The History of Articulators: The "Articulator Wars" Phenomenon with Some Circumstances Leading up to It

Edgar N. Starcke, DDS, Robert L. Engelmeier, DMD, MS, & Donald M. Belles, DMD, MS

Department of Prosthodontics, University of Texas Houston Health Science Center – Dental Branch, Houston, TX

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Correspondence
Edgar N. Starcke, University of Texas HSC at Houston Dental Branch – Prosthodontics, 6516 M. D. Anderson Blvd., Houston, TX 77030. E-mail: Edgar.N.Starcke@uth.tmc.edu

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Abstract

At the dawn of the 20th century, all was not well with the practice of "plate prostheses." Removable prosthodontics had been degrading for several decades and was now generally in low esteem, even though there had been many significant advances. W. E. Walker had introduced adjustable condylar guides, George Snow, the facebow, and Carl Christensen, a method for clinically measuring the condylar inclines. Nevertheless, the average practicing dentist was still using simple hinge articulators and was apathetic to the deplorable state of the artificial teeth available; however, this was all going to change dramatically when two dentists, Alfred Gysi and J. Leon Williams, working together between 1910 and 1914, presented to the profession the "Trubyte Artificial Tooth System" that embodied both a typal system for selecting anterior teeth and new posterior occlusal carvings that made possible, for the first time, the articulation of artificial teeth. This incited many of prosthetic dentistry's elite to introduce their own theories of mandibular movement and the articulators that they designed to reflect those theories. The intense debates that ensued, both in the meeting halls and in the literature, were numerous and lasted for decades. At the time, the "Articulator Wars" had both positive and negative consequences. Today, with many of the "Articulator Wars" issues remaining as part of the practice of dentistry, the "Articulator Wars" can be considered a phenomenon of enlightenment.

"It was the best of times. It was the worst of times."[1] It was a time of discovery and enlightenment, and a time of discord and conflict. No, it was not the 18th century French Revolution, but the second and third decades of the 20th century, in the world of "full and partial plate prosthetics."[2] Prosthetics' elite were battling, in both the literature and in the meeting halls, over concepts of mandibular movement and articulator design that were, without doubt, beyond the grasp of the dental profession. So great was the passion between adversaries, it would have probably "scared the dickens" out of the hapless average practicing dentist who happened upon one of those legendary verbal fisticuffs.

For the high priests of prosthetics, it was undeniably a serious matter, and it became very personal: friendships and alliances were formed, but regretfully for some, lifelong enemies were made. After all, there were ideas to expound and defend, and sadly, egos to protect. Thus was the character of the "Articulator Wars."

The significance of the Trubyte Tooth System on the emergence of the "Articulator Wars"

There was probably no defining moment that can be identified as the beginning of the "Articulator Wars." In all likelihood, it began with two dentists, J. Leon Williams (Fig 1)[3] and Alfred Gysi (Fig 2)[3] who, as a result of their landmark contributions between 1907 and 1914, were instrumental in igniting the spark that led to this remarkable phenomenon. At first, they worked independently, and then in collaboration. This was made possible, incidentally, only by the personal efforts and financial support of George Wood Clapp and The Dentists' Supply Company of New York. This partnership culminated in the introduction of the Trubyte Tooth System and Gysi's technique for the articulation of artificial teeth. These milestones would change dentistry forever.

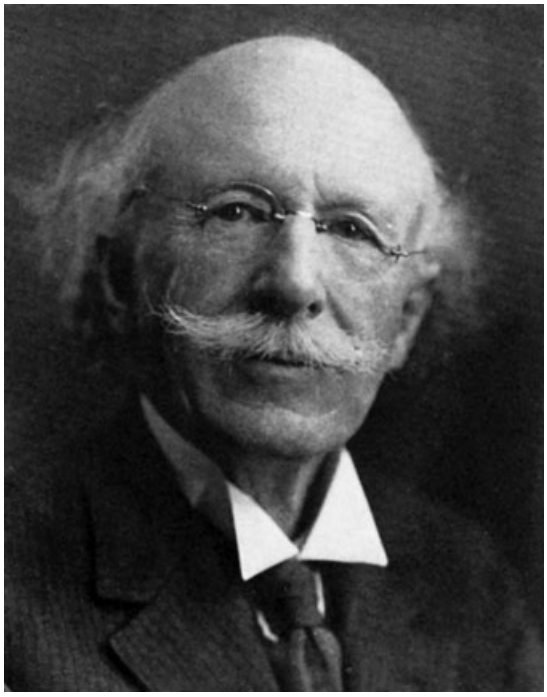

Figure 1 J. Leon Williams, DDS, LDS, FACD (1852–1932).[3]

The mood and state of the profession regarding "Plate Prostheses" prior to the "Articulator Wars"

For most dentists who were working hard to serve the public and make a decent living, there was little interest in the landmark events taking place. Little was known about movements of the mandible by the profession in general. Most likely, the prevailing opinion of the average dentist was that the articulators with which they were familiar (that is, manufactured simple hinge "occluders" and homemade devices such as the "plaster articulator" and the "barn door hinge") were quite adequate to provide dentures for their patients. Articulators with improved functional features, such as those designed by Bonwill, Gysi (the "Simplex"), Snow, Gritman, and Kerr, were readily available but were regarded as too complicated. Even more troubling, the average practicing dentist was apathetic to the deplorable state of artificial teeth available. Realistically, most dentists did not have a clue as to why 90% of their removable prostheses were failures.[4]

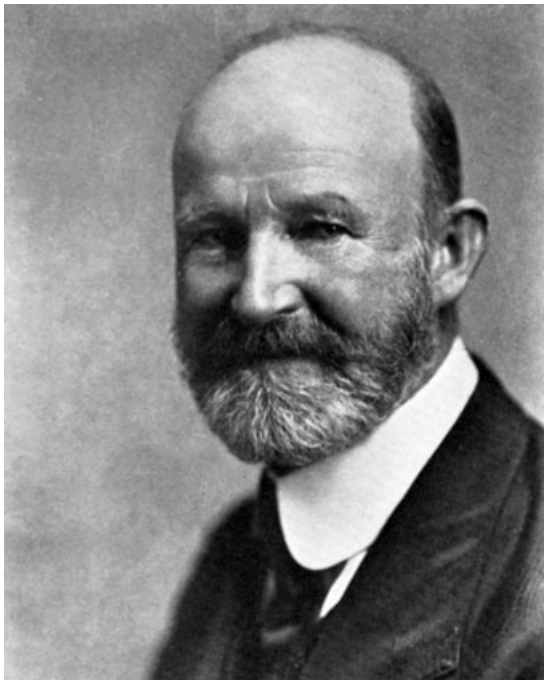

Figure 2 Alfred E. Gysi, DDS, MD, DMD (1865–1958).[3]

