

SVITLANA KHADZHYNova / ORCID: 0000-0002-9630-445X / svitlana.khadzhynova@p.lodz.pl

CENTRE OF PAPER AND PRINTING, ŁÓDŹ UNIVERSITY OF TECHNOLOGY

ENDLESS CORRUGATED CARDBOARD (FANFOLD): PRODUCTION AND APPLICATION

TEKTURA FALISTA BEZ KOŃCA (FANFOLD): PRODUKCJA, ZASTOSOWANIE

ABSTRACT: The increase of demand on corrugated board boxes is connected with a sudden increase of the number of persons who decide on the on-line purchase of goods. It is expected that FMCG sector will be the main generator of incomes for the producers of corrugated board boxes. It is anticipated that the growing demand on packaging in different sectors and boom in the e-commerce in the coming years will create the profitable possibilities of the solutions, employing corrugated cardboard packaging of fanfold type.

Key words: corrugated board, fanfold, corrugator, feeder, box production

STRESZCZENIE: Wzrost popytu na pudła z tektury falistej jest związany z gwałtownym wzrostem liczby osób decydujących się na zakupy online. Oczekuje się, że branża FMCG będzie głównym generatorem przychodów dla producentów pudeł z tektury falistej. Przewiduje się, że rosnące zapotrzebowanie na opakowania w różnych branżach i boom w handlu elektronicznym stworzą w nadchodzących latach lukratywne możliwości dla rozwiązań z tektury falistej typu fanfold.

Słowa kluczowe: tektura falista, fanfold, tekturница, podajnik, produkcja pudeł

Fanfold is a continuous band of corrugated board, creased and folded in harmonica (concertinaed), being also called z-fold, z-cardboard or folding (other English determinations include: endless board and continuous corrugated). The folded corrugated board is a profitable solution, enabling consumption of smaller quantity of material and reduction of material reserves. The fanfold is automatically folded according to the preliminarily set programme during production of corrugated cardboard. At the beginning, the discussed type of cardboard was mainly used in production of packaging in the furniture-producing industry. Due to the fact that the application of the corrugated cardboard in the continuously folded band (fanfold) as opposed to the stack of the sheets of corrugated cardboard increases the flexibility of production; it may be used for manufacture of packaging for the products with different dimensions and in different quantities, so it is the ideal current solution in the production of the so-called "packaging on demand".

Due to the mentioned above reason, the level of the market of the corrugated cardboard of fanfold type is continuously increasing. In 2021, it was estimated at 28.61 billion USD dollars and it is anticipated that it will increase up to 39.86 billion USD dollars in 2030, i.e. the anticipated CAGR (CAGR, Compound Annual Growth Rate) gain in the years 2022-2030 will amount to 3.7% [1]. The increase of demand on corrugated board boxes is connected with a sudden increase of the number of persons who decide on the on-line purchase of goods. It is expected that FMCG sector (abbreviation of Fast Moving Consumer Goods) will be the main generator of incomes for the producers of corrugated board boxes. It is anticipated that the growing demand on packaging in different sectors and boom in the e-commerce in the coming years will create the profitable possibilities of the solutions, employing corrugated cardboard packaging of fanfold type [1].

The advantage includes also the ecological character of the discussed packaging material as it by its nature, is suitable for

recycling. The fanfold board may be produced in different widths (from 300 to 2800 mm), it may be three-layer or five-layer cardboard. Owing to this fact, the fanfold is the optimum solution in the case of the application of enormous quantity of packaging materials in different dimensions and specifications. Specificity of production of fanfold corrugated board. In manufacture of the corrugated board of fanfold type, we may utilize a new or already existing corrugator which should contain a special built-in stacker of fanfold in which the band of the corrugated board will be first creased and then, stacked. There are automatic as well as semi-automatic (the operator supports manually the process of stacking) systems of creasing and stacking the fanfold cardboard. The disadvantage of the manual support includes, first of all, a relatively low speed as well as a low quality of stacking. The maximum rate in the case of automatic stacking is 150-200 m/min. The example of such automated system for stacking of cardboard may be the solution, developed at BHS Corrugated; it has been presented in the paper: "Modern driving systems in corrugator" [3]. The mentioned solution enabled the parallel production of board in a form of sheet manufacture and in a form of continuously folded band (fanfold). The speed of the manufacturing line may reach 200 m/min and the change of the forms may occur at the rate of 70 m/min [3]. The production speed will be determined by such parameters as the number of bands, produced in parallel, their width, the length of the forms between



FIG.1. FANFOLD CORRUGATED BOARD BY RONDO.

