Computer-Aided Design 80 (2016) 1–5

Contents lists available at ScienceDirect

Computer-Aided Design

journal homepage: www.elsevier.com/locate/cad

Editorial

A CAD Tribute to Gerald Farin

Introduction (by N.S. Sapidis)

Gerald Farin was born on March 20, 1953, and passed away on January 14, 2016. The authors of this note feel that his contributions to CAD and CAGD are so extensive and multifaceted that they deserve this special "tribute". Correctly, R. Sarraga emphasizes (in Section 1) Gerald Farin's great contribution to the development of the new scientific field of Computer Aided Geometric Design (CAGD), which focuses on geometric aspects (from many points of view) of CAD and Computer Graphics. Strotman and Wolters focus (in Section 2) on Gerald Farin's work related to the "Geometrization of Splines", that made advanced Spline concepts accessible to nonmathematicians. Section 2 also reveals how wonderfully Gerald Farin combined in his work advanced mathematical research with industrial CAD-system development (here: Daimler Benz' so-influential SYRKO system). Sections 3 and 4 detail significant contributions by Gerald Farin (and his colleagues/students) to two specific application fields, Medical Imaging/Modeling and Ship Design. Does the present Tribute cover all application fields affected by G. Farin's geometric-modeling research? Surely, not! One could have added sections related to Computer Graphics, Image Processing, Reverse Engineering (of geometric models), Manufacturing Processes, etc!

Related to Gerald Farin's contribution towards "Geometrization of Splines" was also his great effort to "translate" mathematical concepts and methods into lively and detailed figures greatly helping readers; see, e.g., Figs. 1 and 2. Wolfgang Boehm taught that to Gerald Farin, who was also very passionate about it! For many years, G. Farin used to create hand-drawn figures as he was finding the then available software tools (for creating figures) not satisfactory for the features he considered vital (e.g., variable line widths). Once he had software tools that could produce the types of figures he liked, he stopped hand-drawing, even though he enjoyed it, because hand drawings took so much of his time.

Gerald Farin's contribution to the development of the CAD journal was also significant: He was an Associate Editor from 1985 to 1996, published twelve important papers in it, and edited a highly influential Special Issue on "The Shape of Surfaces" (July 1988).

On a personal note, I will always remember our days in Bob Barnhill's Math CAGD-Group (at the University of Utah) in 1985–1987: His talks in the "CAGD Seminar" were so influential for graduate students! I used to go early Saturday morning to my office (to work on my study and research), and when G. Farin would show up, I would always go to his office for extensive "private tutoring" on all the material he had taught us in the previous week in the graduate "CAGD course". He would always interrupt his important work and devote all his time to my questions, despite the fact that I was just a fresh Master's student!

1. The Legacy of Gerald Farin (by R. Sarraga)

The great contribution of Gerald Farin to the field of Computer Aided Geometric Design (CAGD) is best appreciated, in the author's opinion, by reviewing the history of CAGD in the early 1980s. In 1980, Farin's Ph.D. advisor Wolfgang Boehm ushered in a new era in CAGD with his paper "Inserting new knots into B-spline curves". The underlying mathematics of this paper was not new, as the paper used the steps of a method for evaluating splines published much earlier by Carl de Boor, and in the context of CAGD the mathematics was already in use, e.g., in the Oslo algorithm of Elaine Cohen, Tom Lyche, and Richard Riesenfeld, which was also published in 1980. Boehm's novel contribution in his paper was interpreting as geometric control points the B-spline coefficients that are calculated in each step of the spline evaluation method. In essence, Boehm extended to B-splines an algorithm developed by Paul de Casteljau of Citroën for polynomial curves expressed in a representation exploited in CAGD by Pierre Bézier of Renault.

http://dx.doi.org/10.1016/j.cad.2016.07.007
0010-4485/

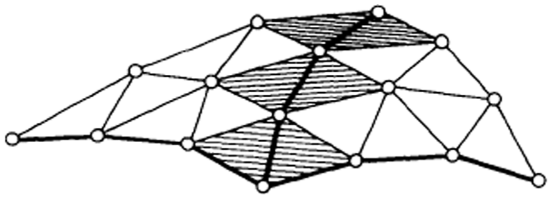

Fig. 1. A hand-drawn figure, created by Gerald Farin, for clearly visualizing "Bézier nets of two C^1 cubic patches" in his paper "Designing C^1 surfaces consisting of triangular cubic patches" (CAD, 14(5):253–256, 1982).

