

CHAPTER ELEVEN

J.P. GUILFORD: A PIONEER OF MODERN CREATIVITY RESEARCH

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ABSTRACT Guilford had an enormous influence on psychology changing not only the concept of the intellect, but how it is measured. This chapter will explore the influence of J. P. Guilford on psychology, a summary of his background at Cornell University, his role in the U.S. Army Air Corps as a research director, and his work at the University of Southern California where he developed the Structure of Intellect (SI). The focus will be on how he made changes to the SI over the years, developed tests for assessment, and the work of Mary Meeker and Robert Meeker who extended the SI with Assessment and Curriculum Development; and the role of creative thinking skills in the creative problem-solving process.

Keywords: Creativity, structure of Intellect, divergent thinking, transformation, creative thinking skills creative problem-solving

Introduction

To live is to have problems, and to solve problems is to grow intellectually.

- J.P. Guilford (1967b)

J.P. Guilford's profound influence on psychology helped to change not only the concept of intellect, but how it is measured, and he impacted the integration of the creative process and problem solving. Guilford received his Ph.D. from Cornell University in 1927 where he studied with Edward Titchener; however, his doctoral chair was Karl Dallenbach with whom he collaborated on a number of studies and publications. His thesis was entitled *Fluctuations of Attention with Weak Visual Stimuli* (Guilford, 1927). In addition, Guilford published research on the auto kinetic phenomenon independently (Guilford, 1928) and with Dallenbach, 1928). He worked on the phi phenomenon



with both Harry Helson (Guilford & Helson, 1929) and Kurt Koffka during Koffka's visit to Cornell University (Guilford, 1967a). These research explorations stimulated a lifelong interest in the unique abilities of the individual. After receiving his doctorate in 1927, J.P. married Ruth Sheridan Burke, who has survived him. They have one daughter Joan Guilford who is a psychologist, and she graciously provided a copy of *An Odyssey of the SOI Model* as a resource for this chapter.

Guilford returned to the University of Nebraska in 1928 as an associate professor of psychology, after a brief stay at the University of Illinois and the University of Kansas. During this period of his life, one of his major publications was his book *Psychometric Methods* (1936) which he later revised in 1954. This book became the standard text for training psychophysicists supplanting Titchener's book *Experimental Psychology* (1905). Guilford's text went beyond covering classical psychophysics and scaling methods, with a major portion of the book covering correlational methods, psychological testing, and the use of factor analysis.

Factor analysis was becoming a keen interest in J.P.'s work and he sought opportunities to learn more about its use by visiting the University of Chicago where he was able to attend evening seminars of L.L. Thurstone. Thurstone was working on his book *Vectors of the Mind* which he published in 1935. There were many lively discussions since Charles Spearman was also visiting the University of Chicago, and J.P. was able to work with Spearman in considerable detail on factor analysis. With this highly motivating interaction with his colleagues, Guilford drafted what would become the multivariate sections of his revised *Psychometric Methods* book. In 1940, J.P. joined the University of Southern California; however, this stint was interrupted in 1942 when he voluntarily joined the U. S. Army Air Corps.

Army Air Corps Experience

When Guilford reflected on this period of his life in his article *Creativity: Yesterday, Today and Tomorrow* (1967b) he said, "The second World War called forth great efforts toward innovation in research and development. ...inventive brains were at a premium, and there were never enough (Guilford, 1967b, 6). In the U. S. Army Air Corps, J. P. was promoted to the position of Chief of the Psychological Research Unit. The research unit was working on the development of the Stanine Project which organized and implemented the standard nine intellectual abilities that were necessary for pilots to be able to effectively fly airplanes. Guilford's work with this project was quite successful and there was a significant increase in the graduation rate of pilots. His research was highly significant influencing the qualifying exams for the U. S. military from the 1950's to the 1970's. In 1946, Guilford retired from the Army Air Corps with the rank of Colonel, and he received the coveted award of the Legion of Merit. As a result of his work with the U.S. Army Corps, he received funding from the Office of Naval Research to assist them in selecting civilian personnel to fill positions as scientists and technologists. This contracted work afforded Guilford the opportunity to create The Aptitudes Research project. The Office of Naval Research contract was refunded over a period of 20 years and led to funding from the Office of Education, HEW, and

the National Science Foundation (NSF). (Guilford, 1986)

