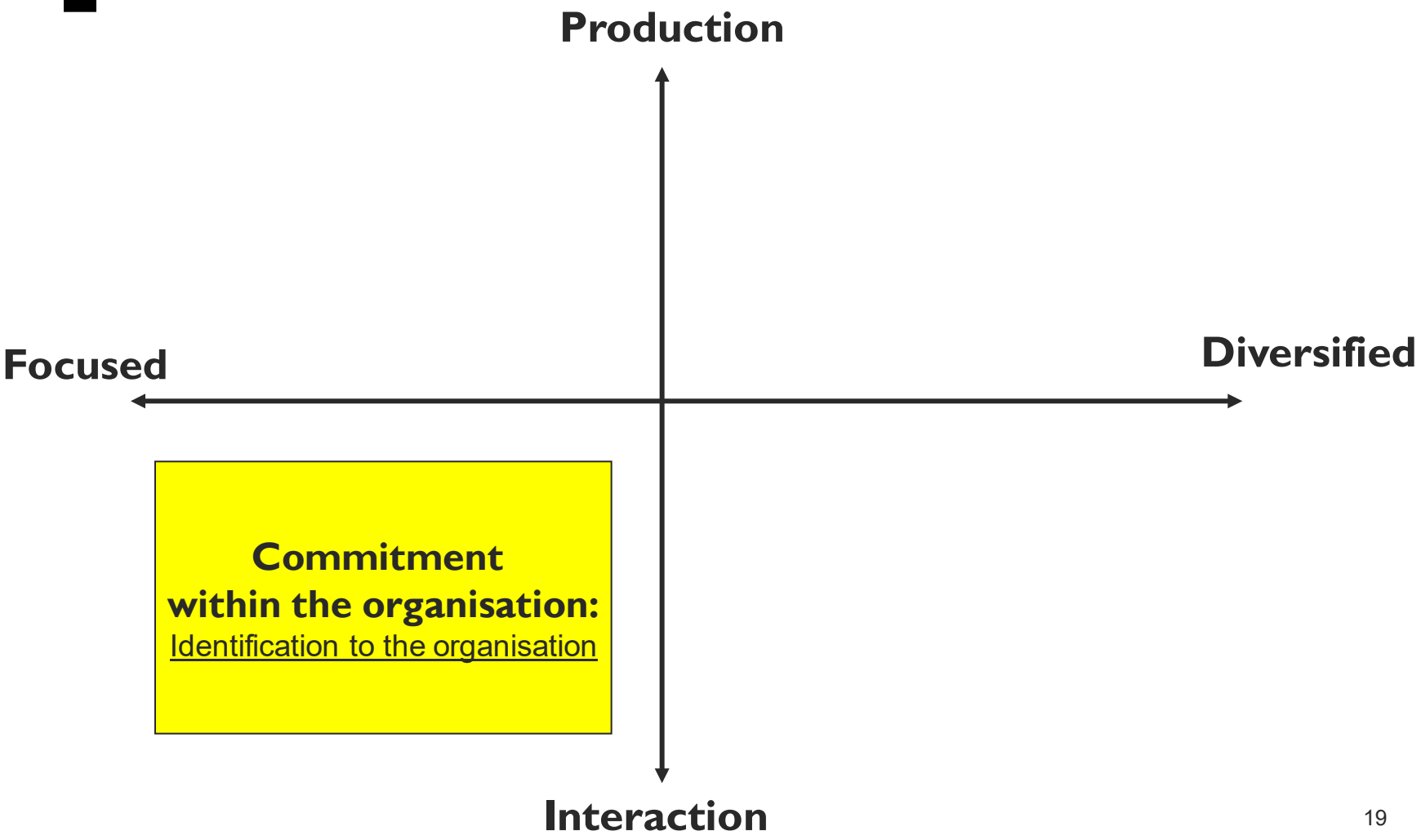
Involvement in the discipline

Practice type: theoretical solution research

- The evolutions in the organisation of research can sometimes lead researchers to ask themselves about the future of research (working in project mode, transferring knowledge, evaluating research) and allow them to begin to reflect on their own practices “an ANR is a way to do a thesis…interesting but on the other hand, diverting me from…”

- The connection with fundamental science and theory is developed in research that conforms to established theories.

Practices Types



Commitment within the organisation

Practice type: Identification to the organisation

- Practices are driven by identification to a community, which is the familiar social community of the researcher or the community of the research institution. “I’ve spent my career in CEA – I’m a CEA clone…”
- The community drives overall directions and the researcher serves the institution, expressing him/herself through impersonal statements.
- The field of nanotechnologies is approached as something natural/habitual where much work has been done over time, often under different labels.
- Careers and directions are perceived as a result of chance, and even put up with as such. “History has shown that disciplines lean towards the world of nanos”.
- There is little reflection on experience or on the actual field of nanotechnologies. Energy is directed towards the collective service or the institution; the scientists are aligned to the policies of their institution or their hierarchies. “There’s the boss and everyone else steps into line”, anticipation is waived to the institution which determines the choices and the overall outlines.