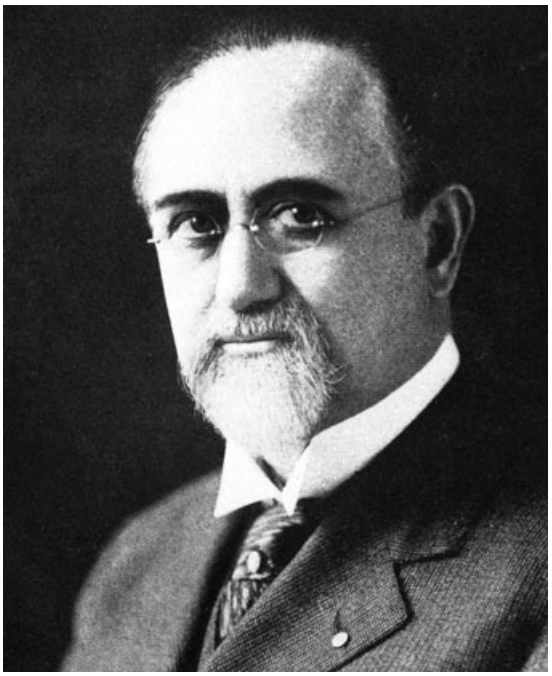

Figure 3 George H. Wilson, DDS (1855–1922). Noted educator and author, he is best known for his "Manual of Dental Prosthetics" and the "Wilson Curve."[3]

During the two decades prior to 1910, the profession was heavily influenced by the pervasiveness of Bonwill's philosophies and his so-called "Anatomical" articulator. As the new century approached, however, investigators began to have a much better understanding of the nature of mandibular movement. This was substantially due to breakthrough contributions like those of William E. Walker (the first adjustable condylar guide articulator, 1896), George Snow (the facebow, 1899), and Carl Christensen (the intraoral "check bite" technique, 1901). For the first time, a practical and accurate method for taking information from the patient and transferring it to an adjustable articulator was possible.[5] This, then, gave some promise of raising removable prosthetics from, as George H. Wilson recounted, the place of low esteem to which it had been relegated for more than half a century (Fig 3).[3,6]

The conundrum was that the artificial teeth available up to that time were abundant but woefully inadequate in almost all respects. The posterior tooth forms were largely carved to mimic human teeth but poorly suited for achieving a balanced occlusion. From an esthetic standpoint, essentially all the anterior molds were based on the old pseudo-scientific "Temperamental" theory. This theory consisted of four categories of tooth forms (Nervous, Sanguine, Bilious, Lymphatic). It falsely assumed that there was a correlation between tooth form and temperament.[7] In 1904, James H. Prothero pointed out that Hippocrates made the first classification of the 'temperaments,' and "then, in about 1804, Dr. Spurzheim modified the older system and this modification is used to a greater or less extent today."[8] Almost everyone accepted the "Temperamental" theory, but realistically, no one really understood it. Another seemingly insurmountable problem was a complete lack of any system of tooth shades.[9]

At the turn of the 20th century, the five largest manufacturers of artificial teeth were S. S. White, H. D. Justi and Sons, Gideon Sibley, Wilmington Dental Manufacturing, and Claudius Ash and Sons.[10] By 1909, The Dentists' Supply Company of New York (The Company) was competing with these giants and according to George Wood Clapp was the only manufacturer that produced a mold guide ("Twentieth Century" Mould Book).[11] In 1909, The Company acquired the *Dental Digest*, published by J. N. Crouse. George Clapp, who was the director of the Research and Development Division of The Company, was appointed Editor-in-Chief as well as Managing Editor. (He probably also cleaned up around the place!) Clapp was a prolific writer and tireless investigator. He collaborated with E. S. Ulsaver, who carved the occlusal surfaces of the latest "Twentieth Century" molds.[12] Clapp was determined to not only accomplish a method to achieve balanced articulation of artificial teeth,[11] but also to establish a useful guide for selecting anterior teeth.[13] Although the "Twentieth Century" molds were a denture-breath of fresh air in a murky fog of artificial tooth disorganization, they never really met Dr. Clapp's expectations. It would not be long before he turned his attention to the work of two prominent investigators, J. Leon Williams and Alfred E. Gysi. Their efforts to improve the esthetics and function of artificial teeth were decidedly exciting to him.

In George Wilson's 1920 short history of "prosthesis," he reported that in the 1840s, Chapin A. Harris declared that, "Prosthesis is . . . the most important part of dentistry." However, Wilson said that "plate prosthesis" had suffered degradation until the last few years, mainly due to three factors: the "noble idea of preserving the natural dental organs, the reluctance of the profession to accept vulcanite, and the introduction of crown and bridge work." He cited Dr. William Hunter's "famous" lecture at McGill University in 1910, in which he characterized certain methods used in the practice of crown and bridge as "American Septic Dentistry." Now, in 1920, Wilson was encouraged by the events of the last decade. He believed that, "the study of, and inventions for, [the articulation of artificial teeth] have been the great causes for the progressive development of [complete and partial dentures.]" Naturally, Wilson was proud to have played a part in the organization of the new prosthetic dentistry society, The National Society of Denture Prosthetists, first organized in 1918 during the meeting of the National Dental Association in Chicago. Unfortunately, Wilson missed out on most of the milestone events to follow because of his death in 1922.[2]

The contributions of J. Leon Williams and Alfred E. Gysi: Bumpy roads to success!

Dr. Williams' journey

Dr. J. Leon Williams made his first attempt to obtain better forms of artificial teeth in 1902 when he made a plea to the Odontological Society in London. His suggestions were noted, but no actions were taken. In 1905, he appeared before the board of directors of one of the major British firms engaged in manufacturing artificial teeth. He pointed out the serious defects of the existing teeth and urged the board to devote resources to produce teeth that would be better suited for "a satisfactory quality of plate service by dentists." The response from the chairman of the board, speaking unofficially for the other major manufacturers as well, was, "The dentists who purchase 90% of the artificial teeth appear to be satisfied with the tooth forms as they are. The number who would pay for the improvements would be too small to justify [the great financial risks]." Faced with what appeared to be insurmountable odds, Williams turned his attention to other interests; however, in 1907, there was a "clarion call" from America to reawaken his interest.[4] Another investigator, Stewart J. Spence, was also convinced that there was a need for better artificial tooth forms. His fervor and perceptions on the matter were expressed in a series of thoughtful and detailed articles beginning in the August issue of the *Items of Interest.*[14]

Dr. Williams was now resolved to awaken the American dental profession to the reality that an improved system of artificial tooth forms based on scientific criteria was essential to successful removable prostheses. He made an impassioned plea to the complacent tooth manufacturers to collaborate with leading prosthetic dentists and to commit sufficient resources to the development of new artificial tooth systems.[4]

