Forecasting the Diffusion of Innovations by Analogies: Examples of the Mobile Telecommunication Market

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For successful business planning it is essential for a company to quantify its products' future sales volumes. In this article we present first results on forecasting the diffusion of products in the telecommunication market. The method used is applicable to established products with sales histories as well as to new products prior to their launch. Building on a System Dynamics formulation of the Bass model, Thomas's framework for forecasting by analogies, i.e. existing products with a high degree of similarity to an innovation, is extended. We illustrate the applicability of the forecasting method by simulating future sales of mobile communication devices and inflight mobile phone usage.

Keywords: Diffusion, innovation, analogy, sales forecast, inflight telephony, mobile phones, pagers

One of the most challenging tasks for managers is forecasting sales volumes. In today's business world there is a constant need for accurate forecasting. For example investment decisions and capacity planning depend on a product's predicted market development. In practice it is often observed that managers are able to give good estimates for a new product's market potential and sales figure in the following year. However, the new product's market performance and the time of market saturation remain unclear. Sales forecasting is especially difficult for new products since they have only a short sales history or even none so far, as in the case of an innovation prior to its launch. How can managers estimate an innovation's diffusion in case e.g. test market situations are hard or even impossible to set up?

In the following a forecasting method for new product diffusion will be provided. First we will look at the future market performance of products for which historical sales data are already available. Then we will focus on forecasting the diffusion of innovations which are not yet launched. To illustrate our method hands-on examples of the mobile communication market will be given.

1. Forecasting future annual sales volumes

In the literature the S-shape of diffusion curves has often been proved and is today widely accepted (Meade and Islam 2006). This concept suggests that the market development of a new product follows an S-shaped curve as shown in Figure 1.

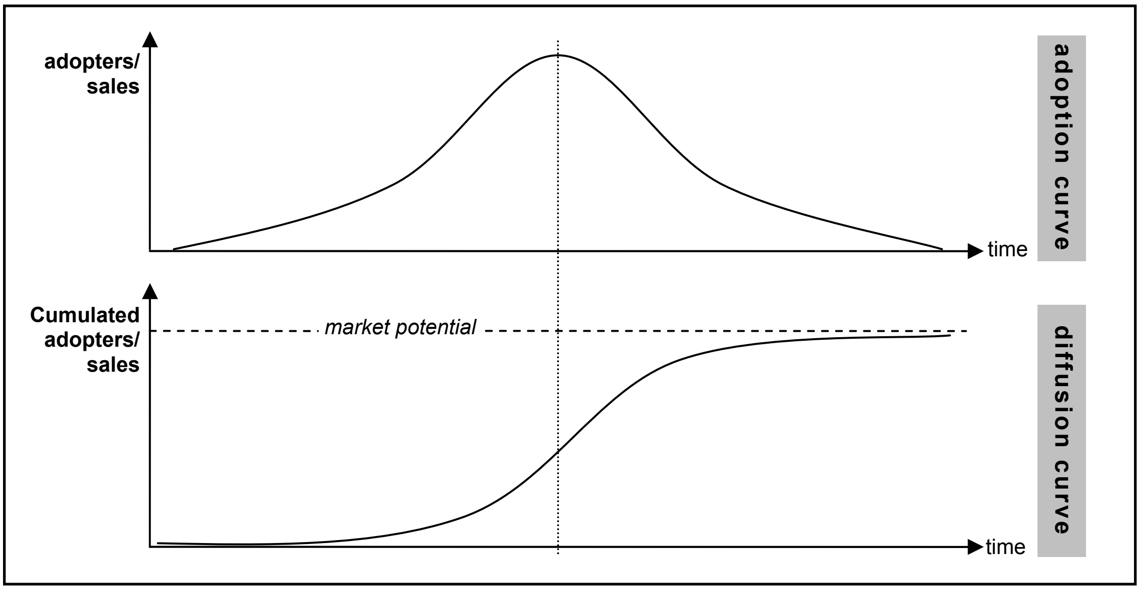

Figure 1: Adoption curve and S-shaped diffusion curve

There will be few users, i.e. adopters, of an innovation in its early days. Then, due to people's response to advertising and word-of-mouth effects demand for the innovation will rise significantly. The diffusion curve's inflexion point indicates the maximum number of new adopters at a time during the product's life. After this point the number of new adopters will slowly decrease until all potential adopters have bought the innovation and the market potential is reached.

1.1. Forecasts for products for which historical sales data are available

The Bass SD-model

The first to analytically and empirically prove the S-shaped pattern of diffusions curves was Frank M. Bass (Mahajan 2000, 3). In the last decades the Bass model (Bass 1969) has proven most useful for describing and forecasting product sales over time (Albers 2004, 243). The model accounts for two categories of adopters: *Innovators*, who are generally interested in new things and are therefore the first to adopt the innovation, and *imitators*, whose adoption decision depends on that of other members of the social system.

