Are we connected?

Ports in Global Networks

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of Erasmus Trust Fund Endowed Professor of Ports in Global Networks
at the Rotterdam School of Management, Erasmus University,
on Friday, November 13, 2015.

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Samenvatting

Wereldwijde *supply chains* zijn gebouwd op drie met elkaar verbonden netwerken: organisatorische, informatie en logistieke. Havens worden via deze netwerken verbonden, en moeten deze netwerken ook verbinden. Synchromodaliteit is een innovatief concept voor (container) transport, en de haven speelt een belangrijke rol bij de verwezenlijking ervan door het verbinden van vervoersnetwerken. De vele wereldwijde *supply chains*, die de haven gebruiken als knooppunt, verwachten de levering van toegevoegde waarde, en dit kan worden verstrekt door het onderling verbinden van de drie soorten netwerken, bijvoorbeeld via het *Port Community Systeem*. Wereldwijde *supply chains* kunnen duurzamer zijn wanneer onderling verbonden netwerken zichtbaarheid creëren, samen met de juiste mechanismen om niet alleen monetaire waarde te ondersteunen, maar ook andere waarden zoals veiligheid en ecologische *footprint*.

Het onderzoek dat nodig is om deze thema's verder te ontwikkelen maakt gebruik van kwantitatieve modellen uit de *operations management*. De ambities en plannen van de leerstoel *Ports in Global Networks* omvat drie met elkaar samenhangende onderzoeksthema's:

(1) Het synchroniseren van transportnetwerken;
(2) Het verbinden van de zeehavens met de wereldwijde supply chains; en
(3) de coördinatie van de wereldwijde supply chains voor duurzaamheid.

De MSc *Supply Chain Management* en de Executive Master *Douane en Supply Chain Compliance* zijn beide onderdeel van het onderwijsprogramma van de leerstoel. De Leiden-Delft-Erasmus *Centre Metropolis & Mainport* bevordert de interuniversitaire samenwerking. Het *SmartPort* initiatief maakt uitgebreide samenwerking met de havengemeenschap van Rotterdam mogelijk. De leerstoel heeft de ambitie om een belangrijke rol spelen in zowel *Metropolis & Mainport* als in *SmartPort*.

Abstract

Global *supply chains* are built on three interrelated networks: organizational, information, and logistics. Ports are connected via these networks, and also need to connect these networks. Synchromodality is an innovative concept for (container) transportation, and the port plays an important role in deploying synchromodality by connecting transportation networks. The large number of global *supply chains* that use the port as a hub require added value, and this can be provided by interconnecting the three types of networks, for example, via the *port community system*. Global *supply chains* can be more sustainable when interconnected networks create visibility, together with the proper mechanisms to support value creation, not just monetary value, but also other values such as security and environmental *footprin*t.

The research required to further develop these topics makes use of quantitative modeling from the field of *operations management*. The ambitions and plans of the Chair *Ports in Global Networks* include three interrelated research topics:

(1) Synchronizing transportation networks;
(2) Connecting seaports to global supply chains; and
(3) Coordinating global supply chains for sustainability.

The MSc *Supply Chain Management*, and the Executive Master *Customs and Supply Chain Compliance* are both involved in the educational program of the Chair. The Leiden-Delft-Erasmus *Centre Metropolis & Mainport* fosters the interuniversity collaboration. The *SmartPort* initiative enables substantial collaboration with the port of Rotterdam community. The Chair has the ambition to play a key role in both *Metropolis & Mainport* and *SmartPort*.

Content

1. Introduction

Dear Rector Magnificus,
Dear colleagues,
Lieve familie en vrienden,
Dear distinguished guests,

Are we connected? Well, perhaps not at this very moment, because you have just been asked to switch off your phones. But maybe you just received a text message as you were connected to an information network. I am very happy that we are together here today. You may be one of my colleagues here at Erasmus University, or you may work at an organization that has ties with the university. We all have personal ties and business relationships. So we are all involved in social networks or in organizational networks. And to get here today, you made use of one or more transportation networks, whether you came on foot, by bike, by car, or by public transport.

In other words, we all are connected via multiple networks, such as information networks, social networks, organizational networks, and transportation networks, and we make use of these networks. The same holds true for seaports.

Figure 1: (a) Deep sea container vessel.

Source: www.ect.com (Courtesy Europe Container Terminals).

It is quite obvious that seaports are connected via multiple networks. We are all aware of the maritime transportation network that connects ports when we see the large vessels call upon our ports at the seaside (see Figure 1.a).

At the landside, we also experience transportation networks, be it the road network with trucks, the railway network with freight trains, or the waterway network with river vessels (see Figure 1.b-d).

Figure 1: (b) Truck. Source: www.ect.com (Courtesy Europe Container Terminals).

Figure 1: (c) Train. Source: www.ect.com (Courtesy Europe Container Terminals).

Figure 1: (d) Barge. Source: www.ect.com (Courtesy Europe Container Terminals).

Therefore, the answer to the question: *Are we connected?* is yes, if we pose the question from the viewpoint of seaports. However, we may extend the question: *Are we connected to multiple networks, and how do we make use of these connections in the best way?* This is what we really want to know. For the case of ourselves as individuals; we enjoy getting involved in social media by connecting via information networks. However, for meaningful use of social media, it is necessary, albeit not sufficient, to connect the information network with our social network, consisting of relationships between people.

The Chair title *Ports in Global Networks* emphasizes that seaports (from now on: ports) are positioned in a variety of global networks.[1] I will argue that ports need to be focal nodes in organizational, information, and logistics networks to create value by being connected via these networks, *and* by connecting these networks. I will not only focus on the creation of economic value, but also on the creation of other values.

1 Quite a few of the observations made about seaports in this document hold true for airports as well.

2. Global supply chains and networks

In this section, we will elaborate on the role of ports in global supply chains, and how supply chains are built on networks. Global supply chains help us to transform raw materials, such as mining products and agricultural products, into more sophisticated products such as smart phones and ... tomato soup (see Figure 2).