Guilford's Challenge at the APA Conference

J.P. Guilford had a profound effect on a wide audience of psychologists, educators and college and university personnel with his Presidential address to the American Psychological Association (APA) in 1950. J. P. was deeply concerned about the lack of research on creativity in psychology and the lack of correlation between education and creative production. He challenged the audience with two questions: How can we discover creative promise in our children and youth? and How can we promote the development of creative personalities? These two questions became J. P. Guilford's professional passion for the rest of his life. In his APA address Guilford defined creativity and discussed the creative personality:

Creativity refers to the abilities that are most characteristic of creative people. Whether or not the individual who has the requisite abilities will actually produce results of a creative nature will depend upon his motivation and temperamental traits. The creative personality is then a matter of those patterns of traits that are characteristic of creative persons...which include such activities as inventing, designing, contriving, composing, and planning (Guilford, 1950, 444)

International Acclaim

At the University of Southern California Guilford taught courses on the Creative Disposition and became well known internationally with his work on psychometrics, creativity and particularly with his theory of the Structure of Intellect (SI) which he introduced in 1955. The SI was Guilford's attempt to codify the concept of intelligence and to provide a systematic taxonomy for its components (Guilford, 1956, 1967a). Guilford's book *Personality* (1959) with its factor analytic approach to the topic, was another significant contribution. The SI model was an extension of Thurstone's primary mental abilities (verbal, comprehension, verbal fluency, number, spatial, visualization, memory, perceptual speed and reasoning). Guilford split the primary mental abilities and added new abilities which increased the number of factors from 7 to 120. J.P. said the factors were independent; whereas Thurstone considered the factors to be correlated.

Structure of Intellect

In *The Nature of Human Intelligence* (1967a) Guilford said every mental task includes three ingredients: an operation, a content, and a product. In the SI model there are five kinds of operations: Cognition, memory, divergent production, convergent production, and evaluation. In addition, there are six kinds of products: Units, classes, relations, systems, transformations, and implications. Last, there are four kinds of content: Figural, symbolic, semantic, and behavioral. Since Guilford said the subcategories are independently defined,

they are multiplicative, so there are $5 \times 6 \times 4 = 120$ smaller cubes. Guilford (1981) later increased the number to 150 and still later to 180 (Guilford, 1986). Guilford's structure of intellect model is depicted in Figure 1.

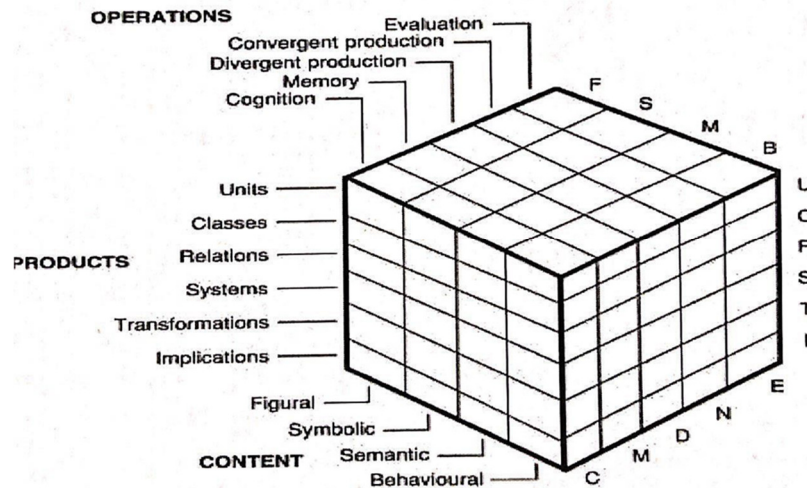


Figure 1: Guilford's Structure of Intellect Model

As Guilford identified a growing number of primary abilities in the SI model, he attempted to find some unifying principles that would provide an easier understanding of the total list of primary abilities. The first principle he identified was that *primary abilities differ according to the kind of material or content that an individual would be working on*. He noted the distinction between verbal and nonverbal abilities that deal with figural materials including concrete, perceived forms and properties, and abilities that deal with symbolic material, made of letters, numbers, and in the verbal semantic category there were abilities that deal with concepts or meanings. Within each of the three categories as to content, factors will differ dependent on the kind of operations such as *cognition* dealing with knowing information, and the discovery or recognition of objects and their meanings, recognition of symbols or words, and discovery or recognition of meaning.

