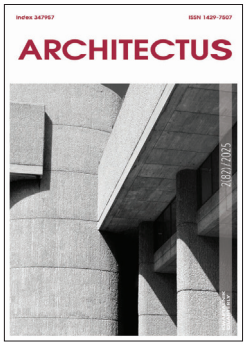

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Straw bale building – a sketch of the invention's history

Abstract

It is widely acknowledged that the technology of building with straw bales was invented in the 2nd half of the 19th century in Nebraska (USA). In the 1970s, this method of construction experienced a revival, followed by the export of related knowledge from the USA. However, there are sources of information on the basis of which this linear view of the invention's history can be challenged and a more complex narrative could be suggested. The aim of this paper was to test the hypothesis that the history of straw bale construction as an invention is multifaceted and that the development of this building technology may have occurred independently in multiple regions around the world.

The research carried out included a critical analysis of the literature on the subject and source documents (including patents), as well as correspondence and interviews, all focused on identifying the earliest uses of straw bales in construction across different countries.

Based on the analysis of the collected documents and testimonies, it was confirmed that the history of the invention of straw bale building technology should not be viewed as a linear process with a single point of origin. Instead, it reflects a series of parallel inventions from various locations – some documented through patent applications, and others emerging through trial and error on building sites.

According to the documents, it should be considered that the invention of straw bale construction may have originated in Indiana, rather than Nebraska, as this state was the place of residence of the first patent holder. The method of using straw bales as infill within a purpose-built wooden frame was independently developed in France. The period of waning interest in straw bale construction took place between 1940 and 1970, although individual straw bale buildings were still being constructed then in the USA, Canada and Europe. In the 1970s and 1980s, the export of know-how from the USA was not the only direction of the flow of information; for instance, the transfer of expertise from Canada to France has also been confirmed.

Key words: straw bale architecture, natural building materials, vernacular architecture, low-tech, plant-based insulation

Introduction

Research problem and justification

It is generally accepted that straw bale building technology […] *emerged in the late 1800s in the Sandhills region of Nebraska where trees were scarce and the soils were not suitable for building the prairie-sod homes* (Tilt, Arkin n.d.)[1]. Many people describe its subsequent development in stereotypical terms, e.g.: […] *Like democracy and jazz, this uniquely American innovation has since been exported to countries around the world* (Tilt, Arkin n.d.).

However, there are sources of information that challenge this linear view of the invention's history and suggest a more complex narrative.

Hypothesis, aim and scope of the research

The purpose of our research was to test the hypothesis that the history of straw bale as an invention is multifaceted and that the development of this building technology may have occurred independently in more than one place around the world.

The temporal scope of the study was limited to the period from the 2nd half of the 19th century – marked by the emergence of hay and straw bale presses in the USA – to 1992, which the author arbitrarily designates as the symbolic end of the pioneering, experimental phase of the development of straw bale building. The study analysed information from the USA, Canada, France, Germany, Denmark,

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[1] The source cited should be regarded as exemplary. The description of Nebraska as the place of origin is found in all books known to the author containing information on the history of straw bale building.

Sweden, Norway and England – countries where interesting data could be obtained. However, it cannot be ruled out that examples of straw bale architecture were also developed in other countries during the selected period.

Outline of content

This article attempts to organise the numerous but scattered clues in the literature regarding where the first straw bale buildings were erected and the circumstances of their creation, along with data from patent documents. It also analyses these sources to determine whether the various described instances of the invention of straw bale building technology (in its variations) were interconnected.

State of research

Scientific publications on straw bale technology are quite numerous, but mostly deal with technical aspects. Texts of a cross-cutting and historical nature are very rare, so the main point of reference remains Roger Welsch's 1970 ethnographic article and its subsequent versions (Welsch 1973; 2020).

Interesting remarks on the development of straw bale architecture are presented by an Australian researcher in her work on the history of the Solomit straw boards (Jolly 1998). A description of the history of straw bale construction in Polish can be found in the doctoral thesis *Straw bale, czyli architektura z kostek słomy w Polsce* [Straw Bale Architecture in Poland] (Jagielak 2023, 27–35).

Due to the nature of straw bale building, which developed "bottom-up" in the 20th century primarily as a do-it-yourself construction method – the main sources of information are press articles, manuals and handbooks. These include, above all, those created by enthusiasts: the magazine *The Last Straw* (published intermittently from 1992 to the present day), and books such as *The Straw Bale House* (Bainbridge et al. 1994) or *Serious Straw Bale. A Home Construction Guide for All Climates* (Lacinski, Bergeron 2000). A concise, international overview of the subject can also be found in *Neues Bauen mit Stroh* (Gruber, Gruber and Santler 2012) and *Podręcznik budowania z kostek słomy* (Minke, Krick 2015) published in Polish[2]. Published memoirs, interviews and other written or recorded statements by individuals involved in the development of straw bale architecture (Knox, Myhrman 2008) serve as an important source of knowledge.

Methods

The research carried out included a critical analysis of the literature on the topic, as well as a search for individual press mentions and information on websites – concerning the earliest uses of straw bales in construction across various countries. Information on the earliest patents on straw bale construction was obtained from the online patent databases (https://patents.google.com/ and https://data.inpi.fr/).

Additional information was gathered by the author through correspondence with individuals and institutions involved in the creation of (and/or research on) early examples of straw bale architecture. The results of the research in draft form were presented in a talk at the "European Straw Bale Gathering 2023" in Branderup, Denmark. Following discussions after the conference, it was possible to complete the data presented in this paper.

The analysis of literature and other sources (e.g., patent database searches) and correspondence leading to the article took place between January 2023 and December 2024.

The photograph of the oldest known house in Europe with wall insulation infill made of straw bales was taken by the author during a study visit in August 2015.

For the purposes of this paper, the author has assumed that the term "straw bale" can, aside from its basic meaning, also function as an abbreviated form of "straw bale building technology" or "straw bale" construction" and is occasionally used in these senses in this text[3].