In the notation of Milling and Maier the Bass model describes sales x_t in period t as follows (Milling and Maier1996, 79):[1]

$$x_t = \underbrace{\alpha \cdot (N - X_t)}_{Innovators} + \underbrace{\beta \cdot \frac{X_t}{N} \cdot (N - X_t)}_{Imitators}$$

X_t are the cumulated sales until period $t-1$ or the number of adopters at the beginning of period t. N is the market potential, i.e. the number of adopters during the product's life. The fraction of all adopters who are innovators is represented by the innovation coefficient α, i.e. the probability for the very first usage. The imitation coefficient β within the term $\beta * X_t /N$ reflects the pressures on the N-X_t imitators who have not yet adopted in period t.

For the sales forecasting estimates for the constants α, β, and N are needed. The market potential N for the new product has to be quantified considering economic developments and business insights. In order to obtain the innovation and imitation coefficients, α and β, we will turn to System Dynamics. The Bass model equation has already been transferred into a SD-version (e.g. Sterman 2000, 332-9). In the following a conveniently simple Bass SD-model (see Figure 2) will be used to simulate the diffusion process in order to identify the parameters α and β.

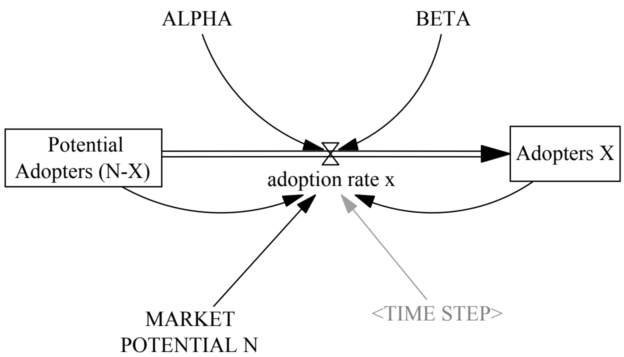

Figure 2: Bass SD-model

The historical sales data available will be approximated by an SD-Model simulation whereby the parameters α and β will be free to adjust. By numerous simulation runs the parameters which generate the best fit between model curve and historical data will be identified based on least square errors between historical data and model simulation.[2] Calibrating the Bass

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[1] Original notation (Bass 1969, 217): *f(t)/(1-F(t))=p+qF(t)=p+qY(t)/m* with *p* and *q* as innovation and imitation coefficient, *F(t)* as cumulative distribution function, and *f(t)* as probability density function of the random variable *t*, the time of new product's adoption. *Y(t)* as cumulative sales at time *t*, and *m* as total market potential.

[2] The best fit between model simulation and historical data is defined as having the maximum payoff. The payoff is a single number that summarises a simulation, measuring the quality of the fit between model curve and historical data. To find the maximum payoff, numerous simulations are run with varying diffusion parameters Alpha and Beta. The parameters are set to be equally important so that their weights for the payoff calculation are 1. At each TIME STEP the historical data set is checked to see if a historical value is available. If it is available, the difference between the data and the model simulation is multiplied by the weight specified and this product is then squared. This number, which is always positive, is then subtracted

SD-model with these values for α and β and an estimate for the product's market potential N will generate a sales forecast simulation with explicit sales volumes at every point in the future.

Case: Mobile phones and pagers

To illustrate the method developed above we will look at examples of the mobile communication market: mobile phones and pagers. A specific of the telecommunication market is that it is partly driven by network externalities. For goods with network externalities frequency and options of usage increase with a growing number of adopters. Table 1 summarises an analysis of the network externalities of mobile phones and pagers.

Type of Network externality	Mobile phones	Pagers
Infrastructure effect *Demand induces offers*	**YES** By large numbers of users suppliers are persuaded to increase their offer, e.g. better area coverage.	**YES** See mobile phones
Member base effect *Individual utility increases with no. of users*	**NO** By existing landline phones a large number of users is already available.	**NO** See mobile phones
Critical mass effect *Utility only if minimum exists*	**NO** This effect is based on the member base effect which is not relevant in this case.	**NO** See mobile phones

Table 1: Network externalities of mobile phones and pagers

The products examined are only characterised by the infrastructure effect. The other two types of network externalities, which can lead to heavily asymmetric behaviour in the SD-simulations, are not relevant here. The infrastructure effect does not need special attention in our framework as the Bass model already implies that supply follows demand (Ihde 1996, 40-1). Therefore, we can proceed applying the forecasting method developed above.

Estimations for market potentials are based on data of the International Telecommunication Union and the United Nations Statistics Division. We will look at European and global market developments separately.

