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Putting Transparent Thinking Approach Solution Factory (TTASF) into Production Implementation of Innovative TTA Genefic Tools

Dr. Mohammad A Aliedeh, New Mexico State University

Dr. Mohammad A. Aliedeh Bio

Dr. Aliedeh is an Associate Professor in the Department of Chemical Engineering, Mutah University, Karak, Jordan. He is now in sabbatical leave in Chemical Engineering Department, New Mexico State University, Las Cruces, NM.

Dr. Aliedeh earned his Ph.D. from New Mexico State University, Las Cruces, NM, USA, and his undergraduate and Master studies from Jordan University of Science and Technology (JUST), Irbid, Jordan. Dr. Aliedeh worked as an operation engineer for Jordan Sulphochemical Company, Zarqa, Jordan.

His basic research interests include Multi-phase Flow, Turbulence Modeling, Heat Transfer, Phosphogypsum Recycling Process, and Engineering Education. He published numerous research papers in those fields in international journals. The added value of his basic research is manifested in by achieving two shifts in Phosphogypsum conventional research: (1) Shifting from lab scale to the pilot plant scale and (2) Shifting from one variable at a time (OVAAT) to factorial design research methodology.

The courageous attempt to shift our PG conventional research from lab scale to the pilot plant scale was the most challenging research approach shift. As a part of his parallel research in Higher Education Reform, Dr. Aliedeh has developed and published a new Educational Reform Approach that is called Transparent Thinking Approach (TTA). TTA is a newly developed value-engrained and thinking based educational reform approach. It is generic and unique features enable it to easily diffuse in all domains.

The real ”fruits” of this new approach will be ”tasted” by ”feeling” the innovative TTA created harmony between depth, meaningfulness, connectedness and simplicity which is reflected in the practical application of TTA concepts, tools, perspectives. TTA solution frameworks, models and tools are expected to give products. TTA products are simply a result of putting TTA Generic Tools into production.

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Innovation Narrative of Putting Transparent Thinking Approach Solution Factory (TTASF) into Production: Implementation of Innovative TTA Genefic Tools

Mohammad A. Aliedeh
Professor of Practice (Sabbatical Leave from Mutah University, Jordan)
Chemical & Materials Engineering Department, New Mexico State University
P.O. Box 30001 MSC 3805, Las Cruces, NM 88003
Email: maliedeh@nmsu.edu or aliedeh@hotmail.com

Abstract

Innovation narrative plays an important role in effectively communicating innovation processes and products. This important role affects the whole innovation process, starting from the initiation of innovative ideas through to their implementation and the promotion of past and present innovations. **Transparent Thinking Approach Solution Factory** (**TTASF**) is an innovative reform approach that is based on transforming Silo, Fragmented and Carousel Effect Thinking individual into a **TTASF** Thinker who is equipped with Genefic (Generic and Specific) Thinking Toolbox. The whole story of **TTASF** Innovation Reform Project is covered in this paper in three parts that will answer three important questions: **Part 1**: Why is change needed? **Part 2**: What is the proposed change? and **Part 3**: How is this proposed change implemented in the Engineering Education Field?

In the last part of **TTASF** innovation story (**Part 3**), numerous examples are presented to clarify and explain how perspective, modeling and maneuvering **TTASF** tools, such as Big Picture Modeling, Analogical Modeling, Dynamic Mathematical Modeling and Simulation, Dynamic Animations Modeling, are implemented in Engineering Education Courses over long periods of academic practice.

Transparent Thinking Approach Solution Factory (TTASF) Innovation Narrative

The important role of innovation narrative

Storytelling plays an important role in the innovation process. This important role affects the whole innovation process, starting from the initiation of innovative ideas through to their implementation and the promotion of past and present innovations. At the initial stage of the innovation process, storytelling plays a very effective role in getting approval for innovative ideas, attracting attention and interest from others, and future refining and developing them. During later stages of the process, storytelling is considered an important tool for promoting innovation to wider audiences, and for encouraging future progress in innovations. The process of building momentum in the innovation process will be highly dependent on how the story is told and the content of the story itself. Storytelling has an important role in enhancing collaboration between innovation teams in organizations and sharing experiences and learning processes. It also enhances the construction of organization, project and individual identities and image. Innovation Storytelling is an essential tool for communicating innovation projects. In summary, the following are the added values of implementing innovation story communication tool (Sergeeva N. and Trifilova A., 2018):

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1. Effective Presentation of innovative ideas,
2. Gaining interest and support for the innovation project,
3. Motivation of project members to innovate,
4. Wide promotion of innovation success stories, and
5. Image Construction of being and becoming "innovative"