[HTTPS://ISSUU.COM/RONDOGAN AHL/DOCS/ENDLOSWP_EN](https://issuu.com/rondoganaahl/docs/endloswp_en)

SOURCE: ENDLESS POSSIBILITIES.

creasing, and the type and properties of the employed paper. The automatic stacker consists of the following subunits (Fig.2):

- creaser of the cardboard,
- folding unit,
- cutting and separating unit, and
- lifting table and evacuation.

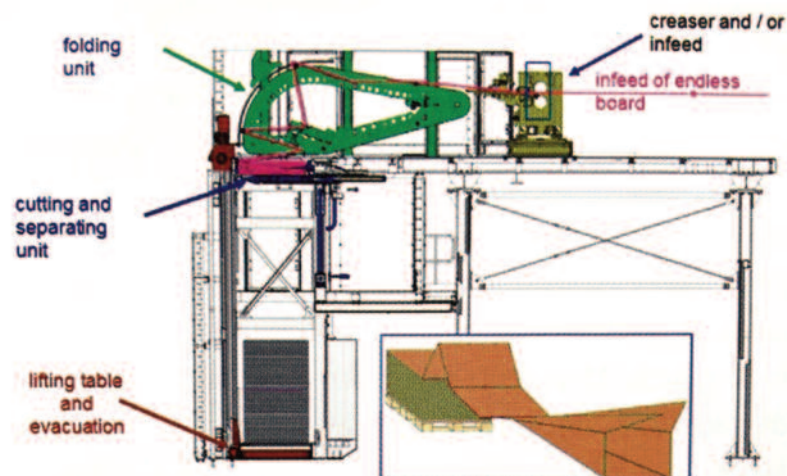


FIG.2. THE SCHEME OF AUTOMATIC STACKER OF FANFOLD BOARD. SOURCE: MUSIELAK S.K., KASPRZYK J.G. MODERN DRIVING SYSTEMS IN CORRUGATOR.

PAPER REVIEW NO 6 (69), 2013, PAGE 367. [HTTPS://SILO.TIPS/DOWNLOAD/NOWOCZESNE-SYSTEMY-NAPEDOWE-W-TEKTURNICY](https://sil0.tips/download/nowoczesne-systemy-napedowe-w-tekturnicy)

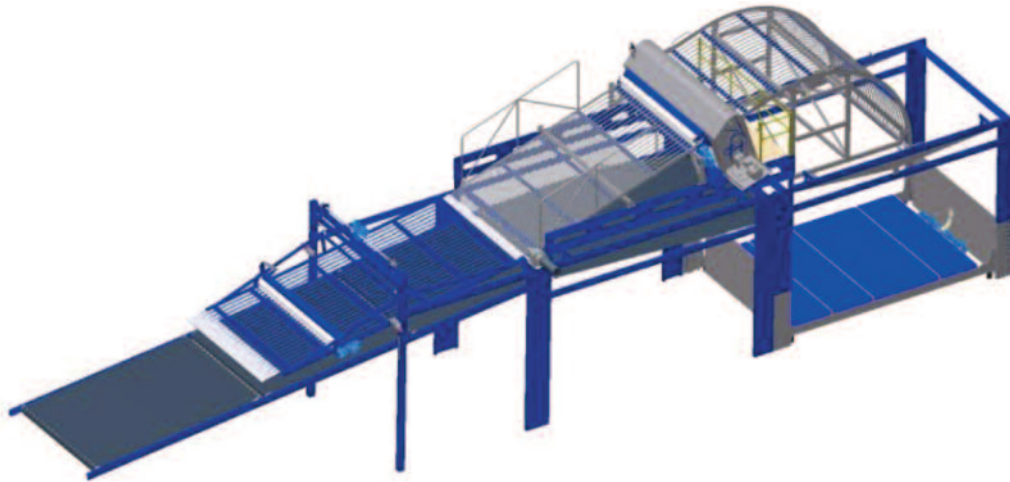


FIG.3. SYSTEM OF FANFOLD CORRUGATED CARDBOARD STACKER BY UNIVERSAL CORRUGATED B.B.