A second kind of operation is *memory or retention*, and Guilford said *our individual memory is not the same for all kinds of information*. His third and fourth kind of operations dealt with productive thinking, and *productive thinking is involved when from given information, we generate other information*. Divergent production goes searching, changes routes and yields multiple answers. Guilford said divergent thinking is where we find the abilities of fluency, flexibility, originality, and elaboration associated with creative performance. *The fifth kind of operation is evaluation*. By checking and re-checking information, memories, and productions, both divergent or convergent thinking help us to make decisions as to their correctness, goodness, appropriateness, or suitability.

The third major principle of classification of the primary intellectual abilities is *in terms of the kind of products achieved by the different kinds of operations applied to the different kinds of content*. Six kinds of products have been recognized and each kind results from the various kinds of operations, and the kinds of products are units of information, class of units, relations between units, patterns or systems of information, transformations, and implications.

Creative Thinking

In *Afterthoughts on the Structure of Intellect* (1988b) Guilford said that the analyses they conducted showed that creative talent is definitely not the same wherever they found it. It depends upon the kinds of SI abilities that the individual possesses to a high degree. Being highly creative depends upon two sections of the SI model, the operations of divergent production and the product of transformation. Divergent production contributes fertility in thinking of alternative ideas and transformation provides changes, creativity, novelty and originality. He shared one of his studies in which they interviewed recognized highly creative individuals and asked them to rate the importance of their use of SI abilities in their work. They rated divergent production abilities high and transformation abilities even higher. In the book *Creative Talents: Their Nature, uses and Development* (Guilford, 1986) provided an entire chapter on transformation in creative thinking with examples of items that could be used to assess the factors. One example for CBT is below:

Behavioral Transformations (CBT)

In the behavioral area Guilford developed a test that illustrates involvement of transformation as in connection with ability CBT. *Social Transformations* asks for selecting from alternatives a pair of described people between whom a certain given remark should have the most different meaning from other pairs in which the same remark is made. Suppose the given remark is "Please" made by the boss to his secretary. The alternative pairs are:

- a) a beggar to a stranger
- b) a father to his son
- c) a chauffeur to a passenger.

The listed correct choice is A. which would change the meaning the most (Guilford, 1986, 77).

Guilford's Concept of a Social Intelligence

Guilford identified an area of abilities pertaining to the cognition of thoughts, feelings and attitudes of other individuals, and this area of intellect he called *social intelligence*, or empathic ability. This area was a type of material he designated as behavioral. He hypothesized that the abilities dealing with behavioral content are parallel to those already known or predicted in connection with other kinds of content. This would include the ability to recognize the behavior of others, and separate abilities for remembering behavior, for engaging in productive thinking about it, both convergent and divergent, and for evaluating our cognitions and conclusions about it. This represents an early recognition of social intelligence that was to come much later in the work of

Goleman (2006) in his book *Social Intelligence*. Products of behavioral intellectual operations would be expected to fall in the same six categories of units, classes, relations, systems, transformations, and implications. He summarized his view by stating:

According to the cognitive view, the organism is an agent that discovers information, remembers information, and uses information in productive thinking, and inevaluating any of its intellectual procedures. (Guilford, 1959, 30)