In his Ph.D. dissertation under Wolfgang Boehm at Braunschweig, Gerald Farin analyzed triangular polynomial surface patches from the geometric point of view used by Bézier, de Casteljau, and Boehm for curves and tensor-product surfaces. Farin's work on triangular patches led to voluminous and fruitful further research by Hartmut Prautzsch, another student of Boehm, by Jörg Peters, a student of Carl de Boor, and by many others. Before obtaining his Ph.D. in 1980, Gerald Farin spent time with Bob Barnhill in Utah during 1978–79, then both of them visited John Gregory at Brunel during 1979–80. Afterwards, Farin worked for Daimler Benz and finally returned to Utah with a faculty appointment. In 1984, Barnhill and Boehm founded the journal *Computer Aided Geometric Design* (*CAGD*) at Elsevier and served as the journal's first two editors-in-chief. They were succeeded in their editorial positions by Gerald Farin and Josef Hoschek, who was succeeded, at the time of his death in 2002, by Hartmut Prautzsch. In the meantime, Farin moved with Barnhill's group from Utah to Arizona State University, where he worked until his untimely death in January 2016.

The collaboration of Boehm and Barnhill was very significant for the development of CAGD in the 1980s and 1990s, because it brought together engineers engaged in geometric visualization and design with mathematicians concerned with mathematical precision. The joint conferences that followed were attended by engineers and mathematicians in a very fruitful cross-fertilization of ideas. Gerald Farin stepped into this new world of interdisciplinary and international CAGD collaboration as one of its principal sponsors.

As editor-in-chief of *CAGD*, Farin exerted a great unifying influence on the developing field of CAGD. He co-directed one of the principal means of publishing in the field. He helped organize many of the most important conferences and workshops. With his wife and professional colleague, Dianne Hansford, he developed CAGD methodology in addition to theory. And he was much in demand as a consultant. For example, he visited General Motors (GM) multiple times, interacting with GM staff members such as Paul Besl, Jim Cavendish, David Field, Bill Frey, Sam Marin, Tom Oetjens, Dave Warn, and the author, and with GM-associated software developers such as Emmanuel Tsimis. During this period, Gerald Farin published several editions of his popular textbook, *Curves and Surfaces for CAGD*. He also published important papers, based on projective geometry, advancing the state of the art of rational B-splines.

Gerald Farin's personal integrity stood out in his role as editor-in-chief. As associate editor of *CAGD*, the author always saw Gerald taking good care that every author be treated fairly, that previous work be properly referenced, and that all papers be processed in a timely fashion.

Gerald Farin's life was exceedingly productive, an outstanding model of exceptional achievement.

2. Gerald Farin's Role in the Geometrization of Splines and its Impact on Industrial Modeling (by T. Strotman & H. Wolters)

Gerald Farin's work on evaluating and manipulating Bézier curves and B-Splines via control points was instrumental in developing the now standard interaction paradigms used in today's surface modeling and design systems as well as mechanical CAD systems. Gerald Farin together with Bob Barnhill and Wolfgang Boehm discovered and further developed the earlier work of Paul de Casteljau and Pierre Bézier. For the authors, as developers of a geometry kernel for SDRC's CAD system, the research performed by Gerald Farin was invaluable. His books on both CAGD as well as NURBS were heavily used for developing curve and surface evaluation algorithms, as well as operations like degree elevation and degree reduction.

Most influential was the introduction of the concept of geometric continuity (see, e.g., Fig. 2), allowing construction of visually continuous curves and surfaces by maintaining well defined constraints on the positioning of control points along common boundaries. This approach not only changed geometry processing algorithms but also how designers would interact with the system to shape curves and surfaces.