Although nowadays straw bales are commonly used to build houses, in the historic buildings in Nebraska (from 1886–1940) hay bales[4] were mainly used, so it is more accurate to call the construction technology of the time "hay bale". For the sake of simplicity, the author has assumed that this early episode of hay bale building falls within the much broader phenomenon of straw bale building, since the way of working with either material is virtually the same.

Results

The main result of the work is a chronologically ordered database of the first buildings (or references to them) and patents on straw bale building technology. Also included are a selection of major publications and conferences/meetings that may have had a significant impact on the development of straw bale. The summarised results are presented in Table 1.

Using the timeline presented in Table 1, it is possible to quickly find points which do not align chronologically or geographically with the commonly accepted, simplified history of straw bale construction. The following section presents an analysis of selected issues.

Nebraska, Indiana… or perhaps Kansas?

The earliest US patents on straw bale building date back to 1880 and 1885, and the inventors filing them in both cases were from Indiana. The first known printed reference to the building of a temporary straw bale school in Nebraska

[2] The Polish edition of this book is referenced here, as the most easily accessible in the country of publication of this article. The original edition was published in German as *Handbuch Strohballenbau, Grundlagen, Konstruktionen, Beispiele.*

[3] A broader explanation of the terms related to straw bale building for Polish speaking readers can be found in the doctoral thesis on straw bale building in Poland (Jagielak 2023).

[4] Which was due to local conditions – prairie grasses were a resource available in great quantities in that area. Hay from the late autumn harvest, the least valuable for fodder but the best building material, was used for construction (Welsch 1970, 21).

Table 1. Timeline of the invention and development of straw bale construction 1890–1992 (elaborated by M. Jagielak)
Tabela 1. Kalendarium wynalezienia i rozwoju budownictwa z kostek słomy 1890–1992 (oprac. M. Jagielak)

Origins of straw bale construction 1890–1940			
Date	Description	Country/location	Source
1880	J.M. Leeds patented the construction of straw bale buildings (load-bearing use of straw bales in walls, i.e., loadbearing straw bale) (Fig. 1)	USA (inventor from Kokomo, Indiana)	(Leeds 1880)
1885	William H. Orr patented the construction of straw bale walls including compression with threaded rods and plastering (Fig. 2)	USA (inventor from Carlisle, Indiana)	(Orr 1885)
1896	Construction of a temporary school building from straw bales	Bayard, Nebraska, USA	(Welsch 1970)
1897	Mention in the *Australian Journal of Agriculture and Industry* of the possibility of building with straw bales [...] *as in Kansas*, and of a barn in Australia (Fig. 3)	Australia (+reference to many buildings in Kansas, USA)	(South Australia 1897)
Circa 1900	Beginning of the period of popularity of straw bale building in the Sand Hills region of Nebraska	Sand Hills region (Nebraska, USA)	(Welsch 1970)
1903	George W. Pickin patented the construction of impregnated straw bale walls with a method of compression and corner reinforcement	USA (inventor from Eue Claire, Winconsin)	(Pickin 1903)
1905	John B. Clayton and Reno D.O. Johnson patented a composite wall and roof construction in which straw bales are the infill of a concrete structure	USA (Missouri inventors)	(Clayton, Johnson 1905)
1920	First houses designed by Emille Feuillette, in which straw bales were used to infill the timber frame	Existing: Montargis, Lille. Probable but not certain: Boulogne, Asine (France)	(Lamache 1921), (E.W. 1921)
1921	Warren Withee built the only known house of this period in the USA outside Nebraska. The building survived until at least the 1990s	Alsen-Fawnlville (South Dakota, USA)	(Bainbridge 1994)
1922	Emile Feuillette patented a building system in France that included timber elements in the form of trusses and straw bales or similar material as infill (infill straw bale construction)	France (inventor from Boulogne sur Seine)	(Feuillette 1922)
1923	Emile Feuillette patented his system in the USA	USA (inventor from Boulogne sur Seine, France)	(Feuillette 1923)
1934–1938	Construction of the mansion of W.H. Burrit (construction time extended due to fire in 1936). First example of the combination of timber frame construction with straw bale infill in the USA	Hunstville (Alabama, USA)	(Herzog 1994)
Circa 1940	End of the period of popularity of straw bale construction in the Sandhills region of Nebraska	Sandhills region (Nebraska, USA)	(Welsch 1970)
Great pause 1941–1973			
1943	The "Rulsche Hut" house – architect J.W.A. Gubbels	Heeze (Netherlands)	(Czabanowski 2006, 90)
1944–1945	House "Huize Heivelden" – architect J.W.A. Gubbels	Heeze (the Netherlands)	(Czabanowski 2006, 90)
Circa 1946	Construction of the modernist restaurant/dancing "The Lone Oak"	Lincoln area (Nebraska, USA)	(Welsch 2020)
1950, 1953, 1955	Construction of several small buildings from straw bales by Norwegian farmers; successively: stable, chicken coop, garage	Norway	(Piet Jensen, email to author 23 August 2023)
1954	Construction of a straw bale church in Bad Heart on the initiative of Pastor Francis Dales (description in press: 1960)	Bad Heart (Alberta, Canada)	(Canada's Historic Places n.d.)
The beginnings of the straw bale revival 1970–1992			
1970	Publication of an article by R. Welsch "Sandhill Baled Hay Construction" in the *Keystone Folklore Quarterly*, in which he described hay and straw bale constructions in Nebraska	USA	(Welsch 1970)
Circa 1972	Bob Doolittle's roundhouse; description in *Mother Nature News* (1973)	USA	(Doolittle 1973)
1973	Publication of an article by R. Welsch "Baled Hay" in *Shelter*, which spread the knowledge that it was possible to build from hay or straw bales, among those interested in low-budget construction	USA	(Welsch 1973)
1974	The Hay House by Glen Gleason	Old Saybrook (New England, USA)	(Lacinski, Bergeron 2000)
1976	Show house in the exhibition "ARARAT" at Moderna Museet	Stockholm (Sweden)	(Biernacki 1980)
1979	House of the organisation Le CUN	Larzac (France)	(Bainbridge et al. 1994)