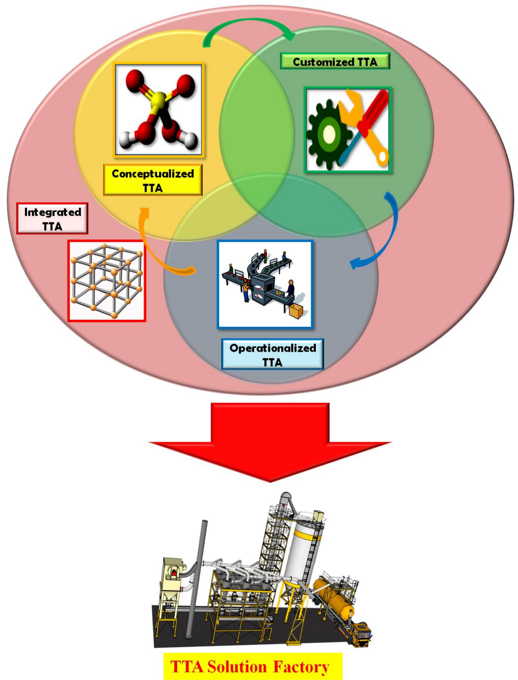

Figure 1: TTA Full story told in six academically referred papers (Aliedeh, M. A., 2015 a, b, c, 2016, 2017, 2018 a)

Narration of TTA Full Story: From Conceptualization to Integration

In the last ten years, TTA solution passed the critical point by passing four important stages starting by conceptualization, publishing its newly developed frameworks, processes, tools and products in a six academically peer-refereed papers, as visually illustrated in Figure 2. These six papers cover nearly all the TTA Solution constructs and tools needed for the design, construction, start-up and pilot product production of TTA Knowledge Production Process. The first paper (A1) mainly focused on developing the needed core frameworks and models. The second and the fourth ones (A2 and A4) presented the customized version of TTA solution by developing a generic thinking toolbox. The third and fifth articles focused on presenting numerous practical TTA pilot products. The sixth paper ended this long documentation of TTA by presenting an integrated framework to accommodate TTA constructs, concepts, processes, and tools. TTA is already conceptualized (A1), customized (A2 and A4), operationalized (A3 and A5) and integrated (A6), as visually illustrated in Figure 2. These six papers are considered as a narration of the TTA full story (Aliedeh, M. A., 2015 a, b, c, 2016, 2017, 2018 a). Educational researchers and practitioners who are interested in reading TTA Full story can read these six papers.

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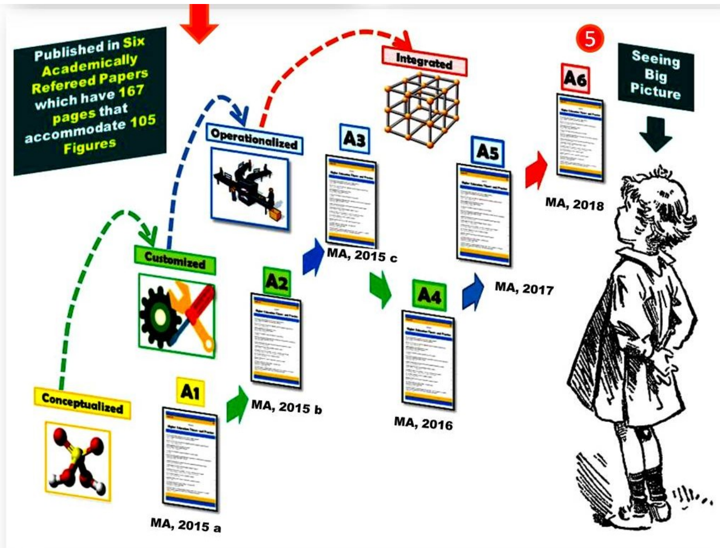

Figure 2: TTA Full story told in six academically referred papers (Aliedeh, M. A., 2015 a, b, c, 2016, 2017, 2018 a)

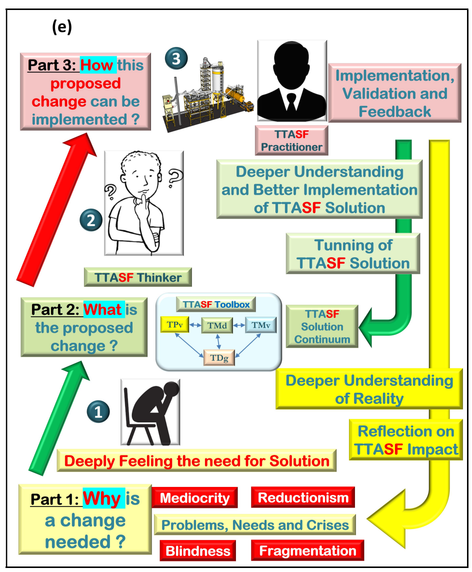

Figure 3: The graphical and animated illustration of the big picture of ***TTASF Innovation Story***

The full narration of TTA Solution describe above is paving the road to get to the next stage of TTA Solution Production by ending the stages conceptualization, customization, operationalization and integration and fully focusing on putting TTA Solution on production phase in all fields as illustrated in Figure 1. In the first stage of offering a new reform approach, the developers will be too many idealists, optimists and dreamers to think that researchers and practitioners are eagerly waiting for a long time to adopt this new reform approach and ready to switch the newly proposed way of thinking. Publishing TTA full story in six academically peer-refereed papers with a total of 179 pages and 142 figures really was a daunting and challenging job (Aliedeh, M. A., 2015 a, b, c, 2016, 2017, 2018 a). But attracting and convincing TTA prospective audience to get introduced to, and to try and taste its benefits and added values will be the next most important job that TTA must achieve.