One of these authors spent a year at Daimler Benz in 1989. Gerald Farin's influence on the proprietary surface modeling system SYRKO was immediately obvious. Many of the concepts that he developed were implemented in SYRKO, the concept of smoothing Class 1 surfaces via reflection lines was a key part of functionality that was unmatched for the longest time.

The seeds for the geometrization of splines were planted in two papers of Gerald Farin's from the early '80s, "Algorithms for Rational Bézier Curves" [2-1] and "Visually C^2 cubic splines" [2-2]. The first introduced what were later to be called "Farin points" and explained a technique for modifying rational curves by adjusting these points along the control polygon. The second explained how to obtain a family of curvature-continuous curves directly from the control polygon. These papers were early indications of how powerful the control-point viewpoint of splines could be.

The seminal 1984 paper "A survey of curve and surface methods in CAGD" [2-3], with joint authors Wolfgang Boehm and Juergen Kahmann, presented this viewpoint in its full glory. This paper became the primary reference for CAGD developers. Its emphasis on control points and use of an extensive figure set was a major influence in the adoption of a more geometrical approach.

For the next 15 years, Gerald Farin alternated between papers describing new CAGD techniques, reviews of various areas of geometric modeling, and books. Each was beneficial to developers, providing insight into new areas or refining our understanding of current techniques.

Aside from the contributions outlined above we would also like to point out that at conferences Gerald Farin was very approachable. He took an active interest in problems we were working on, especially curve and surface approximation. After he understood the problem he would share his insights. Later he would check up on our progress, delighted in our successes and make further suggestions. It is probably safe to say that Gerald Farin was the guiding influence for an entire generation of CAGD developers.

2.1. References

[2-1] G. Farin. Algorithms for rational Bézier curves. Computer Aided Design, 15(2):73–77, 1983.

[2-2] G. Farin. Visually C^2 cubic splines. Computer Aided Design, 14(3):137–139, 1982.

[2-3] W. Boehm, G. Farin, and J. Kahmann. A survey of curve and surface methods in CAGD. Computer Aided Geometric Design, 1(1):1–60, 1984.

3. Contribution to Medical Applications (by Z. Xie & K. Chen)

In addition to his pioneering work in the field of CAGD, Gerald Farin also showed his great passion in the medical applications of geometric modeling. He was a founding and longstanding member of the Internal Scientific Advisory Committee, Arizona Alzheimer's Consortium (AAC). AAC is an Arizona statewide collaboration that capitalizes on its participating institutions' complementary strengths in brain imaging, computer science, genomics, the basic and cognitive neurosciences and clinical and neuropathology research to promote the scientific understanding and early detection of Alzheimer's disease (AD) and find effective disease-stopping and prevention therapies (http://azalz.org/). In this consortium, Gerald Farin represented Arizona State University (ASU) for a number of years and coordinated the effort from different departments of ASU. As a central theme of the AAC research, neuroimaging techniques such as MRI and PET are widely used in identifying disease risks prior to the onset of the disease, assisting diagnosis and prognosis, monitoring disease progression, studying pathology of the disease and constructing sensitive neuroimaging based biomarkers for potential treatment outcome biomarkers. With his involvement and guidance, several of his students including author Xie were involved in the study of AD and AD risks, focusing on neuroimaging techniques. For example, Dr. Lang-sheng Yun, the first Farin student working in this field, used what he learned from Gerald Farin to contribute to the study of Reiman et al. [3-1], reporting the FDG-PET measured hypometabolism in cognitively normal individual who carried two-copies of the apolipoprotein $\varepsilon 4$ allele, a genetic risk to AD. That study contributed to a shift in focus to possible detection and even intervention of AD. Fundamental to all of these goals, adequate image pre-processing such as image registration is needed. Image registration, in its generic sense, is to spatially align, linearly and/or non-linearly, images from different subjects, visits, and from different modalities. It plays a crucial role in image analysis. With image registration, anatomical structure may be delineated and functional or structural difference between subjects can be identified. Under the guidance of Gerald Farin, author Xie applied the free-form deformation method to map one brain image to another. A B-spline transformation is calculated based on point/curve landmarks, structure shape, or the intensity of the given images. To avoid the over fitting issue and reduce the computing load, hierarchical B-spline with smooth constraint was employed to adaptively match two images [3-2]. The method was not only applied in Alzheimer's disease studies [3-3] but also to research on schizophrenia and other diseases [3-4][3-5].