Table 1 continued. Timeline of the invention and development of straw bale construction 1890–1992 (elaborated by M. Jagielak)
Tabela 1 cd. Kalendarium wynalezienia i rozwoju budownictwa z kostek słomy 1890–1992 (oprac. M. Jagielak)

The beginnings of the straw bale revival 1970–1992			
Date	Description	Country/location	Source
1979–1980	Experimental house "Biohaus" – architect Rudolf Doernach	(Hennef-Süchterscheid Germany)	(Minke, Krick 2015)
1981	The home of Athena Swentzell Steen and Brian Reeves	Santa Fe (New Mexico, USA)	(Bainbridge et al. 1994)
1981	Architect Jon Hammond's house and studio (described in a popular article in *Fine Homebuilding* in 1983)	Winters (California, USA)	(Bainbridge et al. 1994)
From circa 1984	Louis Gagne's construction and testing, in which tested a method of erecting the walls of buildings with straw bales and cement mortar	Quebec (Canada)	(Gagné 1986)
1988–1989	Construction of the home of Steve and Nenna McDonald (described in *Permaculture Drylands* in 1988)	Gila (New Mexico, USA)	(Myhrman, The Last Straw 2022)
1989	Meeting of straw bale enthusiasts in Oracle	Oracle, Arizona, USA	(Hammett, Hammett 2022)
1989 and 1991	Study trip by Judy Knox and Matts Myhrman to Nebraska to confirm the durability of straw and/or hay bale buildings	Nebraska, USA	(Hammett, Hammett 2022)
1991	P.L. Brown's article "Houses the Cows Would Love to Eat" on new straw bale buildings published in the New York Times gains unprecedented popularity and is reprinted in many countries	USA	(Myhrman, The Last Straw 2022)
1992	First issue of the *The Last Straw* magazine	Tuscon, Arizona, USA	(The Last Straw n.d.)

appeared in 1902 – it described a structure built in 1886 (Welsch 1970, 31).

As Bridget E. Jolly (1998, 31) mentions, it is also known from an 1897 Australian publication that straw bale buildings were being constructed in the state of Kansas at the time. The article *Buildings of Baled Straw* (South Australia 1897, 191) states: […] *it has long been the practice to build barns and other farm erections with blocks of baled straw*, and even that there were many buildings of this type in Kansas (Fig. 3). This issue definitely requires further research.

Even more surprisingly, the text also mentions the construction of barns with straw bales in Australia (one specific example is given – in the Goulburn Valley in the state of Victoria, together with the indicative information that the structure was built […] *two or three years since*, which would mean a construction date in 1894 or 1895).

On the basis of an analysis of the documents referred to above, it must be concluded that the method of erecting buildings from straw bales was first invented in the state of Indiana, and that its authors were not anonymous pioneers, but specific individuals known by name, who were sufficiently aware of the significance of the intellectual value to have filed patent applications (!). Of course, other scenarios cannot be ruled out on this basis, for example, one that structures made of straw or hay bales had already been erected in Nebraska earlier. On the other hand, the hypothesis that knowledge of the invention from Indiana may have been "carried" to Nebraska (and also Kansas) has both geographical and historical grounding – the westward movement of settlers continued throughout the late 19th and early 20th centuries. The area of the largest known concentration of straw bale buildings in Nebraska, the Sandhills, was designated for homesteading in 1904 (Welsch 1970, 17).

The existence of the aforementioned patent applications has been known in the straw bale building community since at least 1998 – the year in which an article on the subject was published in the *The Last Straw* magazine (Raduazo 1998). However, it has not yet influenced the prevailing historical narrative found in numerous publications, in which the point of origin is in the Sandhills (Nebraska).

However, an important unknown remains: did the patent authors put their ideas into practice? Did they construct any straw bale buildings before making the applications? And, if so, were these buildings constructed at their places of residence or elsewhere? The author does not know the answers to these questions; however, some clues may emerge from an analysis of the patent documents themselves. In the case of both the 1880 patent of Josiah M. Leeds and the 1885 patent of William H. Orr, the descriptions indicate a working knowledge of the material. It is manifested, among other things, by the fact that information about compression of the straw bales (and how to control it) appears in the text. In the case of Leeds, the patent description is formulated in the first person (e.g., […] *I cut hay* […]. *In constructing my buildings, I set up corner posts* […]; Leeds 1880). It seems reasonable to assume that both inventors carried out at least practical experiments with making walls out of straw bales.

Incidentally, it is worth noting that the drawings accompanying the documentation contain errors and are less precise than the descriptions themselves (Figs. 1, 2). Leeds' patent application is of a very practical nature and could have served as a guideline on how to construct a basic temporary outbuilding or dwelling using the simplest materials and in a manner very similar to that used by settlers in Nebraska.

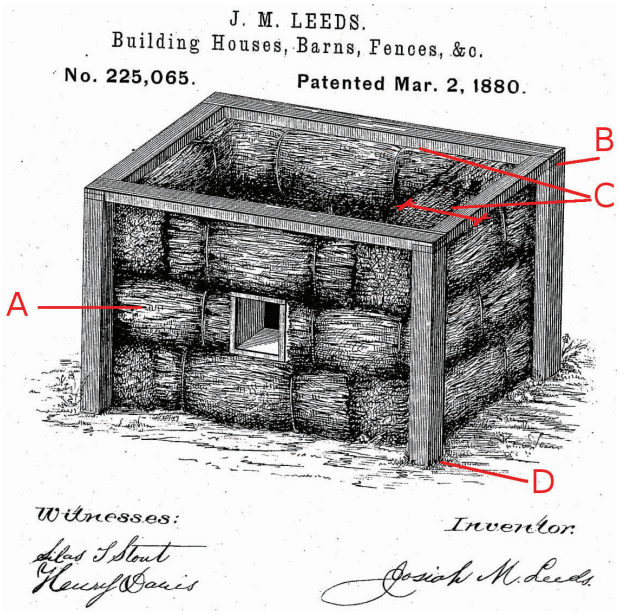

Fig. 1. Figure taken from patent no. US225065 filed by J.M. Leeds; errors are notable:
A – the straw bales are too large in proportion to the building,
B – the walls are not of the correct thickness,
C – the corners made of boards support the ring beam, which is contrary to the information presented in the description of the invention, that this beam is to be laid on the straw bale wall and that the corner posts can be removed after the walls have settled under the load of the roof,
D – the drawing does not show that the corners should be solidly fixed at the bottom, as mentioned in the patent description (source: Leeds 1880, elaborated by M. Jagielak)