Graphical Illustration of TTASF Innovation Narrative

When encountering the ***graphical animated illustration*** of ***TTASF Innovative Narrative*** (Figure 3 (a) to (e)) for the first time you may be overwhelmed by the numerous graphical construction details, but if you concentrate on analyzing the main components of this diagram you will realize that it greatly helps to show you the big picture of all the parts of ***TTASF Story***. It shows that the story is simply made up of three parts. Each part answers an important question that leads to the next one. ***Part (1)*** of the story centers around the theme of accumulated and pressing problems (Reductionism, Fragmentation, Mediocracy, and Blindness) that have pushed for devising **TTASF Solution**. ***Part (2)*** is a brief and informative description of the main important tools, concepts and practices of this **TTASF Solution.** After reading the first two parts (***Part (1) and (2)***), the reader in part (3) will be ready to experience how this innovative ***TTASF solution*** can be implemented in real contexts.

Part 1: Why is a change needed? (Problems, Needs and Crises)

The world sailed in this new millennium with a huge number of problems and challenges that overburden humanity. The burden is growing despite all the development efforts that are exerted by the international community. Scholars and the current circumstances are warning us that we are approaching an age of turbulence and instability. These problems and challenges are highly interrelated and widely spreading in all domains and regions. These alarming circumstances are urging us as academicians and scientists to dig deeply for the root causes of these problems and to try to devise a solution for them before it too late for the global system to sustain pressures and not eventually crash down.

Humanity faces a huge sum of complex and interconnected challenges. These issues do not exist in isolation but are deeply embedded within social, economic, and environmental systems. Their interrelationships are becoming increasingly critical as the pace of global development accelerates. For example, climate change extends beyond being an environmental concern; it is a consequence of rapid capitalist growth and significantly impacts social equity. Similarly, the growing disparity between the wealthy and the poor, coupled with the unequal distribution of resources, exacerbates both environmental degradation and social unrest (Hou, Yunxi, 2024).

To tackle these complex challenges, it is imperative to adopt a comprehensive and interdisciplinary approach to problem-solving. Addressing these challenges in isolation results in oversimplifying their complexity and missing opportunities to leverage synergies between potential solutions. The primary challenges of the new millennium require addressing these issues by treating social, economic, and environmental systems as interdependent, while exploring the strengths and potential limitations of this perspective (Hou, Yunxi, 2024).

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Crisis of Fragmentation

Looking to the world as a devisable, separable and simple system of entities is hindering our ability to devise an effective solution for our complex global system problems. Revealing the hidden interconnectedness and understanding the interaction behavior between these huge number of entities is a crucial step in understanding the complex system behavior and eventually devising an effective solution for the pressing burden of problems (Meadows, D.H. 2008, Homer-Dixon, T. F., 2000, Capra, F., 1996, Klein, J. T., 1990,Taleb, N. N., 2007).

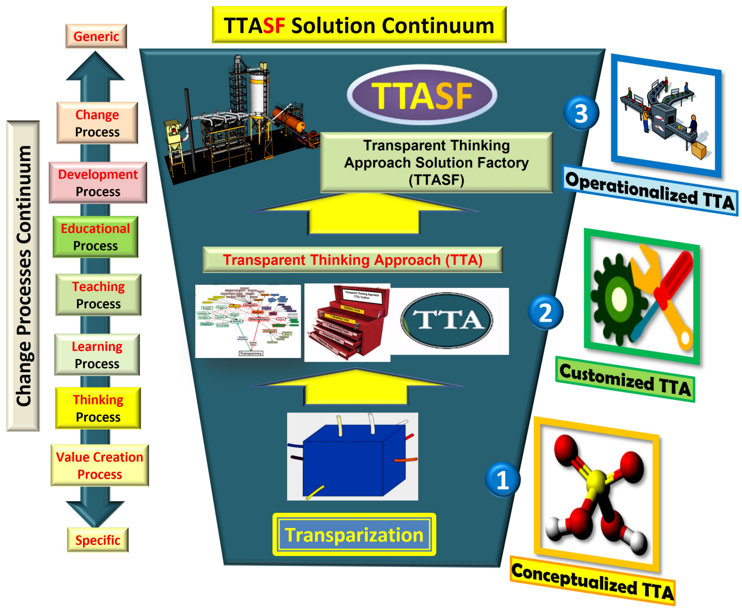

Figure 4: The Evolution of TTASF Solution Continuum

Part 2: What is the proposed change? (TTASF Solution Continuum)

Diving in Change Process Continuum searching for a solution

While searching for solutions for our problems, the TTA thinker dived in life continuum looking for a deeper understanding for the causes and the nature of these problems, see Figure 4. While the "diver" or TTA thinker is searching in the first three layers (change, development and Education), he/she realized that these domains are not accommodating the solution of our problems and that the solution lies deeper in the continuum, see Figure 4. When the thinking layer is searched for a solution, it was found that the defect in our way of thinking is causing all these accumulated problems. Also, TTA thinker discovered that thinking layer is engrained in a deeper value layer in which a **transparency core and instrumental value** reside in. Therefore, the solution that we are looking for is a transparency value-engrained and thinking-based reform approach.