In his article *Creativity, Yesterday, Today and Tomorrow* (1967b) Guilford identified two abilities that he viewed as the most relevant for creative thinking. One was *divergent production* (DP) abilities that include generation of ideas, as in solving problems where variety is important, and other DP abilities include fluency, flexibility, and elaboration. The second ability that Guilford identified as source relevant for creative thinking was *transformation* abilities which include revising what one experiences or knows, thereby producing new forms and patterns (Guilford, 1967b, 8). He viewed creativity as a form of problem solving and worked closely with the Creative Problem-solving Foundation established by Alex Osborn and Sidney Parnes in examining how creativity and creative thinking skills can be integrated with problem-solving. J.P. was a regular attendee at the annual Creative Problem-Solving Institutes (CPSI) and he used these meetings as opportunities to dialogue with Sidney Parnes on the integration of creative thinking skills in the creative problem-solving process (CPS) developed by Alex Osborn and Sidney. They discussed the role of *intuition* and the importance of *incubation* in the creative problem-solving process. Sidney Parnes shared the role of spontaneous imagery that takes place during the creative problem-solving process, the *Aha*, and both agreed the work of Nikola Tesla and his use of imagery in his creative work, was a prime example of the importance of spontaneous imagery and intuition in the creative problem-solving process.

J.P. provided an evening seminar at the Creative Problem-Solving Institute (CPSI) in 1981 on his view of creativity as a type of problem solving. He listed four kinds of problem-solving skills: sensitivity to problems, fluency, flexibility and elaboration. He described sensitivity to problems as the ability to sense or recognize problems; and he said there were three kinds of fluency, *ideational fluency* or the ability to rapidly produce a variety of ideas that fulfil stated requirements as in brainstorming; *associational fluency* or the ability to generate a list of words which is associated with a given word; and *expressional fluency* the ability to organize words into larger units, such as phrases, sentences and paragraphs; flexibility included both spontaneous and adaptive flexibility to produce ideas that are novel and high in quality. The last problem solving skill Guilford identified was elaboration where there can be transformation as one sees new possibilities.

When he was asked how education could change to help close the gap between education and the development of creative individuals, Guilford said educators need to not only teach what is, but there is a need to teach students to think about what could be. He emphasized the importance of rewarding students' new ideas, as well as the importance of their remembering and recalling known facts. He suggested that educators encourage the production of

alternatives and place an emphasis on critical thinking, because evaluation plays a strong role in problem solving. He said students should be taught when to turn criticism on and when to turn it off. He noted a role for stockpiling items of information because creative thinking depends upon a well-stocked memory. Several participants noted this idea's similarity to the concept of a well primed mind (Sisk, 2020).

Benefits of Creative Problem-solving

Guilford was keenly aware of the enormous economic value of new creative ideas and the need for individuals with inventive potentialities, and that industry and government agencies are always looking for productive individuals with good judgment, planning ability and inspiring vision. He said creative productivity depends upon primary traits other than abilities, including motivation factors (interests and attitudes) as well as temperament factors. In many CPSI seminars, he discussed the neglect of research on ways creative thinking skills can be developed in education and the impact that creative thinking skills experiences would have on the creativity and achievement of students (Sisk, 2020).

A Structure of Intellect Problem-Solving Model (SOIPS)

Guilford in *Creative Talents: Their nature, uses and development* (1986) showed how the SI model could fit into a problem-solving episode. In the SOIPS model, the memory store underlies everything else. The SOIP model is depicted in Figure 2 (on the next page). This collection of cognized and remembered items of information contribute to everything that goes on. He said:

The operation of memory keeps a running record of ongoing events.

In the problem-solving episode, SI operations other than that of Memory are represented in the model by rectangles. Memory operations are indicated by the arrow pointing toward the memory storage. Events in solving a problem begin with input into the communication system from the environment (E) or from the person's body or soma (S). (Guilford, 1986, 95).