Forecasting the diffusion of mobile phones

The simulation starts in 1991 with the first commercial worldwide use of GSM. The estimated market potential for mobile phones in the European area is 770 million users. As described above the parameters α and β will be obtained using our Bass SD-model's approximation to historical data. Given the diffusion history of mobile phones in the European area the SD-model simulations yield the best fit to the data with the parameters $\alpha = 0.00649549$ and $\beta = 0.456276$ (Figure 3).

from the payoff so that the payoff is always negative. Maximizing the payoff means getting it to be as close to zero as possible.

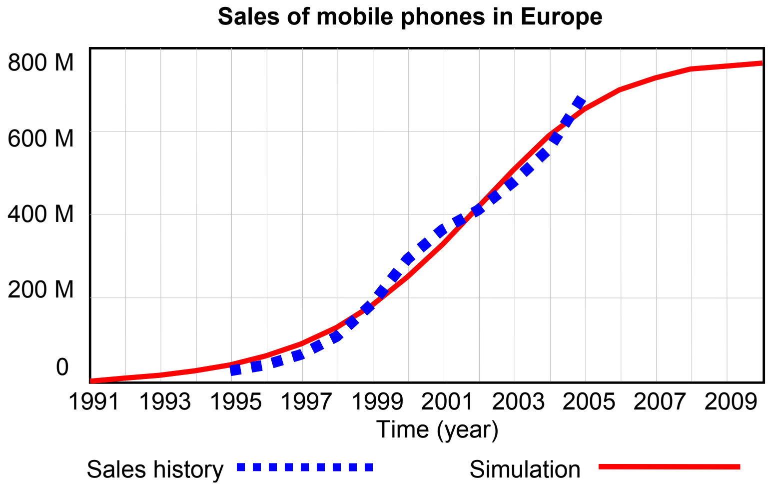

Figure 3: Diffusion of mobile phones in Europe

The global market potential is expected to be 2.34 billion users. The SD model finds the best approximation to the historical data with parameters α = 0.00423316 and β = 0.399059 (Figure 4).

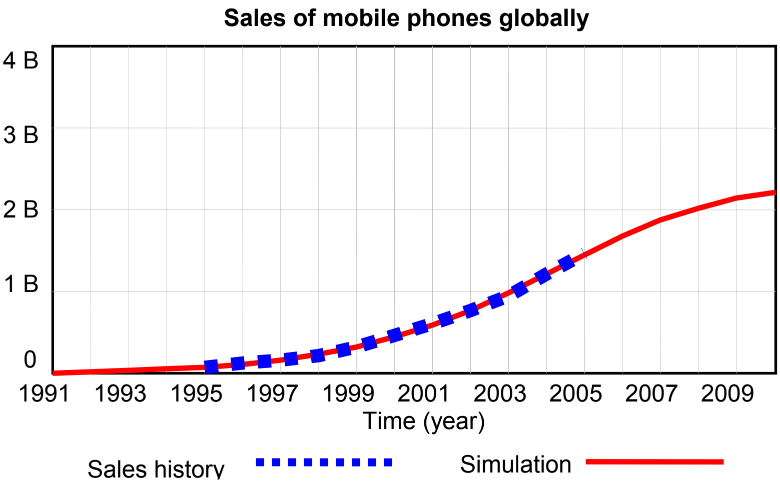

Figure 4: Diffusion of mobile phones globally

Forecasting the diffusion of pagers

Like mobile phones, pagers serve the market for mobile communication and constant availability. The potential of this market is already given above for mobile phones. At the beginning pagers were the only well known and affordable technology in this market. In the middle 1990s pagers were slowly replaced by mobile phones because they incorporate the pagers' features and besides enable active communication. Today sales figures of pagers are declining throughout the world. The estimated European market potential for pagers is (similar to mobile phones) 770 million users. However, due to the market entry of mobile phones the real market saturation is approx. 3.5 million.

The diffusion history of pagers is to be approximated by a model simulation whereby the simulation is to exceed the empirical data in the middle 1990s to show that pager technology was generally substituted by mobile phones. Considering these requirements the best SD-model simulation fit to the historical data is achieved for $\alpha = 0.000127871$ and $\beta = 0.143845$ (Figure 5).