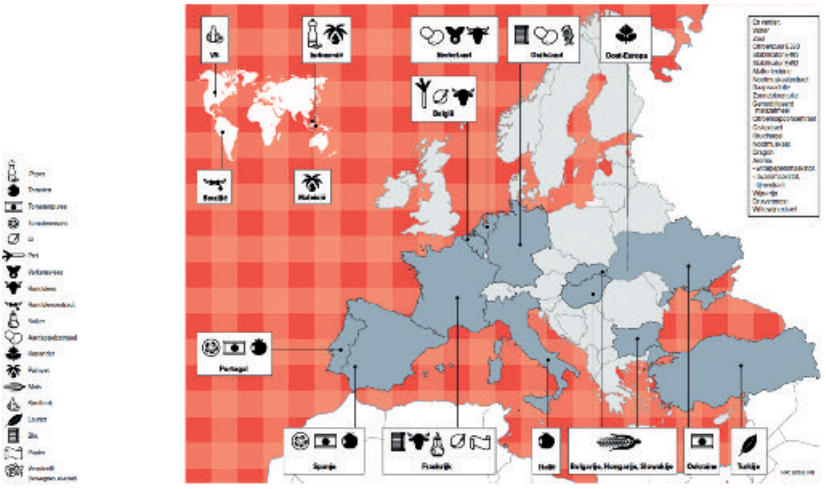
Figure 2: Smartphone and can of tomato soup.

A recent publication in one of our national newspapers[2] described the global supply chain of tomato soup (see Figure 3). It is not very surprising that food products are global, as the first global companies went out to source spices from overseas starting in the 16th century.[3]

2 The Economics section of NRC Handelsblad, published on September 12, 2015, contained a number of contributions related to the tomato soup global supply chain of Unilever brand Unox.

3 A teaching case on 17th century VOC, by Albert Veenstra at the Rotterdam School of Management, has been used in the elective course *Ports in Global Networks* and in the Executive Master *Customs and Supply Chain Compliance*.

Figure 3: The tomato soup global supply chain[4] (Courtesy NRC Handelsblad).



The description in the newspaper shows that a straightforward product such as tomato soup is actually a complex assembly of a large number of ingredients – 37 in fact. Moreover, these ingredients are sourced worldwide, and certain subassemblies, like the blend of spices used in the soup, are produced as intermediate products.

Supply chains have become more complex. It is possible to source, make, deliver, and return products at a global scale. This development has been coined "globalization".[5] This inaugural speech delivered in English is also a consequence of globalization. The introduction of the maritime container (see Figure 4) as standardized loading unit,[6] together with the standardization of transportation, storage, and handling equipment and processes, have spurred a self-enforcing cycle of growing international trade and factors that reduce "logistics frictions" such as trade agreements and lower transportation costs.[7]

4 Figure taken from NRC Handelsblad, Economics special, September 12, 2015, pp E8-E9, courtesy NRC Handelsblad.

5 Theodore Levitt (1983). The Globalization of Markets. Harvard Business Review 61(3): 92-102.

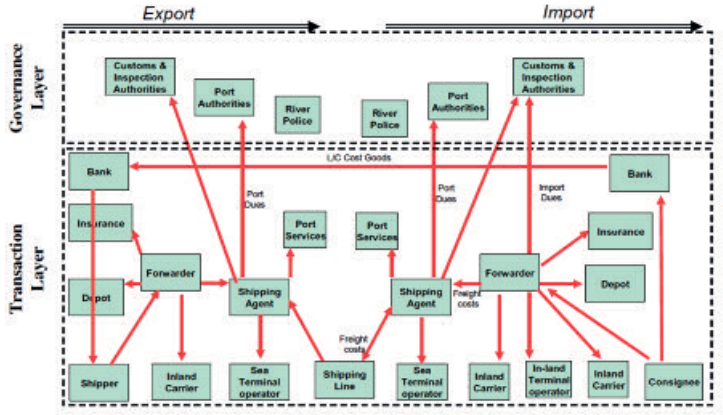
6 The concept "The Physical Internet" propagates the use of standardized loading units throughout the logistics chain for all shipments (see Jeffrey Mervis (2014). The Physical Internet would move goods the way its namesake moves data. Science 344(6188): 1104-1107).

7 Marc Levinson (2006). The Box: How the shipping container made the world smaller and the world economy bigger. Princeton University Press, Princeton and Oxford.

Figure 4: Maritime container.

The standardized loading unit, or a container, is twenty feet long, i.e., about six meters. It can carry about 20 metric tons of goods and can be transported and handled when moving goods around the world.[8] We can use a one-size-fits-all approach to do so and this saves time and money. During my inaugural speech in December 2011, when I accepted the Chair of Freight Transport and Traffic Networks at Civil Engineering and Geosciences at Delft University of Technology, I paid quite some attention to an alternative for the one-size-fits all approach. I will get back to this later.

Figure 5 (a): Supply chains built from multiple networks:
This figure displays an organizational network, which reflects the global supply chain of containerized goods.

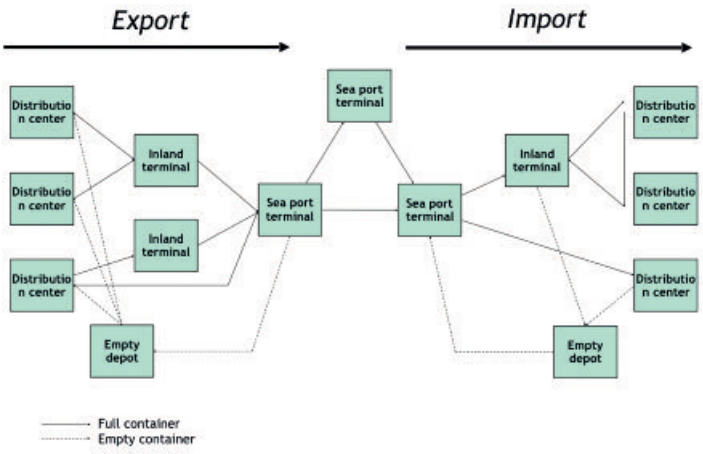


8 The maritime container has been recognized as the most important invention of the past century by the Dutch Academy of Sciences and NRC Handelsblad in an essay contest, won by my colleague Bart Kuipers with his essay "Ja, de container is uitvinding van de eeuw", published in NRC Handelsblad on October 11, 2014.

It has often been argued that supply chains are not linear but more complicated networks.[9] I would like to emphasize that (global) supply chains are built on a number of networks that interact. First of all, a typical focal company in a global supply chain connects with a number of suppliers and customers through business relationships. A global supply chain is built on an organizational network in this way (see Figure 5.a).

Second, if the global supply chain brings forward physical goods, a logistics network emerges that connects sourcing, production, warehousing, and customer use through transportation services (see Figure 5.b).