Il. 1. Rycina pochodząca z patentu nr US225065 zgłoszonego przez J.M. Leedsa; zwracają uwagę błędy:
A – kostki słomy są zbyt duże w proporcjach do budynku,
B – ściany nie mają właściwej grubości,
C – narożniki wykonane z desek podpierają belkę oczepową, co jest sprzeczne z przedstawioną w opisie wynalazku informacją, że belka ta ma być ułożona na ścianie z kostek słomy oraz że słupki narożne można usunąć po tym, jak ściany osiądą pod obciążeniem dachem lub stropem,
D – na rysunku nie pokazano, że narożniki powinny być w dolnej części "solidnie umocowane" (o czym wspomina opis) (źródło: Leeds 1880, oprac. M. Jagielak)

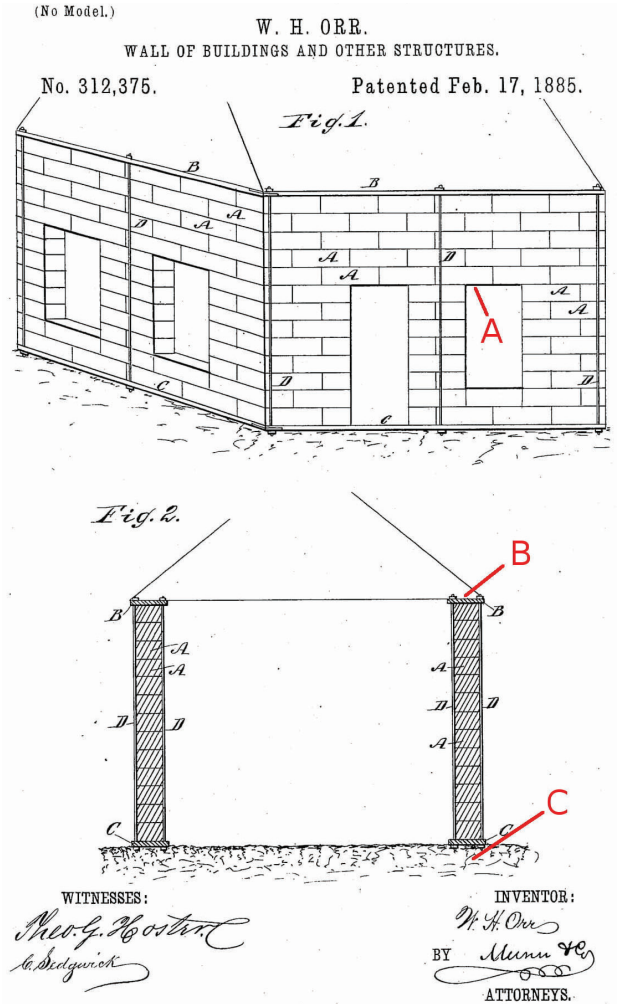

Fig. 2. Figure from patent no. US312375 filed by W.H. Orr; note the unusually small straw bales in the drawing, other notes:
A – there is no information about lintels or boxes/frames for window and door openings,
B – even with the smaller-than-typical dimensions of the straw bales, the possibility of making the ring beam from a single wide plank is seriously questionable in this case, as the forces occurring in compression with threaded rods are considerable,
C – there is no mention of the use of foundations in the description or drawing, which is a serious deficiency for buildings other than temporary ones (source: Orr 1885, elaborated by M. Jagielak)

Il. 2. Rycina pochodząca z patentu nr US312375 zgłoszonego przez W.H. Orra; na rysunku zwracają uwagę nietypowo małe kostki słomy, pozostałe uwagi:
A – brak informacji o nadprożach lub obudowach otworów okiennych i drzwiowych,
B – nawet przy mniejszych niż typowe wymiarach kostek słomy możliwość wykonania belki oczepowej z jednej szerokiej deski budzi w tym przypadku poważne wątpliwości, ponieważ siły występujące przy kompresji za pomocą gwintowanych prętów są znaczne,
C – w opisie ani na rysunku nie ma wzmianki o zastosowaniu fundamentów, co jest poważnym brakiem w przypadku budynków innych niż tymczasowe (źródło: Orr 1885, elaborated by M. Jagielak)

Subsequent patent applications were for other, more complicated methods of building and stabilising walls and/or roofs using straw bales, but these were not widely used in practice.

Nebraska as the cradle of technology – "Nebraska" as a type of construction

Welsch identified 1900–1940 as the main period of hay bale development in Nebraska (Welsch 1970, 33). As part of his research in the late 1960s, he found information or heard references on about 75 buildings (Welsch 1970, 19). In addition to houses and farm buildings, he also learned of other structures, such as a church in Arthur, a large car garage and even hangars for farmers' aircraft (Welsch 1970, 26–29). In the early 1990s enthusiasts of the practical application of straw bale building set out to follow in Welsch's footsteps. Judy Knox and Matts Myhrman found only some of the buildings indicated by Welsch during their travels in 1989 and 1991, but additionally came across others, not described in his article (Knox, Myhrman 2008, ca. 5:30 min).