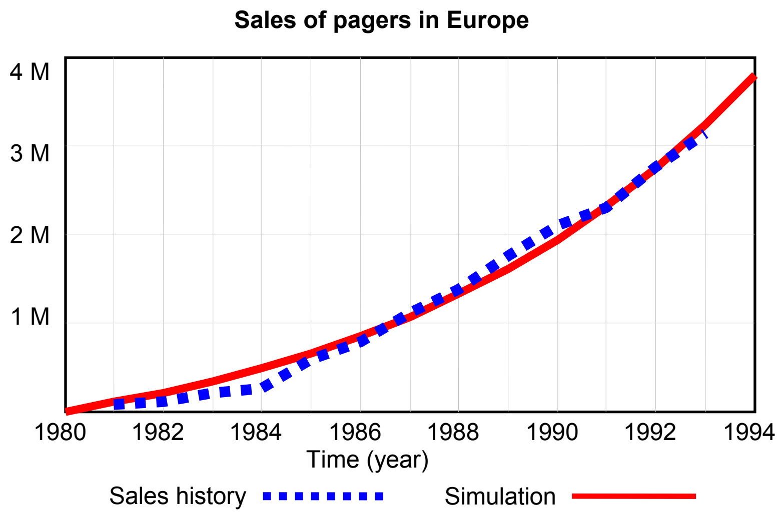

Figure 5: Diffusion of pagers in Europe

The market potential for pagers in the global area is 2.34 billion users. The real market saturation however is approximately 120.5 million. Using the Bass SD-model we can derive the parameters $\alpha = 0.000037908$ and $\beta = 0.285601$ (Figure 6).

Figure 6: Diffusion of pagers globally

Table 2 contrasts the results of our simulations in order to investigate whether the parameters α and β we derived for the two products are plausible.

Product	N	α	β
Mobile phones Europe	770 000 000 p.a.	0.00649549	0.456276
Mobile phones global	2 340 000 000 p.a.	0.00423316	0.399059
Pagers Europe	770 000 000 p.a.	0.000127871	0.143845
Pagers global	2 340 000 000 p.a.	0.000037908	0.285601

Table 2: Overview over the simulation results

Empirical research has found that innovators have high incomes (Rogers 2003, 282-3). Since the statistical per capita income in the European region is higher than in the global area it is logical that the innovation coefficients *α Europe* are bigger than *α global*.

As expected the diffusion of mobile phones was in both areas faster than for pagers. Since both products are sold in the same market with mobile phones integrating the features of pagers, plus allowing active communication, mobile phones are more attractive to all users, innovators and imitators. The superiority of mobile phones is reflected in its comparably high imitation coefficient *β* which indicates intense word-of-mouth effects and social pressure to adopt.

Eye-catching is that at the beginning pagers are globally adopted four times slower than in Europe ($\alpha_{global} < \alpha_{Europe}$), and then diffuse faster ($\beta_{global} > \beta_{Europe}$). As the market for mobile communication has been first accessed by pagers, this technology still had a high degree of perceived newness. Accordingly, the perceived risk was high. Since innovators in Europe can more easily absorb risk due to their good financial situation (European per capita income is higher than the global area) consequently *α Europe* is considerably bigger than *α global*. Interesting is that pagers have faster mass market success in the global region. That is perhaps because in the beginning their perceived relative advantage of the at that time brand new paging technology was higher in comparably sparsely populated global region than in the European area with its dense infrastructure.

The discussion and the comparisons show that the parameters *α* and *β* derived from the SD-model simulations are plausible and consistent. The sales forecasts derived for the new product by calibrating the model parameters α and β using historical sales data are therefore sound and applicable.

1.2. Forecasting a product's diffusion prior to its launch

We have seen how the diffusion of products for which historical sales data is already available can be forecasted. But how do we obtain reasonable parameter estimates for our Bass SD-model if the product has not yet been launched? What if we cannot set up a test market situation to give us an idea about the sales prospects? Forecasting by analogies is the method suggested in this case. It will be described and illustrated with the example of inflight mobile phone usage in the following.

Obtaining parameter estimates using analogies

In order to forecast the diffusion of an innovation the Bass SD-model parameters α and β of the new product need to be estimated. In case no sales history data is available for the innovation, experiences from existing products have to serve as basis for estimations. The more similar the existing products are to the new product the better the estimation. Products with a high degree of similarity to the new product are called analogies.

In the literature there are several approaches to transfering insights from existing products to new products in order to forecast their market development. Bähr-Seppelfricke (1999) defines a general set of product attributes and forecasts a product's diffusion based on its combination of product attributes. Even more simply Easingwood (1989, 69-82) finds that there are different classes of products. Each class is stated to have a distinct diffusion curve so that a new product's diffusion can be forecasted by identifying its affiliated class. Thomas (1985, 45-55) gives a framework for forecasting which is also based on the Bass model. We will further look at this framework in the following, completing Thomas's suggested procedure and its theoretical background.

Our first step towards forecasting an innovation's diffusion is to find appropriate analogy products. These are identified by systematic comparisons whereby the similarity of candidate products and the new products regarding e.g. characteristics of the market environment, production, and demand are examined.[3] Candidate products with the highest degree of similarity to the innovation are called analogies (Thomas 1993, 151-3).

For the chosen analogies the Bass SD-model parameters α and β can be derived from historical sales data as described above we are then able to forecast their future market performance. Here, we complement Thomas's framework who does not clearly state how diffusion parameters α and β may be identified.

