



NWO-breed

Aanvraagformulier Investerings NWO-groot 2015 BOO
Investment Subsidy NWO Large 2015 BOO Application Form

Aanvraagnummer/application number: 175.010.2015.009

1. Aanvrager(s)/applicant(s)

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G. Filarski BA BA	Huygens Instituut voor Nederlandse Geschiedenis
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Prof. dr. E.M.P. van Gemert	Universiteit van Amsterdam Faculteit der Geesteswetenschappen Neerlandistiek
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Prof. dr. F.A.H. van Harmelen	Vrije Universiteit Amsterdam Afdeling Informatica Kunstmatige Intelligentie
Dr. M.C. 't Hart	Huygens Instituut voor Nederlandse Geschiedenis
Prof. dr. H.A. Hendrix	Universiteit Utrecht Faculteit Geesteswetenschappen Italiaanse taal en cultuur
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Prof. dr. I.B. Leemans	Vrije Universiteit Amsterdam Faculteit der Geesteswetenschappen Geschiedenis
Prof. dr. W.W. Mijnhardt	Universiteit Utrecht Faculteit Geesteswetenschappen Descartes Centre for the History and Philosophy
Dr. H. Nijboer	Universiteit van Amsterdam Faculteit der Geesteswetenschappen Mediastudies
Prof. dr. M.R. Prak	Universiteit Utrecht Faculteit Geesteswetenschappen Departement Geschiedenis en Kunstgeschiedenis
Prof. dr. E. Stronks	Universiteit Utrecht Faculteit Geesteswetenschappen Nederlandse Taal en Cultuur
Prof. K. Zandvliet	Universiteit van Amsterdam Faculteit der Geesteswetenschappen Amsterdam School for Culture and History (ASCH)

2. Titel/Title

Golden Agents: Creative Industries and the Making of the Dutch Golden Age

3. Samenvatting/Abstract

The Dutch Golden Age is one of the strongest elements in the international reputation of the Netherlands. Within that context, the arts, or more generally Dutch creative industries, occupy a central place. When president Obama visited The Netherlands in 2014 he went to see The Nightwatch and allowed himself to be captured on camera saying "I love Rembrandt". It is possible he actually meant it. A lot of people love Rembrandt, and museums around the world hold substantial collections of 17th-century Dutch art. The Late Rembrandt exhibition welcomed, between February and May 2015, almost half a million visitors.

Painting, printmaking, book production and other creative industries of the Dutch Golden Age are also of continuous interest to Dutch and foreign scholars from various disciplines. Various research groups, institutions and individual researchers develop data repositories and analytical tools to study the Dutch Golden Age. Unfortunately, this often results in fragmentation and short-term solutions. The Golden Agents project will develop a sustainable infrastructure to study relations and interactions between producers and consumers of creative goods across the long Golden Age of the Dutch Republic. The project will link distributed, heterogeneous resources (both existing and new) on creative industries in the Dutch Golden Age so that researchers will be able to connect images, objects and texts from different sources in a new and meaningful way.

Consumption remains an under-investigated topic with regard to the creative industries in the Dutch Golden Age. The digitization of the enormously rich collection of the notarial acts in the Amsterdam City Archives, and more specifically the probate inventories contained within these records, will provide detailed and socially diverse data on the possessions of cultural goods by the inhabitants of what was probably the most important city of the 17th Century. The Golden Agents research infrastructure enables interaction between various heterogeneous databases by using a combination of multi-agent technology and semantic web solutions, that will be supported by ontologies developed together with domain experts.

The infrastructure is complementary to, and interoperable with the CLARIAH infrastructure. The linked key datasets and domain specific ontologies and standards will enrich the generic ontologies and SKOS standards of the CLARIAH infrastructure. Existing data mining techniques, topic modeling methods and network analysis tools of the CLARIAH platform will be offered to researchers to analyze, annotate and visualize metadata and textual/visual sources. Large datasets of images and text can be explored for a much deeper understanding of consumers responses to developments in styles, genres and fashions in the Dutch Republic.