SOURCE: [HTTP://KARTON.PRO/FILES/UNIVERSAL.PDF](http://karton.pro/files/universal.pdf)

[HTTP://WWW.KARTON.PRO/SHOP/PRODUKCIYA/PROIZVODSTVO_BESKONECHNOGO_GOFROKARTONA/PROIZVODSTVO_Z_KARTONA_55.HTML](http://www.karton.pro/shop/produkcija/proizvodstvo_beskonechnogo_gofrokartona/proizvodstvo_z_kartona_55.html)

In September 2020, BHS Corrugated took over the company Universal Corrugated B.V. The latter company is known for the development of the system of automatic stacker Unifold for corrugated cardboard of fanfold type (Fig.3) and has a big experience in respect of non-standard solutions for the customers. Owing to this fact, it has a very good position at the market. By this, Universal and BHS Corrugated will be able to develop optimally and independently the discussed growing segment of the market and define independently the main areas of activities. As it was given in the press information [4], the task of the Universal team will be to focus, first of all, on design, development, installation, starting up and maintenance of the stacker systems for fanfold corrugated cardboard. The plans will also include the development of special individual solutions for stacking the corrugated board and production of equipment for manufacture of the board of "honeycomb" type [4, 5].

The supplementation of the corrugator with the stacker system for production of continuous fanfold board will allow the producers of corrugated board to master the manufacture of a new product which is currently dynamically developing.

Production of boxes based on the continuous corrugated board (fanfold). The presence of the corrugated (two- and five-layer) fanfold board enabled the passage to the conception of producing the packaging being completely fit to the product – the packaging tailored to the dimensions (Fit-to-Product, FtP).

The appropriate machines were introduced and they facilitated production of boxes made from fanfold board; the mentioned equipment implemented, in general, the following operations:

- cutting the fanfold band;
- performance of the box pattern (creasing, performance of slots, cutting out the "hands" etc);
- laying the glue;
- printing in one cycle.

Machines/equipment intended for production of boxes from fanfold board differ in respect of the automation degree, yield and the range of the performed operations. They may be fed with one stream of fanfold cardboard (Fig.4a) as well as with a few streams (Fig. 4b, 5 and 6). The multi-stream feeding gives the possibility of more optimal selection of the width of the corrugated board band for a specified dimension of flap box. The developed control software plays an important role in planning and implementation of the whole manufacturing process of packaging. In the case of multi-stream feeding, it enables – based on the graphic form of the pattern (in digital form) – the choice of optimum width of the band from which the packaging will be produced, with the minimum quantity of wastes. It facilitates also the process of optimization at the stage of coordination and management of the process of manufacture of single packaging as well as of the series of

packaging and the most complicated and demanding flows of operations connected with the production of packaging made from corrugated board. It accelerates the manufacturing process, allowing the company to dispatch more quickly the orders to the customers.

Two recent market reports, developed by Market Reports World i.e. "Box Making Machines Market 2022 Industry Price Trend, Size Estimation, Industry Outlook, Business Growth, Report Latest Research, Business Analysis and Forecast 2028 Analysis Research" [6] and by Transparency Market Research, entitled "Corrugated Box Making Machine Market – Global Industry

Analysis, Size, Share, Growth, Trends and Forecast 2020 – 2030. Corrugated Box Making Machine Market" [7] contain the list of leading producers of equipment and machines for production of corrugated board boxes. The mentioned list is as follows: Bobst Group SA (Switzerland), EMBA Machinery AB (Sweden), Fosber S.p.a.(Italy), Box on Demand (Panotec, Italy), LCR Group (Italy), KOLBUS GmbH & Co. KG (Germany), Packsize International (USA), Serpa Packaging Solutions (USA), Spark Technologies (The Netherlands), Zemat Technology Group Ltd (Poland), ISOWA Corporation (Japan), Shinko Machine <FG. Co. Ltd (Japan), Saro Packaging Machine Industrie (Mano Industrial Machine Tools, India), ACME Machinery Co. Pvt. Ltd (India),

