# Introduction to a Basic Science of Componentology

We have been doing basic scientific research on a new branch/field of science, **Componentology,** for two decades. **Componentology** is a new field that scientifically studies all aspects of the reality of physical components and parts (e.g., their nature and essential properties); the anatomy, structure, design, and construction of physical CBPs (Component-Based Products) such as cars, computers, and airplanes which are built by assembling components; as well as the methods and mechanisms of real CBE (Component-Based Engineering) such as mechanical and electronic engineering.

Two indisputable principles and proven cardinal rules: (i) Scientific knowledge (in the basic science) for any physical thing or reality (i.e., comprising of descriptions, concepts, understanding, and theories) is invalid and flawed if it contradicts any valid evidence or observations made about the physical thing or reality. (ii) To solve any difficult and unsolved technological problem, engineering research (or applied research) must not rely on any flawed/invalid scientific or theoretical foundations or knowledge.

A proven and indisputable age-old formula: The first step is to conduct a comprehensive scientific study (i.e., basic research) to create a sound theoretical foundation comprising of understanding, descriptions, and theories or scientific insights. Once a sound basic science or theoretical foundation is created by conducting basic research, the second step is to rely on it to conduct applied research (i.e., engineering research by relying on the basic science created in basic research). The prerequisite for software engineering research on "Component-Based Software" is the creation of basic science Componentology, which we have done. It will be obvious that computer science skipped the prerequisite first step (i.e., creating basic science) for applied research.

Scientific disciplines can be classified into two categories: (i) primary or basic sciences, such as physics, biology, and chemistry, and many of their subfields such as microbiology, epidemiology, immunology, pharmacology, genetics, anatomy, and biotechnology; and (ii) secondary or applied sciences, such as medical sciences and engineering disciplines. Research in the applied sciences relies on the basic science (i.e., theoretical foundations) created by basic research. Software engineering is an applied

science that requires theoretical foundations such as Neuronology & Componentology. Computer science is responsible for providing the theoretical foundation for software, so it has the responsibility to create basic scientific subfields such as http://componentology.org & http://neuronology.org.

| **ChatGPT's Insightful & well-articulated answer to the following question** |
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| What are ***Basic research***, & ***Applied research***, & the relationship between them? |
| Basic research, also known as fundamental or pure research, aims to advance knowledge and understanding of a particular subject or phenomenon. It involves exploring the underlying principles and theories that govern a particular area of study, without necessarily having a practical application in mind. The main goal of basic research is to expand our understanding of the world and contribute to the body of knowledge in a given field.<br><br>Applied research, on the other hand, is research that is conducted with the intention of solving a specific problem or addressing a practical need. It is focused on finding practical solutions to real-world problems, and is often conducted in collaboration with industry or other stakeholders. Applied research often builds upon the findings of basic research and seeks to translate these findings into practical applications.<br><br>The relationship between basic and applied research is complex and interdependent. Basic research often provides the foundation for applied research, as the fundamental knowledge gained from basic research can be used to inform the development of practical solutions. At the same time, applied research can generate new questions and avenues of inquiry that can lead to further basic research.<br><br>In many cases, basic and applied research are carried out in parallel, with each informing and influencing the other. The two types of research are both important and complementary, and together they form a vital part of the research ecosystem. |

In summary, we have accumulated comprehensive scientific knowledge about real components, CBPs, and CBE; and relied on it to conduct our engineering research. We have successfully invented technologies and tools that transform software engineering into real CBE that can build any software product as a CBP. Today, no one in the software

world knows this new basic science (i.e., Componentology), and what is known today in terms of descriptions, definitions, and understanding is flawed, since they contradict observations and evidence about real-world counterparts such as physical components, CBPs, and real-CBE for disciplines such as mechanical, aerospace, and electronic engineering that build every complex product (e.g., airplanes, complex machines, or supercomputers) as a CBP by assembling or plugging in multiple physical components.

That is, the core objective of this paper is to recommend the acquisition of valid scientific knowledge by conducting basic research (i.e., Componentology) and relying on valid scientific knowledge rather than relying on baseless 55-year-old pre-paradigmatic assumptions (i.e., misconceptions about so-called components/CBE) in conducting engineering research. We have engaged in basic research for Componentology for over two decades and have accumulated overwhelming evidence and proof that it is impossible to address the infamous software crisis and the problem of spaghetti code without acquiring and relying on comprehensive scientific knowledge about real-world counterparts for software components, CBPs, and CBE.

We have created Componentology to gain objective understanding and scientific insights into all aspects of the reality of real-world physical components (e.g., their nature and essential properties); the anatomy, structure, design, and construction of physical CBPs (Component-Based Products); as well as the methods and mechanisms of real-CBE. Sadly, most computer scientists are fiercely resisting basic scientific research to acquire and use scientific knowledge and insights in understanding and addressing difficult and unresolved technological issues to address the infamous software crisis.

| **ChatGPT's Insightful & well-articulated answer to the following question** |
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| What are ***Basic science***, & ***Applied Science***, & the relationship between them? |
| Basic science is the branch of science that seeks to expand knowledge and understanding of natural phenomena through the development of theories and empirical evidence. This type of science focuses on discovering and understanding the fundamental principles that govern the workings of the natural world, such as the laws of physics, chemistry, and biology. Basic science is also known as pure science or fundamental science. |

On the other hand, applied science, also known as technology or engineering, is the branch of science that applies the principles and knowledge gained through basic science to solve practical problems and create useful products. Applied science aims to use scientific knowledge to develop new technologies, products, and processes that can be used in real-world situations.