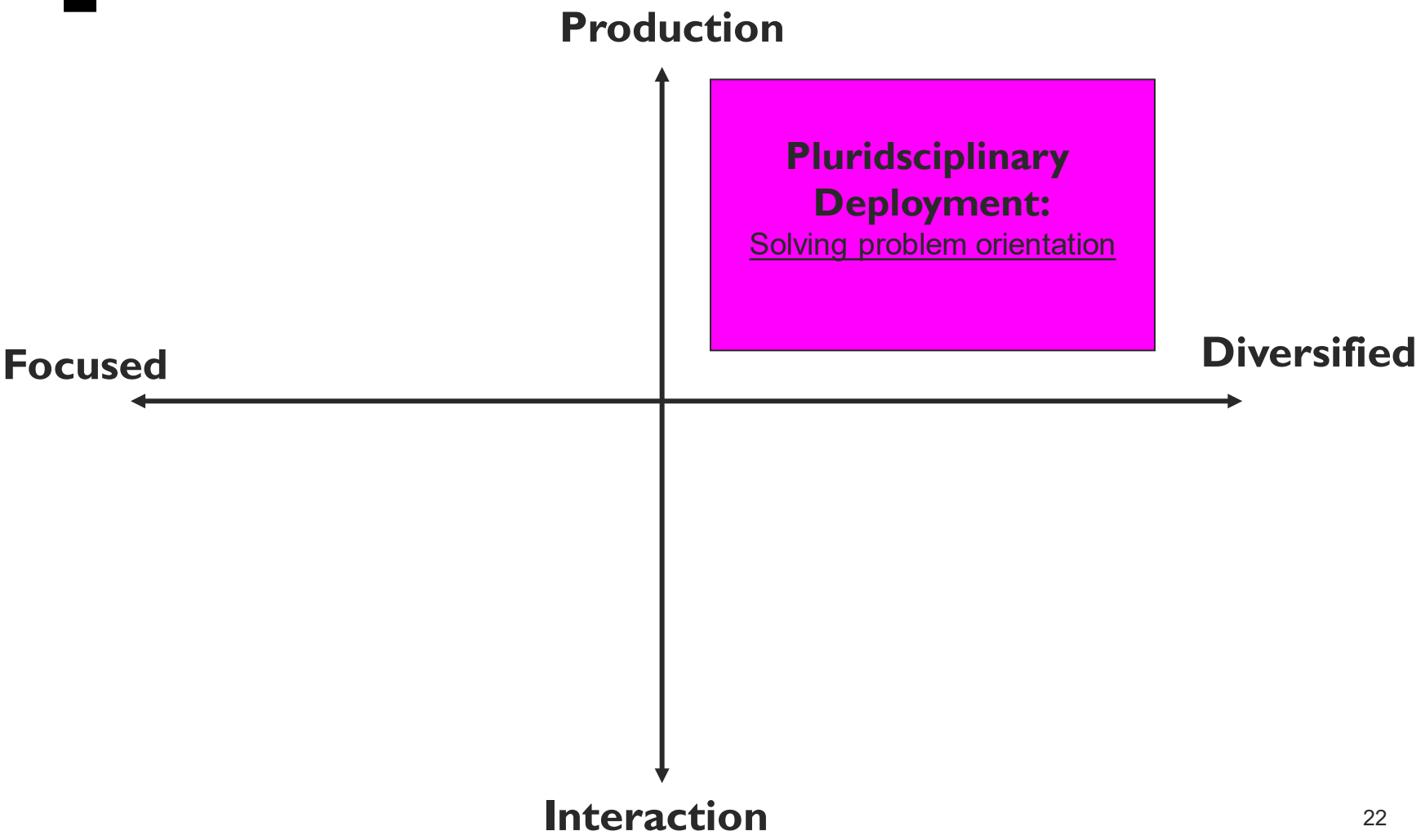
Commitment within the organisation

Practice type: Identification to the organisation

- The connection with science is built up through the implementation of technologies to respond to needs of identified clients (industrial partners) with the aim of transferring knowledge and expertise that relate to concepts of fundamental science. “Yes, in literature, we could predict…But it happens naturally, we have the material, we have the potential application, and we just have to put it together ….”

- Practices are close to engineering science and tend to want to match results to theories, to bring solutions to the technological requirements of industrial clients.

Practices Types



Pluridsciplinary Deployment

Practice type: Solving problem orientation

- Practices are centred in the search for a solution, in going beyond the limits of the discipline. Confidence in one's own abilities to go 'out of the box' and curiosity are drivers for going further. "How does that work, what are the mechanics, what energy does it need? We know how to do it with a laser, a magnetic field, pressure..."

- Nanotechnologies are perceived as an opportunity to accomplish things and notably the possibility to participate in a social dimension, the possibility to be useful. "For me, nanotechnology is the means that I exploit to do things…I need to do things which should be useful for someone…"

- Confidence in one's abilities to go beyond the field and curiosity are key drivers. "My initial training is robust enough to enable me to …..I'm curious; I need to understand, to know that it's possible".