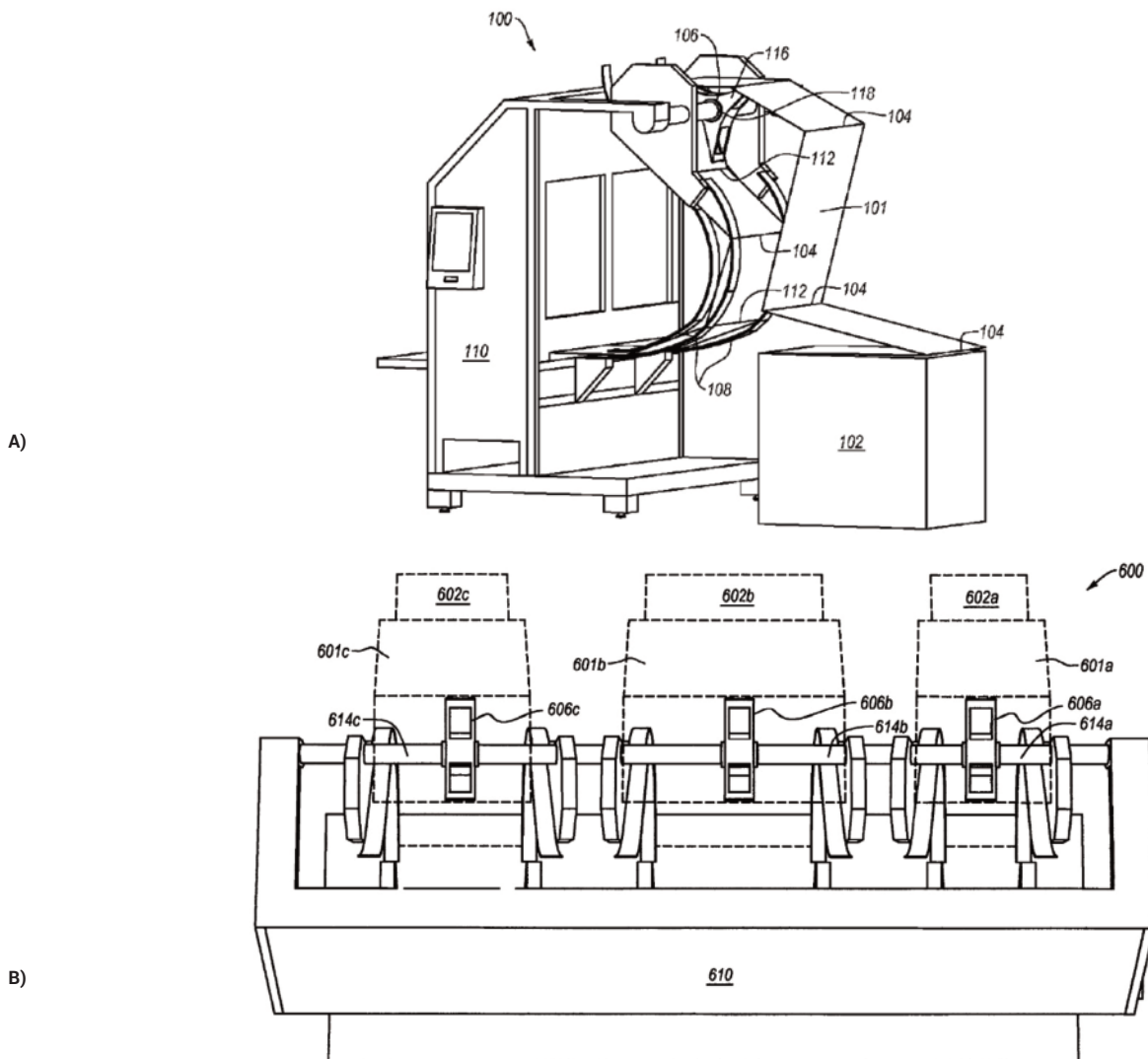


FIG. 4. SINGLE (A) AND MULTI-STREAM (B) FEEDING WITH FANFOLD BOARD, AS DEVELOPED BY PACKSIZE COMPANY. US PATENT WO2010091043A1.

INFEEED SYSTEM. WO2010091043A1. NIKLAS PETTERSSON, PACKSIZE LL C.