The relationship between basic and applied science is a reciprocal one. Basic science provides the foundation for applied science by discovering and understanding the fundamental principles that can be used to solve practical problems. Applied science, in turn, provides a way to test and refine the theories and principles of basic science. This back-and-forth relationship between basic and applied science leads to new discoveries, innovations, and technologies that improve our lives and advance our understanding.

***P.S***: Other related questions to investigate include "what are the differences between basic and applied research/science". It is not necessary to agree with the ChatGPT's answers, but it is vital for scientists to objectively investigate and find indisputably correct answers. Scientists are expected to not only have a good understanding but also know the right answers about basic and applied research/science. Sadly, many computer scientists or reviewers of my research papers feel that it is my obligation to educate them. Based on my two decades of back-and-forth iteration between basic research and applied research, I am sure that the answers of ChatGPT are not far from the truth.

Componentology (i.e., http://Componentology.org) is a basic scientific field and a branch of computer science that provides essential scientific insights & answers to many vital questions, including basic assertions such as these: *Basic assertion#1*: No software researcher or professional, including those considered to be experts on components, knows the difference between parts that are components and parts that are not.

*Basic assertion#2*: No software researcher or professional who claims to be an expert on CBE (Component-based Engineering) for software knows the differences between engineering disciplines that employ real CBE paradigms to build products as CBPs (Component-Based Products), and engineering disciplines that are not Component-Based engineering (and cannot make products as CBPs).

An analogy to illustrate this deplorable state would be: Doctors who claim to be the foremost experts on kidneys do not know the difference between organs that are kidneys and organs (e.g., lungs, liver, and heart) that are not kidneys. No one wants their loved ones to be treated with such ignorance: http://componentology.org/WhatIsScientific.pdf

Why is Componentology Essential for CBSE (Component-Based Software Engineering)? It is impossible to address any complex unsolved technological problem without acquiring and using necessary theoretical foundations and objective insights. It is impossible to invent real CBE for software that can address the infamous software crisis without creating and using Componentology. Likewise, it is impossible to address AGI without creating and using Neuronology.org.

How can the pharmaceutical industry invent drugs without chemistry? Chemistry is essential for the pharmaceutical industry, as it is vital to inventing and making drugs. Similarly, Componentology is essential to invent the tools and technologies for creating real software components and inventing mechanisms to use the components in constructing each large software product as a Component-Based Product (CBP). Componentology is invaluable for addressing the infamous software crises and the problem of spaghetti code.

Similarly, multiple branches of biology are essential for treating various diseases or infections, including Microbiology, Epidemiology, Immunology, Pharmacology, Genetics, Anatomy, and Biotechnology. Each of the above fields provides invaluable theoretical and scientific foundations for medical research and treatments. Similarly, basic research in **http://Componentology.org** and **http://Neuronology.org** provides invaluable scientific and theoretical foundations for applied research in respective areas of software engineering.

When facts of reality are unknown, misconceptions/fiction (which contradict observations or evidence) occupy the place of reality/science. If the basic fields of medical science did not exist, applied research in medicine would be wandering directionless in the darkness of ignorance and fiction. Misconceptions, myths, and fiction about real components, component-based products, and component-based engineering (which contradict observations about them) filled the void in the theoretical foundation due to the

absence of proven scientific theories and evidence about them, which we have accumulated by conducting basic research in http://componentology.org & http://componentology.org/WhyComponentology.pdf.

The body of knowledge (BoK) for any scientific discipline is accumulated by conducting pure or basic scientific research. The BoK for any scientific discipline comprises theories, methods, nomenclature (or definitions), descriptions, and observations (or evidence). If any discipline skips basic research and only conducts applied research, there will be many gaps in its theoretical foundation, which will be filled with misconceptions, flawed beliefs, and illusions. Many gaps in the existing underlying knowledge of CBE for software are filled with misconceptions, myths, and illusions about so-called components and CBPs.

Conducting basic research is an essential step in constructing a sound theoretical foundation for applied research. The knowledge accumulated for any basic science (e.g. Immunology, Componentology, or Genetics) from conducting basic research provides the essential groundwork for applied research to build upon and ensure that the resulting technology or solution is reliable and effective.

It is not acceptable if computer scientists cannot comprehend the vital need of creating relevant basic science and its role in conducting applied research. Sadly, most computer scientists are fiercely resisting basic scientific research, even though the resultant theoretical foundation is essential to conducting applied research. It is impossible to find any evidence that computer scientists have ever created basic sciences such as (i) http://componentology.org, which is essential to applied research for real-CBE for software, & (ii) http://neuronology.org, which is essential to applied research for AGI.

Two important questions to determine if it is necessary to create any new branch of science (e.g. Immunology, Componentology, Genetics, Biochemistry, or Neuronology): (**1**) *Is the creation of the new branch of science essential to fulfill a long vital unmet need (e.g. essential to solving a vital unsolved problem)*? & (**2**) *Is the branch of basic science not yet created or available (i.e. is it missing or overlooked)*? We have created ***Componentology*** since the answer to these two questions is a resounding **'Yes'**.

When facts are unknown about the objective reality of physical components, the anatomy of physical CBPs, & methods of real CBE, misconceptions take their place.

Above: Computer scientists unanimously agreed on the supremacy and vital need for Components & Component-based Engineering more than 50 years ago.

Below: Computer scientists have been still wrestling to build a consensus on description, & definition for Components & Component-based Engineering.

***Componentology.org*** can help computer scientists find correct scientific & objective descriptions (backed by evidence) for Components & Component-based Engineering

**P.S**: Instead of discovering theories, facts to understand the reality of Components, CBPs & CBE (by observing them), researchers are wrestling to build consensus on acceptable beliefs, dogma or ideology for components, anatomy of CBPs, and mechanisms for CBE.