Figure 5 (b): Supply chains built from multiple networks:
This figure displays an logistics network, which reflects the global supply chain of containerized goods.

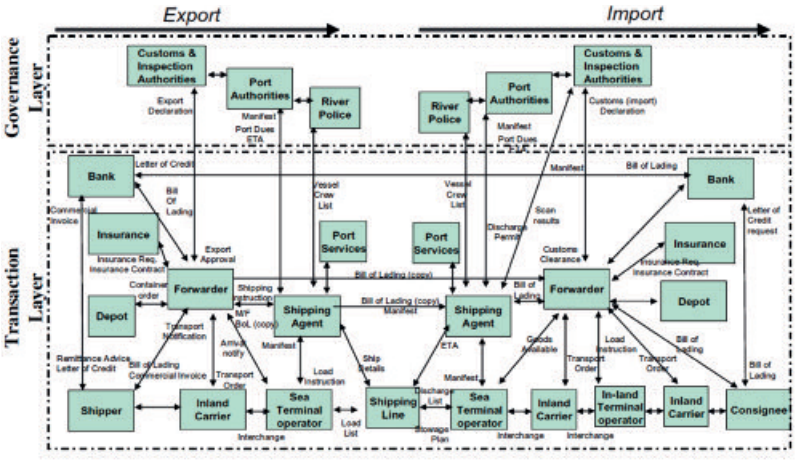


Third, supply chain organizations exchange data between information systems in order to design, plan, and execute processes. The exchange of information in international trade and logistics involves supply chain partners, but also insurance and financial institutions, and government agencies (see Figure 5.c). The international shipment of a container involves dozens of information exchanges between organizations through inter-organizational information systems.[10]

9 For example, see Peter Vervest, Eric van Heck, Ken Preiss, and Louis-Francois Pau (2005). Smart Business Networks, Springer.

10 Peter van Baalen, Rob Zuidwijk, and Jo van Nunen (2008). Port Inter-Organizational Information Systems: Capabilities to Service Global Supply Chains. Foundations and Trends in Technology, Information and OM 2(2-3): 81-241.

Figure 5 (c): Supply chains built from multiple networks:
This figure displays an information network, which reflects the global supply chain of containerized goods.



In this inaugural speech, I will show how these three types of networks appear in my academic work in an interconnected way. A guiding question is:

Which methods should we use to identify and quantify the benefits of connecting organizational, information, and logistics networks?[11]

11 This document focuses on research problem formulations rather than on methodological details, but some indications will be given of the methods used.

3. Synchronizing transportation networks

In this section, transportation networks will be connected. I will argue that this is done by synchronizing the planning and execution of transportation services on various networks and by synchronizing the services with the needs of the final customers, the shippers of the goods.

Synchromodal transport refers to a recent development in the transportation world. Admittedly, it has become a bit of a buzz-word. It has received a lot of attention from stakeholders in the port community and the port hinterland, and it has been put on the agendas of the Dutch top sectors and the European Commission, as there are quite some research challenges at hand.[12]

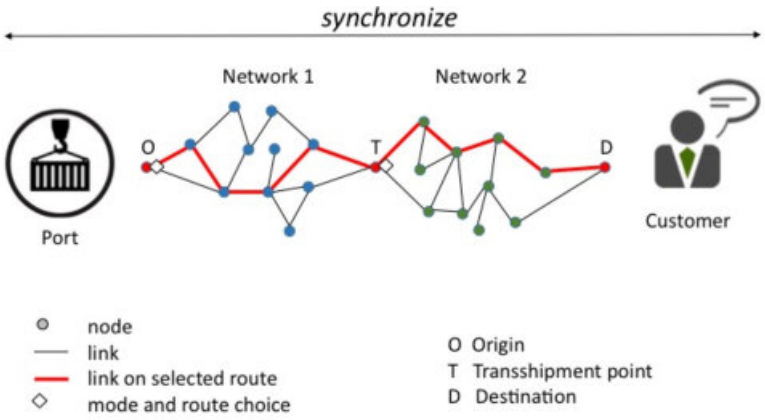
But first let me explain what synchromodal transport is. We will focus on the transportation of standardized loading units, in other words, containers. A river vessel (or barge) is a great transportation means. Although it is expensive to operate and quite polluting, the costs and emissions of barge transportation *per container* are quite low if the barge carries a lot of containers. However, a disadvantage of barge transport is that not all destinations can be reached directly. Often, the containers have to be loaded off the barge, loaded onto a truck, and transported to their final destination. Intermodal transport, which uses multiple transport modes, such as barge, rail, and truck, requires transshipment between modes. The use of standardized containers and handling equipment has made intermodal transport more efficient. But the various transport modes each operate on separate networks: road networks, rail networks, and waterway networks. And each of these networks has its own services. In particular, barges and trains are usually operated according to fixed schedules. Especially those of you who are familiar with public transport understand that if you need to connect between networks, then you end up waiting. That is, if the networks are not synchronized. But first, you have to synchronize your transport services to the needs of the customer, the shippers of the goods. That sounds like a pretty good idea, because they are the ones paying the bill. The only thing that you need to convince yourself of is: *Do I know what the customer really wants?* Assume that two weeks ago you agreed with the customer that the goods should be delivered in Venlo at noon on Tuesday. Are you sure that this agreement still reflects the actual wishes of your customer? Maybe things have changed, and your customer would prefer the goods to be delivered earlier or later. This is the first challenge of synchromodal transport. Second, you have to synchronize your

12 See the national program on logistics (www.topsectorlogistiek.nl) and the challenge on Smart, Green and Integrated Transport of the Horizon 2020 program (ec.europa.eu).

transport services across different networks, e.g., transport services on the rail network with the transport services via the road network. This synchronization will have its own dynamics, as schedules are not always adhered to, due to delays, and so on. In contrast to the situation of public transport, containers do not run from one train to the other. The transfer of containers from one transport means to the other requires handling equipment that needs to be planned as well. To synchronize transport services across various networks, the transport means and handling equipment need to be scheduled and planned carefully. This is the second challenge of synchromodal transport.

Synchromodal transport[13] addresses these two challenges by offering flexible transport services. For example, when a customer books transport two weeks in advance, no specific transport capacity, such as a slot on a barge, will be reserved. Instead, the actual demand for transport, namely the destination with preferred time of delivery will be agreed upon, and updated if necessary. Reserving capacity in the transport system takes place without specifying how the transport will be executed. For example, a synchromodal transportation system will use a truck when it is idle at the right place, and will load the container onto the barge if the departure time and expected transit time of the barge can ensure that the container arrives at the final destination on time. In other words, the opportunistic allocation of containers to transport modes at the last moment is possible by booking transportation without specifying the mode of transport. Moreover, in this way, the transport execution can be tuned to the actual needs of the customer.