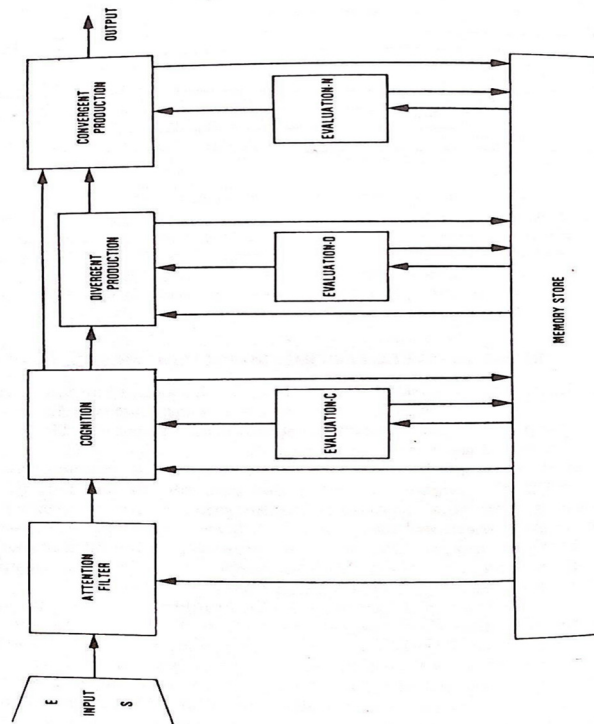


Figure 2: SOIPS model

A Criticism of the Structure of Intellect

In *Afterthoughts on the Structure of Intellect*, Guilford (1988b) said he knew of only one noteworthy criticism in print of the SI model, that of Horn and Knapp (1973) regarding the manner in which the axes were rotated in factor analysis. At first, Guilford used Thurstone's graphic method, but later used Cliff's (1966) computerized method when it became available. Cliff's method involved essentially hypothesizing as to where the axes should go in order to achieve simple structure, positive manifold and psychological meaning, as in graphic rotations. Guilford said we did try out all of the available computerized methods, but the results yielded very poor replication in terms of psychological meaning. Guilford explained Horn and Knapp's work quite succinctly:

Horn & Knapp selected one of our early reported analyses for their illustration of how well a rotation of axes by Cliff's method would pull the axis to an arbitrary goal. They had the computer generate a set of axis positions by chance. The rotations that were affected yielded what they considered to be a fair fit of obtained results in the chance-generated goal. (Guilford, 1988b, 102)

Guilford described the research of Elshout, Van Hemert & Van Hemert (1975) as coming to his rescue when they pointed out that our critics should have generated, not one, but a number of hypothetical factor patterns toward which to rotate, lest the one that they used be a fortunate one for their purpose. The authors did actually follow that plan, computing an impressive index of goodness of fit of each rotated pattern of factors, also using the test on the Horn-Knapp (1973) solution. They found a normal distribution of the indices that the index for the Horn-Knapp (1973) solution was way outside the distribution in the favorable direction (Guilford, 1988b, 102).

Sternberg & Grigorenko (2000) in *Guilford's structure of Intellect model of creativity: Contributions & limitations* addressed Guilford's use of subjective rotations as flawed, and what Guilford interpreted as confirmation of his theory was not, and they said there are more sophisticated confirmatory techniques available now. Concerning the tests that Guilford designed for his SI theory, they recommended these types of tests would benefit from correspondence to the type of tasks used to assess creativity in adults, to show any predictive relevance of creativity. Guilford's contributions were listed as recognition of the importance of precise empirical validation; being one of the first to define intelligence broadly; and sparking interest in the field of creativity when the field was moribund. They concluded that Guilford concentrated on confirmation rather than disconfirmation of his theory and they said. "...until we all do research that allows and even encourages our beliefs to be disconfirmed—in other words, until we act like scientists...each of us is convinced that we alone possess the truth..." (Sternberg & Grigorenko, 2000, 315).

Application of Guilford's SI Theory to Assessment and Curriculum

Mary Meeker, a doctoral student of Guilford at the University of Southern California was keenly interested in applying Guilford's SI theory to the development of assessment instruments and curriculum development. Her dissertation focused on these two areas with application to both children and adults. In his APA address, Guilford said any general theory to be seriously tested would need investigation of primary abilities that could then be improved with practice of various kinds, and positive transfer of effects would be evident (Guilford, 1950, 440).

Meeker responded to this directive and began exploring the potential of applying SI to education based on two major points: 1) intelligence can be precisely measured using a test that identifies an individual's aptitude on the multiple intellectual abilities identified in the Guilford SI model; and 2) The individual's intellectual abilities can be remediated or improved using learning materials that target each particular ability. Meeker called her application of Guilford's theory (SOI) or Structure of Intellect (Sisk, 2020, 7).