In order to know in how far simulation results of the analogies can be transferred to the new product it is necessary to define the relationship between each analogy and the innovation. This can be done drawing on *Multiattribute Choice Theory* which argues that consumers' utility of a product results from their valuation of every single product attribute (Thomas 1985, 49). This micro economic utility function can be translated in a psychologically better interpretable value function (Thaler 1985, 201). According to Fishbein (1963, 233) a person's attitude towards a product is a function of its attributes. The valuation v_j of a product j can therefore be expressed as follows:

$$v_j = \sum_{i=1}^{k} V_i X_{ij}$$

with V_i as the customers' valuation of attribute i, and X_{ij} as assessment in how far product j has attribute i (Bettman 1975, 1).

The customers' valuation v_j expresses in how far the product with its attributes meets the customer's needs. It is actually a measure to tell how similar the assessed product is to the ideal product the customer has in mind. The attributes of the ideal product are evaluated by

[3] For a list of characteristics suitable to evaluate the candidate products to identify analogies see Thomas 1993, 152. Also the PESTEL framework of Johnson/Scholes 2002, 99-103 is recommended which accounts for **p**olitical, **e**conomic, **s**ociocultural, **t**echnological, **e**nvironmental and **l**egal factors.

the customer with an importance V_i. Also the customer determines in how far the assessed product has the attributes of the ideal product (X_{ij}).

In his framework instead of the relationship between assessed product and ideal product Thomas examines the relationship between new product and analogy. This relationship will be the basis for transferring the simulation results from analogies to the innovation. Mathematically Thomas formulates this as follows (Thomas 1985, 50):

$$\alpha_{NP} = \sum_{j=1}^{Z}\left(\sum_{i=1}^{k} V_i X_{ij} A_j\right) = \sum_{j=1}^{Z} v_j A_j$$

$$= \begin{bmatrix} V_1 & V_2 & V_3 & V_4 \end{bmatrix} \cdot \begin{bmatrix} X_{11} & X_{21} & X_{31} & X_{41} \\ X_{12} & X_{22} & X_{32} & X_{42} \\ X_{13} & X_{23} & X_{33} & X_{43} \\ X_{14} & X_{24} & X_{34} & X_{44} \end{bmatrix} \cdot \begin{bmatrix} A_1 \\ A_2 \\ A_3 \\ A_4 \end{bmatrix}$$

$$\beta_{NP} = \sum_{j=1}^{Z}\left(\sum_{i=1}^{k} V_i X_{ij} B_j\right)$$

with α_{NP} and β_{NP} as the new product's innovation and imitation coefficient, $j=1...N$ analogy products, $i=1...k$ attributes of the new product, V_i as the attribute i's importance for the customers, X_{ij} as evaluation in how far the new product has the attributes i of the analogy j, v_j as assessed similarity (or customers' valuation) of analogy j, and A_j and B_j as innovation and imitation coefficients of analogy j, respectively.

According to the procedure of the *Multiattribute Choice Theory* the customers' valuation for a new product is a sum of their valuation for a single product attributes. In the literature the product attributes of the innovation identified by Rogers (2003, 223-66) are the dominant concept: relative advantage, compatibility, complexity, triability, observability. The perceivable risk is often added (Bähr-Seppelfricke 1999). These six attributes can serve as a pattern which can be operationalised for each specific innovation.

As customers already know each of the innovation's attributes form existing products they will be able to evaluate them. They need to assess in how far the analogy has the new product's attributes (X_{ij}) and how important they find each attribute (V_i). The customers' valuation v_j expresses in this forecasting method the similarity between analogy j and new product assessed with the importance of each product attribute i. This assessed similarity measure v_j defines the relationship between analogy and new product. That means this measure tells us in how far the insights from analogies can be transferred to the new product. The parameters α and β of the analogies will therefore be weighed with this assessed similarity measure v_j, giving us the innovation's diffusion parameters α_{NP} and β_{NP}.

In order to be able to simulate the innovation's diffusion its market potential N needs to be estimated. It has to be quantified considering economic developments and business insights. Information sources could e.g. be expert interviews or market studies. Having set the market potential we can finally simulate the innovation's diffusion using our Bass SD-model.

Table 3 summarises the steps of this innovation diffusion forecasting method.

I.	Identify analogy products
II.	Estimate Bass Model parameters for each analogy
III.	Assess importance of the new product's attributes and find out to what extent analogies have the new product's attributes
IV.	Calculate parameters for the new product
V.	Estimate the new product's market potential
VI.	Simulate the new product's diffusion

Table 3: Steps of the innovation diffusion forecasting method

Case: Inflight mobile phone usage

To illustrate the innovation diffusion forecasting method developed above we will now look at a hands-on example from the mobile communication market. Lately a new technology has enjoyed attention in the media: It may soon be possible for passengers to use their own mobile phones on board of an airplane during a flight. We will examine what number of users over time the innovation "inflight mobile phone usage" can expect. Unfortunately, the case presented will not build on our actual data set due to confidentiality arrangements. Hence, the forecast presented will serve illustration purposes only.

