The 5th TRIZ symposium

# Transitions of Japanese manufacturing methods from the viewpoint of constructing and utilizing explicit and tacit knowledge ~The rise of New Empiricism~

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# Explicit knowledge and tacit knowledge

1966: Michael Polanyi proposes tacit knowledge
1995: Nonaka Ikujiro proposes SECI model

| Explicit knowledge | Tacit knowledge |
|---|---|
| ・Readily comprehensible knowledge expressed in words, writing, numbers | ・Hard-to-express knowledge such as experience and know-how |
| ・Rational, analytical, universal (general), objective, clear, digital | ・Intuitive, personal, integrated, subjective, ambiguous, analog |
| ・Can be stored/transmitted | ・Hard to store/transmit |
| ・Contributes to education/spread of science & technology | ・Creative force, challenge to the unknown, challenge to boundaries |

Reference: E. Murakawa, Technology and the Inheritance of Skills [in Japanese] (2002, Osaka University Press)

# Creation cycle

## Step 1: Learning the basics

- Acquisition of the basics; watching

## Step 2: Hands-on experience

- Repetition of the basics; collaborative work

## Step 3: Cultivating tacit knowledge

- Nourishing intuition and insight; trial and error

## Step 4: Expressing explicit knowledge

- Verbalization; quantification

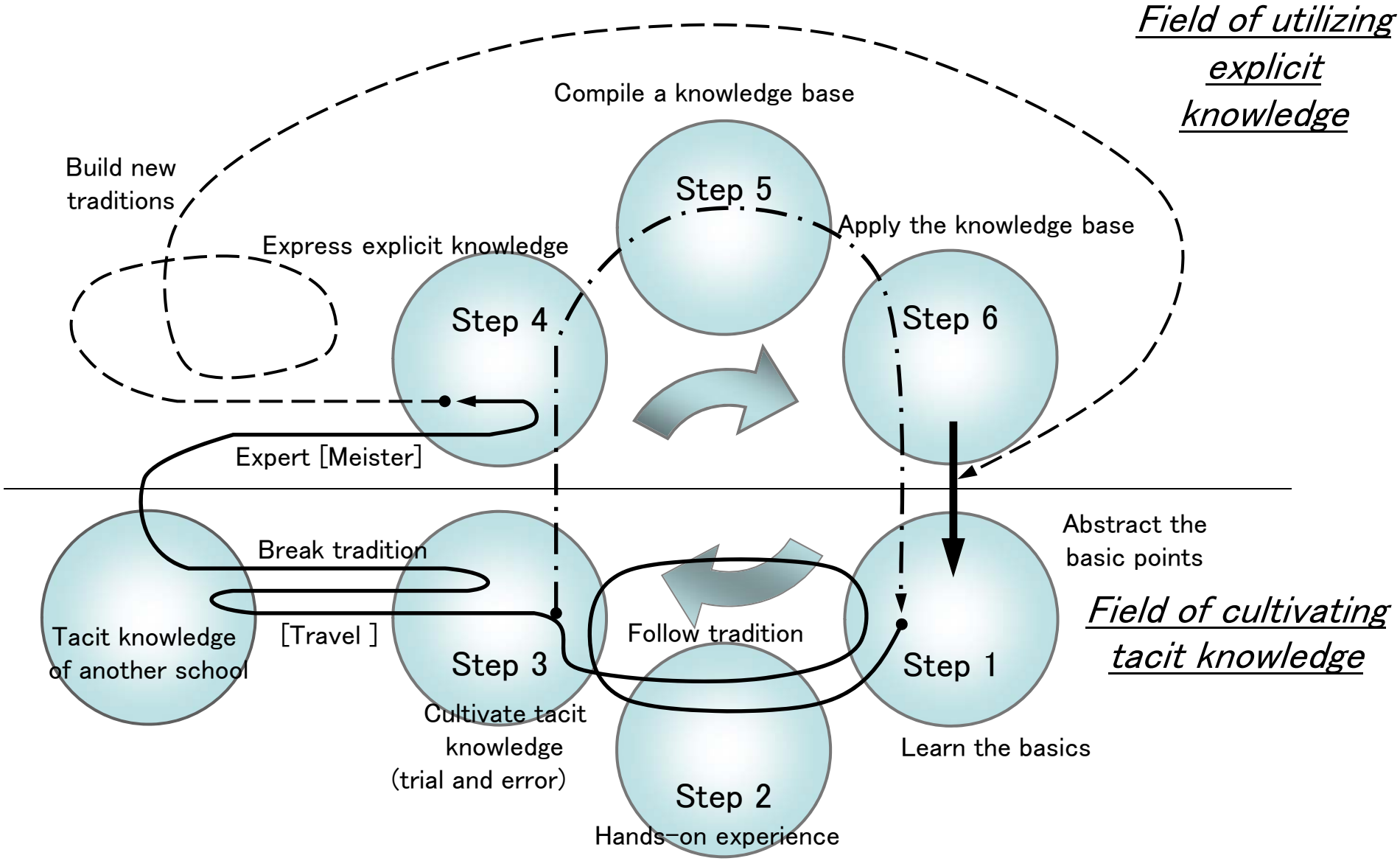
## Step 5: Compiling a knowledge base

- Systematization and digitalization of explicit knowledge

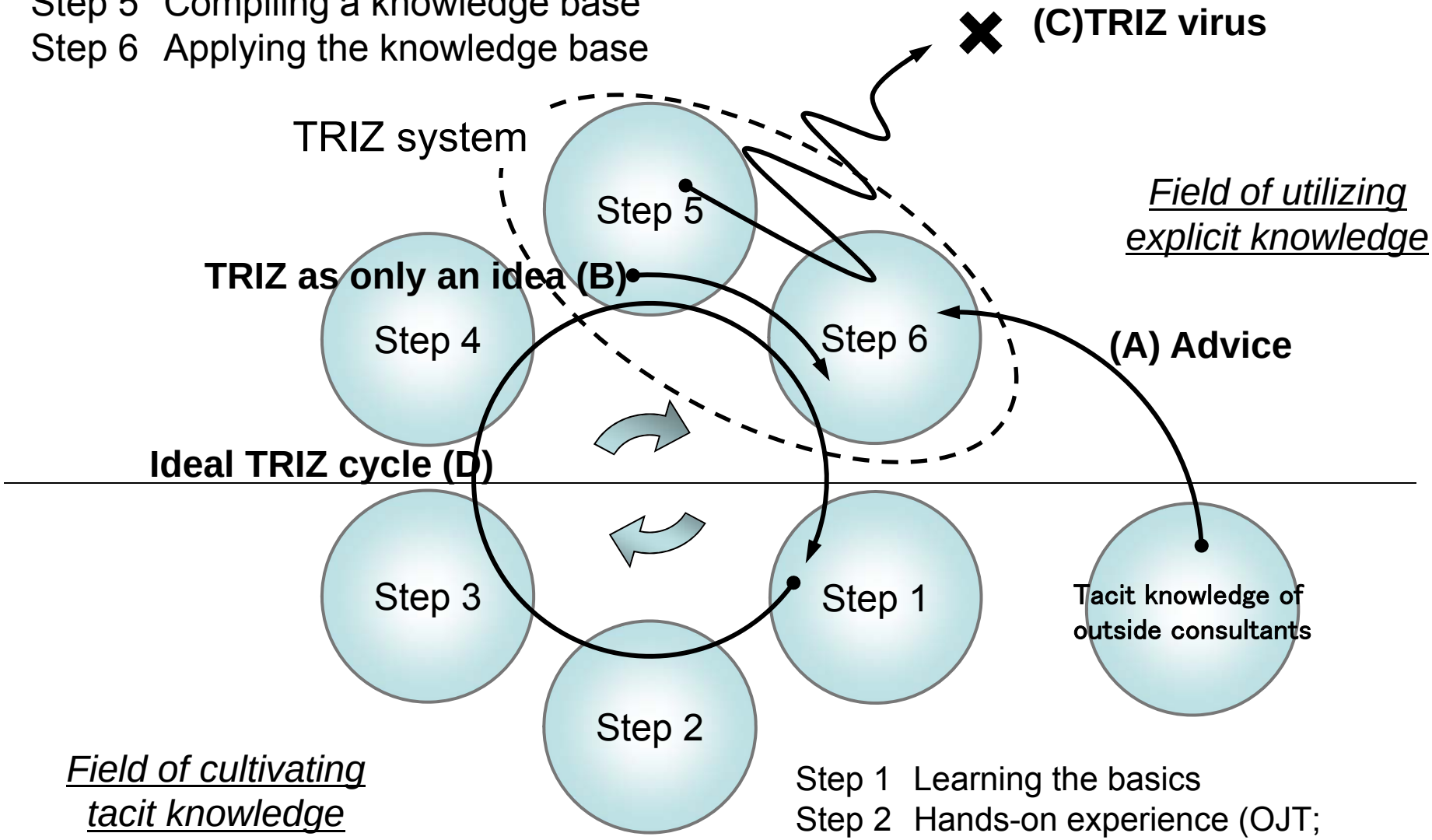
## Step 6: Applying the knowledge base

- Combination and application

# Creation cycle of apprenticeship in Japan

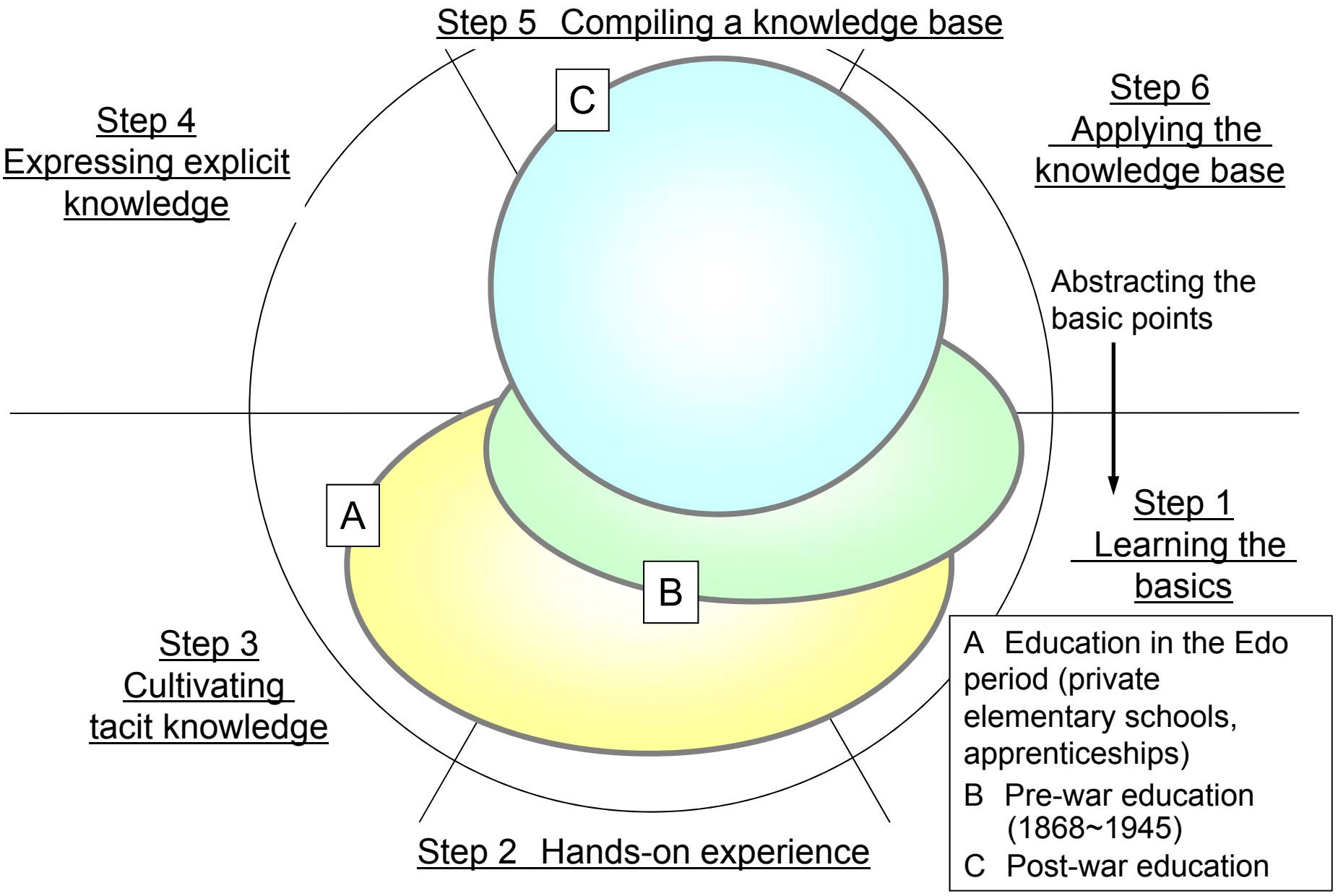


Step 4 Expressing explicit knowledge
Step 5 Compiling a knowledge base
Step 6 Applying the knowledge base