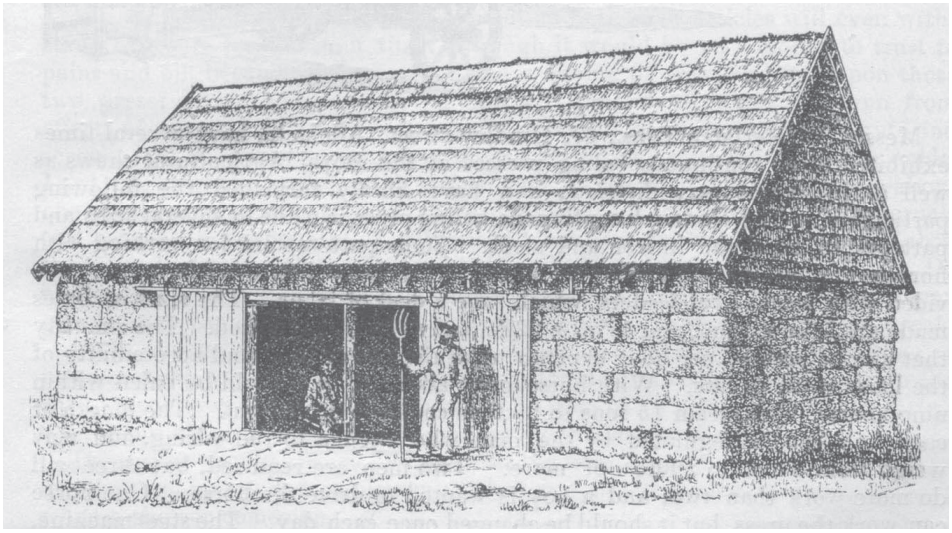

Fig. 3. A straw bale barn from Kansas (author unknown; source: South Australia 1897, 191; scan made by the National Library of Australia, at the request of M. Jagielak)

Il. 3. Stodoła z kostek słomy w Kansas (autor nieznany; źródło: South Australia 1897, 191; skan wykonany przez National Library of Australia, na zlecenie M. Jagielaka)

The buildings erected in Nebraska differed in details of construction, including the orientation of the straw bales in the wall, the use or non-use of mortar between the bales, and the manner in which window openings were made. However, they had some essential features in common: straw bales were used as load-bearing elements (like bricks in a wall) and were often plastered (at least in the case of permanent buildings). This type of straw bale construction is called "load-bearing straw bale", "Nebraska-style" or simply "Nebraska".

The demand for straw bale structures dwindled as other building materials became increasingly available. After 1940, virtually no such structures were built in the San Hills area any more. The Lone Oak Inn may be considered to be the swan song of this period of development. It was probably built in 1946 – outside the Sandhills, a few miles from Lincoln (Welsch 2020). It was a two-storey building designed in the modernist style and was the first clear demonstration that straw bale building technology could be applied not only to the erection of small rural buildings, but also to public buildings. Sadly, it was demolished in 2012 (Welsch 2020).

From South America to Europe or vice versa?

The early 1920s saw another interesting episode in the history of straw bale building. In 1920, the first buildings designed by engineer Emile Feuillette were constructed in France. These were probably the first European examples of the use of straw bales in construction and, at the same time, the world's first combination of modular wooden structure and straw bales.

Shortly after construction, the building in Montargis (Lamache 1921) was featured in *La Science et la Vie* (along with numerous photographs of the construction), and four buildings were mentioned in "Le Génie civil" (E.W. 1921). Two of these still exist today – in Montargis and Lille (Fabienne Pasquier, email to the author, February 14, 2023).

The engineer patented his solution in France (Feuillette 1921) and in the USA (Feuillette 1923). The author has not been able to find conclusive evidence to confirm whether the inventor knew that straw bale buildings were already being constructed in the USA during that period. Jolly (1998, 19–24) considers that the solution proposed by Feuillette is a further development of the construction methods known and used in the USA. However, this has little bearing on the evaluation of his invention[5]: he was the first to propose the use of straw bales as infill between the elements of a fittingly designed wooden frame (Figs. 4, 5). Similar solutions are now referred to in literature as "infill straw bale". The known buildings erected by Feuillette had two overground storeys, presented high quality both technically and aesthetically, and were adapted to the urban or small-town locations in which they were constructed. When rendered, they visually resembled masonry buildings and, in terms of thermal insulation of the walls, they had superior properties than those built using other common technologies of the time. Jolly (1998, 20) hypothesised that the solutions proposed by Feuillette could have been more widely adopted during the reconstruction of areas destroyed during World War I. This guess was based only on the warm reception of the invention by the press and on an awareness of the immense housing needs of that time. In conclusion, it should be noted that there is no confirmed information that the ideas of the French inventor found a direct continuation in France or other European countries or in the USA. Nevertheless – the filing of the patent application in the United States may have been a moment of intercontinental knowledge transfer. Unfortunately, it seems that engineer Feuillette's invention was forgotten for many years, and the "revival" of straw bale construction in France only began at the very end of the 1970s, triggered by an external impulse.

[5] In doing so, the author proposes to take the construction described in the patent and implemented in buildings in Montargis and Lille (Turcoing) as the basis for evaluating Feuillette's system. Such a narrowing down is needed because the patent documentation contains mixed descriptions and illustrations of two not fully compatible solutions. One of them is in line with that used in the mentioned houses. The other is a kind of hybrid between the infill and load-bearing use of straw bales and, from today's perspective, seems far less practical (Fig. 4).

The first straw bale insulated timber-frame building in the USA was a mansion built between 1934 and 1938 in Huntsville, Alabama. Its owner, William H. Burrit, claimed in a 1950 newspaper interview that the method of erecting the house was inspired by his personal experience of the properties of straw to provide insulation against heat (Herzog 1994, 25). If he was indeed unaware of the buildings constructed in Nebraska or France, he may be considered another contender for the title of inventor of straw bale building technology. All the more so, as the building incorporated a number of solutions not found elsewhere.

The great pause. The discontinuation of straw bale building in Nebraska, new developments in Canada and Europe

According to the typical narrative of American authors, there was a pause in straw bale development after 1940s, which did not end until the 1970s, when straw bale buildings were discovered and described by Welsch. However, this break between the 1940s and 1970s was not complete. Several isolated instances of straw bale building from this period have been documented.