Figure 6: Synchromodal transport.



13 Behzad Behdani, Yun Fan, Bart Wiegmans, and Rob Zuidwijk (2015). Multimodal Schedule Design for Synchromodal Freight Transport System. European Journal of Transport and Infrastructure Research, Under Review.

In Figure 6, we indicate synchromodal transport in a stylized fashion. Both at the origin (O), which could be at the port, and at transshipment points (T), a mode of transport and route are decided to meet customer demand at the destination (D) in the best way. Note that the choice for a particular mode of transport may still allow for multiple routes on the mode network. Moreover, the route between origin and destination may involve multiple consecutive modes of transport, and therefore may involve multiple networks. The transportation services on the different networks and the needs of the customers have to be synchronized to ensure efficient transportation while meeting customer needs.

We may conclude:

Synchromodal transport aims to synchronize between transportation networks and the customer demands.

Academic research aims to develop methods to quantify to what extent synchromodal transport improves performance, compared to e.g. truck transport or intermodal transport in the case when transport modes are booked in advance. Let me outline how we have embarked on this research in a number of projects. As usual, we build from earlier experiences on related research topics.

The pick-up and delivery of containers from and to the port by truck is known as container drayage, a problem studied by Jordan Srour during her PhD studies under my supervision and with promotor Steef van de Velde[14]. A fleet of trucks needs to be dispatched and routed in such a way that customer demands are met and the truck fleet is utilized as much as possible, i.e., so that the number of empty kilometers is minimized.[15] In the process, containers are allocated to fleet capacity. Allocating containers to train and barge capacity is even more difficult, as a large number of containers are transported by a single transport means, i.e., a barge or train set. In most cases, this coordination problem is solved by offering a schedule with fixed departure times along fixed routes. Even in such cases, providing smooth connections between transport services is difficult, and is also an interesting topic of research in public transportation.[16]

14 Jordan Srour (2010). Dissecting Drayage: An Examination of Structure, Information, and Control in Drayage Operations. PhD thesis, Erasmus University.

15 Tamas Mahr, Jordan Srour, Mathijs M. de Weerdt, and Rob Zuidwijk (2010). Can agents measure up? A comparative study of an agent-based and on-line optimization approach for a drayage problem with uncertainty. Transportation Research: Part C 18(1): 99–119.

16 Leo G. Kroon, Leon W.P. Peeters, Joris C. Wagenaar, and Rob A. Zuidwijk (2014). Flexible connections in PESP models for cyclic passenger railway timetabling. Transportation Science 48(1): 136-154.

Due to its dynamic nature, synchromodal transport requires coordination and information exchange between organizations, since multiple organizations and networks are involved. Therefore, the availability of quality information puts synchromodal transport in a more favorable position,[17] in certain cases competitive with truck transport for time-pressed shipments.

The provision of capacity in a synchromodal setting, where transport bookings are made without specifying the mode of transport, requires a unified approach toward the available transport service capacities on road, rail, and waterway networks. This is challenging as the nature of the use of infrastructure capacity by transport services varies among transport infrastructures. As road traffic relates to the use of infrastructure capacity by autonomous travelers, traffic management comes down to guiding travelers to make optimal use of the infrastructure.[18] In contrast, the use of rail infrastructure is governed by the centralized allocation of capacity to demand in rail networks. Allocating infrastructure capacity to traffic flows, and vehicle capacity to containers that need to be transported brings new research challenges.

The differences among the various transport modes and networks have received little attention in the existing body of knowledge.[19,20] New research could explore which methods are fit to comprehensively assess transport capacity across various infrastructures and modes, in order to decide on the allocation of demand to available capacity in a synchromodal system.

The booking of transport modes in advance signals that capacity needs to be reserved and that logistics and administrative procedures need to be planned and executed. If the booking is not mode specific, such a signal is not given and the planning and deployment of resources therefore requires careful consideration. In particular, pricing bookings that are not mode specific is not straightforward, since the associated costs depend on choices to be made upon

17 Rob Zuidwijk and Albert Veenstra (2015). The value of information in container transport. Transportation Science 49(2): 675-685.

18 M. Papageorgiou, M. Ben-Akiva, J. Bottom, P.H.L. Bovy, S.P. Hoogendoorn, N.B. Hounsell, A. Kotsialos, and M. McDonald (2007). ITS and Traffic Management, in: Cynthia Barnhart and Gilbert Laporte, Editor(s). Transportation, Handbooks in Operations Research and Management Science 14, pp. 715-774. Elsevier.

19 An Caris, Cathy Macharis, Gerrit Janssens (2013). Decision support in intermodal transport: A new research agenda. Computers in Industry 64 (2): 105-112.

20 Teodor Crainic and Kap Whan Kim (2007). Intermodal transportation, in: Cynthia Barnhart and Gilbert Laporte, Editor(s). Transportation, Handbooks in Operations Research and Management Science 14, pp. 467–537. Elsevier.

arrival of the container. Research could focus on methods to determine optimal pricing policies, which support the allocation of transport capacity to demand for bookings that are not mode specific.[21]

So far, we focused on research that studies alternatives to truck transport, such as intermodal and synchromodal transport. On the other hand, recent developments in automated driving and truck platooning may change the competitive position of trucking, also from an environmental point of view. Together with Niels Agatz, I will focus on business models and planning tools that support the adoption of truck platooning among road carriers.[22] Truck platooning occurs when two (or more) trucks drive in convoy. In order to obtain fuel savings, the distance between trucks needs to be very short (0.3 seconds) which requires automated driving capabilities and communication technologies between trucks. For truck companies to invest in such technologies and to form platoons with trucks of other road carriers, business models and planning methods that bring interesting value propositions to the stakeholders involved need to be developed. In this case, the organizational network of the road carriers and the transportation network of road trips need to be connected.

21 The funded NWO project, Integrated Synchromodal Transport System Analysis (ISOLA), allows us to further the work on synchromodal transportation with a new PhD student.

22 We have recently started an NWO funded project on truck platooning, and the Port of Rotterdam has specific interest in the concept and the impact it may have on environmental performance and accessibility of the port.