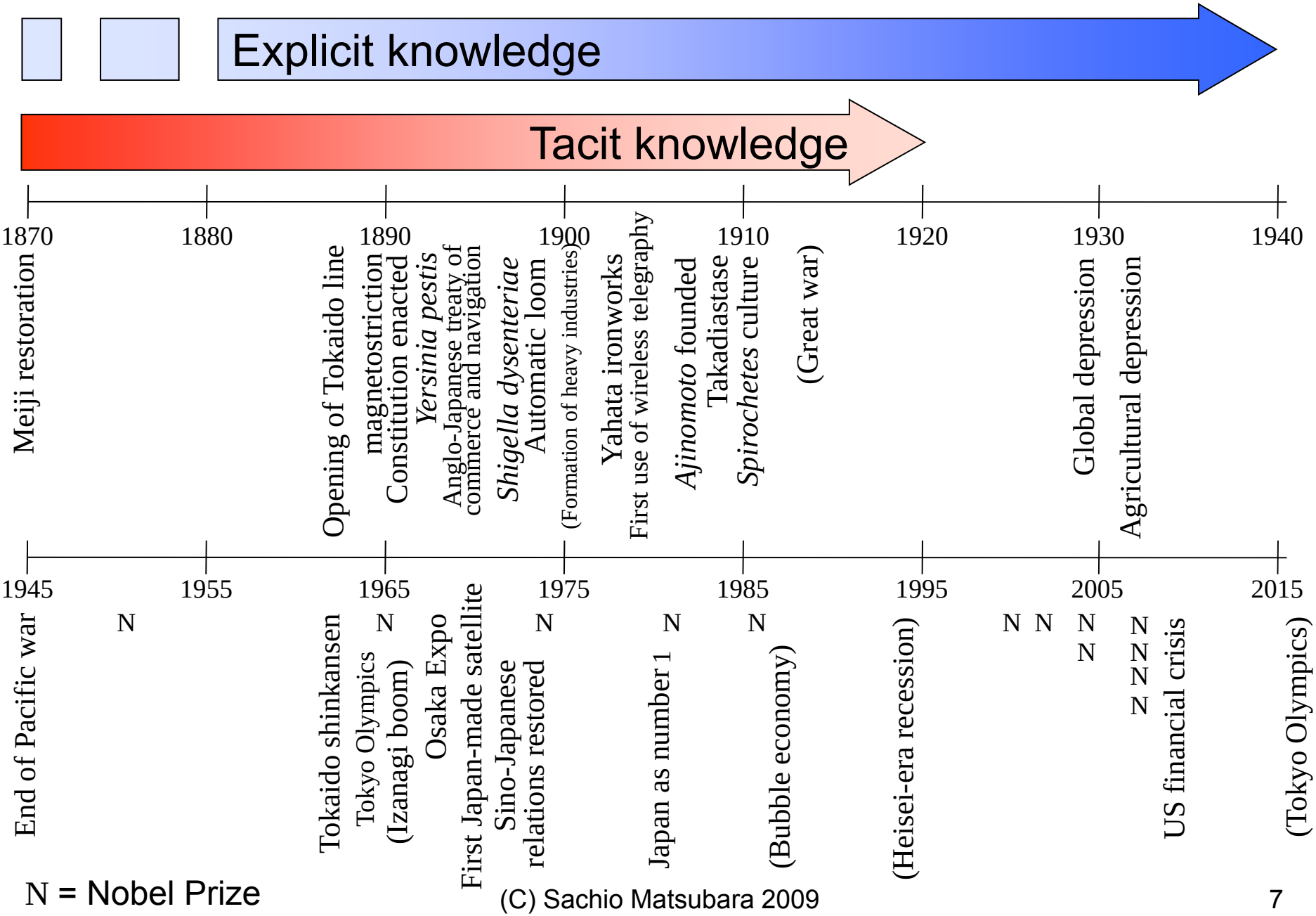

Step 1 Learning the basics
Step 2 Hands-on experience (OJT; collaborative work)
Step 3 Cultivating tacit knowledge (experiments; trial and error)