Step I: Identify analogy products

To match the new product's components inflight voice call and inflight text messaging the two analogy products chosen are mobile phones and pagers. In the real case inseat telephones and internet on board were also taken into consideration to reflect the special consummation situation onboard during a flight.

Step II: Estimate parameters α and β for each analogy

Here, we can draw on the results of our former analysis summarised in Table 2.[4]

Step III: Assess the innovation's attributes' importance (V) and the similarity between analogies and new product (X)

Having identified the analogies' parameters α and β the challenge is to determine the variables V_i and X_{ij}. The next step is therefore to define the new products' attributes. Table 4 lists the products attributes of inflight mobile phone usage.

[4] In this article the area for short-haul flights is called European market. The regions for long distance flight (without the European traffic) will be referred to as world/ global/ intercontinental market.

New product: Inflight mobile phone usage
Relative advantage
Better availability
Better opportunities of communication
Limited written communication (text messaging)
Talk (voice calls)
Access to information
Exchange of information, interaction
Choice of communication method
Payment per minute (voice calls)
Payment per piece (text messages)
Time saving
Pastime
Compatibility
Mobile Phone usage within existing contract
Communication with existing networks
Social compatibility depending on loudness of communication method used
Usage flexible concerning type, time, and volume for individual needs
Own device usable
Complexity
Retaining familiar usage
Keeping familiar method of payment
Triability
Usage according to individual needs (way, time, volume)
Observability
Usage observable for others
Usage and experiences can be judged and communicated
Perceivable risk
Low economic risk for testing
Insecurity concerning connection quality
Insecurity concerning social acceptance (esp. concerning loudness)

Table 4: The new product's attributes

For each attribute the potential users' assessments of importance V_i and similarity X_{ij} are based on an online survey. The similarity $X_{i,j}$ between analogy *j = mobile phone, pager* and the new product (Table 5, line 1) is the average of the similarity values for all single attributes. For example, mobile phones are 73% similar to the new product while pagers have only 42% similarity.

The next step is to assign to the attributes *i* their importance to the customers V_i. For each attribute this value (V_i) is multiplied by the degree of similarity X_{ij}. The result of this calculation $v_j = \sum_{i=1}^{k} V_i X_{ij}$ is the value v_j which defines the relationship between each analogy j and new product. The values v_j for each analogy are divided by the number of attributes i to norm them on a scale between 0 and 1 (Table 5, line 2).

To derive the new products diffusion model parameters α_{NP} and β_{NP} each analogy has to contribute according to its relationship to the new product. The relations of the values v_j among each other are the weights (Table 5, line 3) with which the model parameters α and β of the analogies will form the new product's diffusion parameters ($weight(j) = v_j \Big/ \sum_{j=1}^{k} vj$). The parameters of analogy mobile phone contribute 64.9% to the parameters of the new product, pagers contribute with 35.1%.

	Mobile phones	Pagers
Similarity between analogy and new product	0.73	0.42
Relationship between analogy and new product (similarity assessed with attribute's importance)	0.48	0.26
Weights (influence of analogy's parameters on new product's ones)	**64.9%**	**35.1%**

Table 5: Relationship between analogy and new product

Step IV: Calculate the new product's parameters

Now, having derived the weights with which the analogies' parameters α and β are to contribute we can calculate the new product's parameters α_{NP} and β_{NP} for e.g. European flights. The results are presented in Table 6.

	Mobiles phones	Pagers
Weights	64.9%	35.1%
Analogies (Europe)		
$\alpha_{Analogy}$	0.00649549	0.000127871
$\beta_{Analogy}$	0.456276	0.143845
New Product (Europe)		
$\alpha_{NewProduct}$	**0.004259534**	
$\beta_{NewProduct}$	**0.346567471**	

Table 6: Diffusion model parameter *α* und *β* of the new products

Step V: Estimate the innovation's market potential

To finally forecast the new product's diffusion it is necessary to assess the market potential of inflight mobile phones (Table 7). The market potential's maximum level is all passengers onboard. Assuming that 85% of European passengers today have a mobile phone onboard this gives us a minimum level for the market potential. For Lufthansa, for example, the annual number of passengers in European traffic is 40.4 million (Lufthansa, 2005).

Market potential N (in m.)	Europe
All passengers	40.4
Passengers with mobile phone on board	85% → 34.3

Table 7: The new product's market potential

Step VI: Simulate the new product's diffusion

Inflight mobile telephony is assumed to be launched in 2007. The Bass SD-model simulations yields a sales forecast for every point of time in the future. Given the maximum and minimum market potential the sensitivity towards estimations of *N* can be analysed. In our illustrative case market saturation will occur around 2035 with the maximum market potential and in approximately 2034 for the minimum *N* (Figure 7). The maximum annual number of sales can be expected in 2021 (Figure 8). At this point of time about 50% of the passengers are already using their mobile phones during flights.