4. Connecting seaports to global supply chains

One of the main challenges that global hubs such as the port of Rotterdam face is the sustainable development and use of its logistics capabilities. The connectivity (or accessibility) of the port can be measured as the extent to which the port is able to handle sea vessels and land transport modes effectively, efficiently, and in a timely fashion. The Rotterdam Port Authority has put a lot of effort into improving the connectivity of the port both at the land side and at the sea side. The capacity at the sea side is being enlarged by the construction of a number of deep sea terminals by competing port operators on a recent land extension, called Maasvlakte II.[23] To enhance the connectivity at the land side, the Port of Rotterdam Authority created, together with other organizations, companies to improve accessibility on the road network (Traffic Management Company) and the rail network (Keyrail).[24] Other ports in the world, such as the Ports of Los Angeles and Long Beach, have also made investments to improve their connectivity.[25]

Market organizations, such as the deep sea terminal operators, also play a role in improving the land side connectivity. For example, Europe Container Terminals (ECT) is developing new services to more effectively use alternative transport modes (i.e., other than truck), according to the extended gate concept. An extended gate is "an inland intermodal terminal directly connected to seaport terminal(s) through high capacity transport means such as river vessel and train, where customers can leave or pick up their standardized loading units at the inland terminal as if directly at a seaport, and where the seaport terminal(s) can choose to control the flow of containers to and from the inland terminal."[26]

This development has inspired our research on the impact of new business models on the design, planning, and execution of multimodal transportation services on a network. PhD candidate Panagiotis Ypsilantis is studying the joint design and pricing of container multimodal transport services in an extended

23 APM Terminals and Rotterdam World Gateway opened new terminals on Maasvlakte II in 2015.

24 See the strategy document "Port Compass" of the Port of Rotterdam; in particular, the section on accessibility.

25 The Alameda Corridor is a fast rail connection between the Ports of Los Angeles and Long Beach, and the national rail system near downtown Los Angeles (also see www.acta.org).

26 Albert Veenstra, Rob Zuidwijk, and Eelco van Asperen (2012). The extended gate concept for container terminals: Expanding the notion of dry ports. Maritime Economics and Logistics 14: 14-32.

gate network,[27] and has compared port-to-door transport and port-to-port transport. It turns out that prices of port-to-door transport are determined by the market, so revenues are fixed, and transportation service design is cost-based. In contrast, the pricing of port-to-port transport needs to be considered jointly with service design; the profit maximization is not only driven by cost minimization, but also by revenue enhancement.[28]

PhD candidate Hamid Saeedi at Delft University of Technology, supervised by Bart Wiegmans and myself, is conducting research on intermodal freight transport networks. His work focuses on the impact of mergers and collaborative arrangements on intermodal network market concentration. Intermodal transportation markets consist of a variety of submarkets, such as those associated with pre-haulage and end-haulage services in a region, terminal operation services in a region, and main haulage transportation services between origins and destinations. The market concentration of these sub-markets can be connected in a consistent way by making use of network theory.[29] We anticipate that this work will provide new insights into intermodal transportation markets that will be of value to regulators.

Ports do not only connect to the networks at the sea side and the land side, but also to global supply chains which make use of these networks. The Port Vision document of the Port of Rotterdam explains how the global port plays a role in global supply chains, both as a global hub and as an industrial cluster (see Figure 7).[30]

27 The research by Panagiotis Ypsilantis was partially funded by the Dinalog project Ultimate.

28 Panagiotis Ypsilantis and Rob Zuidwijk (2014). Joint design and pricing of intermodal port - hinterland network services: Considering economies of scale and service time constraints. To be resubmitted to Transportation Science.

29 Hamid Saeedi, Bart Wiegmans, and Rob Zuidwijk (2015). Modeling market concentration on intermodal freight transport networks. Manuscript.

30 An interactive website and downloadable document of the Port Vision 2030 (Port Compass) is available via www.portofrotterdam.com. Courtesy Port of Rotterdam Authority.

Figure 7 (a): The port as a hub. Courtesy Port of Rotterdam Authority.

Figure 7 (b): The port as an industrial cluster. Courtesy Port of Rotterdam Authority.

First, the port as a global hub is a transshipment point of incoming and outgoing good flows. In other words, the port acts like a node in global supply chains. Second, the port as an industrial cluster hosts a number of industrial organizations and service organizations between which synergies can be created.[31] These organizations act in global supply chains. For example,

31 See, for example, Chapter 5 in: Rick Hollen (2015). Exploratory Studies into Enhancing Innovation-Driven International Competitiveness in a Port Context. PhD thesis, Erasmus University.

industrial and service organizations in the petrochemical cluster and in the biochemical cluster are involved in global energy supply chains. There is, however, a potential conflict of scope between global supply chains and ports, especially in the case of containerized goods. To understand this, consider the following question: *How many different global supply chains are connected to the port of Rotterdam, given that 12 million containers are transshipped each year?*[32] A lot, although it is almost impossible to come up with an unambiguous answer. In any case, it clarifies that the global supply chains of container logistics, featuring massive shipment and handling of containers, are not the same as the global supply chains of individual shippers. In each of these supply chains, senders and receivers of goods expect seaports to be enabling nodes in their networks. Their specific requirements are driven by economic, but also by environmental and societal interests.

In other words, the competitive position of ports does not only depend on internal performance such as productivity and hinterland connectivity, but also on the role the seaport is able to play as a global supply chain partner.[33] The seaport as a community is expected to offer added value services to all these specific supply chains though its industrial, trade, logistics, and information capabilities.[34] Ports may need to become information hubs. The Port of Rotterdam Authority has designed digitalization as its *fifth modality*.[35] This creates a number of challenges and opportunities that require the development, dissemination, and application of academic knowledge.[36] I will detail some of these challenges and opportunities in the next section. Here I will also get back to alternatives to the one-size-fits-all approach in container transport mentioned earlier.

32 In 2012, throughput of import and export containers at the Port of Rotterdam was 11.9 million twenty feet equivalent units (source: www.portofrotterdam.com).

33 Ross Robinson (2002). Ports as elements in value driven chain systems: the new paradigm. Maritime Policy & Management 29(3): 241-255.

34 It could also be argued that ports should offer these added value services while collaborating with other ports in global networks. Here port communities could manifest themselves as global players just like terminal operators and deep sea carriers.

35 See www.portofrotterdam.nl for column "Without data, no logistics" by Ronald Paul, COO at the Port of Rotterdam Authority, January 9, 2014.