Pluridsciplinary Deployment
Practice type: Solving problem orientation

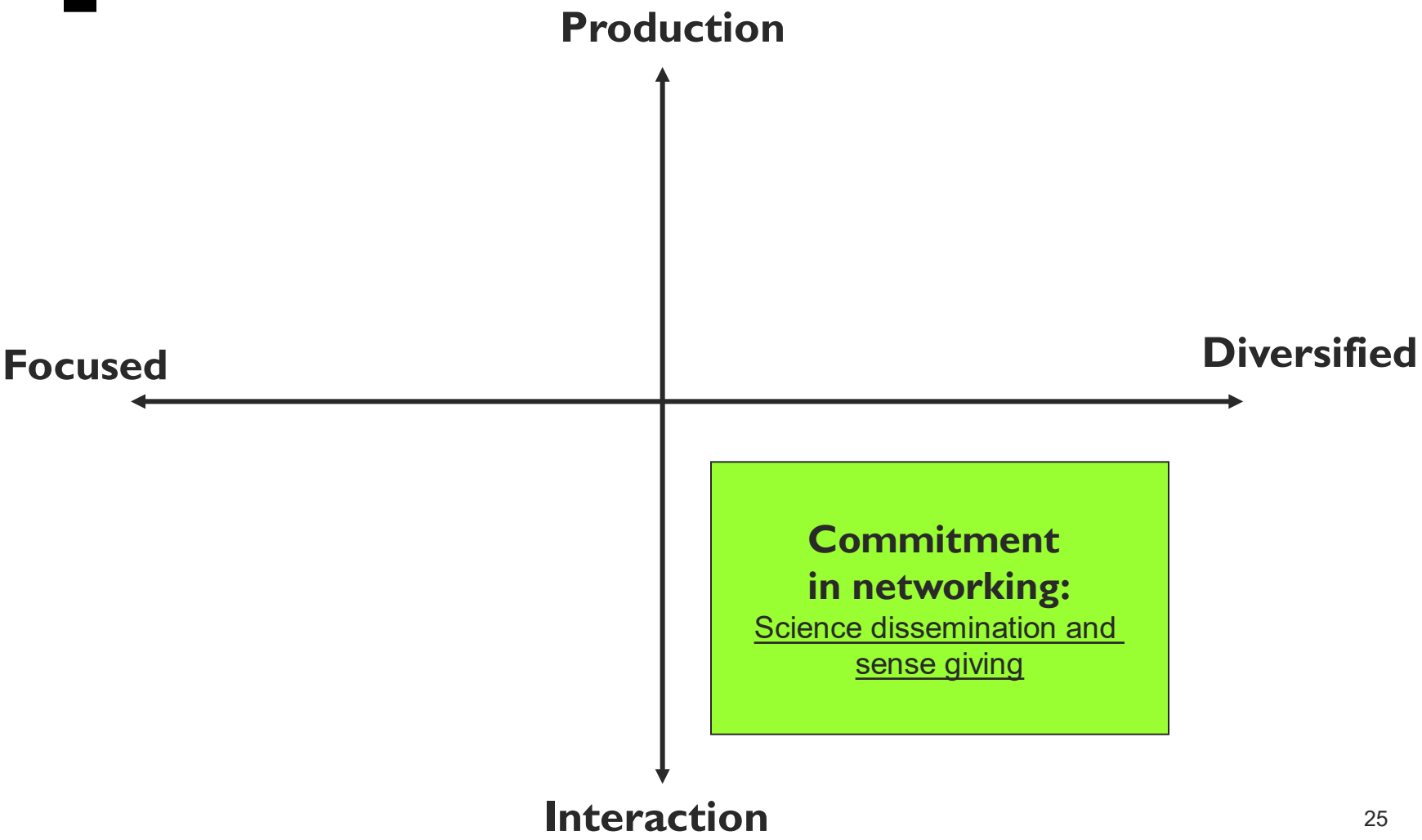
- The researcher expresses him/herself in the first person and sets out to immerse him/her in an interaction on the scientific, social and economic world.

- The capacity for anticipation is expressed and the connection to the future is marked.

- In parallel there is a relatively weak emotional distancing with the subject, the words are passionate, we sense pleasure and emotions. “A desire to make a mark, which the world will remember..." I don’t want to be remembered for the Big Bang, but for a discovery which could have an impact on the socio economic world.”

- Intuition moulds the practices and is rooted in an elevated level of transversal knowledge of science.

Practices Types



Commitment in networking - Practice type:
Science dissemination and sense giving

- Practices are rooted in the search for a guiding sense and the explanation of implicit knowledge.
- There is a strong engagement in the management of knowledge, the capacity to define or modify a model of knowledge: "At the moment there's an overlap between the scales, because there are the two routes, up and down, and that has really generated an exchange between fields…which makes for a real interdisciplinary exchange…"
- Nanotechnologies are perceived as an opportunity to learn and break down barriers between knowledge bases.
- There is a marked connection with the future "what I am looking for is a global perspective and an exploratory approach."

Commitment in networking - Practice type: Science dissemination and sense giving

- The researcher has an active regard to understanding and detecting what emerges.
- He exploits his stock of experiences in different spheres of interactions and connections: “it develops through direct interactions, conferences, seminars…or I work through my colleagues who have their own network and who can propose interesting ideas…”
- The network is at the heart of collaboration and interaction at all stages of projects and beyond projects.
- Collaborative practices are anticipated and built up: “There are similar ideas which are complementary and which should be brought together otherwise we will have projects within projects…”.

- Guiding communities of knowledge, thanks to the double approach of immersion and overview, enables staying right in the centre of the field, in perfect interface with events, whatever their nature. “…keep a strong image but enable to enlarge the field without losing competences…”.The connection to science favours clear models and the production of new models.

Markers of commitment

- In summary, each of the practices deciphers a type of connection to science which structures each of the fields of action that surpass the frame of the project, but is also applicable to the core of the project: what production, which interaction, which position with which perspective or anticipation of the results.