The Golden Agents research infrastructure will also reach audiences outside academia and support the documentation on a wide array of objects preserved in cultural heritage institutions, many of which are major tourist attractions. It will thus contribute to NWO's role as the research foundation underpinning the Creative Industries top sector in the Dutch economy



Application form

Investment Subsidy NWO Large 2015-2016

The completed application form including attachments should be submitted electronically via the Iris system (personal account of the main applicant). Please ensure that the form and attachments are saved in PDF format. Iris is accessible via the NWO website: www.iris.nwo.nl. Please use the Verdana font, size 8.5, line spacing 13 and keep to a **maximum of 30 pages A4 (incl. attachments)**.

Please read the brochure Investment Subsidy NWO Large 2015-2016 before completing this form.

The closing date for the submission of applications is 19 May 2015, 13.59 hrs. The date and time on which you upload via Iris is the valid submission date and time.

General information

Applying university/institute

University/institute

Royal Netherlands Academy of Arts and Sciences (KNAW)

Faculty

Huygens Institute for the History of the Netherlands

Project leader/coordinator

Title(s)

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Preference for correspondence

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Title of investment project

Golden Agents: Creative Industries and the Making of the Dutch Golden Age

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Abstract/executive summary

Project summary

The Dutch Golden Age is one of the strongest elements in the international reputation of the Netherlands. Within that context, the arts, or more generally Dutch creative industries, occupy a central place. When president Obama visited The Netherlands in 2014 he went to see The Nightwatch and allowed himself to be captured on camera saying "I love Rembrandt". It is possible he actually meant it. A lot of people love Rembrandt, and museums around the world hold substantial collections of 17th-century Dutch art. The Late Rembrandt exhibition welcomed, between February and May 2015, almost half a million visitors.

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The *Golden Agents* research infrastructure will also reach audiences outside academia and support the documentation on a wide array of objects preserved in cultural heritage institutions, many of which are major tourist attractions. It will thus contribute to NWO's role as the research foundation underpinning the Creative Industries top sector in the Dutch economy.

[469 words]

Summary of the investment proposal for the general public

The Dutch Golden Age's paintings, books, ceramics etc. still fascinate millions of people, but how did these creative outbursts merge? In the Golden Agents Research Infrastructure, so-called computer agents ingeniously connect existing and new databases to facilitate interdisciplinary research that unravels the inner dynamics of this creative miracle.

[48 words]

Key words

1) history of Dutch creative industries 2) Dutch Golden Age 3) multi-agent technology 4) digital humanities ontologies 5) linked open data

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Co-applicants [in alphabetical order]

- 1 Prof. Arianna Betti (UvA-ILLC) - Philosophy of language, logic and ontology
- 2 Dr. Frans Blom (UvA-ASCGA) - CREATE member; Dutch Golden Age culture
- 3 Dr. Mehdi Dastani (UU) – Multi-agent technology, artificial intelligence, intelligent systems
- 4 Dr. Paul Dijstelberge (UvA) - CREATE member; history of print and book culture
- 5 Gertjan Filarski BA, BA (Huygens ING) – CTO; project manager IT – CLARIAH Board member - Technology
- 6 Prof. Oscar Gelderblom (UU-UCEMS) - Financial history
- 7 Prof. Lia van Gemert (UvA-ASCGA) - Principal Investigator of CREATE; history of Dutch literature
- 8 Prof. Frans Grijzenhout (UvA ASCGA) - History of Art (art market)
- 9 Prof. Frank van Harmelen (VU-Network Institute)- Knowledge Representation and Reasoning. Semantic Web
- 10 Prof. Marjolein 't Hart – (Huygens ING/VU) - Political History in Global Context and socio-economic history
- 11 Prof. Harald Hendrix (KNIR, UU) – Italian studies, comparative literature, book history and correspondences
- 12 Prof. Geert Janssen (UvA) – Early Modern History - (Migration history)
- 13 Prof. Eric Jorink (Huygens ING, Leiden University) – History of science and scholarship
- 14 Dr. Elmer Kolfin (UvA-ASCGA) – History of Art (print culture; iconography)
- 15 Prof. Inger Leemans (VU) - Cultural history
- 16 Prof. Wijnand Mijnhardt (UU - Descartes Centre) - History of science, history of publishing
- 17 Dr. Harm Nijboer (UvA) CREATE member; data base development, history of material and consumer culture
- 18 Prof. Maarten Prak (UU- UCEMS) - Social and economic history
- 19 Prof. Els Stronks (UU- UCEMS) – Early Modern Dutch literature
- 20 Prof. Kees Zandvliet (Amsterdam Museum/UvA- ASCGA) – History of elite culture; history of Amsterdam