# Creation cycle of TRIZ



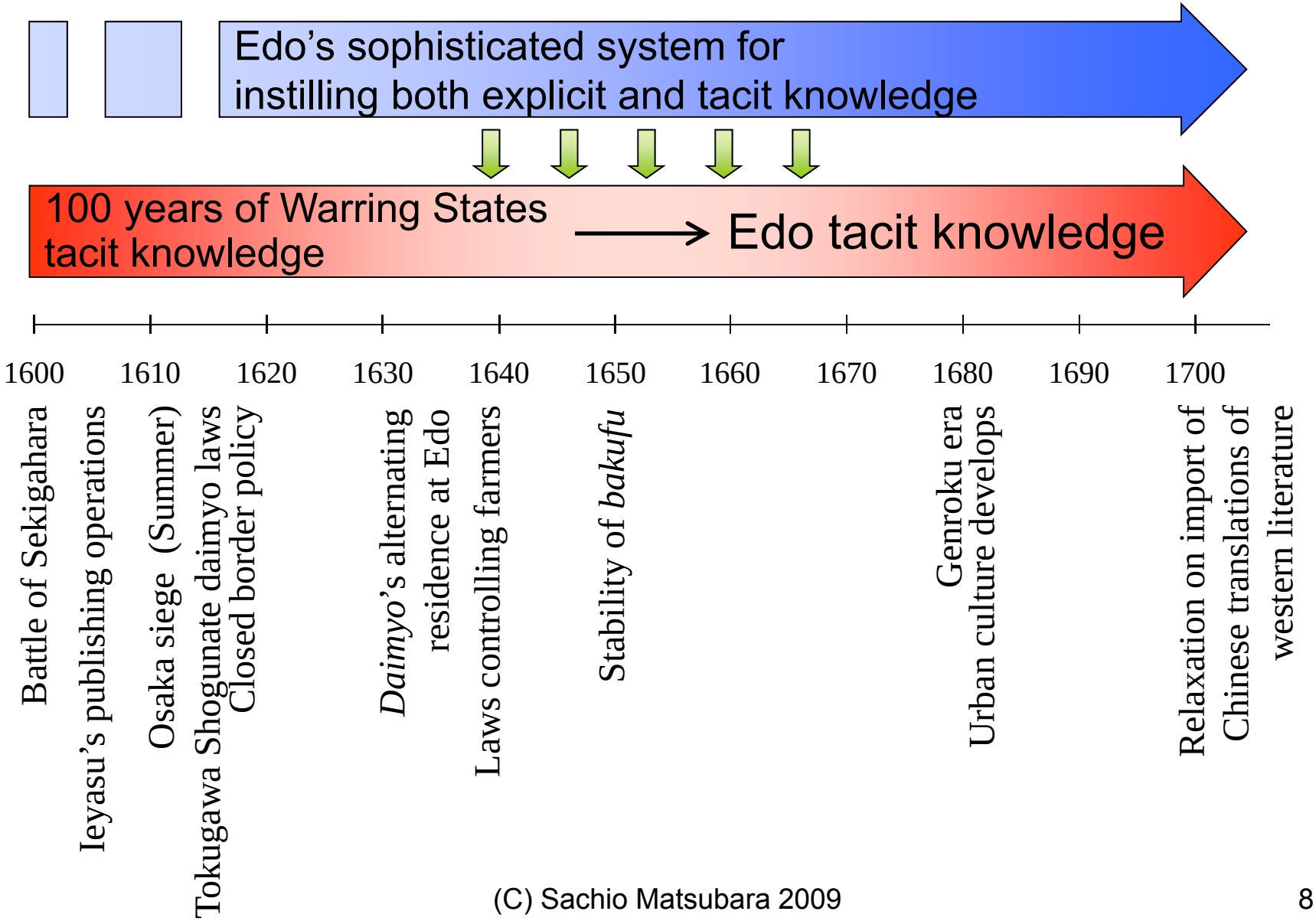

Transitions in the Japanese education system from the point of view of intellectual creation cycle