Williams found an ally in Rodrigues Ottolengui, editor of *Items of Interest*. Williams gained access to the profession through the pages of this dental journal with a readership of about 15,000. In the November 1907 issue,[15] he labeled the types and numbers of both anterior and posterior teeth available as "utterly foolish" and a "system-less system" and asked for all interested dentists to write to the editor and express their ideas, desires, and suggestions for better artificial teeth.[4]

The response from the profession was underwhelming! It seemed to justify the statements of the manufacturers in London 2 years before. Dr. Williams received only three replies, two from Europe and one from America. They were from Alfred Gysi, Zurich; Booth Pearsall, England; and L. P. Haskell, Chicago.[4]

Dr. Ottolengui wrote a powerful editorial in support of Williams, but its tone was not optimistic.[16] He pointed out that Dr. Williams had said, "from time to time that some student of the subject" would complain how inadequate the available

artificial teeth were and would hold the factories responsible for this dilemma. Ottolengui again reminded his readers that the demand for change and the responsibility for determining new tooth forms and colors rested with the dentists. He admonished the profession to take an interest and help Dr. Williams in his Herculean task. Following the editorial, Williams wrote letters for several more issues of the *Items of Interest*. After that, the subject was, as it had been many times before: D.O.A. According to George Clapp, realistically, particularly at that time, improved tooth forms simply could not be produced. Tooth manufacturers could not produce them, because they knew nothing about how dentists used them. Members of the dental profession could not tell the manufacturers what the forms of teeth should be, because they did not know. Even Dr. J. Leon Williams did not know![4]

Weary and not in the best of health, Williams returned to London in the early summer of 1908 to study and to carve anterior teeth to try to determine a scientific basis for a new tooth system. Like almost everyone else in the profession, Williams was an advocate of the Temperamental Theory. He planned to build his new system by crossing each basic temperament mold with another to develop ten molds. He envisioned only six sizes of each; however, his persistent problem was that he simply could not reconcile the lack of scientific principles of the Temperamental System.

After gaining more experience in carving teeth and producing some of the most superior teeth to date, Williams returned to America in November 1909 to present his new system of forms, sizes, and shades. These teeth would not only be more natural in appearance, but the selection would be greatly reduced to include the more frequently seen forms in natural teeth.

Again, Williams soon discovered that tooth manufacturers were simply not willing to take such a financial risk that his proposed new tooth system would incur. Only one manufacturer, The Dentists' Supply Company of New York, was prepared to take the risk. This company was deeply involved in the process of developing the "Twentieth Century" tooth molds. And even though this venture had not proven to be altogether successful thus far, in December 1909, The Company reached an agreement with Williams to finance his work on a new system of anatomical tooth molds. The caveat was that he would present evidence of interest from those dentists making the dentures and not just the profession's elite.[4]

No sooner had contractual arrangements been completed between Dr. Williams and The Company, than the first of a series of landmark articles based on Alfred Gysi's 1908 book, *Beitrag zum Articulationproblem*, appeared in the January 1910 issue of the *Dental Cosmos.*[17]

Williams wasted little time arranging a meeting with Gysi in Zurich to explore the possibility of a collaborative effort to produce better tooth forms. After the two men reached an understanding, Williams returned to London to continue his search for answers to the elusive anterior tooth form dilemma. Returning to America in June 1910, Williams addressed several national dental organizations. This time he received resolutions of enthusiastic support. The Company accepted these endorsements, with others from additional sources, that Dr. Williams' work should be continued with their financial support.[4]

Williams remained in America through the summer and into the fall, working with Dr. Clapp and studying museum skulls, both modern and ancient; however, still being frustrated by the lack of adequate numbers of skulls in America, in October 1910, he returned to London to study the excellent skull collections there. Then, in late November 1911, while examining several hundred central incisors sent to him by H. E. Friesell, he noticed that when putting them down, he had unconsciously sorted them into four groups. "The rest," to repeat an old adage, "is history." Williams' revelation was that the anterior teeth could be placed into three types—square, tapering and ovoid—with variations of each. He also recognized a relationship between the maxillary central incisors of these tooth types and facial types.[4]

Meanwhile, Alfred Gysi had been working on three different occlusal carvings since 1912. The depths of the "bite" were described as "shallow, medium and deep." The decision as to which occlusal carving would be selected as the initial Trubyte mold was based simply on the fact that very few dentists followed any scientific method of making impressions or taking jaw relation records. Therefore, the "shallow" carving was chosen so there would be less chance of dislodging the denture due to the inevitable clinical errors.[4] Figure 4 compares Dr. Gysi's first Trubyte posterior carvings (G, H, I) with the Dentist's Supply Company's "Twentieth Century" molds (D, E, F) and molds following Bonwill's formulation (A, B, C).[18]

It would take Williams another 3 years to refine his anterior teeth and to devise a Formula of Classification to compare tooth forms to facial forms. He also assisted Gysi with his posterior tooth carvings (Williams carved the buccal and lingual surfaces of the premolars and molars). It was not until all were in accord with the outcome that The Company agreed to present the new Trubyte Artificial Tooth System to the profession. So, just how much money did The Company invest in the new Trubyte Tooth System? Surprisingly, according to Clapp, the initial investment was between $500,000 and $1,000,000! And that was in 1914 dollars![4]

Williams introduced the New Trubyte Tooth System on March 10, 1914 at a special meeting of the First and Second District Dental Societies of New York (Fig 5). Dr. Williams had finally succeeded in discrediting the old unscientific Temperamental Theory, waking up the profession to a new and practical method of selecting artificial anterior teeth. Interestingly, one dentist expressed his appreciation to Dr. Williams with a poem (Fig 6).[19] Incidentally, Williams coined the name Trubyte for the dental profession in America. Because of language issues in Europe, the name Anatoform was adopted for its use there.[4]

It is noteworthy that J. Leon Williams, as a result of his extensive study of the dentition of ancient, prehistoric, and modern human skulls from all corners of the globe, was also the first to recognize that there was no correlation between tooth types and the size and shape of the skulls![7] This seemingly inconsistent finding surely must have had him pondering upon what scientific principle his New Trubyte Artificial Tooth System was actually based. So, why has Williams' concept of square, tapering, and ovoid tooth forms had such as profound and lasting effect? Perhaps it is because it has proven over time to be an easy, simple, and manageable guide for selecting denture teeth.