Collaboration partners:

- 1 Stadsarchief Amsterdam (Amsterdam City Archives): Dr. Ellen Fleurbaay (director)
- 2 Koninklijke Bibliotheek (KB): Dr. Marieke van Delft (Short-Title Catalogue, Netherlands-STCN)
- 3 Rijksmuseum/Rijksprentenkabinet: Lizzy Jongma (Datamanager, Registration & Documentation Department)
- 4 Netherlands Institute for Art History (RKD): Dr. Chris Stolwijk (director) and Drs. Reinier van 't Zelfde (Head Automation and Information Retrieval)
- 5 Meertens Institute (KNAW): Prof. Nicoline van der Sijs (NEDERLAB with DBNL–Probate Inventories Database)
- 6 Lab 1100: Pim van Bree (MA) and Geert Kessels (MA) (Software development NODEGOAT platform)

Steering Group* and Program Group

Prof. Charles van den Heuvel* (Huygens ING; UvA-ASCGA) - (P.I.- Project Leader) – History of Science/Digital Methods in Historical Disciplines

Drs. Guido Gerritsen MMO* (Huygens ING) (Secretary – Project Coordinator/Financial Control)

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Prof. Maarten Prak (UU- UCEMS) – Economic and Social History

Prof. Els Stronks* (UU- UCEMS) – Early Modern Literature – Digital Humanities

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Scientific Advisory Board

Dr. Marten Jan Bok (UvA) – History of Golden Age Art Markets: development ECARTICO

Prof. Julia Noordegraaf (UvA – Mediastudies) – Principal Investigator of CREATE

Prof. Nicoline van der Sijs (Meertens Institute; RUN) – NEDERLAB

Dr. Wilma Gijsbers (expert of use of notarial archives for historical research)

Technical Advisory Board

Prof. Rens Bod (UvA) – (UvA) –Digital Humanities; Director of the Center for Digital Humanities

Pim van Bree MA (LAB1100) – Developer of NODEGOAT

Prof. Stefan Gradmann – (KULeuven)- Literary Studies; Semantic Web Technology/Ontologies; Head of Central Library