# Comparison of explicit and tacit knowledge pre- and post-war




N = Nobel Prize

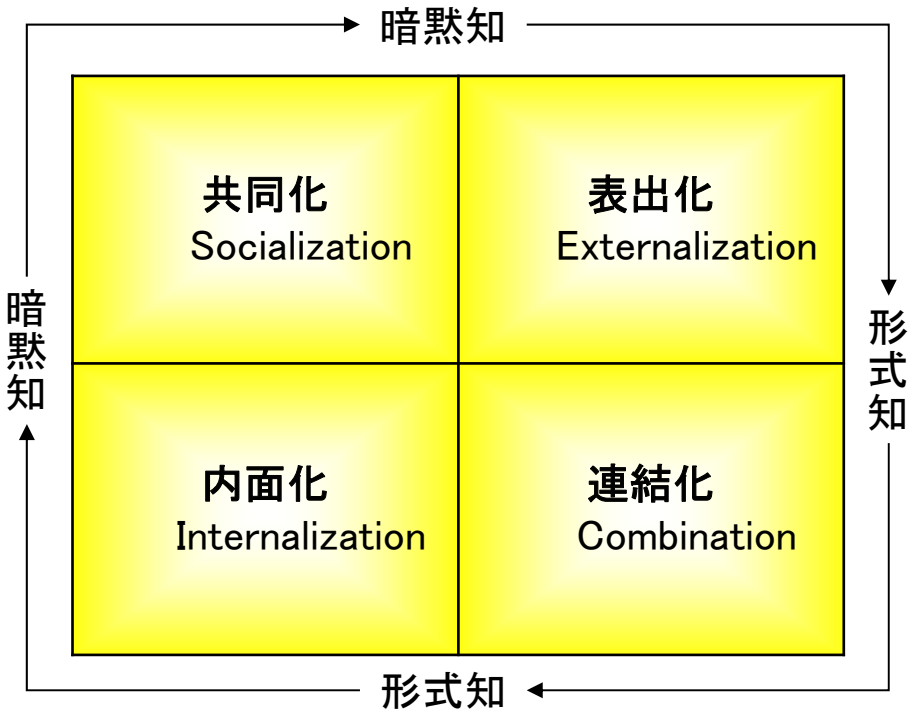
# Tacit knowledge in the Edo era



- 50 years theory of tacit knowledge
  - Tacit knowledge from previous era lasts 50 years.

- 20 years theory of explicit knowledge
  - New explicit knowledge takes 20 years to permeate society.

# SECIモデル




- 共同化（Socialization）
  共通の体験などによって、暗黙知を獲得・伝達するプロセス
- 表出化（Externalization）
  得られた暗黙知を共有できるよう形式知に変換するプロセス
- 連結化（Combination）
  形式知同士を組み合わせて新たな形式知を創造するプロセス
- 内面化（Internalization）
  利用可能となった形式知を基に、個人が実践を行い、その知識を体得するプロセス

出典：「知識創造企業」野中郁次郎、竹内弘高著／梅本勝博訳／東洋経済新報社／1996年
（「The Knowledge-Creating Company」の邦訳）

# High Concept 1/2

Key points of Daniel Pink's keynote speech at AUTM2009

- The 20th century was the information age
  - Direct, logical thinking style of programmers, lawyers and MBA-holders predominated
- In the future, we also need 'right-brain thinking'
  - Left-brain thinking: Logical, analytical, linear
  - Right-brain thinking: Intuitive, instinctive, inclusive, holistic

# High Concept 2/2

- The next age is the ‘Conceptual Age’
- Society will be built on creativity, empathy and an integrated vision
- Holistic thinkers will work in more than one area of expertise and will solve tough problems,

  e.g., mathematician & designer, pastor & pediatrician,

  pianist & management consultant

# History repeats itself
## —TRIZ and the empiricism spiral —

- While after the 19th century it became common to apply scientific results to technology, the scientific revolution in Western Europe in the 17th century was brought by document-oriented intellectuals who studied the concept of empiricism proposed by craftsmen in the 16th century

- In the 21st century, it will be possible to develop TRIZ further through a fusion between TRIZ and empiricism

# Transmission（*Densyo*) and Dialectics

- Transmission/oral transmission
  - “The master said...”, “People in the past said...”
  - Through transmission only the best knowledge is selected

- Dialectics
  - Dialogue-style argument
  - Sophistry may defeat valid argument (Socrates)
  - Theory of Ideas introduced (Plato)
  - In the field of natural sciences dialectics functions correctly since its object of study, nature itself, embodies the Ideas
  - In fields such as social sciences and humanities, dialectics can produce conclusions wide of the mark when applied without a consideration of Ideas

Reference: M. Takuma, *Raison d’etre strategies workshop material* [in Japanese] (Dec., 2008)


"He who thinks long-term prospers. He who thinks short-term becomes poor." Ninomiya Sontoku
46 consecutive years of increased income and profits
Received 'Best Manager Award', 2002 (Nikkan Kogyo Shinbunsha (industry newspaper))

# The words of Ninomiya Sontoku

He who thinks long-term prospers.
He who thinks short-term becomes poor.
The long-term thinker plants saplings for 100 years hence.
He sows in Spring and harvests the fruits in Autumn.
Thus he prospers.
He who thinks short-term becomes poor.
Thinking the Autumn harvest too distant from Spring, he does not plant.
Fixated on today's profit,
He looks only to reap without sowing.
Thus great poverty befalls him.