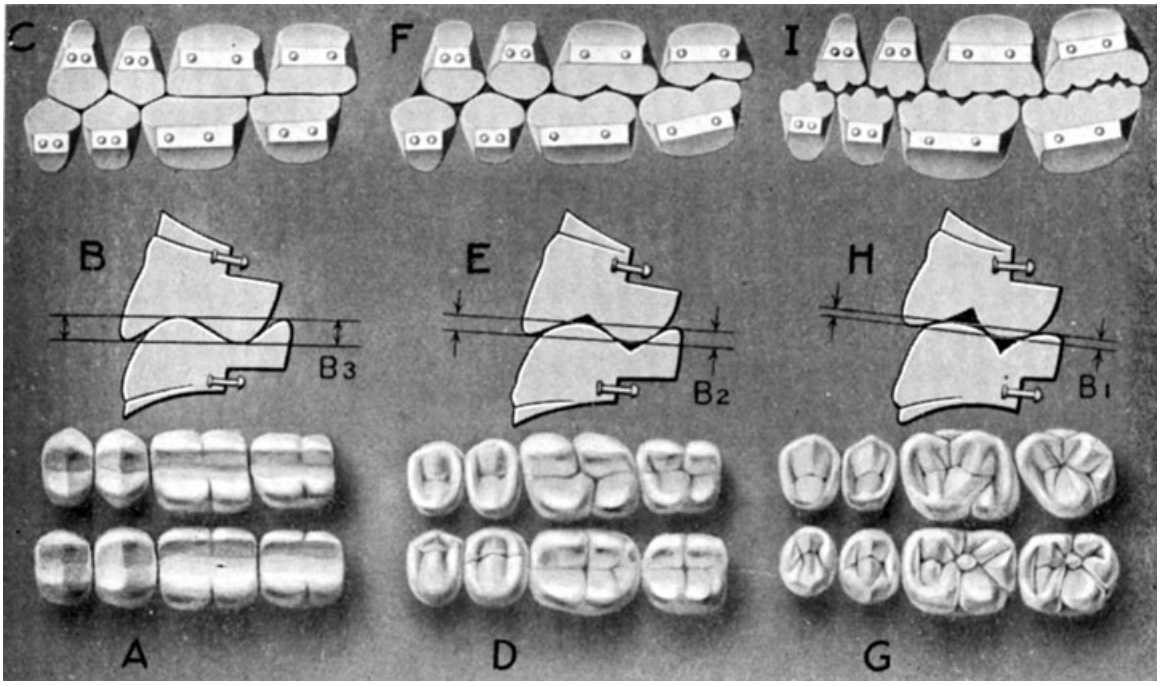

Figure 4 This illustration compares Gysi's first Trubyte posterior carvings (G, H, I) with The Dentist's Supply Company's "Twentieth Century" molds (D, E, F) and molds carved to Bonwill's specifications.[18]

Based on scientific principles or not, it will always have a place in the practice of prosthodontics.

An interesting aside! J. Leon Williams met his match but never knew it!

Dr. Williams' quest to develop a system of better artificial teeth was a long and arduous journey that took a toll on his health. Nevertheless, he persisted, developing a keen interest in anthropology. He had the unique opportunity, in both America and Europe, to examine skulls of many different races and nationalities, including modern, ancient, and prehistoric. To his delight, he was even asked to help in some of the restoration efforts. With the cooperation of the museums of natural history in England and France, he studied the skulls of the Neanderthals and Cro-Magnons.

Of course, the big question of the day was: Did humans descend from the apes or did humans and the apes have a common ancestor? Williams considered his "discovery" of the typical forms in the teeth of man and manlike apes as evidence that man and apes descended from a common ancestor. He was now quite eager to continue his investigations.[4]

In 1912, Charles Dawson excavated fragments of a skull and mandible of what was believed to be the fossilized remains of the earliest human to date from a gravel pit in Piltdown Common, East Sussex, England. The specimen was given the Latin name, *Eoanthropus dawsoni* "Dawson's Dawn-man." It was estimated to be more than 500,000 years old and possibly the elusive "Missing Link!" After his discovery, Dawson took the fragments to Arthur Smith Woodward of the British Museum. Excited about the discovery, Dr. Woodward accompanied Dawson to the site to help with further exploration.[18] At a meeting of the Geological Society of London held on December 18, 1912, Woodward announced his finding of the Piltdown skull and his restoration of the fragments indicating that it indeed represented an evolutionary "missing link," because it had a human-like cranium and an ape-like mandible.[18]

When Dr. Woodward's restoration of Piltdown man was made public, Dr. Williams called to the attention of Sir Arthur Keith, Hunterian Lecturer at the Royal College of Surgeons, that Woodward's restoration could not be correct, because he made the mandibular incisors larger than the maxillary incisors. In addition, the cuspids would not allow the lateral movement that was evident in the wear patterns of the molars. Keith agreed with Williams' assessment, and the two men presented their restoration of the skull, Keith, the cranium, and Williams, the dentition, at the 1913 London meeting of the International Medical Congress (Fig 7).[20] Their work was applauded and unanimously accepted by the attendees. Figure 8 shows the reconstruction of Piltdown man from the study of the skull by Dr. Williams.[21] In recognition of Dr. J. Leon Williams' contributions to the knowledge of the anatomy of the Piltdown skull, he was elected a Fellow of the Royal Anthropological Institute of Great Britain and Ireland.[4]

Of course, it is now well known that Piltdown Man was a hoax, likely the most famous archaeological hoax in history. This is because so much time and effort was expended on it, leading scientists to ignore important discoveries of the 1920s. This threw reconstruction of human evolution off track for decades. In 1953, 20 years after Williams' death and

Figure 5 Dental office wall hanging of the Trubyte Mould System for patient education, Dentist's Supply Company of New York, ca. 1914 (from the collection of Dr. Starcke).

over 40 years after its "discovery," Piltdown Man was finally scientifically proven to be a fraud, having been discovered to be a composite of a human skull of medieval age and a orangutan mandible with the teeth filed down to appear more human.[21]

Who was the culprit? It will probably never be known for sure, but Charles Dawson is surely on top of the list, as is his colleague, Martin Hinton; however, also on the list of suspects are Sir Arthur Keith, and surprisingly, Arthur Conan Doyle![21]

Dr. Alfred Gysi's journey

The following quote is from George Wood Clapp, speaking before the second meeting of the National Society of Denture Prosthetists (N.S.D.P.) in Boston, MA, on August 18, 1920 (from unpublished minutes): "When Dr. Gysi came to this country with a revolutionary proposal, his proposal was so gigantic that it did two very definite things: First, it appalled the manufacturers to whom [his articulator] was presented; second, it passed completely over the heads of the profession, and Dr. Williams had to go over to this country and by the exercise of his enthusiasm and conviction and magnetism arouse the profession at an appreciation of what could be done."[22]