As illustrated in Figure 4, the diving in change process continuum and the discovery of transparency as a core thinking perspective paved the road for innovation construction of TTASF Solution Continuum that is characterized by three stages: (1) The establishment of Black Box Transparization Process as the core concept that helped to cluster the whole TTASF Continuum. (2)

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Development of TTASF Toolbox with Modeling, Maneuvering, Perspective and Diagnosis Toolsets, and then (3) Developing the concept of solution factory as an overarching construct for all solution generation processes.

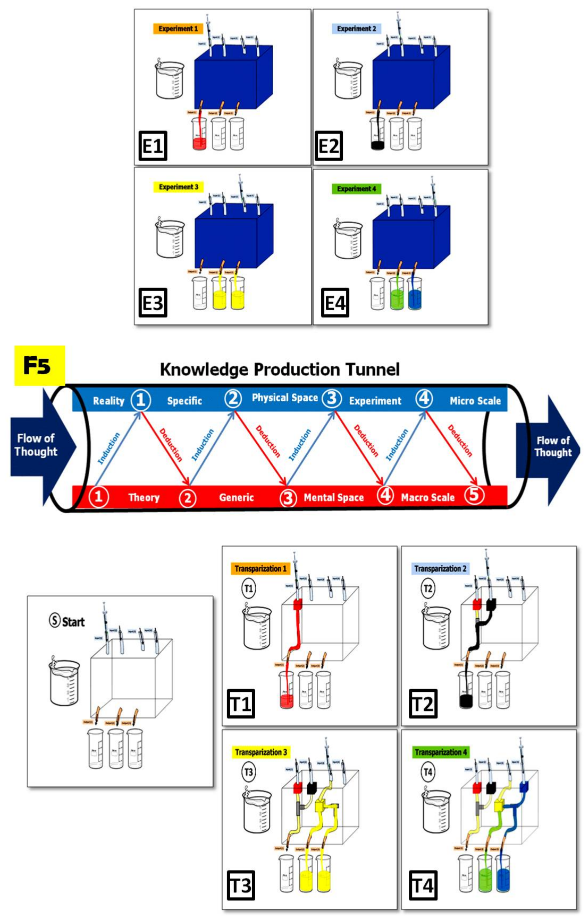

Figure 5: Black Box Experiment and The Use of TTA Knowledge Production Tunnel

Figure 6: TTASF Genefic Toolbox with four basic Toolsets

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Part 3: How this proposed change can be implemented? (Implementation in Engineering Education)

TTASF Modeling Tools Implemented in this Research.

TTASF gathered the widest spectrum of modeling tools that are shown in Figure 7. Picture, mathematical equations, road maps, fashion presenter, physical object, story, analogy, journey, drama, conceptual framework, video, animation, text, role character are all examples of models in all different fields as illustrated in Figure 7.

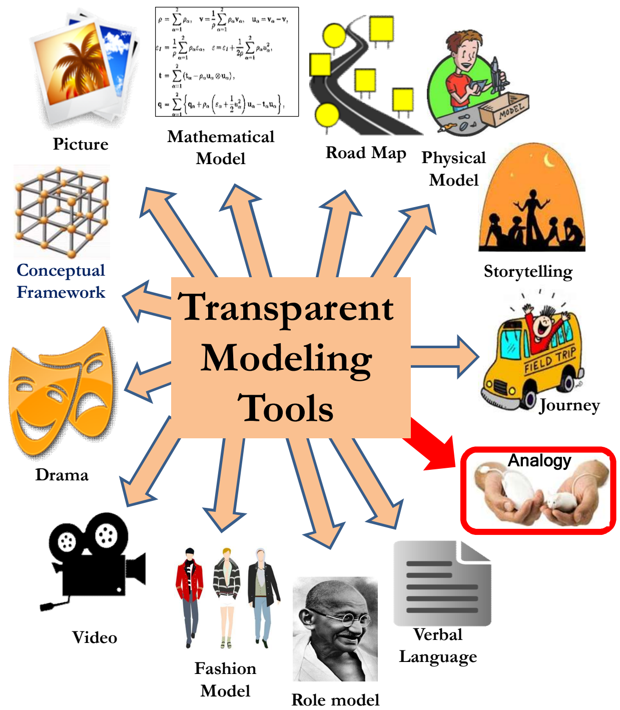

Figure 7: TTASF Modeling Tools (Aliedeh, M. A., 2015 a, b, c, 2016, 2017 and 2018)

In this research four types of TTASF models are going to be implemented:
1. TTASF Analogical Graphical Modeling
2. TTASF Big Picture Static Graphical Models
3. TTASF Dynamic Animation Models
4. TTASF Mathematical Dynamic Process Models

TTASF Analogical Graphical Modeling

Analogy as an important cognitive tool

Einstein and Infeld (1967) in their book "The Evolution of physics" described deeply the important role of analogy between phenomena that seams distant and how these phenomena looks after being deeply and analogically analyzed.

> ***"It has often happened in physics that an essential advance was achieved by carrying out a consistent analogy between apparently unrelated phenomena…. The association of solved problems with those unsolved may***

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> ***throw new light on our difficulties by suggesting new ideas. It is easy to find a superficial analogy which really expresses nothing. But to discover some essential common features, hidden beneath a surface of external differences, to form, on this basis, a new successful theory, is important creative work." Einstein and Infeld (1967)***

This quote indicates the significant role that analogy plays in deepening our understanding of the surrounding phenomena and ending in discovering useful connections. In other words, we try to reveal the hidden connections inside things or phenomena to deeply understand them. Analogy is one of the most important cognitive tools that helps in creating this deep and meaningful learning. These deep insights are sometimes hidden under superficial analogy.