Source: Tsukakoshi Akira "Let's Build a Great Company" (2004, Funya）

# Importance of trial and error

- In the apprentice system, 'watching' is valued over 'reading' or 'listening'
- Things taught in books or speech are soon forgotten
- The process of trial and error fosters tacit knowledge
- The master only shows the final results
- Hunger for knowledge fosters pleasure in working things out. This process gives the learner greater creativity and insight than the master.
- Daniel Pink also points out the importance of failure

# Kondratiev waves

- Kondratiev waves are 50- to 60- year bussiness cycles discovered by Russian economist Nikolai D. Kondratiev after analyzing data on wholesale price indexes, bond prices, wages, import/export values and coal and steel production in the West in the 1920s
- At the wave endpoint, there is economic depression, revolution and phase shifts in human society. These waves are recognized as an economic reality, but their causal mechanism is not known.
- Schumpeter's theory is that 'the appearance of genius entrepreneurs and the acceleration of technological innovation brings about creative destruction'. But it is unclear why genius entrepreneurs appear in 50- to 60-year cycles.

# Kondratiev waves in terms of tacit and explicit knowledge

- During social upheaval, much failure is experienced and much tacit knowledge is instilled
- Tacit knowledge is used immediately to control social disorder
- People with this tacit knowledge gradually disappear from society. Under the new social system created by their tacit knowledge, stable economic growth is enjoyed.
- There is less need for the tacit knowledge sought during social upheaval
- Efficiency is valued, so explicit knowledge is prized and tacit knowledge neglected
- Tacit knowledge weakens, social change can no longer be met appropriately, and the risk of social upheaval re-emerges

# Kondratiev waves and the Edo era 1/2

- The Edo government knew that controlling the long-term cycle of change was crucial
- They understood that instilling tacit knowledge was important for lasting peace
- They aimed to create contexts for instilling tacit knowledge in various spheres of life

# Kondratiev waves and the Edo era 2/2

- *Shuhari* incorporates Kondratiev's cyclic process of 'growth, destruction, creation' into a training program for individuals

- A 'fully-fledged adult' is a competent person endowed with both tacit and explicit knowledge

- Because this training system incorporates '*ha*' (destruction), society itself can maintain long-term, stable growth

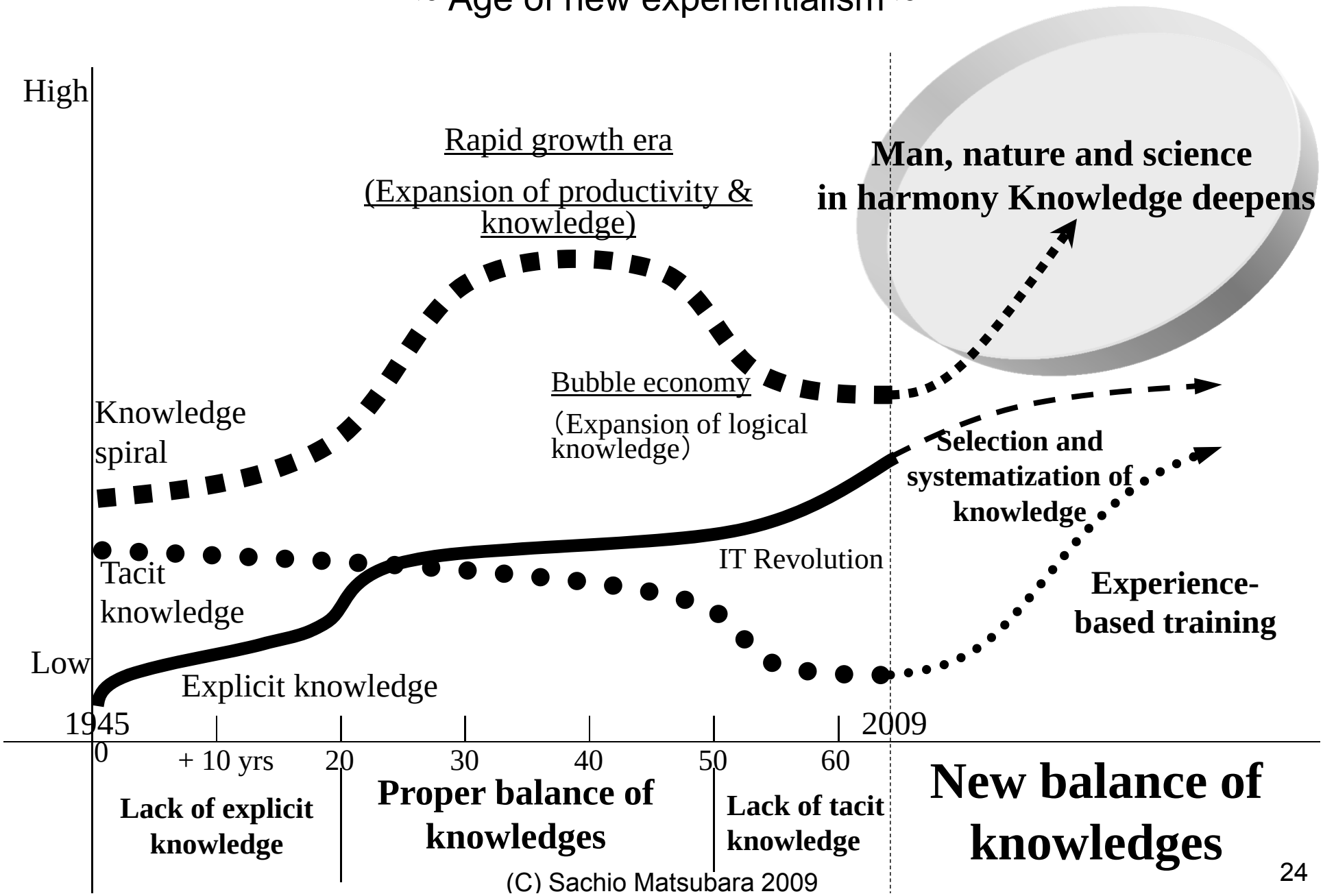
# Collective knowledge – the third knowledge - 1/2