In addition to medical image analysis, Gerald Farin looked for other opportunities to apply geometric methods in medical problems. In late 2015, he visited Phoenix Children's Hospital to explore 3D scans of the oral cavity to produce a quantifiable model addressing congenital defects in children.

Gerald Farin's influence on the medical field is not limited to his direct involvement in research. Because of his work, people in different fields can better understand the concepts of geometric modeling and use them in different applications. After earning his Ph.D., author Xie joined the Radiology department at the University of Pennsylvania for post-doctoral training. The first day in the lab, he was surprised to find Gerald Farin's book "Curves and Surfaces for CAGD" on the bookshelf. In fact, his books are frequently cited in publications in the medical field [3-6][3-7][3-8][3-9]. Geometrical methods are not only used in data visualization and modeling, but also in image registration, image segmentation, intensity correction, and image reconstruction, among others. Although he is not with us any more, his work will continue to inspire people in the medical field in developing better ways for healthcare.

3.1. References

[3-1] E. M. Reiman, R. J. Caselli, L. S. Yun, K. Chen, D. Bandy, S. Minoshima, S. N. Thibodeau, D. Osborne. Preclinical evidence of Alzheimer's disease in persons homozygous for the epsilon 4 allele for apolipoprotein E. New England Journal of Medicine, 334(12): 752–758, March 21, 1996.

[3-2] Z. Xie and G. Farin. Image registration using hierarchical B-splines. IEEE Transactions on Visualization and Computer Graphics, vol. 10, no. 1, pp. 85–94, 2004.

[3-3] J. Gee, L. Ding, Z. Xie, M. Lin, C. DeVita and M. Grossman. Alzheimer's disease and frontotemporal dementia exhibit distinct atrophy-behavior correlates: A computer-assisted imaging study, Academic Radiology, vol. 10, no. 12, pp. 1392–1401, 2003.

[3-4] P. Yushkevich, A. Dubb, Z. Xie, Ruben Gur, Raquel Gur, J. C. Gee. Regional Structural characterization of the brain of schizophrenia patients. Academic Radiology, 12(10): 1250–1261, 2005.

[3-5] Z. Xie, S. Liachenko, P. Chiao, S. Carvajal-Gonzalez, S. Bove, T. Bocan. In vivo MRI assessment of knee cartilage in the medial meniscal tear model of osteoarthritis in rats. Medical Image Computing and Computer-Assisted Intervention, 13(pt3), 57–64, 2010.

[3-6] T. McInerney and D. Terzopoulos. Deformable models in medical image analysis: a survey, Medical Image Analysis, vol. 1, issue 2, pp. 91–108, June 1996.

[3-7] C. Bajaj and S. Goswami. Modeling cardiovascular anatomy from patient-specific imaging data. Computational methods in applied sciences (Springer), 13:1–28, 2009.