[HTTPS://PATENTIMAGES.STORAGE.GOOGLEAPIS.COM/9E/9E/4B/3C37E56283EAD9/WO2010091043A1.PDF](https://patentimages.storage.googleapis.com/9E/9E/4B/3C37E56283EAD9/WO2010091043A1.PDF)



FIG. 5. MULTI-STREAM FEEDING OF FANFOLD BOARD IN PACKSIZE EQUIPMENT

[HTTPS://WWW.PACKWORLD.COM/HOME/PRESS-RELEASE/13288104/PACKSIZE-CORRUGATED-CARTONS](https://www.packworld.com/home/press-release/13288104/packsize-corrugated-cartons)

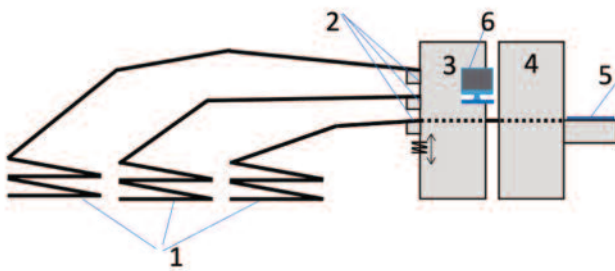


FIG. 6. THE SCHEME OF BOXMAT FANFOLD EQUIPMENT BY ZEMAT COMPANY, AS BEING FED WITH THREE STREAMS OF FANFOLD BOARD:
1 – THREE STACKS OF THE FOLDED BAND OF FANFOLD TYPE;
2 – THREE MOBILE CASSETTES OF FEEDING MODULE;
3 – FEEDING MODULE; 4 – CUTTING-SLOTTING-CREASING MODULE;
5 – PATTERN (FORM) OF THE BOX; 6 – CONTROL SOFTWARE.

SOURCE: OWN ELABORATION.

Shanghai Print Young International Industry (China), Shengli Carton Equipment Manufacturing (China), Wenzhou Zhongke Packaging Machinery Co. Ltd (China) [6-8]. A part from the mentioned above companies is producing the equipment which have the possibility of working with multi-stream fanfold cardboard feeders, for example, Packsize International, Box on Demand, LCR Group, Spark Technologies and Polish company Zemat Technology Group.

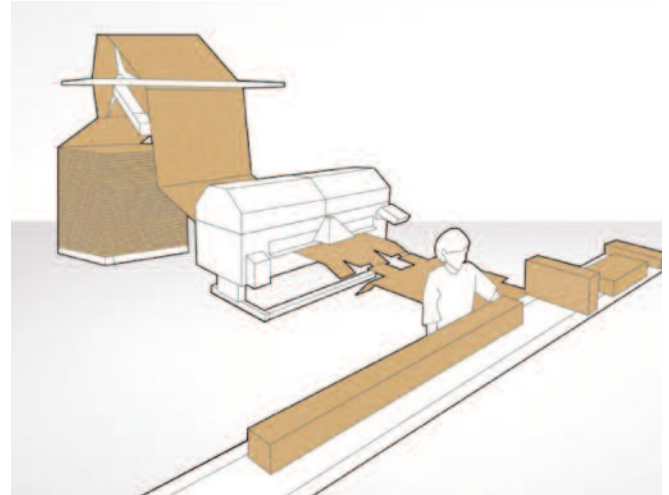


FIG. 7. INTEGRATION OF MACHINE FOR PRODUCTION OF FANFOLD CORRUGATED BOARD BOXES AND PACKAGING LINE. ENDLESS POSSIBILITIES. FANFOLD CORRUGATED BOARD BY RONDO.

[HTTPS://ISSUU.COM/RONDOGANAH/DOCS/ENDLOSWP_EN](https://issuu.com/rondoganaahl/docs/endloswp_en)

Irrespectively of the method for packaging the products, i.e.: manual packaging, packaging by a simple machine, or a complex packaging line, fanfold corrugated board works perfectly in a wide spectrum of packaging processes (Fig.7). In the case of packaging of great quantities of products, the application of specifically designed machines/lines gives a great potential. The mentioned machines give big possibilities of the development in e-commerce sector and may be combined with the packaging line what allows the reduction of costs of packaging the products and acceleration of the whole cycle. The worldwide innovative system of automatic packaging CVP-500 by Neopost Shipping from Drachten (The Netherlands), as being installed in Poland, may the example of the discussed possibilities [9]. The principle of functioning of the mentioned system consists in the following operations:

- the packed product or a few products are placed on the transmission belt;
- scanner 3D of CVP-500 system determines the dimensions of the product/products intended to be packed and the information is sent to the box-manufacturing machine;
- the fanfold cardboard is automatically taken from the feeder. Then, the dispatch box is produced and its dimension is ideally fit to the contents;
- the label is printed and adhered to the box.