- We can also categorise the markers of engagement by the type of practice by including the following dynamics which structure the activities like links in the value chain:
  - ***Production:*** scientific experiences, analysis and deduction and findings
  - ***Interaction:*** organization of relational processes and interactions, organization of internal players, peer and institutional recognition …,
  - ***Position:*** personal position as researcher in a field and a research theme at the heart of projects and in the scientific field
  - ***Anticipation:*** perspectives, vision and findings in the medium and long term, (project management and project follow-up, definition and evolution of research theme, career development…)

MARKERS OF COMMITMENT

Range of **PRACTICES** ***Practice type***	**THEORETICAL SOLUTION RESEARCH** ***Focusing***	**IDENTIFICATION TO ORGANISATION** **Technologic**	**SOLVING PROBLEM ORIENTATION** **Invention**	**SCIENCE DISSEMINATION SENSE GIVING** **Modelling**
PRODUCTION	FOCALISED	IN LINE WITH THEORY	PLURIDSCIPLINARY	MODELS
INTERACTION	DISCIPLINE COMMUNITY	INSTITUTION COMMUNITY	OUTGOING & PARTICIPATORY	STRATEGIC NETWORKING
POSITION	ACADEMIC	INSTITUTIONAL	MIDST	HUB
ANTICIPATION	IN LINE WITH DISCIPLINE	IN LINE WITH INSTITUTION	INTUITION	ELUCIDATION

Findings on Career Path

Findings

- **Second result analysis: <u>the same analytical framework can be applied to careers</u>**

  According to the original socialization of the young researcher (discipline, thesis, post-doc first projects and scientific cooperation), it is possible to distinguish the path as they are:

  ➔ **<u>focused on scientific output</u>**

  ➔ **<u>focused on interactions and meaning output</u>**

  and

  ➔ **<u>Built on a logic of specialization</u>**

  ➔ **<u>Open to multiple influences</u>**

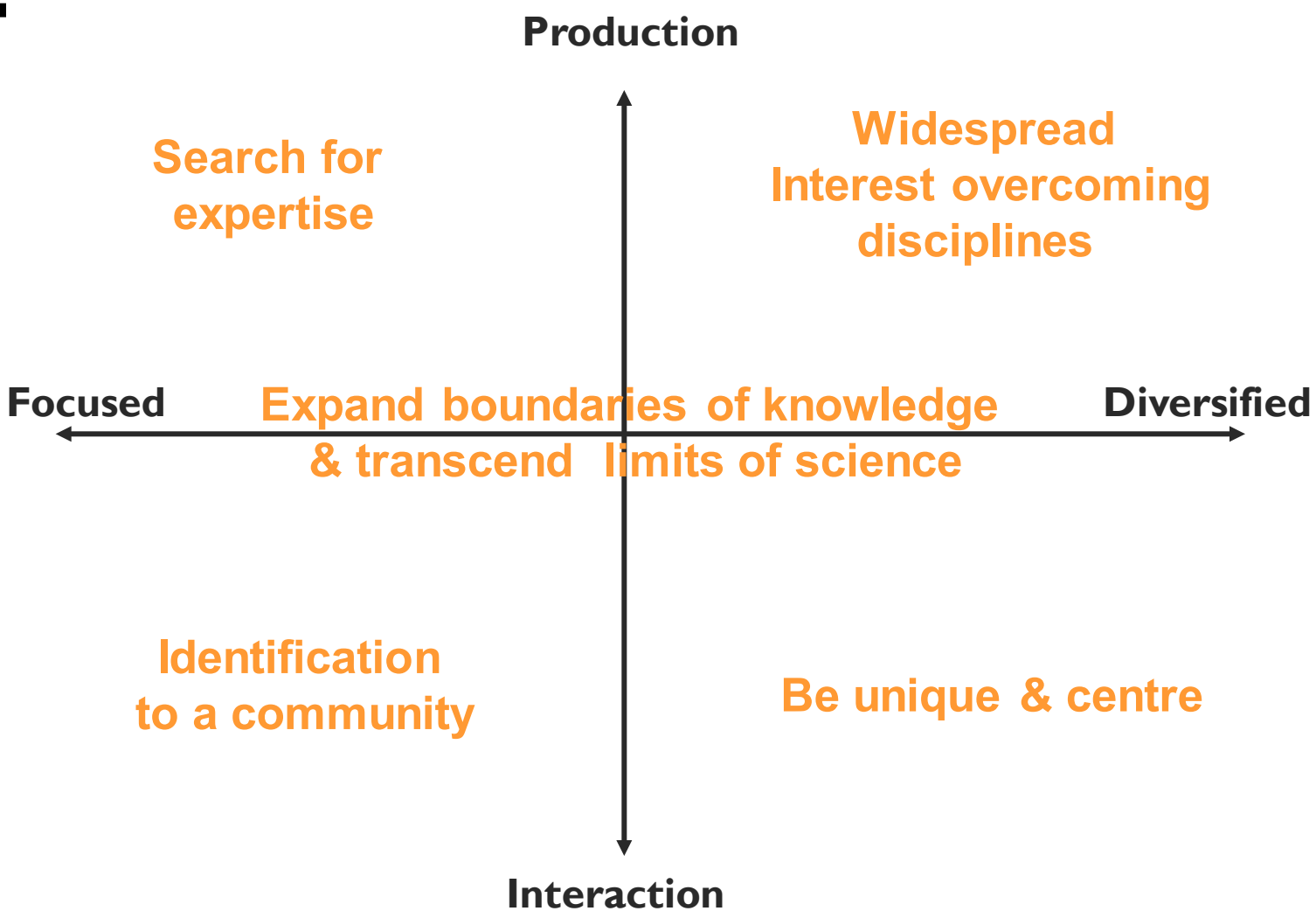
Findings

We classify career path & motives to build career following :