Between 1943 and 1945, in Heeze, the Netherlands, during wartime restrictions and shortages of building materials, two houses were built from straw bales, designed by the architect Johannes W.A. Gubbels (Czabanowski 2006, 90). There is no available data to support a link between these buildings and earlier developments in the USA or France. However, it is worth noting that Heeze is only 200 km away from Lille, where one the houses built earlier according to Feuilette's design is located.

Another isolated case is the construction of a small church from straw bales in Bad Heart, Alberta, Canada, in 1954, at the initiative of the experienced builder and pastor Francis Dales (Canada's Historic Places n.d.). It is not known whether he was inspired by earlier buildings in the USA, and if so, which ones. Information about it was published in 1960 in the *Grassland News* newspaper owned by the agricultural machinery company New Holland (Welsch

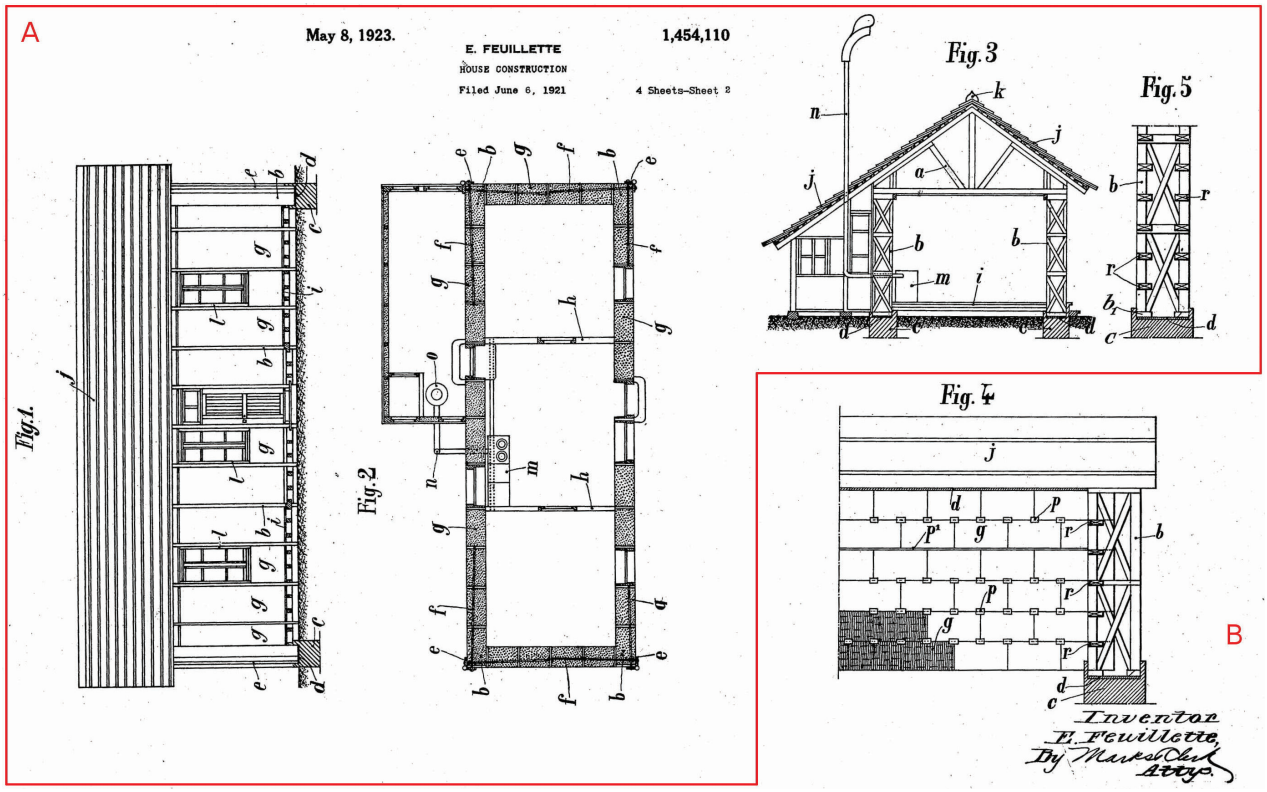

Fig. 4. Figures from patent no. US1454110 filed by E. Feuilette:
A – Figs. 1–3, 5 show a structure in which the truss posts "b" are spaced one straw bale "g" apart (the module of the structure and the sizes of the bales are coordinated), this solution was used in practice in Montargis and Lille (Turcoing), B – Fig. 4 view of the wall (left) combined with cross-section (right) show two different solutions. The distance between successive posts in the wall is unspecified, but it is at least four bales lengths. The bales ("g") are laid staggered, as in Nebraska, but with the addition of horizontal wooden elements (longitudinal "r" and transverse "p") to reinforce/stabilise the wall together with plaster reinforced with steel mesh (source: Feuillette 1923, elaborated by M. Jagielak)

Il. 4. Ryciny z patentu nr US1454110 zgłoszonego przez E. Feuilette'a:
A – Figs. 1–3, 5 pokazano konstrukcję, w której kratownicowe słupki "b" rozmieszczone są w odległości jednej kostki słomy "g" od siebie (moduł konstrukcji i rozmiary kostek są dopasowane do siebie), to rozwiązanie zastosowano w praktyce w Montargis i Lille (Turcoing), B – Fig. 4 widok ściany (po lewej) połączony z przekrojem (po prawej) pokazują dwa różne rozwiązania. Odległość między kolejnymi słupkami w ścianie jest nieokreślona, ale wynosi co najmniej cztery długości kostek. Kostki ("g") są układane z przesunięciem, jak w Nebrasce, przy czym dodatkowo wprowadzone są drewniane elementy poziome (podłużne "r" oraz poprzeczne "p"), które mają wzmacniać/stabilizować ścianę razem z tynkami zbrojonymi stalową siatką (źródło: Feuillette 1923, oprac. M. Jagielak)

Fig. 5. Interior of the building "Maison Feuilette" in Montargis: in the foreground, the "truth window" providing a glimpse inside the wall, on some century-old straw bales (photo by M. Jagielak, 2015)

Il. 5. Wnętrze budynku Maison Feuilette w Montargis: na pierwszym planie „okienko prawdy" zapewniające wgląd do środka ściany, gdzie znajdują się około stuletnie kostki słomy (fot. M. Jagielak, 2015)

2020). The article may have been another example of international transfer of knowledge or inspiration.