36 The complexity and environmental management issues of global supply chains also received attention in a special issue of the prestigious journal Science [Science volume 344, issue 6188].

5. Coordinating global supply chains for sustainability

Coordinating decisions among supply chain organizations is central to the theory and practice of supply chain management. Probably the most discussed topic in supply chain management is the bullwhip effect,[37] which is a dynamics caused by decentralized forecasting and ordering. It can be mitigated by coordination and information exchange throughout the supply chain. The work on supply chain coordination and information exchange is usually motivated by economic performance improvements through revenue enhancement or cost reduction. The coordination of activities in supply chains to enhance environmental or societal performance has received much less attention, although a lot of work has been done on closed-loop supply chains.[38]

The research of the Chair focuses on the (joint) involvement of global supply chains and seaports in voluntary or regulated programs that aim to reduce the negative externalities of their logistics activities. Seaports can play a pivotal role in connecting networks to create visibility in global supply chains though information technologies and thereby make global supply chains more efficient, environmentally benign, and secure.

The example of carbon footprint reduction has received particular attention. While some programs are regulated, such as the Emissions Trading System for large direct emitters in Europe,[39] other programs are voluntary, such as the supply chain wide emission reduction programs initiated by some OEMs (Mattel, SCA) and retailers (Walmart, Tesco). In supply chains, the reduction of negative externalities needs to be coordinated as the associated investments and returns are not distributed evenly. Financial incentives can be used as a means of coordination, but other instruments can be used, such as supplier relationship management.[40]

37 Hau Lee, V Padmanabhan, and S Whang (1997). Information distortion in a supply chain: The bullwhip effect. Management Science 43 (4): 546-558. This is the most cited paper on supply chain management in Scopus (1898 times on October 27, 2015).

38 Our department has done a lot of work on closed-loop supply chains; one of the most cited papers on the topic is: Moritz Fleischmann, Patrick Beullens, Jacqueline Bloemhof-Ruwaard, and Luk Van Wassenhove. The impact of product recovery on logistics network design (2001). Production and Operations Management 10 (2): 156-173.

39 More information about the EU ETS can be found via http://ec.europa.eu/clima/policies/ets/

40 Angharad Porteous, Sonali Rammohan, and Hau Lee (2015). Carrots or sticks? Improving social and environmental compliance at suppliers through Incentives and penalties. Production and Operations Management 24(9): 1402-1413.

Research on coordinated emission reductions will focus on logistics activities, such as international transportation and logistics, in which multiple organizations are jointly involved. Preliminary work has considered the role of carbon accounting rules in coordinating carbon reduction efforts in supply chains by means of game theoretical models.[41]

Port authorities also want to play an important role in creating incentives to reduce carbon emissions in global supply chains.[42] The Environmental Ship Index (ESI) aims to measure greenhouse gas emissions throughout the global maritime transport chain, and the ESI is used in voluntary programs by port authorities.[43] I envisage that quantitative modeling of supply chain coordination problems may help to improve the design and operation of voluntary or regulated carbon reduction programs that will involve global supply chains and port communities. Ultimately, even port authorities may be held accountable for the footprint of the supply chains that use the port as a node in their logistics network.[44]

PhD candidate Xishu Li, supervised by Rommert Dekker, René de Koster, and myself, has developed quantitative models to design optimal public and private green strategies. These include policy measures by port authorities that are aimed at stimulating environmental performance improvements in global supply chains, capacity investment strategies of competitors in the production of green container transportation services, and green product launch in a competitive environment.

Organizations may also collaborate and share information to reduce the environmental footprint of their supply chain. In order to do so, the environmental footprint of a product needs to be measured and accounted for. The governance of the corresponding "chain of custody"[45] may vary. For sustainable hard wood, the certification is very strict; the customer must be assured that the specific item has been harvested in a responsible way. For sustainable energy, the certification is based on accounting principles; the amount of energy

41 Felipe Caro, Charles Corbett, Tarkan Tan, and Rob Zuidwijk (2013). Double-counting in supply chain carbon footprinting. Manufacturing & Service Operations Management 15(4): 545-558.

42 See the guidance document "Carbon footprinting for ports" via wpci.iaphworldports.org.

43 See the ESI homepage at the World Port Climate Initiative: esi.wpci.nl.

44 The example of whale meat transported via the Port of Rotterdam, where external stakeholders scrutinized the port authority and carrier Samskip on the matter, is not completely on point, but may serve as an illustration:
See http://www.portofrotterdam.com/en/News/pressreleases-news/Pages/samskip-statement.aspx.

45 The term "chain of custody" in sustainable supply chain context is commonly used in the case of forest products.

sourced in an environmentally responsible way must exceed the amount of green energy sold to the markets. Information systems play a key role in the deployment of these various chains of custody. Quantitative modeling may help to identify chain of custody governance models that allow global supply chains to reduce and account for environmental impact, while taking into account the available quality of information.

My research focuses on information systems that support port communities. These Port Community Systems[46] provide IT services that help connect information networks with logistics networks and create value through better logistics services or logistics cost savings, while the organizational network of adopters of the system is relevant as well. In order to reduce market risks, port community systems may develop into platforms which are the equivalent of public infrastructures. The development of port IT services on these platforms could be done by (commercial) third parties. The pricing of these IT services on such platforms, where users are both producers of data and consumers of services that use the data, is an interesting topic which is studied by PhD candidate Irina Romochkina together with Eric van Heck, Peter van Baalen, and myself. Although the adoption of inter-organizational systems has received a lot of attention, the impact of the adopters' business network structure on the system benefits needs further investigation.[47]

Global supply chains are initiated by global trade. The added value of information systems that support the management of global trade processes can be measured in terms of enhanced operational performance of the supply chain.[48] Moreover, information systems ensure that logistics execution in supply chains becomes more reliable, and so to reduce the risks associated with financial settlement of international trade transactions. This helps to reduce the costs of e.g. letter of credit and cargo insurance premium. Further research is needed in the interactions between trade processes and logistics execution in global supply chains, both for containerized and bulk products.

46 Peter van Baalen, Rob Zuidwijk, and Jo van Nunen (2008). Port Inter-Organizational Information Systems: Capabilities to Service Global Supply Chains. Foundations and Trends in Technology, Information and OM 2(2-3): 81-241.

47 The TEN-T project Boxreload in which we are involved provides a good basis for such research.

48 Warren H. Hausmann, Hau L. Lee, Graham R.F. Napier, Alex Thompson, and Yanchong Zheng (2010). A process analysis of global trade management: an inductive approach. Journal of Supply Chain Management 46(2): 5-29.