The product packed into the discussed box is ready to dispatch. The application of automatic packaging system reduces considerably the costs of the work at the packaging stands (it may replace even up to 10 persons). It also eliminates completely the necessity of using the additional fillers in the boxes as the dimensions of the produced box are fit to the product which is packed in.

THE ADVANTAGES OF THE PACKAGING PRODUCED FROM FANFOLD CORRUGATED BOARD

The main advantages of employing the fanfold board in combination with the machines and lines for manufacture of fanfold corrugated board boxes include:

- a reduced consumption of material – owing to the choice of optimum width of the corrugated board band in relation to the specified dimension of the box;
- the reduced consumption of material – elimination of the necessity of adjusting the additional filling materials in the packaging that is not fit to the size of the product;
- reduction of the negative effect on the environment due to the minimization of raw material wastes in a form of corrugated board;
- saving of storage area: fanfold replaces many individual forms of corrugated board sheets;
- smaller consumption of corrugated board during packaging of the products; in such case, the size of packaging is adjusted to the product alone, there is no “empty” space to be occupied;
- a simplified process of administration of storage, management of reserves and ordering;
- the possibility of better utilization of the existing infrastructure owing to dimensional production of the boxes. Greater quantity of boxes may be places of the truck, on transporter or at every stage of the supply chain.

The fanfold corrugated board conquers the market of raw materials and packaging owing to its competitive advantages. At the very beginning of the application of fanfold corrugated board, it was employed for packaging of the products with big dimensions (furniture); to-day, the range of the application of

the fanfold corrugated board is very wide; they are used in production of packaging of furniture, car parts, electronic products, different consumption good and industrial products and in e-commerce.

LITERATURE

- [1]. Global Fanfold Corrugated Market Size By Products (Single-walled, Double-walled, and Triple-walled), By Applications (E-Commerce, Offline Retail), By Geographic Scope And Forecast. <https://www.verifiedmarketresearch.com/product/fanfold-corrugated-market/>
- [2]. Fanfold Corrugated Market 2020 Industry Size by Global Major Companies like Braepac Packaging, International Paper Company, Smurfit Kappa, DS Smith, etc. <https://menafn.com/1099783904/Fanfold-Corrugated-Market-2020-Industry-Size-by-Global-Major-Companies-like-Braepac-Packaging-International-Paper-Company-Smurfit-Kappa-DS-Smith-etc>
- [3]. Musielak S. K., Kasprzyk J. G. Nowoczesne systemy napędowe w tekturnicy. *Przegląd Papierniczy* nr 6 (69) 2013, s. 363- 368. <https://silo.tips/download/nowoczesne-systemy-napedowe-w-tekturnicy>
- [4]. BHS Corrugated acquires UNIVERSAL, the leading solution provider for continuous Fanfold corrugated board 27.09.2020. <https://www.bhs-world.com/en/news/bhs-corrugated-acquires-universal-the-leading-solution-provider-for-continuous-fanfold-corrugated-board>
- [5]. <https://www.universal-corrugated.com/company/>
- [6]. Market Reports World. Box Making Machines Market 2022 Industry Price Trend, Size Estimation, Industry Outlook, Business Growth, Report Latest Research, Business Analysis and Forecast 2028 Analysis Research. <https://www.newschannelnebraska.com/story/47311977/Box-Making-Machines-Market-2022-Industry-Price-Trend-Size-Estimation-Industry-Outlook-Business-Growth-Report-Latest-Research-Business-Analysis-and-Forecast-2028-Analysis-Research>
- [7]. Transparency Market Research. Corrugated Box Making Machine Market – Global Industry Analysis, Size, Share, Growth, Trends, and Forecast, 2020 – 2030. Corrugated Box Making Machine Market. <https://www.transparencymarketresearch.com/corrugated-box-making-machine-market.html>
- [8]. VPK Group launches its new European brand fit2size® for Fanfold corrugated packaging solutions. <https://www.vpkgroup.com/en/news/vpk-group-launches-its-new-european-brand-fit2size-for-fanfold-corrugated-packaging-solutions>
- [9]. Rewolucja procesu pakowania. E-Commerce, fulfillment, produkcja, Logistics Manager, nr 3 (7), 2019 <http://www.logistics-manager.pl/wp-content/uploads/magalone/lm-032019/pdf/full.pdf>.