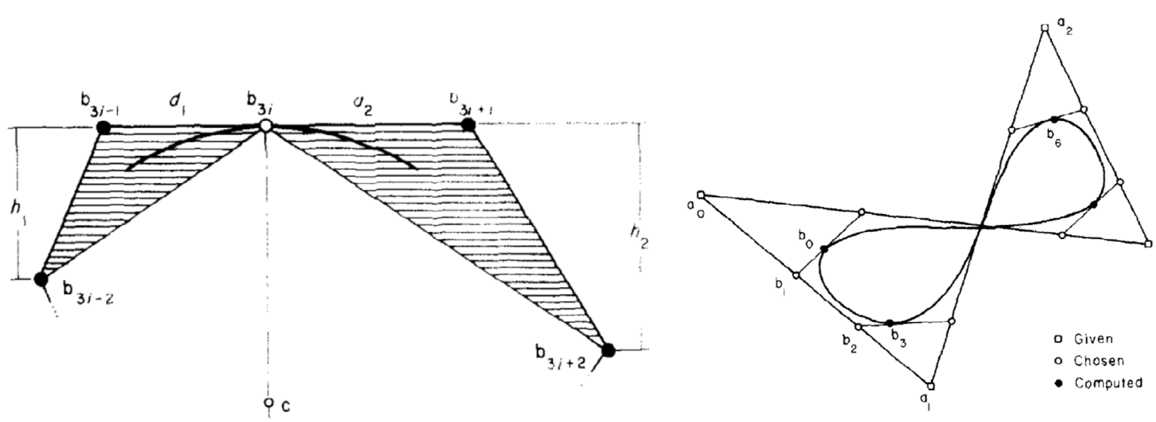

Fig. 2. Visually C^2 conditions, for Bézier curves and for B-splines, in hand-drawn figures, created by Gerald Farin, for his paper [2-2].

[3-8] W. Annicchiarico, G. Martinez, M. Cerrolaza. Boundary elements and β-spline surface modeling for medical applications, Applied Mathematical Modeling, 31(2), 194–208, February 2007.

[3-9] A. Wahle, P. M. Prause, S. C. DeJong, M. Sonka. Geometrically correct 3-D reconstruction of intravascular ultrasound images by fusion with biplane angiography — methods and validation. IEEE Transactions on Medical Imaging, Aug, 18(8):686–99, 1999.

4. Gerald Farin's Influence on Ship Design & Construction Software (by N.C. Gabrielides & N.S. Sapidis)

For centuries, the shipbuilding industry has been one of the leading sectors of engineering developments worldwide. Should we appeal to Gerald Farin's own words [4-1], "The earliest recorded use of curves in manufacturing environment seems to go back to early AD Roman time, for the purpose of shipbuilding…No drawing existed to define a ship hull; these became popular in England in the 1600s". The use of drawings for design and contractual documentation had not changed in industry until recently; Pierre Bézier, referring generally to the manufacturing industry in the early fifties, wrote [4-2]: "As it was, things were running smoothly, according to a tradition that, in Western Europe, was four centuries old" and he complemented: "…but when the field of fluid dynamics became very important, the shape of aircraft or boat hulls needed greater accuracy". Horst Nowacki [4-3] dates the birth of Computer-Aided Ship Design (CASD) in 1960. One of "the main roots preceding the later full development of CASD", he says, "was the desire for digital representation of the ship geometric product model replacing the tedious and error prone graphical process of ship lines definition". Hydrodynamic and strength assessment of the hull certainly require an analytical definition of the hull shape.

Today, the predominant representations used in CASD systems are parametric polynomial forms, in particular Bézier, B-splines and NURBS curves and surfaces. The need for adopting NURBS as a standard was due to realization that they allow a unified geometry representation for polynomial and quadric surfaces. However, the scenery during the late eighties was much foggier than today. At that time, NURBS researchers were working to improve NURBS handling and promoting them in the CAD community. Among those who had supported and had foreseen global use of NURBS, Gerald Farin played a leading role with highly influential papers, like [4-4] & [4-5], and books [4-6] [4-7] [4-8].

When talking about ship modeling, the first problem a ship designer faces is the generation of the ship lines (curves) by interpolating or approximating point data. This process results in a set of curves which need to be faired, because their curvature plots exhibit unwanted wiggles (see [4-9] and references therein). Gerald Farin was the first to propose fairing methods having the desirable property of acting locally. Automatic fairing offers a paradigm on how purely scientific developments directly influence industry sectors. Today, twenty-five years after the publication of those works and their offspring (see, e.g., [4-10] & [4-11]), CASD systems take fairing seriously; see e.g. [4-12]. To this end, Gerald Farin's works very strongly influenced related academic research as well as industrial R&D and software implementations.