Clapp went on to say, "When Dr. Gysi produced the first adaptable, I was so tremendously impressed with the possibilities . . . of making custom made dentures, that I persuaded The Company to bring them to this country and introduce them

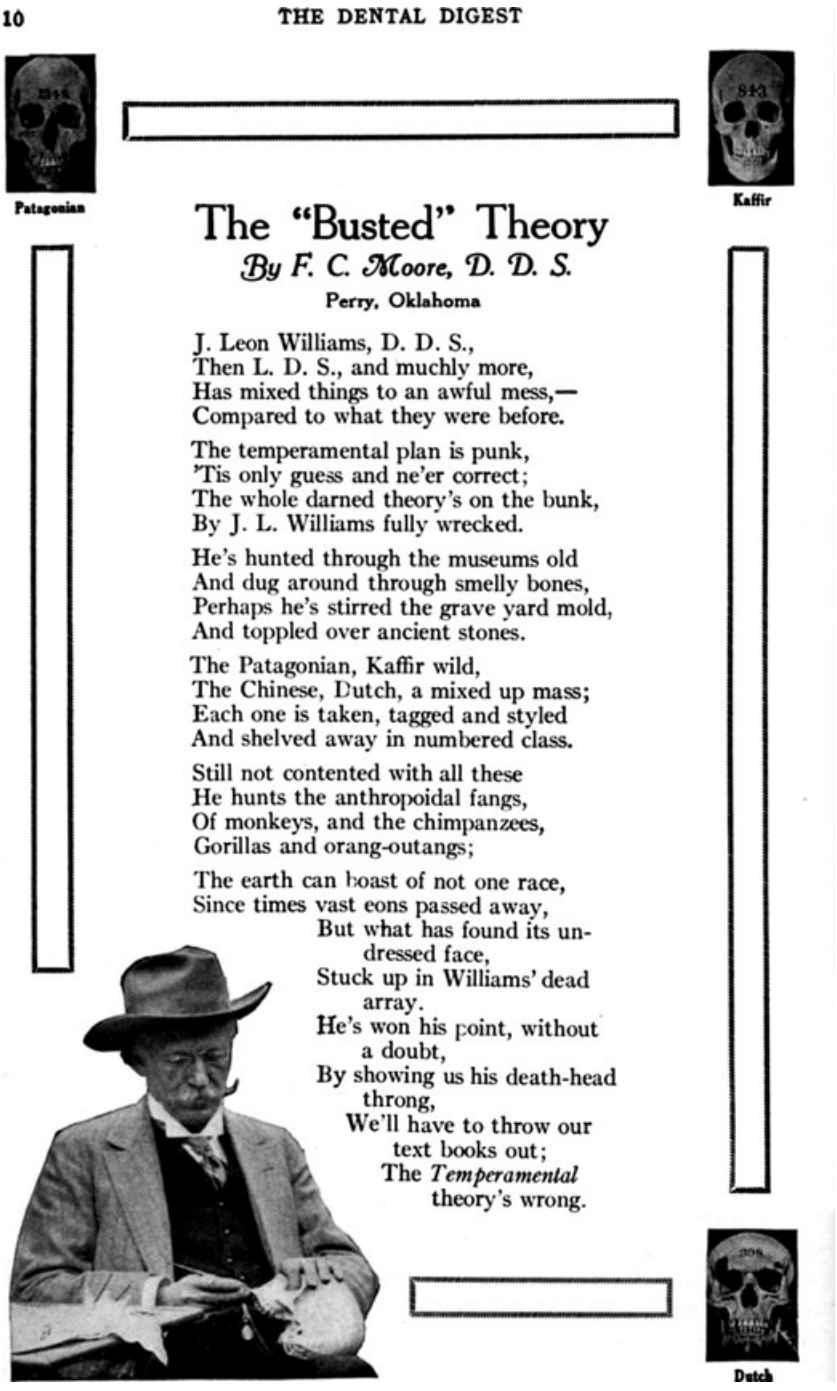

Figure 6 "The Busted Theory," a poem dedicated to Dr. J. Leon Williams by F. C. Moore, DDS, an avid fan of the new Trubyte Tooth System.[19]

to the profession. We wanted to make them over here, but we could find no factory to make them."[22] The reality was that it was cost-prohibitive to either import or manufacture them in America in any reasonable quantity. Even the executives at the Buffalo Machine Company were astounded when told that the "Adaptable" would require a 50-dollar price tag. After all, most of their articulators were being sold for about 85 cents. So once again, George Clapp came to the rescue, with The Company picking up the tab for a limited number (probably 50+ articulators) targeted principally for the prosthetic elite. As interest grew in the Gysi-Williams Technique, it became obvious that all aspects of the technique could not be mastered by text alone. The Company began to receive requests for personal instruction. As a result, arrangements were made for Dr. Gysi to come to America in July 1913 to conduct two postgraduate classes, each of 2 weeks duration, beginning in August. For this purpose, The Company established the "Gysi School of Articulation," and through the courtesy of The

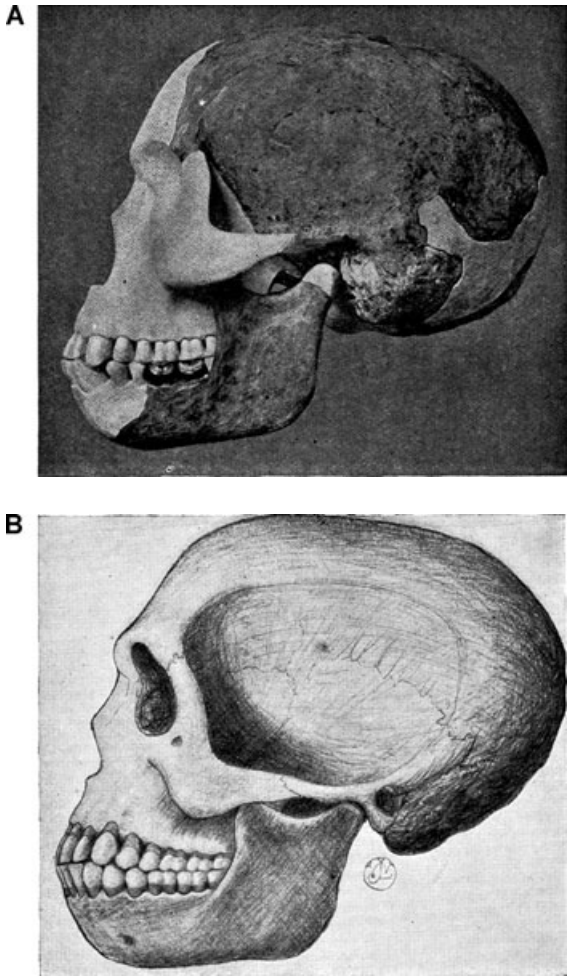

Figure 7 (A) Arthur S. Woodward's restoration of the Piltdown skull.[19] (B) J. Leon Williams' restoration of the mandible and dentition of the Piltdown skull. Sir Arthur Keith restored the cranium.[20]