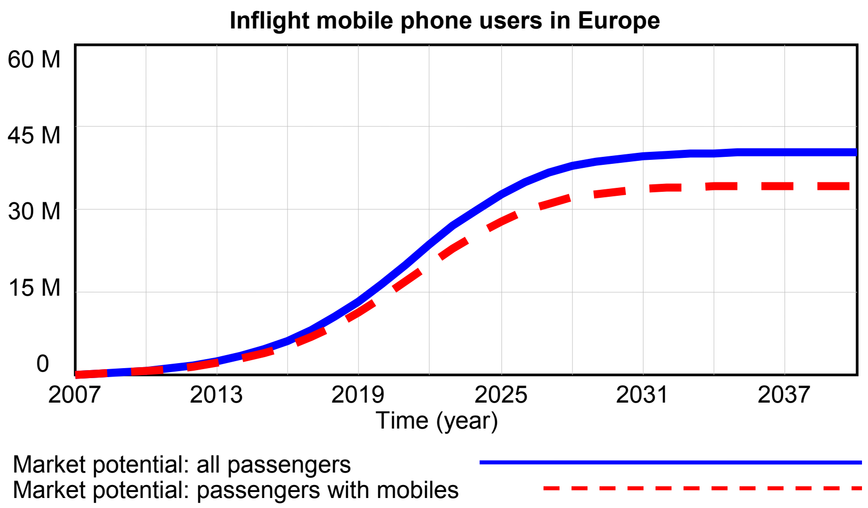

Figure 7: Inflight mobile phone usage in Europe

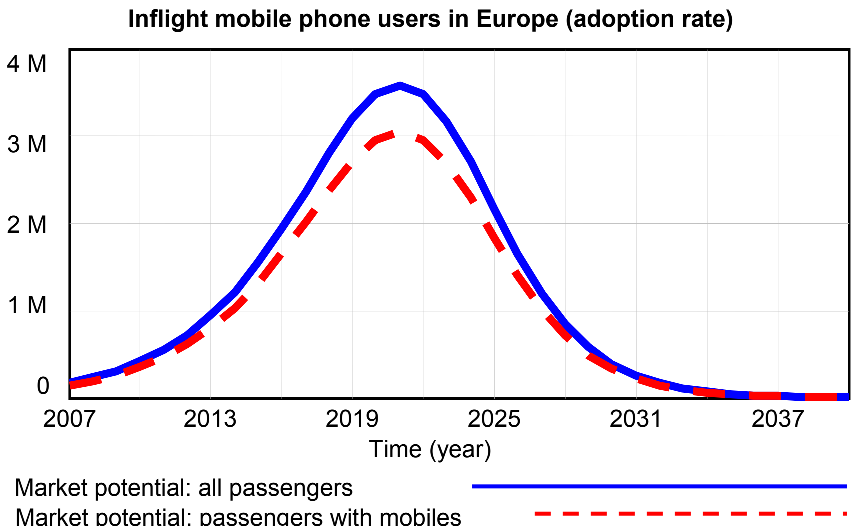

Figure 8: Annual number of innovation's new users in Europe

The results obtained can serve as a basis for a business case. In order to decide whether or not the inflight mobile phone usage is e.g. favourable for an airline, the forecasted number of users is the essential information needed. Building on this, communication habits, usage prices, an underlying business model, and costs calculations can be compiled in a business case. Its results, along with other important determinants such as image and product philosophy, will then lead to a management decision whether or not an innovation is favourable.

2. Conclusion

Based on the S-shaped diffusion curve of the Bass equation we have developed a method to forecast the diffusion of established products with sales histories as well as the diffusion of new products prior to their launch. Building on a System Dynamics formulation of the Bass model, Thomas's framework for forecasting by analogies, i.e. existing products with a high degree of similarity to an innovation, has been extended.

The applicability of the forecasting method has been illustrated by simulating future sales of mobile phones, pagers, and inflight mobile phone usage. The resulting sales forecasts are the basis for investment decisions. Building on the method's simulation results it is possible to calculate business cases and assess a product's future potential.

Prerequisite for the business use of our method is that its results enjoy the necessary acceptance among the decision takers. The simplicity of the underlying model, the Bass-SD-model, serves this purpose adequately. This clear, transparent, and empirically proofed basis of our forecasts will facilitate a wide acceptance of the method's results. Moreover, the forecasting by analogies is strongly based on customers' evaluations (see Step III). Their fears, habits, likes, and dislikes are thus directly included into the forecasting method enforcing the acceptance of its results.