Prof. Jan Odijk (UU) – Director of CLARIAH

Top 10 relevant publications

- Betti, Arianna & Hein van den Berg, 'Modelling the History of Ideas,' *British Journal for the History of Philosophy* 22, (4), (2014): 812–835.
- Dastani, Mehdi&JorgeGomez-Sanz, 'Programming multi-agent systems,' *The Knowledge Engineering Review*. vol. 20(2), (2006): 151-164,.
- Gelderblom, Oscar. *Cities of Commerce: The Institutional Foundations of International Trade in the Low Countries, 1250-1650* (Princeton, NJ: Princeton University Press, 2013).
- Heuvel, Charles van den 'MAPS: Manuscript map Annotation and Presentation System: Linking formal ontologies with social tagging to (re-)construct relationships between manuscript maps and contextual documents.' *Digital Humanities 2009 conference, 22-25 June, University of Maryland, Proceedings* (2009): 138 –141.
- Heuvel, Charles van den, Sander Spruit, Leen Breure, & Hans Voorbij, , 'Annotators and Agents in a Web-based Collaboratory: Disclosing Cartographical Collections.' In: J. Trant & D. Bearman (eds). *Museums and the Web 2010: Proceedings. Toronto: Archives & Museum Informatics*. Published March 31, 2010.
<http://www.archimuse.com/mw2010/papers/heuvel/heuvel.html>
- Kolfin, Elmer & Jaap van der Veen(eds.), *Gedrukt tot Amsterdam. Amsterdamse prentmakers en uitgevers in de Gouden Eeuw* (Zwolle: Waanders/Amsterdam Museum Rembrandthuis 2011)
- Leemans, Inger, 'Picart's Dutch Connections: Family Trouble, the Amsterdam Theatre and the Business of Engraving.' In: M.C. Jacob, L. Hunt, W. Mijnhardt (eds.), *At the Interface of Religion and Cosmopolitanism: Bernard Picart's Cérémonies et coutumes religieuses de tous les peuples du monde (1723-1743) and the European Enlightenment* (Los Angeles, Getty Research Institute, 2010), 35-58.
- Nijboer, Harm 'Fashion and the early modern consumer evolution. A theoretical exploration and some evidence from seventeenth century Leeuwarden.' In: Bruno Blondé, Eugénie Briot, Natacha Coquery & Laura van Aert (eds.), *Retailers and consumer changes in Early Modern Europe. England, France, Italy and the Low Countries*, (Tours: Presses Universitaires François-Rabelais, 2005): 21-36.
- Prak, Maarten, 'Painters, guilds and the art market during the Dutch Golden Age.' In: S.R. Epstein, Maarten Prak (eds.), *Guilds, Innovation and the European Economy, 1400-1800* (Cambridge: Cambridge University Press, 2008): 143-171.
- Zandvliet, Kees, *De 250 rijksten van de Gouden Eeuw: kapitaal, macht, familie en levensstijl* (Amsterdam: Rijksmuseum, 2006)

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Investment proposal

Research program and research field(s)

This section describes the research infrastructure needed to answer the overarching research question, followed by a presentation of eight projects of the applicants currently running or submitted for funding that will be enhanced with the *Golden Agents* research infrastructure.

Fields of research, research program and research question(s)

Fields of research

Golden Agents aims to develop a sustainable infrastructure to study interactions between producers and consumers of the creative industries in the making of the Dutch Golden Age, from multiple perspectives and in a comprehensive, cross-disciplinary way. This infrastructure consists of 1) a multi-agent platform based on semantic web solutions and ontologies that will 2) link existing databases with information on the production of the creative industries of the Dutch Golden Age, 3) and a newly developed database with information on the consumption of creative goods (as found in notarial acts of Amsterdam City Archives); all of which will allow 4) complex searches in, and visualizations of these searches in the united databases by creating access to sophisticated digital tools, and 5) the broader embedding of the *Golden Agent* infrastructure in national and international research infrastructures. The creation of this infrastructure is important for various fields of research, including art history, literary history, theatre studies, and economic history. Applying multi-agent technology to such complex datasets presents a major challenge to information science. Connecting (meta)datasets from various hugely successful creative industries (book industry, art industry, silver industry etc.) will allow scholars from all over the world to study the dynamics of the Dutch Republic's creative industries in a unprecedented manner. Moreover, the *Golden Agents* infrastructure harbors a potential for research beyond the creative industries of the Dutch Golden Age in other research fields, such as legal studies, economy, finance and business studies, sociology and innovation studies.

The Dutch Golden Age is one of the most remarkable and enduring features of the international reputation of the Netherlands. Dutch and international scholars have described it from various historical perspectives, such as financial history (Gelderblom & Jonker, 2004), colonial history (Emmer & Gommans, 2012), migration history (Janssen, 2014), maritime history (Gaastra, 2003), cultural history (Schama, 1987), the history of ideas (Israel, 2001), and history of science (Cook, 2007; Margócsy, 2014). This infrastructure aims to innovate existing research on the history of the creative industries of the Dutch Golden Age that thus far have been studied separately and on a detailed level. It will allow large scale, comprehensive and interdisciplinary research into the interdependence of Dutch creative industries and the complex ways in which they were governed by production and consumption.