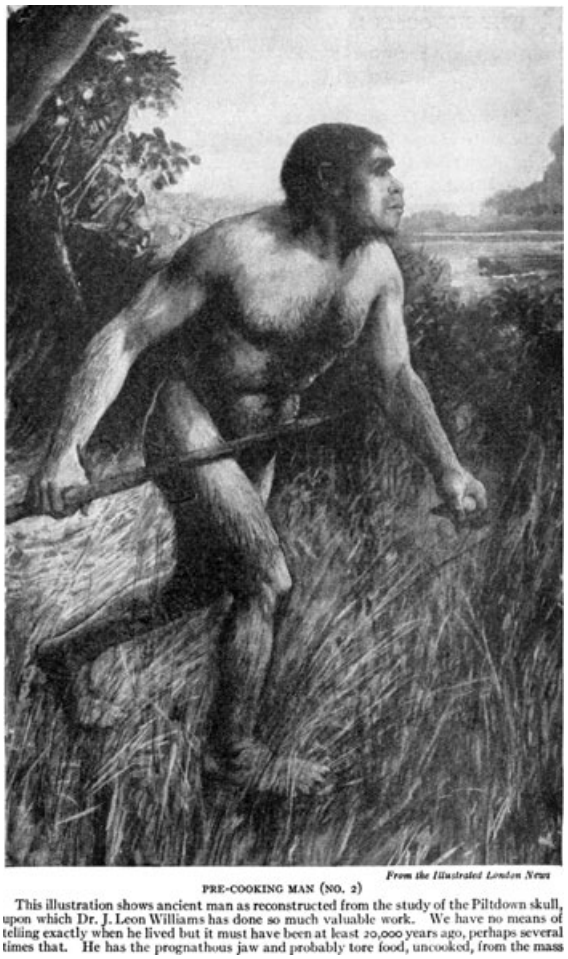

Figure 8 This illustration shows a concept of prehistoric man as reconstructed from Williams' comprehensive study of the Piltdown skull.[21]

College of Dental and Oral Surgery, the courses were given in the new college building, which provided the best facilities dentistry had to offer.[6]

The courses were intended to provide instruction in all aspects of complete denture construction. Among those participating as faculty with Dr. Gysi were J. Leon Williams, George H. Wilson, and S.G. Supplee.

A roster of those who attended the first two classes was to become a veritable "who's-who" of prosthetic dentistry (Fig 9).[26] Their enthusiastic response and eagerness to share the new Gysi-Williams principles created an overwhelming number of requests to The Company to provide instruction. Gysi could no longer remain in America, so as soon as the two classes were completed, one of the attendees, Russell W. Tench of New York (Fig 9B), became associated with The Company and was tasked with organizing future classes. According to George Clapp, Tench was successful in updating and improving many aspects of the course. Because more room was required, the course was moved to The Company's Research and Development facility, where eight chairs were eventually needed.[4]

In 1914, The Company published *Prosthetic Articulation*,[23] edited by George Clapp, to provide a text for The Company's courses and for those teaching postgraduate courses in America and in foreign countries. This textbook provided instruction in the use of Gysi's "Adaptable" articulator, even though it was very difficult to obtain; however, it also featured Gysi's "Simplex" articulator and Snow's facebow. In 1918, The Company published a revised and condensed version of the previous text, *Professional Denture Service*,[24] edited by Clapp and Tench. Inexplicably, however, it again featured, along with the "Simplex," the "Adaptable" articulator. Even before 1918, the "Adaptable" was unobtainable from any source. Incidentally, Gysi had embraced "The Happy Average Way" with his "Simplex" articulator.[25] It should also be noted that the "Simplex" had come under criticism as early as 1912 because there were those who believed that just for the sake of expediency, Gysi had turned his back on his own seminal principles.[25] Clearly, as his ongoing research and articulator designs would demonstrate, he clearly had not done so. He was just a good businessman.

ANOTHER PICTURE OF THE FIRST CLASS.

1. D. A. Zurbrigg, Philadelphia, Pa.
2. W. E. Cummer, Toronto, Ontario.
3. W. H. Thompson, Cranbrook, B. C.
4. D. D. Campbell, Kansas City, Mo.
5. F. P. Moore, Hamilton, Ontario.
6. M. A. Schwartz, New York City.
7. G. W. Clapp, New Rochelle, N. Y.
8. Prof. Gysi, Zurich, Switzerland.
9. G. H. Wilson, Cleveland, Ohio.

THE SECOND CLASS.

1. W. T. Willard, West Toronto, Ontario.
2. R. W. Tench, Franklinville, N. Y.
3. C. J. R. Engstrom, Los Angeles, Cal.
4. W. H. Richards, Knoxville, Tenn.
5. B. F. Thielen, Paris, Texas.
6. C. J. Stansbury, Seattle, Wash.
7. W. Randall, Louisville, Ky.
8. F. W. Hergert, Seattle, Wash.
9. H. C. Werts, Beaver Falls, Pa.
10. G. W. Clapp, New Rochelle, N. Y.
11. Prof. Gysi, Zurich, Switzerland.
12. S. G. Supplee, New York City.
13. W. K. Bradfield, St. Petersburg, Fla.

Figure 9 (A) Some members of the first class of the "Gysi School of Articulation," August 4, 1913.[6] (B) Some members of the second class of the "Gysi School of Articulation," September 2, 1913.[6]

The Company continued to offer the Gysi-Williams postgraduate classes for almost 10 years; that is, from September 1913 until early in 1923, during which time approximately 4000 dentists from America and 21 foreign countries received instruction. This number included faculty from 37 dental schools. Many attendees returned home to teach postgraduate courses in their own communities.[4]

Storm clouds begin to gather

The winds of war were beginning to blow as early as 1914. Although Gysi's landmark principles were exceptionally well received, some could not accept his view that the vertical and lateral "rotation points" of the mandible existed only as "theoretical rotation centers" and not actual anatomic structures. Gysi cited William Walker's Physiological articulator (1897) and Richard Breuer's research on mandibular movement (1908) to support his theory. He apparently recognized there was a mechanical solution for mimicking mandibular movement in an articulator;[26] however, it is understandable there would be wide skepticism over Gysi's "rotational points," a feature he had incorporated into his "Adaptable" and "Simplex" articulators. Since before the turn of the 20th century, inventors who were exploring the character of mandibular movement regarded the glenoid fossae as the centers of rotation, and their articulator designs reflected this concept. Therefore, Gysi's theory pertaining to the position of the "rotation points" would remain a problematic issue.[27]

The adversaries

By about 1915, it became quite evident that two distinctive schools of thought on mandibular movement and articulator design were emerging: the "condylar" (or "anatomic") and the "geometric" (or "nonanatomic").[25,28] The "condylar" school, advocated by Alfred Gysi and his supporters, placed emphasis on condylar guidance as the major influence on occlusion. It was recognized that each patient required specific measurements. Therefore, emphasis was placed on designing the controls of the articulator to accept records taken from the patient.