- Intuitive people combining explicit and tacit knowledge are rare in any organization
- Every organization has people strong in just tacit or explicit knowledge
- Through cooperation, knowledge spirals can manifest at the group level,
  e.g., the 'QC circle‘ in Japan’s rapid growth era

# Collective knowledge – the third knowledge - 2/2

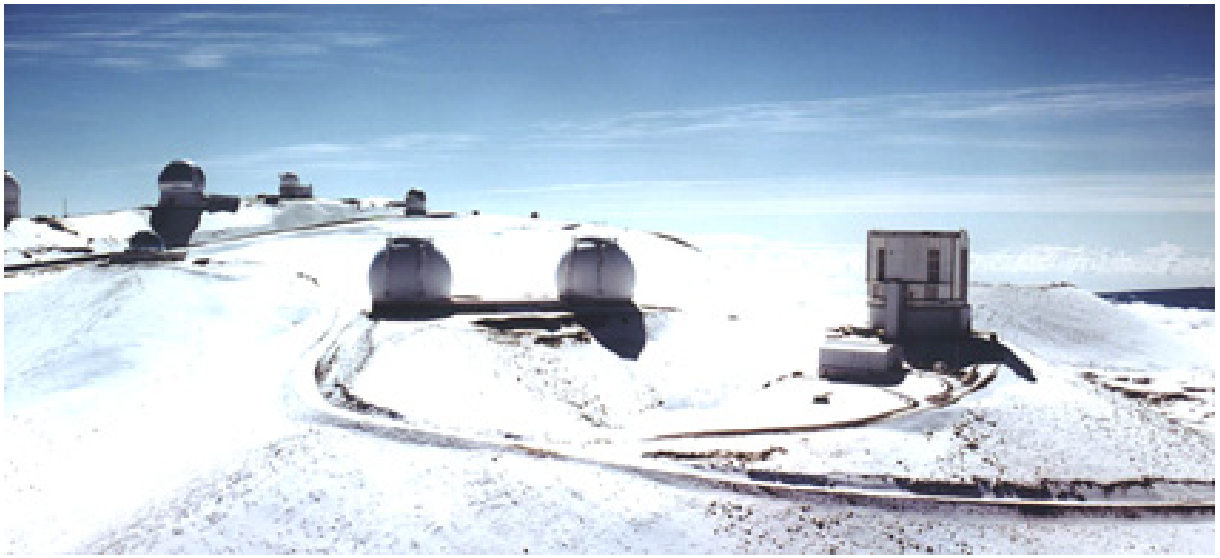
- Japanese proverb: “Out of the counsel of three comes wisdom”
- In the *Shuhari* system, the communal living with the master and senior pupils was extremely important
- Merging the two levels of knowledge gives rise to the 'third knowledge' expressed as inspiration

# Changes in manufacturing viewed from explicit and tacit knowledge
## ~ Age of new experientialism ~



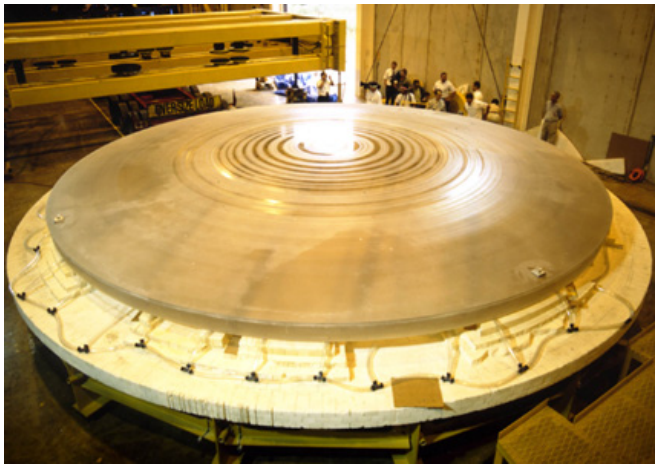
# ナガセインテグレックス

〈世界最高精度口径8．2メートル〉すばる望遠鏡の技術を支える。



Manufacturing with humility, reliable and faithful to principles

“Out of the counsel of three comes wisdom”
At NAGASE we’ve made this our practice as the highest method for problem-solving