After graduation, Mary Meeker and her husband Robert Meeker, a psychologist developed an SOI Institute that produced SOI tests and educational materials developed during Mary's work on her doctorate, and afterwards as an independent research effort. They conducted training throughout Texas, and eventually expanded nationally and internationally to certify people as

SOI diagnosticians. The Guilford SOI model involves the matching of an individual participant and an assignment with educational experiences developed for each specific intellectual component. For example, the Figural category in the content dimension deals with sensory materials. It represents a kind of concrete intelligence needed by engineers, artists, musicians, mechanics, and machine operators. This intelligence can be identified by selected items on the SOI test and increased by well-chosen activities (Meeker, 1987).

Bridges Learning Systems

U.S. Senator William Brock founded Bridges Learning Systems, a commercial enterprise that implemented school programs based on Meeker's SOI work and on an Integrated Practice Protocol (IPP) that Mary Meeker developed with Robert Meeker (Meeker & Meeker, 1992). An IPP includes SOI related assessment and learning and teaching materials that incorporate intelligence assessment such as the SOI-LA test for vision assessment and sensory integration (Sisk, 2020). These activities were implemented in Bridges Labs.

Bridges Labs at Paris ISD

Paris Independent School District (PISD) in Paris, Texas developed a Bridges SOI lab to work with students who were having difficulty staying on task and who had behavioral issues. The SOI lab can be described as a *gymnasium for the brain* in which students work on exercise activities focusing on visual, auditory and sensory motor activities, and on training tasks including sensory exercises, fine motor and perceptual activities, and trampoline and balance board exercises. Students also engage in *independent book work* on individualized program tasks that develop sensory integration and focus skills. The students at the Paris ISD spent a minimum of 45 minutes a day working with a lab specialist two days per week during the school year. Evaluation of the Paris Bridges Lab found the program helped the students focus, stay on task and concentrate on their work. As a result, the students improved both academically and behaviorally. Standardized tests and assessment results indicated positive gains for the students and significant outcomes, notably in reading and math.

One student who had been referred to the Bridges Labs for behavior issues and difficulty in focusing, was the center on the high school basketball team. After working in the lab, he was no longer being referred to the principal for his behavior, and the basketball coach said his foul shots greatly improved. This could be traced to the visual motor activities in the lab in which the students stand on one side of the room and swing a pendulum at a target on the other side of the room. Teachers of this young man reported that he had more pride in his work, was asking more questions, and he said he enjoyed the emphasis on being focused.

Retirement from the University of Southern California

Guilford's retirement from the University of Southern California had little or no effect on his productivity. With his book *The Nature of Human Intelligen-*

ce (1967a), Guilford continued to influence the field of psychology, particularly through his work on the Structure of Intellect. He supported the establishment of the *Journal of Creative Behavior* by the Creative Education Foundation by writing an initial keynote article *Creativity: Yesterday, today, and tomorrow* (Guilford, 1967b). He predicted in that article that future investigations would probably take two major directions; one toward a more detailed and complete understanding of the process of creative thinking; and two, a survey of the conditions that influence creative thinking, both positively and negatively. The work of Gerrard Puccio, the current chairman of the International Center for Studies in Creativity at Buffalo State College where the rich history of creativity research started with the work of Alex Osborn and Sidney Parnes, testifies to the accuracy of J. P.'s prediction. Puccio and his colleagues use an approach they call *FourSight* that includes four steps: Clarifying, Ideating, Developing and Implementing. They say the ability to spot problems and devise smart solutions is being recast as teachable skills (Pappano, 2014).

Changes in the Structure of Intellect

Some Changes in the Structure of Intellect was published after Guilford's death in the journal *Education Psychology Measurement* (Guilford, 1988a). The article introduced changes that included the five areas of Content properties: Visual, auditory, symbolic, semantic and behavioral with figural changed to include visual and auditory. There were changes in Operations including memory as memory retention and memory recording. Then Operations would read Cognition, memory recording, memory retention, divergent production, convergent production and evaluation. Citations of the research justifying these changes were included in the article. These changes are depicted in Figure 3.