The proponents of the "geometric" school theorized that the mandible rotates around a single central radial axis with the axis being located above and/or behind the plane of occlusion. The condylar paths were disregarded as having any influence on occlusion with only tooth contacts guiding the mandible during mastication.[25]

In the late 1920s, a third school of articulator design, the "positional" (or "3-dimensional"), entered into the conflict. From this school arose the term "tripod" for articulator design. Instruments based on the "tripod" principle had no restraining condylar hinge. The positional relations (rather than the movements) of the mandible were recorded by setting three guides with "check-bites."

Clearly, the "Articulator Wars" was not just a phenomenon of conflicts between three schools of thought. On the contrary, there were heated arguments over a myriad of issues within each faction as well. This is exemplified by the debate over Gysi's "rotation points." Of course, the feud between Gysi and Rupert Hall (who seemed to move from one school to another at will) is legendary and lasted for decades.[29]

In about 1916, Rupert Hall introduced his "conical" theory, along with his articulators based on this principle. It was met with strong resistance because it was diametrically opposed to the widely popular "condylar" school. Hall was so aggressive in promoting his theories that some reacted with disdain. George Monson, on the other hand, when he presented his "spherical" theory and introduced his "Mandibulo-Maxillary" articulator, faired somewhat better, having defended his theory "surprisingly well."[27] Nevertheless, the lines had been drawn, and there was never to be a complete accord between the two factions.

When C. J. Stansbery introduced his "Dental Orient" articulator and check-bite technique in 1928,[30] it brought an immediate and angry protest from Rupert Hall.[27] Hall, who had little success in promoting his articulators based on his "conical" theory, had begun to explore the "3-dimensional" concept of articulator design. In an article published just 4 months after Stansbery's, Hall claimed that he had introduced the 3-dimensional articulator to the profession in 1926. He said it was regrettable that Stansbery had taken "full and complete credit for the '3-dimensional' principle in articulator construction."[31]

The next articulator Stansbery introduced, the "Tripod," has a cloud over it because it is believed to bear his name by deception. James House presents compelling evidence that the articulator known as the "Stansbery Tripod" was originally designed by George Hollenback.[27]

A pivotal event

The "Articulator Wars" is generally remembered only in random images and thus far, this article has presented it in this manner; however, it truly was a phenomenon of remarkable magnitude permeating the entire profession and creating great concern and bewilderment within organized dentistry as well as among ordinary practicing dentists. By 1918, many inventors were contracting with both large and small manufacturers to produce their highly competitive articulator models. The total of the articulator models was approaching 50, but there was a relatively small market of dental practitioners to purchase them.[27] To complicate matters even more, some of the more determined inventors began to promote their articulators around the country on the "speaking circuit" in "study club" settings. Needless to say, the byword of the day was "confusion;" however, in the midst of chaos, a small number of the leaders of prosthetics came together to found the N. S. D. P. This was one of the most important events in the development of articulator design, and was, without question, an integral component of the "Articulator Wars." Organized in August 1919, the avowed goals of the membership were to work out their differences in a workshop setting and to design, as W. A. Giffin envisioned, "an articulator which would combine the good points of all [the theories and designs] and might be called the 'Liberty Articulator'."[32] Giffin, who was instrumental in organizing the N. S. D. P., admitted this never materialized. So the battle raged on.

Incidentally, it is interesting to note that there are always those businessmen, who by exercising a little ingenuity, turn the worst of times into their own personal best of times. Figure 10[33] exemplifies the efforts of one these entrepreneurial ventures.