In the 1950s and 1960s, at least four simple straw bale farm buildings (stable, poultry house, garage, storehouse) were built in Norway (Piet Jensen, email to the author, August 23, 2023). These were small, in some cases temporary, structures erected by farmers. What is remarkable here is not only their creation, but also the fact that the architect Piet Jensen managed to find and record information about them.

The revival of straw bale in the USA and beyond

The 1970s

The field research carried out by Welsch was the initial impetus for bringing back into use the methods of straw building practised in early 20th century Nebraska. His work was published – first in *Keystone Folklore Quarterly* and then in *Shelter*, a publication that achieved great popularity in the counterculture movement[6]. The book, full of photos and drawings of traditional, vernacular and DIY architecture from all over the world, has become an important source of inspiration for many people looking for a way to cheaply build a house with their own hands and live close to nature. Sold in considerable numbers and reprinted many times, it also found its way to Europe. At first, the article by Welsch's in this publication triggered modest actions. Individuals scattered across the USA built some (mostly small, often temporary) structures out of straw bales. Often they had only that one-page text from *Shelter* or other articles[7] as a guide – or even just a verbal message that it was possible to build with straw. The only straw bale house of this decade in the USA known to the author, well documented in the literature (Lacinski, Bergeron 2000, 25–27), and still existing today, is the "Hay House" in Old Saybrook (David Brown, email to the author, 4 September, 2023).

As in the USA, experiments with building with straw bales were also being carried out in other countries during this period. In 1976, such a house formed part of the "ARARAT" exhibition at Stockholm's Moderna Museet. The event was controversial and much attended by the public (Jansson 2015). Interestingly – photographs of the house from the exhibition even appeared in the Polish periodical *Architektura* (Biernacki 1980, 89, 90).

The author managed to find a note stating that during a search conducted in Canada in 1978 Jorg Ostrowski was able to document several existing straw bale buildings, beside the church in Bad Heart (ASH-Autonomous… 2011).

In 1979, the first straw bale house in France was built after many years' break (Bainbridge et al. 1994, 14). Located on the Larzac plateau, it was an illegal building (without a permit) – the work of members of the pacifist organisation "Le CUN". They learned the building method themselves, by trial and error, on the basis of just a verbal hint that it is possible to build with straw. The information came to them from Canada (Hervé Ott, email to the author, February 17, 2023).

Between 1979 and 1980, an experimental "Biohaus" house designed by Rudolf Doernach was built in Hennef-Süchterscheid, Germany (Minke, Krick 2015, 13). The author was unable to find out whether the designer was aware of the existence of other straw bale buildings at this stage. However, the solution used suggests that this was an experiment not supported by an understanding of the material's characteristics – the straw bales were covered with foil, which led to fungi growth and decomposition (Gernot Minke, email to the author, August 23, 2023).

These examples of buildings scattered around the world, and mostly not very impressive, illustrate the phase of slow development by trial and error, preceding the straw

[6] Including the "Back to Land" movement.

[7] E.g., in *Mother Earth News* or *Permaculture Drylands* magazines.

bale revival proper. At that time, the object of international transfer was not so much the technology of building with straw bales, but the basic information and the very idea that it was possible.

If one takes into account the lack of developed networks and the absence of manuals – it can be hypothesised that many people were "inventing" the ways of building with straw bales for themselves during these years. A similar situation continued in the 1980s.

The 1980s

According to some sources, the actual watershed moment for the popularisation of straw bale building was linked to an article published in 1983 in *Fine Homebuilding* magazine. The text described a house and studio by architect Jon Hammond (Tilt and Arkin n.d.) that had been built two years earlier. A small building plastered in white, with gently rounded corners and other sculpturally shaped elements, aroused enthusiasm of numerous male and female readers and, for a long time, established the idea of the desirable characteristics of a straw bale house.

Experiments with different ways of building were carried out parallelly in Canada by Ostrowski in Alberta and Louis Gagné, Francois Tanguay, Clode Deguise, Clement Doyer and Michel Bergeron in Quebec, among others (Lacinski, Bergeron 2000, 16). Gagné developed his own system of building with straw bales with wide cement mortar joints between. Bales were laid without staggering vertical joints to create a "concrete grid" as a load-bearing structure (Gagné 1986), which was somewhat reminiscent of the technology described in a 1905 US patent (Clayton, Johnson 1905). Given today's knowledge of the buildings physics, this solution can be judged as a dead end in the development of straw bale. However, it is possible that these were the world's first straw bale building experiments conducted in collaboration with governmental institutions.

Francis Tanguay's role is not widely known but certainly important as he also lectured and provided training in France in 1985, 1987, and in 1989 (Bainbridge et al. 1994, 14). This was the first known example of an organised, intercontinental transfer of knowledge about straw building, predating similar events in English-speaking countries.

It's worth noting that the beginnings of the coordination and organisation of the straw bale community in the US did not come until the late 1980s and early 1990s. Of the earlier period, Matts Myhrman said: *It was not a revival at that point at all. At the most it was dozens of people who had built a handful of Nebraska-style buildings, many done in Cochise County (Arizona) or other areas that required no building codes* (after: Hammett, Hammett 2022).

Early 1990s

It was not until the early 1990s that the straw bale community in the USA consolidated to such an extent that the first manuals could be published, education organised and efforts made to include the technology in building codes.