Guilford received honorary doctorates from the University of Nebraska (1952) and the University of Southern California (1962), but his most treasured honor was his election to the National Academy of Science and to the International Society of Intelligence Education (ISIE) in Japan. He was elected to the ISIE presidency and served for 10 years. During this ten-year period, ISIE developed an intelligence test based on the SOI model and translated all of Guilford's books into Japanese. The society published a book entitled *Odyssey of the SOI Model* which contained a 20-page autobiography of J.P. and his article *Afterthoughts on the Structure of Intellect* (Guilford, 1988b). At the initial conference of ISIE in Japan, Guilford proposed a presentation with the title *Intelligent Education is Intelligent Education*. Sidney Parnes, the president of the Creative Education Foundation introduced J. P. with the title of *Odyssey of the SOI model* which the ISIE organizers thought the participants would be more able to recognize his work, rather than J.P.'s proposed title of *Intelligent Education is Intelligent Education* which was on a plaque on his office desk at the University of Southern California.

A Japanese sculptor Yoshio Matsuda created a bronze commemorative bust of Guilford that was presented at the initial ISIE conference. Mary Meeker and Robert Meeker were featured speakers at the ISIE conference in Japan, and they helped organize a second ISIE conference held in California.

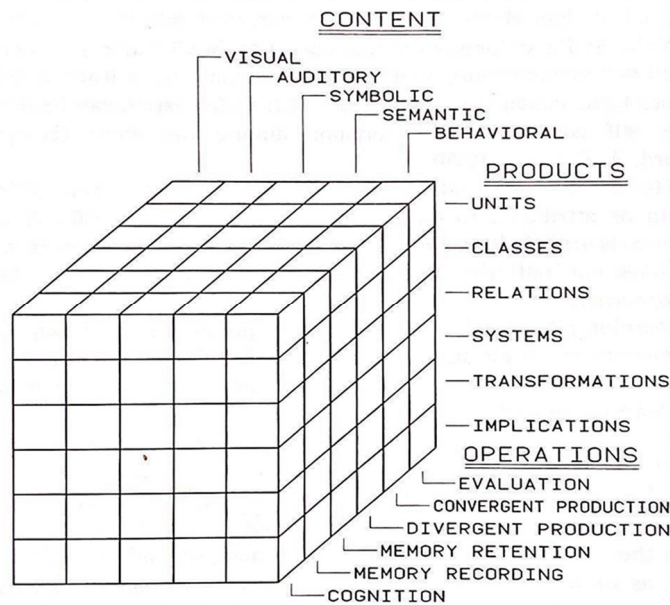


Figure 3: Revised and enlarged structure-of-intellect model

Concluding Remarks

J.P. Guilford's pioneering efforts in the field of psychology and psychometrics are foundational for the measurement of cognitive processes. He contributed hundreds of articles and monographs to the research literature, as well as 43 books. In his *Structure of the Intellect* model, the mind, thoughts and mental processes are considered as a set of factors classified according to their unique variations. Included among these factors is the attribute of creativity (Guilford, 1967a). His work on the Structure of Intellect contains major implications for education, measurement and creativity. Guilford's work in creativity provided a foundation for a good part of the research now being conducted on creativity. In his *Afterthoughts on the Structure of Intellect* (Guilford, 1988b), said the SOI model suggested some interesting considerations, its development showed that investigating how human individuals differ in their functioning, we can also discover how they are alike. This understanding can lead to greater consideration of individual differences, and how best to work toward the creative development of individuals. Guilford said the consequences of the future of mankind's present and future efforts to gain understanding and control of creative performance is incalculable. He said to live is to have problems and to solve problems is to grow intellectually (Guilford, 1967b, p. 12). He said as we identify the strengths of our students and within ourselves, we can celebrate these resources and begin to rewrite what we imagine to be possible, with our intuition and transformation. J.P.

was spot on seeing the importance of creativity, the power of the creative process and the need to develop creative thinkers.

One of Guilford's professional satisfactions was seeing Akira Chiba using the SOI in their gifted programs in Japan, and its positive effect on their education. Guilford viewed creative education having several important outcomes including developing self-starting, resourceful and confident persons. He said these individuals would be ready to face personal, interpersonal, and other kinds of problems. He described self-confident people as being tolerant, where there is a need for tolerance, and that a world of tolerant people would be peaceful and cooperative. He concluded, "Thus, creativity is the key to education in the fullest sense and to the solution of mankind's most serious problems (Guilford, 1967b, 13).

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