- **Their degree of concentration:**
  - The orientation, the original training have been concentrated on a particular sector or thematic discipline:
    ➔ **Search for expertise**
  - Similarly, the interactions have been exclusive and community focused with a strong sense of belonging:
    ➔ **Search or defence for an scientific & institution identity.**

- **Their degree of diversification:**
  - Their different channel, has enabled them to acquire sufficient depth of knowledge (physics, chemistry, mathematics ...) to promote gateways towards multi-disciplinary, or even to the hybridization of previously separate disciplines:
    ➔ **Search for complementary coverage of the research topic**
  - Similarly, experiences from different backgrounds and cultures (industries, countries ...) have promoted the integration of different practices and networks driven by the desire to play a role or be essential in a given field:
    ➔ **Be unique & centre (in the academic or scientific world)**
    ➔ **Expand boundaries of knowledge & transcend limits of science**

motives to build career



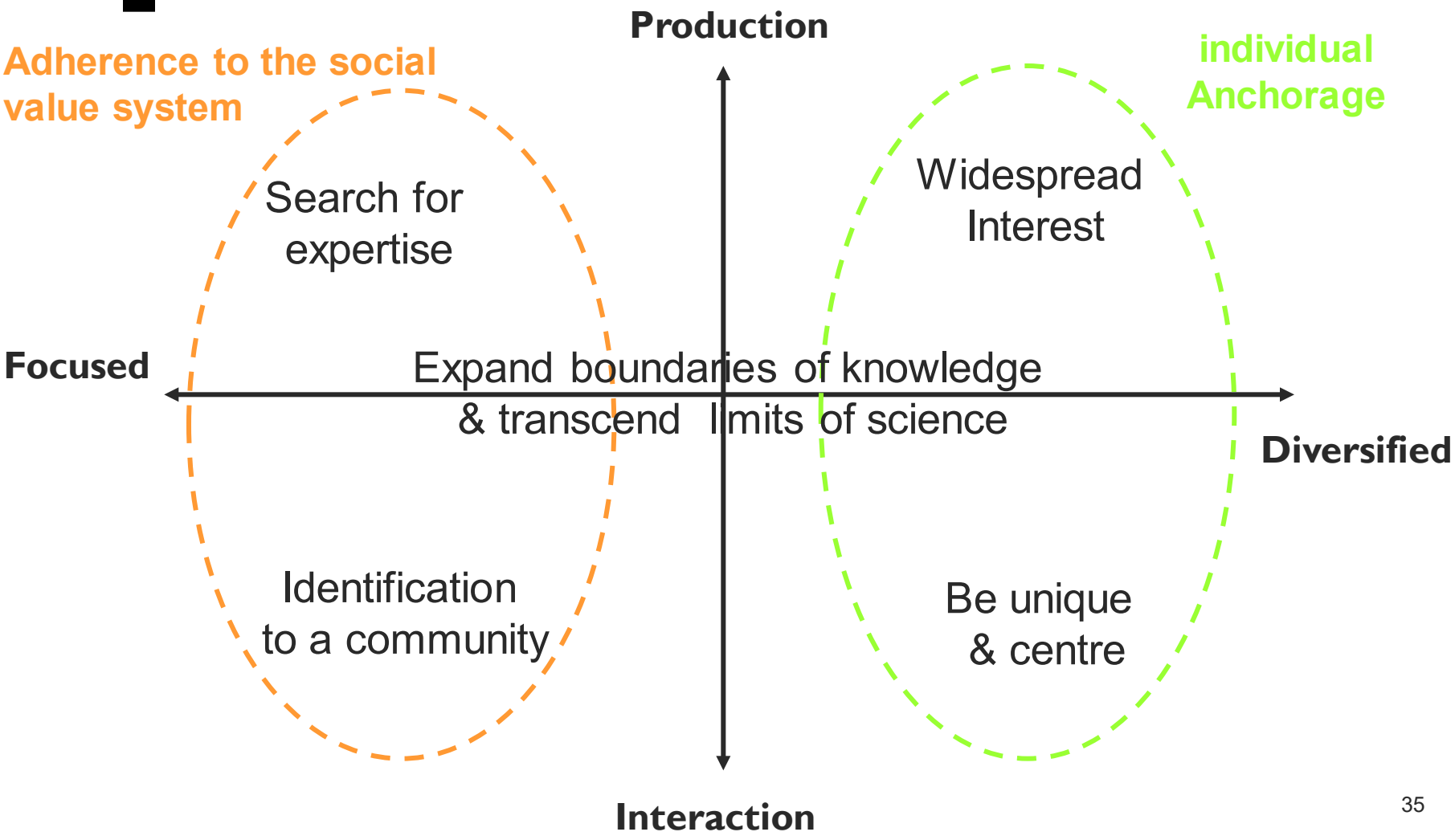
Findings

- The impulses of motivation and the fact of managing opportunities and constraints in careers make the professional career a profound reveller of choices:
  - Adherence to a social value system or anchoring in more intimate or individual impulses
  - Search for identity or resemblance or attraction to what's different or complementary

  …and structure the career path and forms of engagement.