Implementing Analogy in Creating Deep and Meaningful Learning

Analogy (and similarly metaphor and simile) is considered a cognitive device that creates a relationship between things, processes, or concepts in an analog domain with similar ones in a target domain. Learners are intuitively drifted to employ what they already fully understand in a certain analog domain to structure a similar deep understanding in another target domain. A highway of transfer of knowledge between the two domains is established which results in more elaborate connections, namely deeper understanding. The product of deeper understanding is a transferable knowledge between the two domains (Jonane, L., 2015).

Meaningful learning occurs when the learners visualize connections between newly studied material and what they already know. Analogy mapping between analog domain and target domain to create connections and insights is a form of meaningful learning. As the learner dig deeper in creating connections between domains, a more meaning is created. Links created by analogy promote conceptual understanding and create coherence between prior knowledge and newly structured one (Harrison, A. G., 2006).

Avoiding being drifted into misunderstanding zone

Analogy is a device that connects two entities that are similar in certain aspects, but they are also different in others. Learners and instructors must be careful in using this cognitive device in order not to drift into the misunderstanding zone. Glynn (2008) wrote about this:

> ***"Analogies are double-edged swords: They can foster understanding, but they can also lead to misconceptions".***

As Duit, et al. (2001) explain:

> ***"A growing body of research shows that analogies may be powerful tools for guiding students from their pre-instructional conceptions towards science concepts. But it has also become apparent that analogies may deeply mislead students' learning processes. Conceptual change, to put it into other words, may be both supported and hampered by the same analogy"*** *Duit, R. et al. (2001)*

Learners and teachers should keep in their minds that analogy usually leads to meaningful and deep learning if it is used carefully. But, if analogy is misused, it may result in forming misconceptions.

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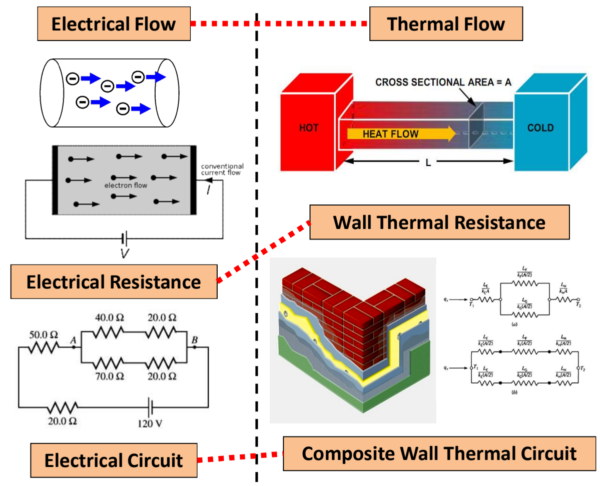

Figure 8: Thermal-Electric Analogy of resistances in series-parallel arrangement (Aliedeh, M. A. 2018).

Real Interaction Evidence of Basic and Educational Research

The following is a real example that gives evidence on how the mutual interaction between Basic Research Continuum (BRC) and Educational Research Continuum (ERC) gives research insights. I taught the Heat Transfer Course in Mutah University, Karak Jordan for several times. Teaching one dimensional heat conduction calculation for composite wall based on thermal resistance analogy results in gaining research insight that result into a basic research paper in heat transfer (Aliedeh, M. A. 2018).

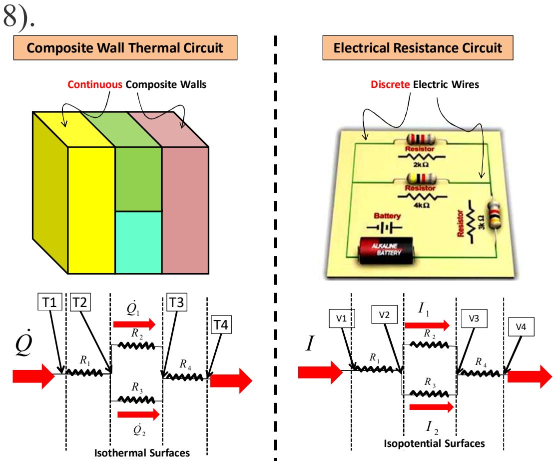

Figure 9: Comparing and Contrasting Composite wall circuit with electrical resistance circuit (Aliedeh, M. A. 2018).

Because Analogy is considered as a double-edge sword, thermal engineers should be cautious in analogical maneuvering between electrical and thermal domains in order not to be slipped into building misconceptions about thermal resistance concept. Composite wall thermal resistance (CWTR) modeling is one of the practical examples that illustrates the probability of misusing analogy. Heat Transfer undergraduate textbooks coverage of CWTR suffers a lean towards "cookbook" coverage that report concise statements that lack deep clarification and illustration. Transparent Thinking Approach (TTA) is employed to present detailed calculations and illustrations of a typical CWTR modeling based on isothermal and adiabatic assumptions. The

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calculation of a typical CWTR for different values of wall thermal conductivities shows that the difference in parallel walls thermal conductivity is creating a large discrepancy that may reach 80% between heat flows calculated based on isothermal and adiabatic assumptions. It was found that for a series-parallel arrangement of composite walls with high difference in parallel wall thermal conductivity values, the true value of heat flow is bracketed between the isothermal and adiabatic heat flow values. The transparent way of presenting CWTR modeling can be readily included in any standard heat transfer textbook and results in greatly enhancing CWTR modeling coverage.