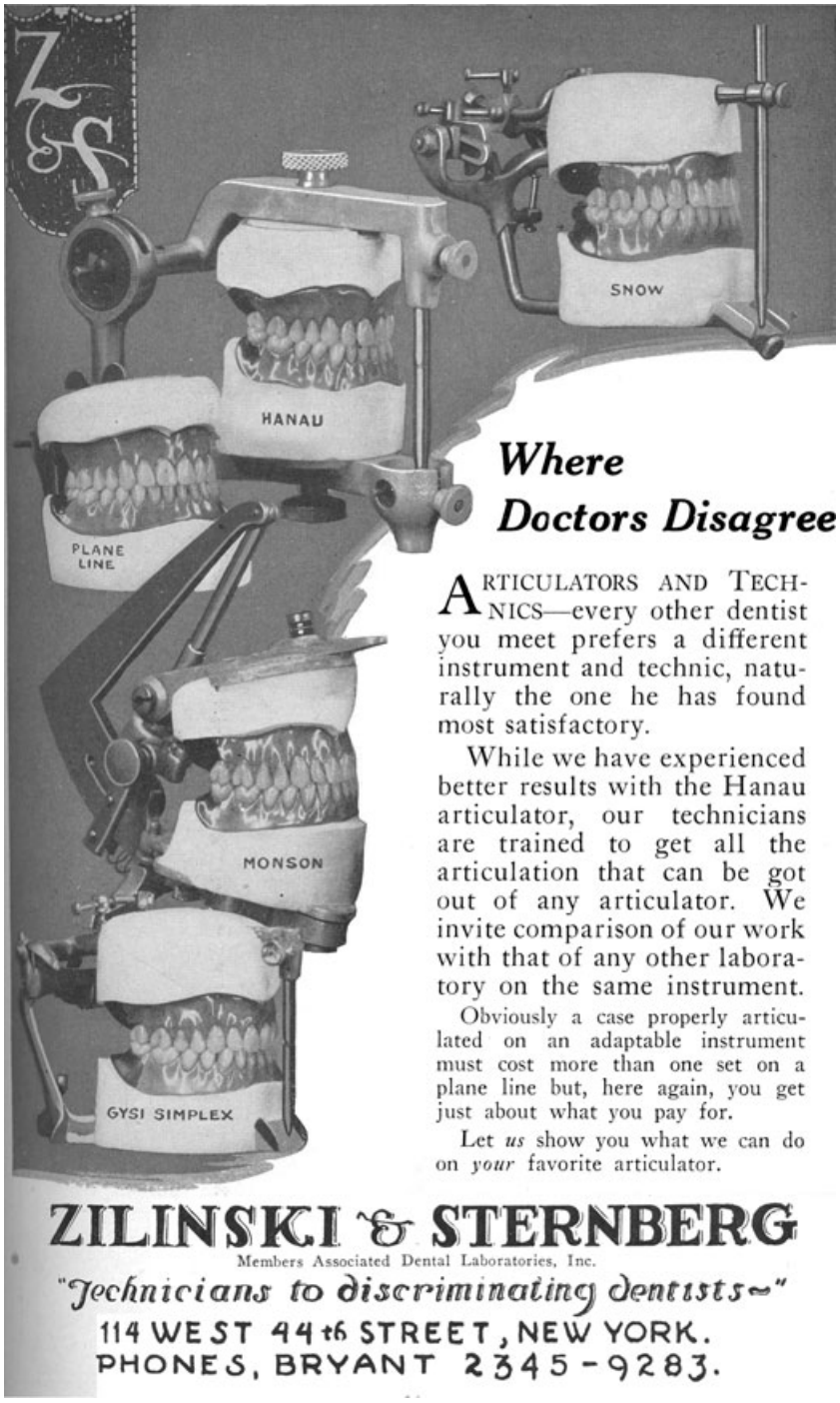

Figure 10 Advertisement for Zilinski & Sternberg Dental Laboratories, "technicians to discriminating dentists."[33]

Editorial: "What is wrong?"

The following quotations are from an editorial written by Charles N. Johnson (Fig 11)[34] in the June 1927 issue of the *Journal of the American Dental Association.* He expressed his profound concern that "the current status of full denture construction, (and especially that of articulators) has reached the point where it can only be described as 'confusion worse confounded'." He exclaimed: "the time has come when something must be done to remedy this condition!"

Johnson went on to declare in his editorial that, "In our literature in recent years . . . more articles have been written on full denture work than about any other topic. And yet in the face of all of this . . . there seems to be as much uncertainty in the minds, not only of the profession as a whole, but also of the full denture men themselves.

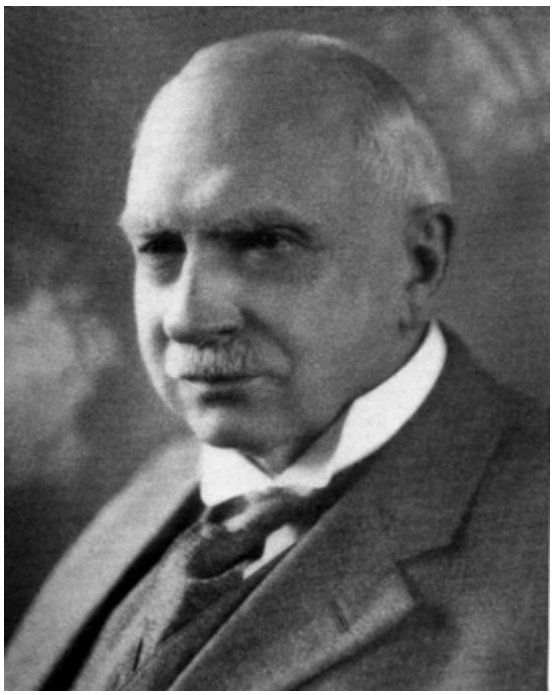

Figure 11 Charles N. Johnson, LDS, DDS, MDS, MA, LLD (1860–1938). Throughout his career, Johnson was intimately associated with educational and literary developments in dentistry. He was editor of four journals, including the *Journal of the American Dental Association*. He was also the author of three textbooks, most notably, the *Textbook of Operative Dentistry*.[34]

"Something is wrong," he said. "No subject in dentistry is incapable of solution if the proper approach is made . . . . It is difficult to escape the suspicion that, among our full denture men, there is something more than a mere lack of cooperation. From the outside, it looks as if there was a deliberate pulling apart for the purpose of furthering some favorite idea . . . no yielding of preconceived notions, which is always necessary in arriving at the truth. [Eclipsing all other issues], articulators have loomed as paramount. Every conceivable kind of articulator has been advocated, from a barn door hinge to the most elaborate (and, by the same token, the most expensive) contrivance in the imagination of man.

"Surely," Johnson continued, "there is a common ground on which [these leaders in denture prosthetics] may agree . . . and to have a willingness to accept the truth when it is presented, whether it agrees with preconceived ideas or not.

"As it now stands," he concluded, "the status of full denture work is not a credit to the profession, and we can never hope that it will be until the leading men in this specialty sink their prejudices and get together in a wholehearted effort to standardize the work and place it on a simpler and more nearly uniform basis. Who will be the Moses to take the initiative and lead us out of the wilderness?"[35]

A leader out of the wilderness, indeed! How could so many who agreed on so little for so long ever conceive of the notion that there may be an inventor among them whose philosophies would have any greater effect on the dental profession than their own? Surprisingly, for some scholars, this question was not that far-fetched.

Felix A. French, in a 1954 article published in the *Journal of Prosthetic Dentistry*,[36] recalled the utter confusion of the 1920s because the number of techniques advocated was bewildering, and the concepts of mandibular function were varied and contradictory. Dr. French commented on A.E. Boyce's 1928 article describing how most techniques and their associated articulators failed to produce the results claimed for them.[37] French believed that the great variation in instrumentation was exceedingly troublesome because it was a result of a misinterpretation of fundamental principles of physics pertaining to prostheses. "It was essentially an engineering problem, and those trying to solve it were not engineers. It was at this time that Rudolph L. Hanau came to the rescue."[37]

Contrary to the other theories, Hanau proved that reproduction of mandibular movements in an articulator was not the solution to the problem, but that articulator movements were only equivalent to anatomical movements. Furthermore, these equivalent movements were a result of securing records from the patient and the "resilient and like effect" of the supporting tissues. Hanau also contributed the "Laws of Articulation" and their graphic reduction to the "Quint," a guide for the arrangement of artificial teeth, to the profession. French concludes with this comment: "It is remarkable that this consulting engineer should have found the solution to a problem so particularly dental and quite outside his field of academic training [as an engineer]."[37] Today, Hanau would be proud to see how widely accepted the fruits of his labor and that of his company have become.

James House reminds us that it was during the second meeting of the N. S. D. P. in August 1921 that Hanau presented his first important paper[38] on articulator design and development. He worked extremely hard to prove his point that none of the then-existing articulators were adequate. His fierce competitive spirit gained him many followers, but also many bitter enemies. His somewhat difficult personality did not help him in that regard. Sometimes he would win his point and sometimes he would not, but nevertheless, he forced inventors to defend what they looked upon as "sacred cows." And through it all, the understanding of dental prostheses was advanced many years beyond what might have been had the N. S. D. P. never existed.[22]

(There will be more on the life and work of Rudolph Hanau and his company in the next two articles in this series.)

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