- Each stage in a career constitutes arbitration on the choices and resources to mobilise which prove to be decisive on the type of practices.
  - "For a chemist, the possibility to observe atoms is a golden opportunity…"
  - I always wanted to take a kind of shortcut …I wanted to do my thesis in a field outside the mainstream…"

Motives to build career



Findings

- **Mobility, a paradoxical characteristic of engagement**
- **If we closely observe the types of career trajectories, we can discern different scripts, favouring the passage from one position to another with:**
  - Mobility in line with the social value system
  - Mobility with anchorage in the individual
  - Mobility that encompass all axes: Mobility and openness on all axes

Findings

- **Mobility in line with the social value system**
  - Researchers are looking for a community that is close to their vision of science and in their discipline.
  - Change is experienced as an upheaval, a constraint or a lever to find responses to problems in professional life.
  - Careers have a weak opening towards extra-community interactions (projects and international networks, industrial contacts): “This is not what I want…it’s a really big job… coordinating a European project is an enormous task, and I don’t think I have the time…”
  - Researchers have a central motivation to create more stable conditions, for example, choosing to orient their career towards the dissemination of expertise or to invest at a more local level, in order to reduce existing tensions between the economic and scientific worlds.
  - However, sometimes tenders favour a shifting towards other fields. When it happens there can be a tendency to follow or simply participate, without having taken any conscious step, in those projects to which they will greatly contribute: “the project was followed by a chemistry ANR, which I didn’t expect… I would never have thought we could use this material …How was I supposed to know…”

Findings

- **Mobility with anchorage in the individual**
  - These researchers are not motivated by something external to them – they position 'I/me' as the subject of action... "When I'm asked about my scientific career, the only thing I say, which is the only real thing, is the interest of the work,….I always choose a path that cuts across."
  - Their careers are structured by their personal challenges (their interest in a subject, the systems, others, learning and going further.)
  - While they are anchored in action, it is more difficult to transfer in writing the result of their work. The theoretical part, due to purism or rigour, escapes them a little: "Where shall I publish this? Will it be noticed? I try to do that but it doesn't work…I don't really master that aspect, I'm aware it's important, but I find it hard to optimise it…"
  - Conversely, those who lean towards interactions (conferences, references, networks) have a wider intellectual agility to share and communicate their vision and results and a greater ability to be more visible: "It helped me being a director; it enabled me to develop a large network of contacts, in scientific or even political circles…it made me much more visible."

Findings

- **Mobility and openness on all axes**
  - Practices situated at the heart of the matrix are significant of the search for equilibrium between intrinsic aspiration and social participation.
  - Thanks to a capacity for engagement and absorption, these PIs manage to reducing tensions in a dynamic movement…
    - Movement between communities, aspirations and the divergent interests of different actors
    - Movement between different structures and organizations

    …movement which is the source of a temporary equilibrium where innovation takes inspiration.

- The characterisation of practices in mobility and openness on all axes allows us to define a **grammar of engagement**, by qualifying the major trends of this form of engagement.

Findings: grammar of engagement

Production

- ***Double loop*** between conceptualisation, experimentation and technological applications: "people who make things say it could come from there and that's it. If there's no loop to use it… it doesn't go anywhere." GT3CE. It is not enough to create; you have to find the technologies and make sure that they can be properly integrated.

- ***Momentum*** or ascending knowledge driven by chaining project. The repetition of non-identical projects that are linked to the central idea of making progress in the field of research creates an order (not juxtaposition) of mounting intensity. The pace accelerates, with every project feeding into the mass of knowledge and the network.

- ***Informal Lobbying*** for financing (grants and funds, both public and private), which includes project management skills, a drive to get involved and steer the projects (writing, etc) and the ability to win contracts in the private sector: "oh yes, contracts help you to work on relevant research" CP1ES; as well as the skills or access to skills for writing proposals in response to calls for tender.

Findings: grammar of engagement

Interaction

- ***Disambiguation*** or the capacity to make sense of meaning and the implication of events or situations.

- ***Soft power*** or the ability to drive the project forward and share strategy and objectives. In other words, to give sense, using a mix of cognition, action and reciprocal influence: "There's no hierarchy inside projects, people are completely free… you've got to show that you are there without imposing… I tend to go and see them regularly" RP1IE. Practices are varied, sharing only the ability to foster collaboration without hierarchy (ability to invent a format suitable for leading the subject of research and not the team)

- ***Knowledge brokering*** or the ability to identify the additional skills required using multiple contacts and the embedded network.