TTASF Big Picture Static Graphical Modeling

As an example of seeing the big picture, Figure 10 illustrates how graphical modeling and animation is implemented in showing the student the full story of heat transfer course and how the basic heat transfer knowledge is accumulated to pave the road for introducing the design of heat exchangers.

Another example is presented in Figure 11 trying to uncover the see the big picture of transport phenomena in Chemical Engineering Knowledge. This example illustrates how graphical modeling is helping students build a big mental image of how the fields of transport phenomena interact to create a unified knowledge continuum.

Another important example for implementing the big picture graphical tool is in the big picture of modeling and simulation in heat transfer field by classifying the different heat transfer cases into 8 groups (Case A to Case H). These cases starts by case A in which temperature has no independent variables to Case H in which temperature has all four independent variables T(x. y. z, t) between these two extreme cases there are a number of case that covers all possibilities, as graphically illustrated in Figure 12.

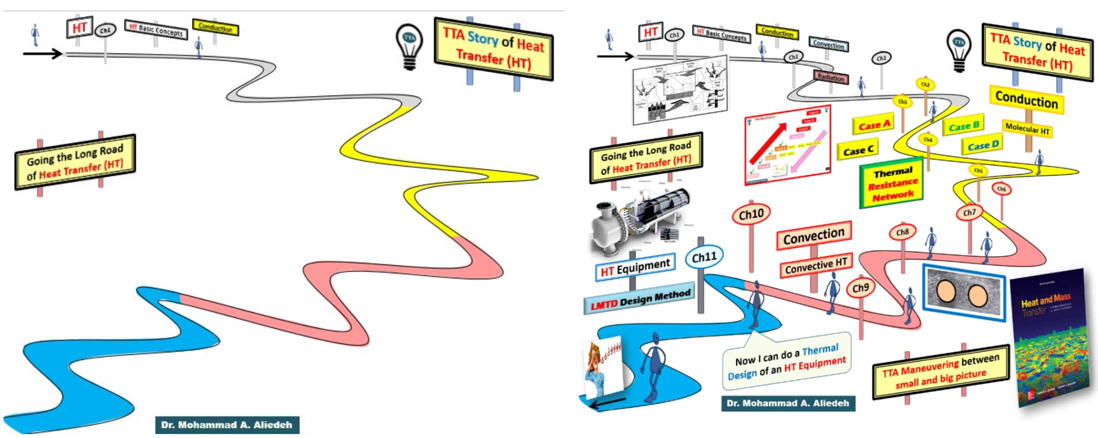

Figure 10: Big picture of Heat transfer Course Knowledge Coverage

TTASF Dynamic Animation Modeling

As an example of how Animation modeling Tool is adding the dynamic added insights to the graphical models, Figure 13 illustrate how animation immensely helped in deeply understanding the dynamics of bisection method calculation by connecting the flow of numbers with the graphical representation on the graph.

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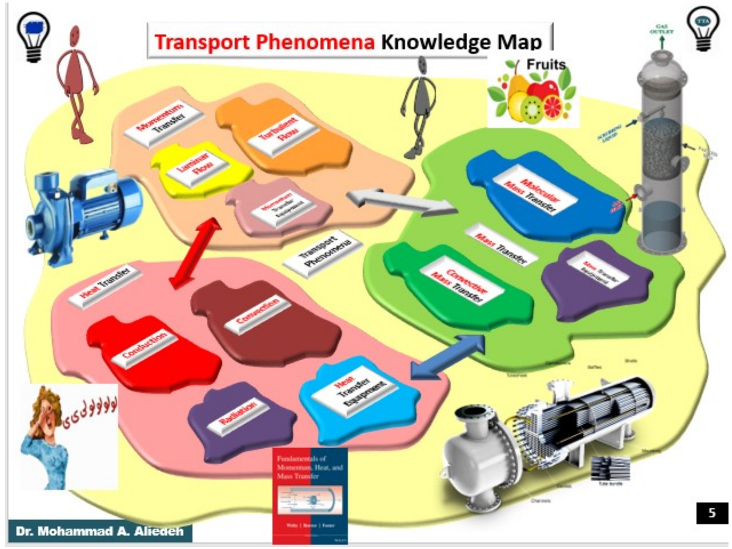