Another topic for further research is the coordinated management of risks in global supply chains. This coordination is important because one organization may experience the impacts of a particular risk, while another organization may be in a better position to deal with the risk at hand. The management of risks in global supply chains has received progressive attention in recent years,[49] in particular the management of the supplier base of a focal firm. The research of the Chair focuses on risk management in cross-border trade and logistics, where customs authorities play a role as social planners.

Organizations may share information and coordinate their actions to reduce risks in their supply chain. In global supply chains, the capture, processing, and communication of data to comply with enhanced customs regulations are instrumental in this respect.[50] In two projects funded by the European Commission,[51] we explored such "collateral benefits", i.e., better supply chain risk management and better operational performance, next to better compliance. Customs not only seeks to engage global supply chains in regulated programs, but also in voluntary programs, such as CTPAT and AEO.[52]

Dutch and UK Customs aim to make further steps in the supervision of international transport of containers. As I just mentioned, EU projects have investigated the collateral benefits of new business models where Customs organizations have access to operational supply chain data via a *data pipeline* to better assess the believability of declarations, or even further, to assess the risks of global supply chains based on system audits instead of inspections of individual transactions.[53] Morteza Pourakbar has started to work with me on risk management in global supply chains, focusing on the collaboration between Customs and property right owners to deal with counterfeit products.[54] The aforementioned *data pipeline* enables the sharing of cargo information between supply chain partners and governmental agencies.

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49 Christopher Tang (2006). Perspectives in supply chain risk management. International Journal of Production Economics 103(2): 451-488.

50 Hau Lee and Michael Wolf (2003). Supply chain security without tears. Supply Chain Management Review 7(1): 12–20.

51 Several researchers from our department have been involved in the FP7 EU projects INTEGRITY and CASSANDRA, which both considered the use of inter-organizational information systems for security and global supply chain efficiency.

52 CTPAT is the US Customs-Trade Partnership Against Terrorism, in which trade partners comply with security criteria and receive benefits like expedited processing in return (www.cbp.gov). The Authorized Economic Operator (AEO) program of the European Commission, Taxation and Customs Union is of a similar nature; see also (ec.europa.eu).

53 David Hesketh (2009). Seamless electronic data and logistics pipelines shift focus from import declarations to start of commercial transaction. World Customs Journal 3(1): 27-32.

54 Morteza Pourakbar and Rob Zuidwijk (2015). Towards a Counterfeit-Proof Global Supply Chain. Manuscript.

In the Dinalog project, *Cargo Driven Intermodal Transportation*, we further investigated the improvement of container logistics performance by control at the cargo level. The reasoning is that common container logistics practice is focused on handling and transporting containers, and does not fully reap the potential benefits of optimizing the handling and transportation of the cargo inside the containers. Some of these benefits have already been recognized by the business world. The practice of transloading cargo from one type of container to another, for example, is justified by better utilization of land transport means.[55] The source of inspiration of the aforementioned Dinalog project is Cool Port, a new cold storage cluster, specialized in the storage and handling of refrigerated and frozen cargo in reefer containers.[56] Identifying further benefits requires academic research. Modeling and quantitative assessments help to design control mechanisms for container logistics at the cargo level, and help to decide on information sharing of the contents of the container by showing to what extent the benefits outweigh the costs.

The added value achieved by supply chain coordination in terms of risk reduction and reduction in environmental footprint is not inherent to the product as delivered to the final customer. This explains the need for certification, i.e., the need to demonstrate to the final customer e.g. the risk exposure and environmental footprint associated with the supply of the product. Even for attributes that are inherent to the product, such as quality, certification is used as a mechanism to convey value attributes other than price. These values may be translated into a willingness to pay for premium product or may provide a competitive advantage in the market. An international trade system has been created to support global supply chains based on monetary value, but we are becoming increasingly aware of the need to sustain other values, such as the quality of the natural environment, the quality of life of the people involved in supply chain activities, and security. We need to investigate how global supply chain coordination mechanisms, such as certification and supply chain relationship management, can help to sustain these other values. Perhaps you agree with me that these values are also relevant for a can of tomato soup, and the certificates displayed on the product label signify this. Given the above, there is also a case to make for ports to play an instrumental role in sustaining other values in global supply chains, and I have argued that ports have already started to do so.

55 Transloading and other cargo handling practices in container transport are discussed in: Jean-Paul Rodrigue, Jean Debrie, Antoine Fremont, Elisabeth Gouvernal (2010). Functions and actors of inland ports: European and North American dynamics, Journal of Transport Geography 18(4): 519-529.

56 See the "Rotterdam Cool Port" project at www.portofrotterdam.com.

6. Plans and ambitions

The Chair title, *Ports in Global Networks,* is inspired by the title of an elective course at RSM in which I have been personally involved since 1999. As I have explained, the title represents a number of interesting topics that require further research, that need to be shared with a variety of audiences, and that demonstrate or hold the promise of successful application in practice.

I will now formulate the ambitions of the Chair and the plans to reach those ambitions. I have organized this along the creation, dissemination, and valorization of knowledge.

Knowledge creation

The research presented can be organized in three interlaced research topics:
(1) Synchronizing transportation networks;
(2) Connecting the port to global supply chains; and
(3) Coordinating global supply chains for sustainability.

The ambition is to further develop these research topics, based on funded research projects, in many cases together with industry. In particular, it is my aim to develop a research team of PhD students, post-doctoral researchers, and faculty on these topics. The research plans outlined above should allow the team to publish in top tier journals on a regular basis. The role of external stakeholders is very important as an inspiration for new research topics that help create double impact, i.e., both academic and societal impact, and as a source of relevant data that can help to establish and validate research findings.

As its trail blazer, I believe that the Center Metropolis & Mainport has the task to host the port related academic community at the Leiden, Delft, and Erasmus universities. The center recognizes the need to develop, disseminate, and valorize knowledge on the connections between metropolises and mainports. It aims to do so while making use of the joint academic communities of the Leiden, Delft, and Erasmus universities that work on the topic areas of the center. The center focuses on four themes: Sustainability, Synchromodality, World Port City, and Secure International Trade and Global Clusters.