Research program

Nowadays, 17th-century art is very important for the international reputation of the Dutch Golden Age.¹ The enormous production of paintings was however but one aspect of the success of the Golden Age creative industries (Rasterhoff, 2013). One artistic product that was probably even more popular with Dutch households in all layers of society than paintings, was silverware (De Vries, 1975). Dutch publishers dominated European book markets during the second half of the 17th century and the early 18th century (Lankhorst & Hoftijzer, 1995). Dutch architecture was exported to the countries bordering on the Baltic (Ottenheim & De Jonge 2013). Dutch cartographers mapped the New World (Zandvliet, 2002). Dutch companies were instrumental in bringing Asian products to European markets

¹ Several dates are associated with the Golden Age of the Dutch Republic. The most common association is the 17th century. We are interested in the long Dutch Golden Age, including the early stages, still in the 16th century, and the gradual decline in the 18th. Changes in cultures do not coincide with dates that mark important political events. Literature often refers to the Fall of Antwerp in 1585, but the emigration of actors of the creative industries to the Dutch Republic started earlier and Dutch culture did not change overnight after the invasion of French troops in 1795. Therefore we use rather arbitrary the years 1580-1800 to demarcate the long Dutch Golden Age.

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(Van Campen & Eliëns, 2014), while at the same time stimulating the emergence of homemade equivalents such as Delftware (Van Dam, 2014). The creative industries of the Dutch Golden Age have already been a rich field for scholarly investigation. Much of the attention has focused on creative branches in Amsterdam, the city that not only played a leading role among the seven provinces of the Dutch Republic, but was largely responsible for the worldwide impact of Dutch creative industries at the time. Much of this scholarly attention focused on individual artists and their works, single institutions (academies, guilds), single markets, or single trade networks or workshops, thus charting only fragments of the total production. At another level, fragmentation is also at play: data repositories and analytical tools to study the Dutch Golden Age are developed by various and independently working research groups, institutions and researchers. Also, data collection has focused on patterns in production rather than consumption. In order to come to a deeper understanding, not of *individual artists* and *fragmented case studies*, but of *industries* and their dynamics in the creative outburst of the Dutch Golden Age, we need:

1) to **connect existing databases** with data and metadata on the creative production in Amsterdam and the surrounding provinces. The large number of sources of different aspects of the creative industries of the Dutch Republic during its Golden Age that have been digitized in the two last decades (containing metadata about the production and distribution of the books, prints, silverware, poetry, theatre plays, etc.) need to be connected and synchronized.

2) to **develop a new database with (meta)data on consumer reactions** to creative products – a seriously understudied aspect of the creative industry at the time. Although some progress has been made with inventories of art collectors and ordinary people, as well as data coming from art auctions (Montias, 1982, 1991, 2002; Bok, 1994), a vital source of information is missing. This can be overcome by digitizing some essential sources, mainly the rich collection of probate inventories stored in the notarial archives of Amsterdam and to connect those with probate inventories of other Dutch cities in national and international collections. Adding metadata and indexes to the scans of the original documents will provide valuable insight in the social stratifications of cultural goods in Amsterdam with its leading role in the global economy.²

3) to **develop a multi-agent platform** based on web semantics and ontologies that allow complex searches in the heterogeneous, complementary databases.

4) to **give access to tools (embedded and fueled by national (CLARIAH, NEDERLAB) and international research infrastructures)** that enable researchers to explore the inner dynamics of the creative industries of the period.

The innovative roles of different agents (from artists to publishers to scholars) in the creative industries of the Dutch Golden Ages are poorly understood because developments in various styles, genres and fashions in material and immaterial creative expressions have been studied individually and in isolation. This may sound odd, given for instance the large number of art historical monographs, but it has proven difficult to trace developments beyond such broad categories as 'portrait' or 'landscape', the size of works, or their style ('fine painting' versus 'loosely painted', Renaissance versus Baroque, and so on). Such refinements of categories are also important to trace development of styles, genres and fashions in ceramics (design and embellishments), or silverware, and in literary texts. With the proposed infrastructure we would be not only able to uncover the mechanisms behind the production of creativity, but also chart the impact of consumers' preferences on innovation. *Innovation* is a key term in today's creative industry, but little is known of the historical meaning and role of this concept in the making of the Dutch Golden Age. Patents on products, ranging from books to imitation marble, provide some insight in innovations in the

² Given the enormous importance of the notarial archives for global history, the Amsterdam City Archives is currently applying for a position on the UNESCO World Heritage list.