Figure 11: Big picture of Transport Phenomena

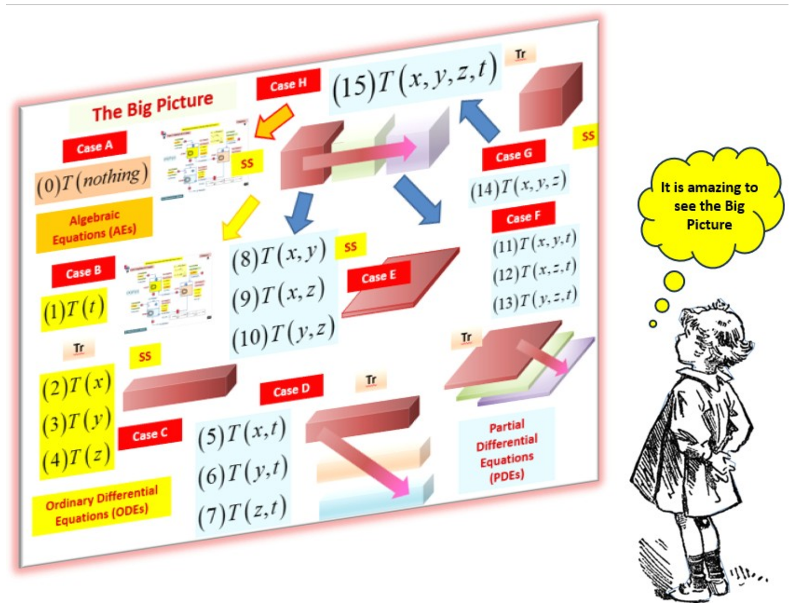

Figure 12: The Big picture of Modeling and Simulation in Heat Transfer Field

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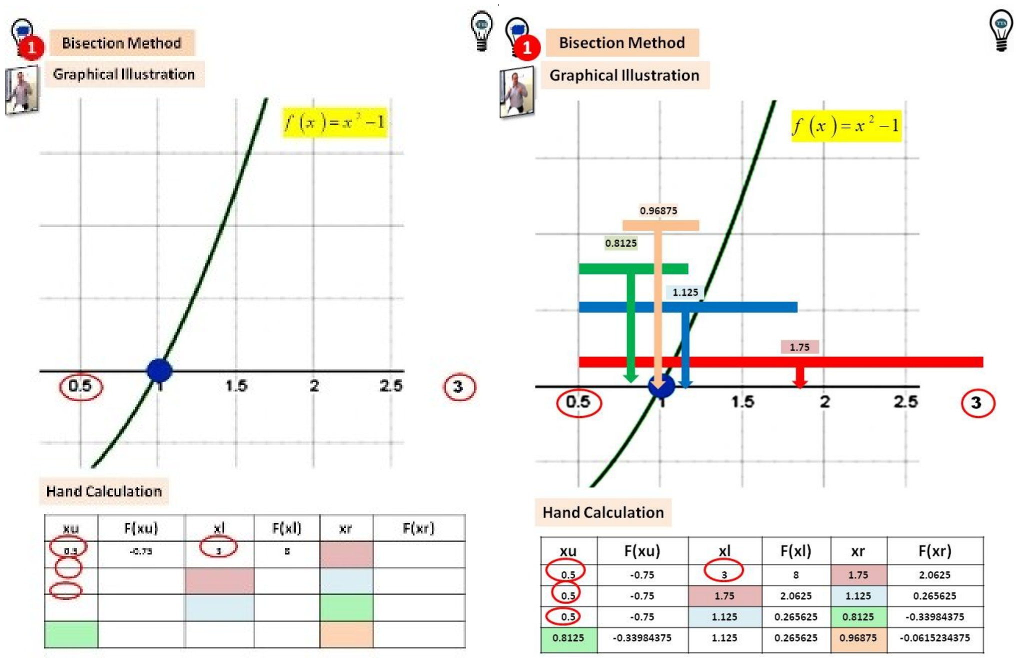

Figure 13: Employing animation in creating an intimate connection between numerical calculation and graphical representation of bisection root finding method.

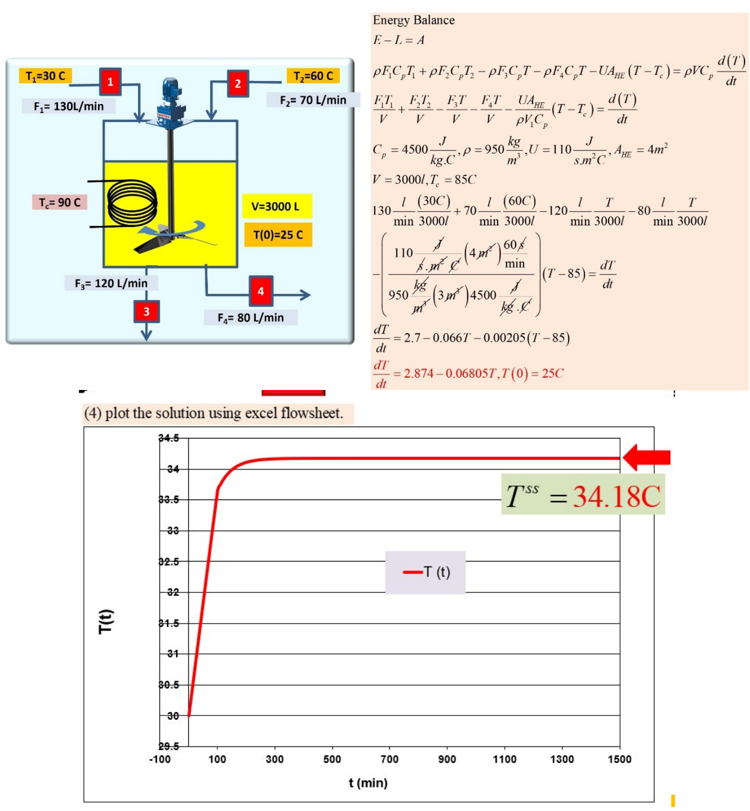

Figure 14: Employing Mathematical Models to represent the dynamic behavior of chemical processes.