Knowledge dissemination

The Chair supports a core course in the MSc *Supply Chain Management* and also supports the elective *Ports in Global Networks*, and contributes to the MSc *Maritime Economics and Logistics*. The Chair has supported the development of and contributes to the Executive Master *Customs & Supply Chain Compliance,* which is based on collaboration between Erasmus University, Delft University of Technology, and Eindhoven University of Technology, and with corporate partners TNO and The Tax and Customs Administration of the Netherlands.

The Chair will further develop PhD courses offered in the national Operations Management and Logistics Program. A book with two dozen contributions by port academics also helps to disseminate port related research.[57] In addition, train-the-trainer programs with universities in Indonesia will be further developed, and such programs may also be initiated in other parts of the world.

I will further investigate opportunities to set up pre-experience and post-experience programs. In particular, I will examine the feasibility of a six-month program on top of port relevant MSc programs sponsored by organizations in and around the port via internships, and I will start an open program on port related issues. Most educational initiatives will be undertaken in collaboration with other port professors at Erasmus and other universities such as Delft University of Technology.

Knowledge valorization

Recently, industry expressed their interest to help foster "brains for the port", and we as a university have a pivotal role in this. In 2010, Erasmus University bundled its maritime and port-related research and education in Erasmus Smart Port Rotterdam, an interfaculty center of excellence, supported by the Port of Rotterdam, Deltalinqs, and the Rotterdam municipality. SmartPort continued this initiative in 2015 as a collaborative agreement between the aforementioned external stakeholders, and Erasmus University and Delft University of Technology. SmartPort has developed five roadmaps in which universities collaborate with industry and government: Logistics Connectivity, Infrastructure, Chemical Industry & Energy, World Port City, and Port Strategy. The aim is to further improve the mechanisms that SmartPort uses to bring practitioners and academics together in teams to develop new research themes that will have double impact.

57 Currently, the book *Ports and Global Networks* is being prepared with editors Harry Geerlings, Bart Kuipers, and myself.

The question: *Are we connected?* is relevant to our academic community when it develops, disseminates, and applies knowledge. Thanks to initiatives like SmartPort, we are connected to our external stakeholders so that we can discover the right knowledge questions together, and can make the port smarter by connecting local and global networks.

7. Acknowledgements

Let me start these acknowledgements by saying that this Chair, and the collaboration of the Erasmus University with the port of Rotterdam is rooted in the vision of the late professor Jo van Nunen. I am very grateful for his role in my personal development and in the inception of SmartPort.

Distinguished Board, President, and Deans of Erasmus University, Vereniging Trustfonds Erasmus University Rotterdam, and Members of the Appointment and Advisory Committees,

I would like to thank you for the opportunity to develop the Chair of *Ports in Global Networks*, and to connect with the local and global networks of academics and practitioners. In particular, I would like to thank our Dean Steef van de Velde for his support right from the start.

Dear colleagues at Delft University of Technology,

Your support in developing the Chair of *Freight Transport and Traffic Networks* at the Department of Civil Engineering and Geosciences laid the foundation for my further academic development. I thank you and look forward to our continued collaboration.

Dear colleagues at Rotterdam School of Management,

It is both my privilege and pleasure to continue to work with you in a very pleasant working atmosphere, for which I would especially like to thank our secretaries Ingrid, Cheryl, and Carmen. Discussions with the PhD students I am involved with about new ideas and their PhD research projects give me a lot of energy. It is also stimulating to work with young talented faculty. In particular, I have had the pleasure to witness the development of Niels Agatz and Morteza Pourakbar, and I am happy to work with them. To collaborate with great scholars such as Leo Kroon, René de Koster, Eric van Heck, Wolf Ketter, and Jan van de Ende is very inspiring. I look forward to the interesting projects ahead of us, and to new working relationships in the school.

The development of the new Executive Master and Diploma Programme *Customs and Supply Chain Compliance* is bound to be successful because of the dedication of a great team of people from within and external to Rotterdam School of Management, for which I am grateful. It is also one of the many occasions where I work together pleasantly with my colleague Albert Veenstra, with whom I share the fascination of port-related topics.

Dear port professors,

An increasing number of professors and other faculty at Dutch universities, and in particular at the Erasmus University and Delft University of Technology, are actively working on port related projects. I strongly believe that our work to help build SmartPort and develop "brains for the port" is of vital importance to the port community and to the universities themselves. I thank you, and in particular Rommert Dekker and Lorant Tavasszy, for the stimulating collaboration, and I believe we can look forward to a bright future.

My academic career started with my own PhD project. I thank my former promotor Harm Bart for his conscientious guidance, which remains to serve as an example for me. The PhD was a Leiden-Delft-Erasmus project as my PhD supervisors were representatives of these universities.

I would like to thank the supervisory board of the Leiden-Delft-Erasmus initiative for the support they have given so far to the Centre Metropolis and Mainport. After a slow start, I am confident the center will grow to its potential to further develop an academic community that will have its own academic agenda and that will feed Smartport with the creation, dissemination, and valorization of knowledge. I look forward to the continuation of the work in and around the Centre with those involved.

I am grateful to the Port of Rotterdam, the Municipality of Rotterdam, and Deltalinqs for their continued efforts to engage with the universities to further develop SmartPort. Since its inception in December 2010, the development of SmartPort has been a challenge and a rewarding experience. I would like to thank Tijn Folmer and Bart Kuipers for their pleasant collaboration in the early years.

I have had the honor to work with a number of people from the port community to make SmartPort a truly joint initiative. At the moment, a number of roadmaps have been developed under the leadership of Michiel Jak. I very much enjoy the collaboration with the roadmap team on Logistics Connectivity, where practitioners and academics have inspiring discussions on research ideas that have double impact, but also on the role of the university in disseminating knowledge to the port community.

Lieve ouders,

Ik ben jullie dankbaar voor het vertrouwen dat jullie altijd in mij hebben gehad, en voor de steun en vrijheid die jullie mij gaven om mijn eigen keuzen te kunnen maken.

Lieve Saar en Neel,

Vier jaar geleden schreven jullie nog lieve briefjes om mij met beide benen op de grond te houden. Nu is een bepaalde blik al voldoende om mij te doen realiseren dat het nu echt tijd is voor andere dingen dan werk. Ik ben jullie dankbaar voor wie jullie zijn.

Lieve Wendel,

Ik ben je dankbaar voor alle liefde, steun en kritische aandacht die onmisbaar zijn in het leven van een vak-idioot. De verbindingen tussen mijn soms wat hoogdravende ideeën en de realiteit zijn aan jou toe te schrijven.

Ik heb gezegd.

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