Ship hull (re)construction is the composition of the hull surface by patches smoothly interpolating or approximating an arbitrary topology curve-net (see, e.g., Fig. 3 and [4-13]). The key-term in this problem is the "smoothness" of the resulting surface while the challenge stems from the "irregularity" of the given curve net. Three main approaches to the related "n-sided hole filling problem" exist [4-14], namely: (a) direct representations of n-sided patches by transfinite interpolants, (b) decomposition of n-sided elements into triangles, and (c) decomposition of n-sided elements into quadrilateral elements. Gerald Farin published influential papers on the continuity conditions between rectangular and triangular patches [4-15] [4-16] [4-17] [4-18]. He also devoted part of his research to the development of methods for creating Bernstein–Bézier polynomial patches over arbitrarily shaped triangles (see [4-19] and references therein). Although the CAD/CAE community is dominated by the use of rectangular surfaces – at least for surface modeling – finite element solvers are based on both rectangular and triangular elements. Earlier approaches on triangular elements lacked the elegance of Bernstein–Bézier formalism, as Gerald Farin bears out in [4-1].

No less important is the use of triangular [4-21] or rectangular [4-22] NURBS representations in connection with developable surfaces. Such surfaces possess properties highly desirable in manufacturing [4-23]. Surfaces modeled using standard techniques may be far from being developable. In this respect, approximating the original model by a composite developable surface offers an advantage in the manufacturing steps of a ship-hull (or wing and body of an aircraft or a car, etc) [4-24]. In his work [4-25], Gerald Farin (and H. Pottmann) showed how to convert developable NURBS surfaces from the dual form into the standard tensor product representation, thus extending the usability of developable surfaces also to systems based on NURBS.

Closing this limited memorandum, let us recall our early years in the University when we were introduced to Computer Aided Geometric Design through Gerald Farin's textbooks, especially "Curves and Surfaces for CAGD" [4-6]. We all could recognize a charismatic writer hidden behind the lines, who was clarifying the inward significance and the beauty of the presented mathematical ideas. In a most natural way, the complex mathematical objects were transformed into tools used by the naval architects and the software developers of CASD systems. Expressive, not imitative, the readability of his writings revealed a litterateur through the mathematician. Is there any better way to inspire young naval architects and influence the ship building industry?

4.1. References

[4-1] Farin, G., A History of Curves and Surfaces in CAGD, In Handbook of Computer Aided Geometric Design, Farin G., Hoschek J., Kim M.-S. (eds), ISBN: 978-0-444-51104-1, Elsevier, 2002.

[4-2] Bézier, P., A View of the CAD/CAM Development Period, IEEE Annals of the History of Computing, 20 (2) (1988) 37–40.

[4-3] Nowacki H., Five decades of Computer Aided Ship Design, CAD 42 (2010), 956–969.

[4-4] Farin G., Algorithms for Rational Bézier Curves, CAD 15(2) (1983) 73–77.

[4-5] Farin G., From Conics to NURBS: A Tutorial and Survey, IEEE Computer Graphics and Applications, 12(5) (1992) 78–86.

[4-6] Farin G., Curves and Surfaces for CAGD – A Practical Guide, 5th ed. Morgan Kaufman Publishers, Academic Press, 2002.

[4-7] Farin G., NURBS for Curve and Surface Design. From Projective Geometry to Practical Use. AK Peters, 1999.

[4-8] Farin G. and Hansford D., The Essentials of CAGD, AK Peters, 2000.

[4-9] Farin G., Sapidis N., Curvature and the Fairness of Curves and Surfaces, IEEE Computer Graphics and Applications, 9(2) (1989) 52–57.

[4-10] Pigounakis K.G., Sapidis N.S., and Kaklis P.D., Fairing Spatial B-Spline Curves, Journal of Ship Research, 40(4) (1995) 351–367.

[4-11] Zhang C., Zhang P., and Cheng F., Fairing Spline Curves and Surfaces by Minimizing Energy, CAD 33 (2001) 913–923.

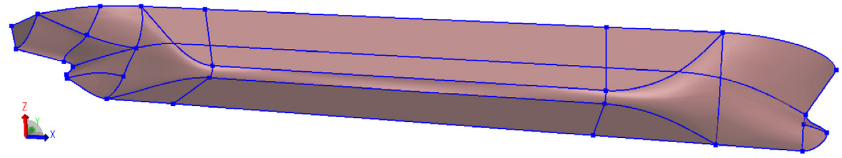

Fig. 3. Ship hull surface, constructed from an irregular curve-net, consisting of triangular and rectangular patches (using Sesam-GeniE [4-20]).