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To stress the importance of revealing the dynamics of graphical constructs, animation is implemented in showing how TTA Thinker can maneuver in life continuum by striding between values and passing through thinking and development till it gets to change. This deep concept of diving in and out in life continuum cannot be grasped easily without implying the animation modeling tool. The author implemented animation modeling to show the dynamicity in TTASF as a far-reaching reform approach in all domains.

TTASF Mathematical Dynamic Process Modeling

Mathematical modeling is one of the most important modeling tools to represent the dynamical behavior of a chemical process as shown in Figure 14. In Figure 15, the dynamic simulation of concentration in a system of tanks is illustrated using animation modeling of the concentration profiles and the color intensity of each tank. The intensity of tank color in each tank is representing the dynamic change of the concentration in each tank, as illustrated in Figure 15.

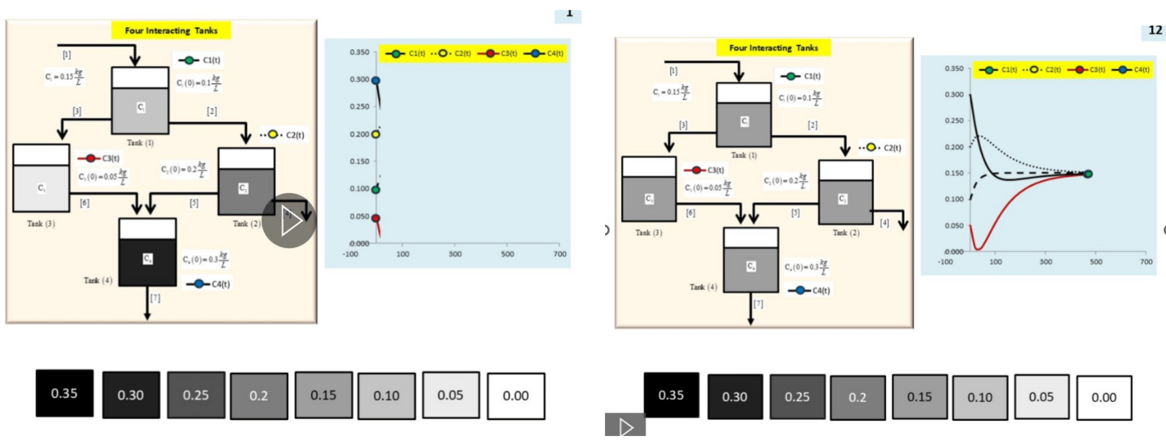

Figure 15: Employing animation in creating a dynamic picture of change in concentration in system of tanks.

In Conclusion: Putting TTASF Modeling Tools in Production

Innovation narratives are critical for effectively communicating the processes and products of innovation. They influence all stages of the innovation journey, from idea generation to implementation and promotion. As **TTASF** reform solution innovation story told us, **TTASF** is based on transforming Silo, Fragmented and Carousel Effect Thinking individual to **TTASF** Thinker who is equipped with **TTASF** Thinking Toolbox. It is expected that this paper will add more evidence of the effectiveness of **TTASF** modelling tools in knowledge transfer of engineering knowledge and skills.

The **TTASF** aims to tackle the root cause of many global crises: **fragmentation**. Fragmentation leads to negative outcomes such as mediocracy, reductionism, silo syndrome, and a failure to address systemic problems effectively. The approach emphasizes relieving these issues through Continuum Thinking and **TTA** Maneuvering Tools.

The Core Components of **TTASF** are:

1. Transparization: Establishes transparency as a foundational thinking perspective.
2. Genefic Toolbox: Equips individuals with generic and specific tools for integrated and adaptable problem-solving.

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3. Solution Factory Continuum: Transforms complex challenges into actionable solutions using structured frameworks and dynamic tools.

TTASF's Comprehensive Framework incorporates 42 distinct thinking perspectives, modeling tools, and maneuvering tools to promote holistic and dynamic thinking. It effectively integrates theory and practice, enabling seamless navigation between different perspectives and tools to represent and solve complex problems. TTASF provides a structured reform pathway that addresses the root causes of systemic issues and fosters innovation in both education and broader fields. TTASF highlights the importance of integrated, systemic, and transparent methodologies in tackling overwhelming global challenges.

TTASF tools, such as Big Picture Modeling, Analogical Modeling, Dynamic Mathematical Modeling and Simulation, and Dynamic Animations Modeling, have been successfully implemented in engineering education. These tools enhance learning and problem-solving by bridging theoretical concepts with practical applications.

These conclusions emphasize **TTASF**'s transformative potential, illustrating how its tools and methodologies address fragmentation, foster innovation, and enhance educational and systemic reform. The approach's focus on transparency and interdisciplinary thinking has potential applicability beyond engineering, offering a model for addressing complex, multifaceted problems in various domains.

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