Findings: grammar of engagement

Position

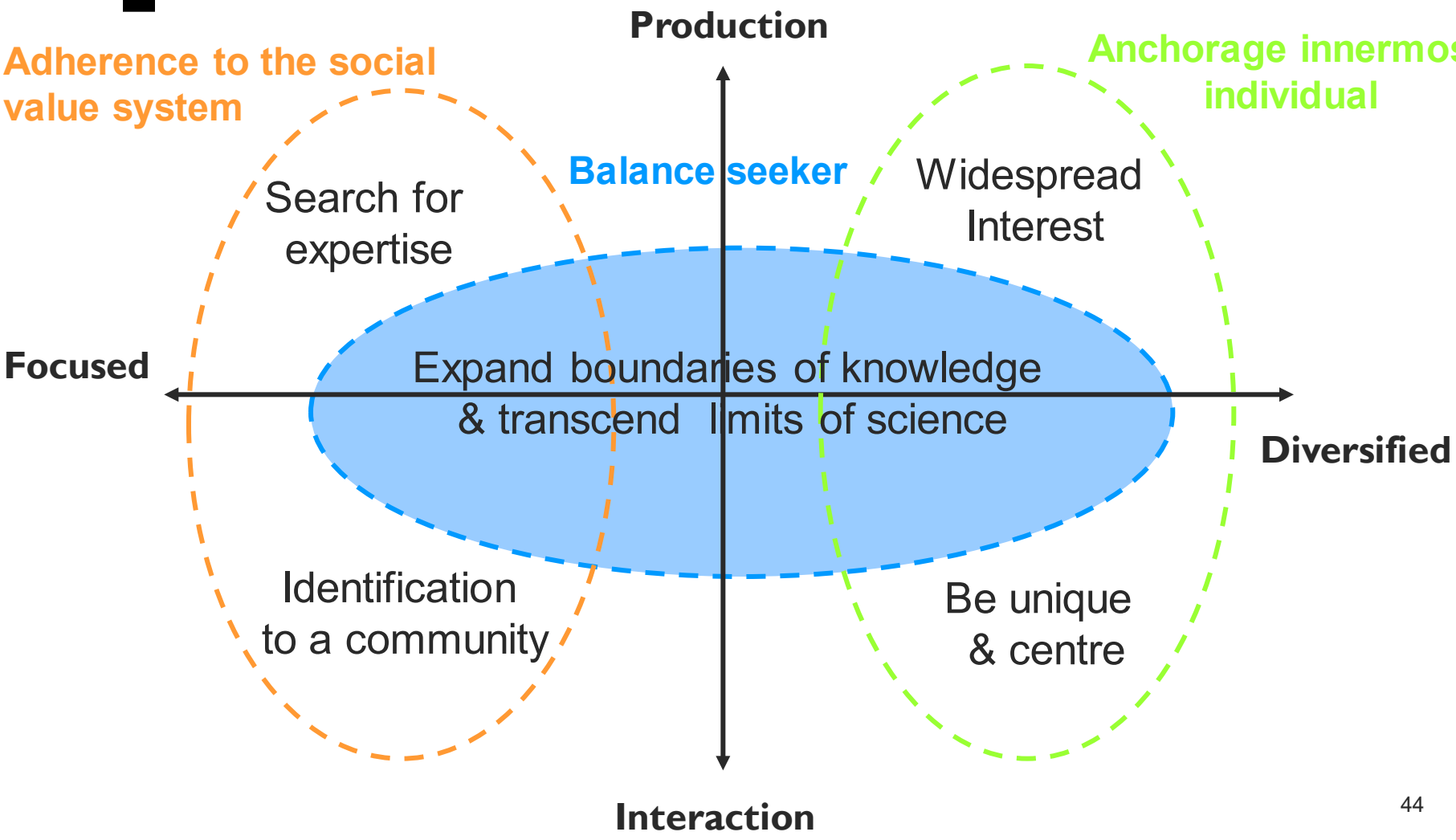
- ***Positioning in the field:*** ability to adopt a position in a specific field must initially be focused. The key is to "Expand one's network without losing one's skills" BT1LA, in order to construct an identity and visibility. "If you publish, you've got to go to conferences, or nobody reads you." CP1ES. Just like a marketing positioning (offer, target, competitive edge), the positioning must have three fundamental constituents—the choice of field, potential targets (functions, market, or industry applications), competitive advantage. The competitive advantage is the subtle balance between the usefulness of the subject, its potential applications and the available resources.
- This positioning in the field includes peer recognition, generally through publications, and recognition by institutions, which issue calls for tender. It also includes recognition by industry, providing understanding and helping to overcome technological barriers.
- ***Reconciling intimate and social motives****:* practices reveal a need to resolve the conflict between sharing and disseminating on the one hand and keeping, retaining on the other. "People who keep the results of their work for themselves… to be honest I'm really not very interested in that!" CP1ES; "Letting everybody drink clean water…."BP1LE

Findings: grammar of engagement

Anticipation

- ***Mindset that is both conceptual and intuitive****:* the difficulty is that when a project works, one can only say retrospectively that it was possible: "It worked on paper, as there were three labs with complementary competencies, that were even very close… but we didn't anticipate a scale problem…." CP1ES.
- Conceptual scientific knowledge and background may falsify the perception of reality by substituting stability for mobility and discontinuity for continuity.
- Anticipation practices expose an ability to unify divergent perceptions of reality: "Some things are similar and complementary. There needs to be some kind of overlap, otherwise we end up with projects inside projects." GT1CE…