[4-12] MAXSURF (Naval Architecture Software for all Types of Vessels) Island Computer Systems Ltd, Authorized Bentley Channel Partner (2016). http://www.maxsurf.net/index.html.

[4-13] Gabrielides N.C., Ginnis A.I., Kaklis P.D. and Karavelas M.I., G^1-smooth Branching Surface Construction from Cross Sections, CAD 39(8) (2007) 639–651.

[4-14] Westgaard G., Nowacki H., Construction of Fair Surfaces over Irregular Meshes, In SMA'01 Proceedings of the 6th ACM symposium on Solid modeling and applications, ACM, 2001, 88–98.

[4-15] Farin G., Bézier polynomials over triangles and the construction of piecewise C^r polynomials. Technical Report TR/91, Brunel University, Uxbridge, England, 1980.

[4-16] Farin G., A construction for the visual C^1 continuity of polynomial surface patches, Computer Graphics and Image Processing, 20 (1982) 272–282.

[4-17] Farin G., Designing C^1 surfaces consisting of triangular cubic patches. CAD, 14(5):253–256, 1982.

[4-18] Farin G., Visually C^2 cubic splines, CAD 14(3):137–139, 1982.

[4-19] Farin G., Triangular Bernstein-Bézier Patches, CAGD 3 (1986) 83–127.

[4-20] Sesam-Genie, DNV-GL Software, https://www.dnvgl.com/services/software-for-structural-analysis-of-ship-and-offshore-structures-sesam-genie-1096.

[4-21] Cantón A., Fernández-Jambrina L., Non-degenerate developable Triangular Bézier Patches, In Curves and Surfaces: 7th International Conference, Avignon, France, 2010, Boissonnat J.-D. et al (eds) Springer, 2012, 207–219.

[4-22] L. Fernández-Jambrina, B-spline Control Nets for Developable Surfaces, CAGD 24 (2007) 189–199.

[4-23] Chen M., Tang K., Quasi-developable Surface Modeling of Contours with Curved Triangular Patches, Computers and Graphics 37(7) 2013, 851–861.

[4-24] Subag J., Elber G., Piecewise Developable Surface Approximation of General NURBS Surfaces with Global Error Bounds, In Geometric Modeling and Processing 2006, M.-S. Kim and K. Shimada (eds) (2006) 143–156.

[4-25] Pottmann H., Farin G., Developable Rational Bézier and B-spline Surfaces, CAGD 12 (5) (1995) 513–531.

Kewei Chen
Neuroimaging Research and Analysis Lab, Banner Alzheimer's Institute, Banner Health, 901 E. Willetta St., Phoenix AZ 85006, USA
E-mail address: Kewei.Chen@bannerhealth.com.

Nikolaos C. Gabrielides
DNV GL — Software, DNV GL S.A., Veritasveien 1, 1363 Høvik, Norway
E-mail address: Nikolaos.Gavriilidis@dnvgl.com.
URL: https://www.dnvgl.com/software/.

Nickolas S. Sapidis *
Department of Mechanical Engineering, University of Western Macedonia, Bakola & Sialvera St., Kozani, GR-50132 Greece
E-mail address: nsapidis@uowm.gr.
URL: http://mech.uowm.gr/index.php/staff/317.

Ramon F. Sarraga
(Retired) Staff Researcher, General Motors Research and Development Center, Warren, MI, USA
E-mail address: rsarraga@gmail.com.

Timothy Strotman
Siemens Product Lifecycle Management Software Inc., 2000 Eastman Drive, Milford, OH 45150, USA
E-mail address: tim.strotman@siemens.com.
URL: http://www.siemens.com/plm.

Hans Wolters
Windows and Devices Group, Microsoft Corporation, 1065 L'Avenida, Mountain View, CA 94043, USA
E-mail address: hanswo@microsoft.com.

Zhiyong (Sean) Xie
WRD Imaging & Engineering, Pfizer Inc, 610 Main St., Cambridge, MA 02139, USA
E-mail address: Zhiyong.xie@pfizer.com.

* Corresponding editor.