3. Further research

The quality of the forecasts conducted with the methodology developed above depends on several critical steps: the choice of appropriate analogy products, an estimation of the market potential, the division of the new product into product attributes, and the survey's respondents. Therefore, managers' experience, e.g. supported by expert interviews, is crucial to ensure quality forecasts. Sensitivity analysis and plausibility checks for the results derived are always recommended.

Futher research may overcome the methods weaknesses in the future. For example, so far the method does not indicate what the threshold is that distinguishes candidate products from analogies. Neither is there a standard evaluation metric to assess a candidate's suitability.

Also research may focus on a technique that can generally be applied to divide the innovation into its attributes. As Rogers' product characteristics that we applied in our analysis are rather vague, a starting point would be to develop a way to operationalise them.

The forecasting method can also be improved by integrating more influencing variables into the SD-model without spoiling the model's advantageous simplicity. The pure Bass equation, i.e. the SD-model's basis, does not offer the possibility to simulate a flop. Within this theory product's market potential will always be reached.

Moreover, it would be interesting to be able to forecast not only the number but also the frequency of usage. In our case of inflight telephony the model would then be capable to simulate not only how many users there will be in the future but also how often they will use their mobile phones during flights.

REFERENCES

Albers, Sönke. 2004. Forecasting the Diffusion of an Innovation Prior to Launch. In *Cross-functional Innovation Management. Perspectives from Different Disciplines*, edited by Sönke Albers, 243-258. Wiesbaden: Gabler.

Bähr-Seppelfricke, Ulrike. 1999. *Diffusion neuer Produkte – Der Einfluss von Produkteigenschaften*. Wiesbaden: Deutscher Universitäts-Verlag.

Bass, Frank M. 1969. A New Product Growth Model for Consumer Durables. *Management Science* 15 (5): 215-227.

Bettman, James R., Noel Capon and Richard J. Lutz. 1975. Multiattribute Measurement Models and Multiattribute Attitude Theory – A Test of Construct Validity. *Journal of Consumer Research* 1 (4): 1-15.

Easingwood, Christopher J. 1989. An Analogical Approach to the Long Term Forecasting of Major New Product Sales. *International Journal of Forecasting* 5: 69-82.

Fishbein, Martin. 1963. An Investigation of the Relationships between Beliefs about an Object and the Attitude towards that Object. *Human Relations* 16: 233-240.

Ihde, Olaf. 1996. *Internationale Diffusion von Mobilfunk – Erklärung und Prognose länderspezifischer Effekte*. Wiesbaden: Deutscher Universitäts-Verlag.

Johnson, Gerry and Kevan Scholes. 2002. *Exploring Corporate Strategy*. Harlow: Pearson Education.

Mahajan, Vijay, Eitan Muller and Yoram Wind. 2000. New-Product Diffusion Models – From Theory to Practice. In *New-Product Diffusion Models* edited by Vijay Mahajan, Eitan Muller, and Yoram Wind, 3-24. Boston: Kluwer Academic Publishers.

Meade, Nigel and Towhidul Islam. 2006. Modelling and Forecasting the Diffusion of Innovation – A 25 Year Review. *International Journal of Forecasting* 22: 519-45.

Milling, Peter and Frank Maier. 1996. *Invention, Innovation und Diffusion – Eine Simulationsanalyse des Managements neuer Produkte.* Berlin: Duncker und Humbolt.

Rogers, Everett M. 2003. *Diffusion of Innovations*. New York: Free Press.

Sterman, John D.: Business Dynamics – Systems Thinking and Modeling for a Complex World, Boston 2000,

Thaler, Richard. 1985. Mental Accounting and Consumer Choice, in: *Marketing Science* 4 (3): 199-214.

Thomas, Robert J. 1985. Estimating Market Growth for New Products: An Analogical Diffusion Model Approach. *Journal of Product Innovation Management* 2: 45-55.

Thomas, Robert J. 1993. *New Product Development – Managing and Forecasting for Strategic Success*. New York: Wiley.

Online Data Sources

Deutsche Lufthansa AG. 2006. *Annual Report 2005*. Date of access: 24 Mar 2007 http://www.lufthansa-financials.de/lhir/pdf/en/DLH-GB_2005e.pdf.

GSM Association. *Brief History of GSM & the GSMA*. Date of access: 15 Aug 2006. http://www.gsm world.com/about/history.shtml.

International Telecommunication Union (ITU). 2005. *Europe's Telecommunication / ITC Markets and Trends 2003/2004*. Date of access: 29 March 2006. http://www.itu.int/ITU-D/ict/statistics/at_glance/Europe_RPM _2005.pdf.

RCR Wireless News. *RCR's Top 20 – International Paging Markets*. Date of access: 27 July 2006. http://www.rcrnews.com/files/intl%20paging.pdf.

United Nations Development Programme. *Human Development Report 2005*. Table 5 Demographic Trends. Date of access: 28 June 2006. http://hdr.undp.org/statistics/data/indicators.cfm?x=123&y=1&z=1.