There was also a noticeable increase in press publications about straw bale building. An illustrated text, printed in colour, on the front page of the section on houses in the New York Times, was a real milestone (Myhrman, The Last Straw 2022). The interest generated by the article provided the impetus to accelerate the development of straw building in the USA. The text was reprinted by newspapers in many countries, which helped to promote the idea of accessible straw bale construction. In 1992, the first issue of *The Last Straw* was published, a magazine that became an important forum for the exchange of information on straw bale construction – not only in the United States, but also internationally. This moment was arbitrarily regarded by the author as the symbolic end of the pioneering phase of straw bale building. At the same time, it was not the end, but rather the beginning of the dynamic development of this technology.

Summary

On the basis of the available documents, it can be concluded that the invention of the technology of erecting buildings with load-bearing straw bale walls was made by J.M. Leeds from Indiana. It is therefore likely that the place of invention was the state of Indiana and not Nebraska.

Nebraska, specifically the Sandhills region, remains the only known area where straw bale building technology was applied on a larger scale in the 1st half of the 20th century. It is also the only known place in the world where a group of such buildings has withstood the test of time, and served as a source of knowledge for subsequent generations of builders.

The building technology of infilling a specially designed frame structure with straw bales was invented in France. The inventor, Emile Feuillette, filed patent applications both in France and the USA. His solution – also implemented in practice – differed significantly from that used in Nebraska.

During the period of waning interest in straw bale construction between 1940 and 1970, individual straw bale buildings continued to be built. Examples are known from the USA, Canada, the Netherlands and Norway. Whether these cases are connected remains unclear. It is possible that some represent independent reinventions of the building method, developed without awareness of prior examples and patents.

In the 1970s and 1980s, attempts to build with straw bales were made in various places around the world. Some of these follow publications originating in the United States, for others there is no such certainty. In the 1980s, innovative experiments with different ways of building with straw bales (including faulty ones) were carried out extensively in Canada, and there are also documented examples of knowledge transfer from Canada to France.

Conclusions

The analysis of the timeline presented in Table 1, together with the detailed description of selected events and periods of development of the technology, leads to the confirmation of the thesis that the history of the invention of straw bale building technology is multifaceted and should not be seen as a linear process with a single starting point. This is because it is made up of many inventions – both

those confirmed by patent applications and solutions discovered on building sites and improved by trial and error, typical for vernacular architecture.

From the first patent applications, it is possible to identify at least two countries where straw bale construction technology has been invented, or rather two different technologies: in the USA, the load-bearing use of straw bales, and in France, the infill use of straw bales. The available documents also show that the invention of load-bearing straw bale was made by Leeds, who was from the state of Indiana, not Nebraska. At the same time, it is worth remembering that Nebraska is rightly regarded as the cradle of straw bale construction since it is the place where this method of erecting buildings went beyond the phase of isolated experiments.

In addition, the research results include instances in which straw bale technology was rediscovered by people building either with no information at all about the existence of earlier buildings constructed in this way, or with only hints on the subject at their disposal.

This paper describes selected situations in which knowledge transfer occurred (or could have occurred) between different centres of straw bale building development. Although the collected information of this kind is incomplete, it confirms that the export of know-how from the USA was not the only direction of knowledge transfer and inspiration in the development process of straw bale construction.

The location of other early straw bale buildings should be a subject of further research, which should include also countries not covered in the article. The interrelationships between successive instances of the invention of the technology combined with a detailed tracing of paths of development and exchange of knowledge (especially in non-English-speaking areas) could form another promising topic for in-depth study.

For researchers in sociology and history, it might be interesting to trace the social, economic and legal conditions that led to the intensive development of straw bale construction in certain regions at specific times.

The history of the evolution of straw bale building technology, including types of construction, ways of organising construction or the tools and materials used, requires a separate study.

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Streszczenie

Budownictwo z kostek słomy – początki historii wynalazku

Powszechnie uznaje się, że technologia budowania z kostek słomy (*straw bale*) powstała w 2. połowie XIX w. w Nebrasce (USA). W latach 70. XX w. rozpoczął się proces odrodzenia tego sposobu wznoszenia budynków, a później – eksport wiedzy z USA. Istnieją jednak źródła, dzięki którym można poddać krytyce tę linearną wizję historii wynalazku i naszkicować obraz bardziej złożony.

Celem badań było sprawdzenie hipotezy, że historia wynalazku *straw bale* jest wielowątkowa oraz że powstanie tej technologii budowania mogło nastąpić niezależnie w wielu miejscach na świecie. Przeprowadzone badania objęły: krytyczną analizę literatury przedmiotu i dokumentów źródłowych (w tym patentów), korespondencję, rozmowy ukierunkowane na poszukiwanie pierwszych zastosowań kostek słomy w budownictwie w różnych krajach. Dane zostały podsumowane w formie tabeli.

Na podstawie analizy zebranych dokumentów i relacji potwierdzono, że historia technologii budowania z kostek słomy była wielowątkowa i nie powinna być postrzegana jako linearny proces z jednym punktem początkowym. Obejmuje ona wynalazki pochodzące z różnych miejsc i te potwierdzone zgłoszeniami patentowymi, i te odkrywane w warunkach budowy i doskonalone metodą prób i błędów. Biorąc pod uwagę dokumenty, należy uznać, że miejscem wynalezienia budownictwa z kostek słomy mógł być stan pochodzenia autora pierwszego zgłoszenia patentowego, czyli Indiana, a nie Nebraska. Wynalazku polegającego na zastosowaniu kostek słomy jako wypełnienia odpowiednio zaprojektowanej konstrukcji drewnianej dokonano we Francji. Okres zaniku zainteresowania budownictwem z kostek słomy przypadł na lata 1940–1970, mimo to pojedyncze budynki *straw bale* wciąż powstawały w USA, Kanadzie i Europie. W latach 70. i 80. XX w. eksport *know-how* z USA nie był jedynym kierunkiem przepływu informacji, potwierdzono m.in. transfer wiedzy z Kanady do Francji.

Słowa kluczowe: architektura z kostek słomy, naturalne materiały budowlane, architektura wernakularna, architektura low-tech, materiały izolacyjne pochodzenia roślinnego