Motives to build career



Implications of findings

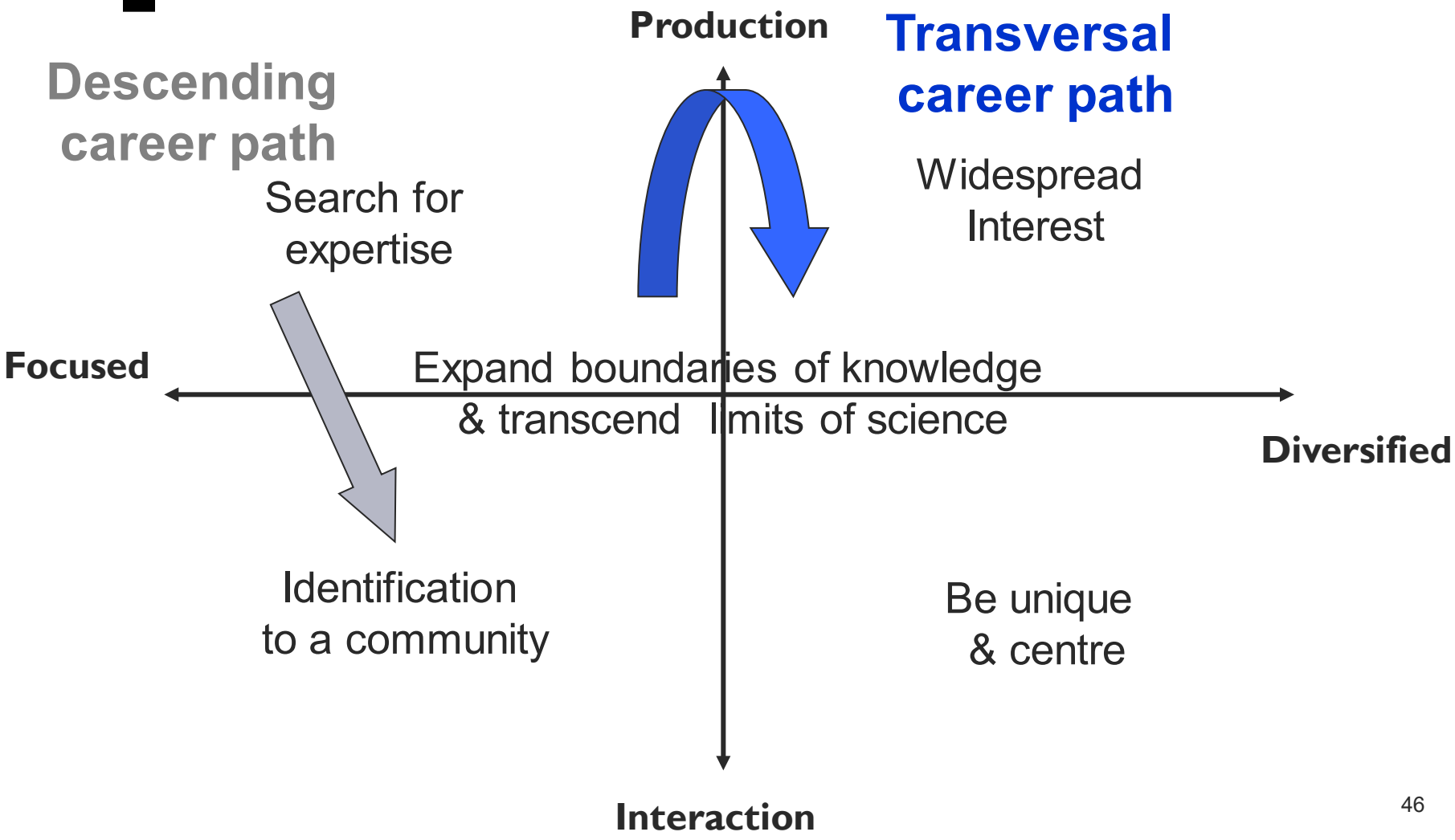
- The central research question was how Project investigators manage to organise and coordinate research, modes of collaboration, facing growing complexity and paradigm shift (upheaval in the funding system, and expanding universe of knowledge).

- Our hypothesis was based on the suggestion that there are different ways to commit in Science, one being rather focused on production (science in the making), the other being related to interaction in the diversity (science in the sense making).

- Our analysis confirms this hypothesis, and sheds more light on possible implications (for scientific policy, profile selection, development, etc):

  - **Descending career paths**—from focused production to community interaction—correspond to the management of stabilised fields.
  - **Transversal career paths**, on the other hand, like those in the emerging nanotechnology field, promote the management of the interface that is needed between subjects, universities, laboratories and industry, environments and cultures.

Motives to build career



Conclusion & Further development

- The possibility of changing the frame of reference (changing discipline or setting) is fundamental even if it's not sufficient. They favour the integration of other perspectives, other methods, other ideas and innovation (it's a change to level 2 according to the Palo Alto school).Their capabilities of engagement are inseparable from the framework of representation in which they are active and the importance of success at the heart of the organization.
- They display a highly independent spirit and have a capacity to self-manage to start again. The practices at the heart of the matrix are of particular interest. They introduce the notion of a key moment, a pivotal event that can reveal contributions and engagements to Crossing boundaries, Building prospect & Connecting communities and knowledge.
- To emphasise its specificity, we represent the typical practices linking it to specific skills that we compare to:
  - the direct route in the mountains, to advance on screes (a shifting stony ground)
  - the mountain helicopter's emergency strategy.

Conclusion & Further development

- The *stony ground image* reveals the capacity to surf on moving without any precise or pre-conceived idea, without prism on the future, integrating symetrically all weak signals to adjust position, partnership and strategies. In that sense we integrate V.Mangematin concept of surf to deal with complexity. (surf when you are in the middle of institutions).

- The *landing Helicoptere strategy* stress the capacity to immerge and overhang successively to catch what is at stake globally and with depth without falling into the traps of stagnation.

DATA TABLE

PRACTICES	THEORETICAL SOLUTION RESEARCH	IDENTIFICATION TO ORGANISATION	SOLVING PROBLEM ORIENTATION	SCIENCE DISSEMINATION SENSE GIVING	KNOWLEDGE BROKER	SUM
SAMPLE NUMBER OF INTERVIEW	4	5	3	3	5	20
INTERVIEW STATISTIC WORDS	59816	30349	32190	27507	76866	226728
CV	4	3	3	1	5	16
Projets	PNANO	PNANO	PNANO	PNANO	PNANO	PNANO