出典:
にいがた製菓調理師専門学校
えぷろん　ホームページ

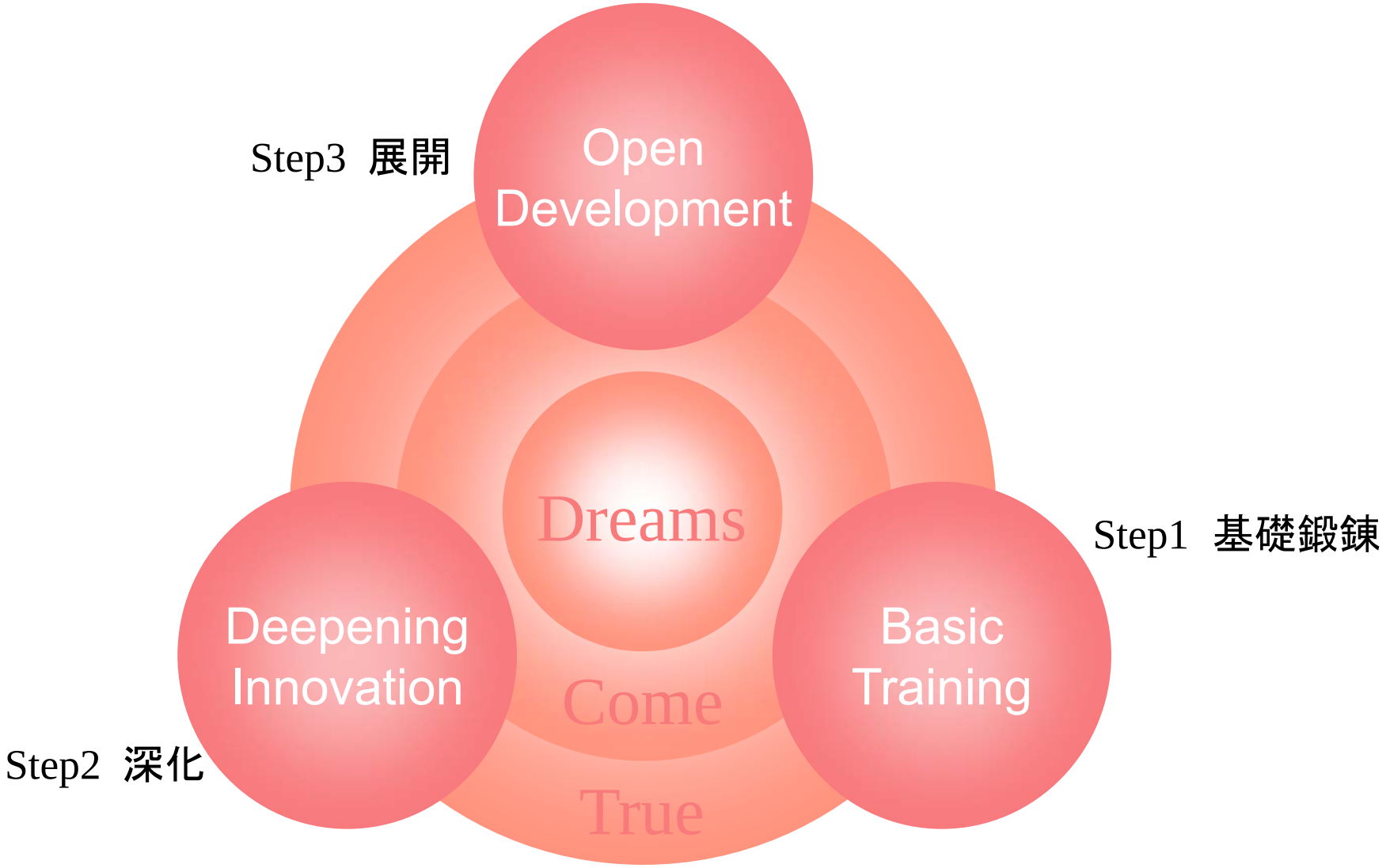
「えぷろん」は私の夢の結晶。
今度はあなたが、
ここで夢をかなえてください。


You can achieve your dreams.
The important thing is to learn gradually
from the basics.


学校法人三星学園　学園長　渡辺弘子

出典：にいがた製菓調理師専門学校
えぷろん　ホームページより

# B.D.O. cycle ~ New *Shuhari* ~




夢は実現する

# Summary

- Use both explicit and tacit knowledge
- To instill rich tacit knowledge, reconsider experience-based training methods that provide mastery of techniques through rigorous training in the foundations, communal living, and trial and error
- Emphasize the quality of information. Systematize knowledge after thorough examination of information. (This point will come up in future TRIZ research)

# The words of Basil H. Chamberlain (1850～1935)

"Only a people with its roots firmly planted in the past can be expected to flower and bear fruit in the future."

# Thank you

References
(1)Darrell Mann," Hands-on Systematic Innovation",2002
(2)松原幸夫「欧米型発明創造技法と日本の伝統的創造技法との比較」第5回日本知財学会予稿集（2007年）
(3)松原幸夫「学校教育等における発明創造技法の活用」第5回日本知財学会予稿集（2007年）
(4)村川英一「熟練技能の継承と科学技術」（大阪大学出版会、2002年）
(5)西之園晴夫・宮寺晃夫編著「教育の方法と技術」（ミネルバ書房、2004年）
(6)松原幸夫「新潟県における熟練技術の育成法についての研究」第6回日本知財学会予稿集（2008年）
(7)山本義隆「一六世紀文化革命2」（みすず書房2007年）

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