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creative industries (Heuvel 2014; Heuvel 2015). Moreover, the legalization of intellectual property rights in patents and privileges gives an indication which new products were short lived or sustained over time.

It is the main goal of this research program to compare creative production and consumption on a macro-level (as done on a small scale in Rasterhoff, 2013). Rasterhoff's comparison between art and book production needs to be enriched, not only with information on books and paintings from other databases than the ones used in that particular project, but also deepened and contextualized. Information on actors and artefacts of different creative industries of the Dutch Golden Age – digitized, coded, annotated with metadata and indexed and curated – will unveil hidden aspects of the riddle that the enormous explosion of creativity the Dutch Golden Age still presents. In order to bring together information on various aspects and facets of the productions of the creative industries, existing databases will be equipped with API's for import and export using CLARIAH standards and thesauri. This is a first step towards the exchange of information in the databases that are currently dispersed over various universities, cultural heritage institutions and individual researchers. Connecting the existing databases with the newly built database on consumers' responses is the second important step.

The truly innovative aspect of building this infrastructure lies in the third step: the use of an artificial intelligence design will enable users to find answers to their queries in this multitude of data more precisely and multi-dimensionally (for instance combining data on geographical, chronological and conceptual levels). The design of a multi-agent platform that uses the various RDF schemes related to distributed datasets in combination with ontologies developed by domain experts is a new phenomenon in the humanities. Although such ontologies are developed within the CLARIAH framework on a more generic level (for instance for personal and geographical names) and in a socio-economic history pilot led by Frank van Harmelen, the development of a set of coherent ontologies that will allow deep and complex searches, is a novelty in the humanities. In developing these ontologies and the multi-agents platform, we will include the work of CLARIAH and the socio-economic history pilot, but move beyond existing work by aiming at the development of ontologies that allow searches into the shifts in meaning of specific concepts (concepts such as innovation, knowledge construction or creativity (that is not only expressed in material products, but also in immaterial ways such as in new forms of knowledge and language production) (Betti & Berg 2014). In doing so, we will introduce a much desired, more qualitative, hermeneutic approach to the Digital Humanities (referred to as "digital hermeneutics", see Capurro, 2010; Akker e.a., 2011). These specific ontologies are developed in close cooperation with CLARIAH: not only because it is one of our goals to enrich the CLARIAH infrastructure, but also because interoperability with the CLARIAH infrastructure will enhance the sustainability of the *Golden Agents* infrastructure.

Ad 1) An infrastructure to use existing information for comparative, comprehensive research

In recent years several initiatives have been taken for the integration of data from various projects, to allow more comprehensive analyses of the production of cultural goods and services in the creative industries of the Dutch Golden Age. For instance, supported by NWO KIEM funding, the Amsterdam Centre for Cultural Heritage in the project *Creative Nodes in Amsterdam's Actor-Artifact Networks* (CANAAAN) automatically links data of the Amsterdam Museum (on artefacts of the Dutch Golden Age) with data of ECARTICO (on artists and other cultural actors in the Dutch Republic). A similar initiative was the project *Mapping Notes and Nodes in Networks: Exploring potential relationships in biographical data and cultural networks in the creative industry in Amsterdam and Rome in the Early Modern Period*, funded as a KNAW Private Public Participation Project, in which parts of ECARTICO, Hadrianus (a database with names of Dutch artists and scholars in Rome), and Sculptors on the Move datasets were linked with the software tool NODEGOAT to create, analyze and visualize multi-layered networks in which actors and cultural artefacts were mapped. Both projects expressed the need to link more data of actors and artefacts for a more comprehensive understanding of the creative industries. Also, in both cases the creation of a comprehensive database was limited by a step-by-step approach of linking only a few datasets, and in both cases different standards were used. Past and current attempts to link and integrate information from existing, distributed databases thus reflect the need for more comprehensive approaches in research on the creative industries of the Dutch Golden Age as described in this proposal. We use standards and SKOS that are compliant with the CLARIAH infrastructure. We will build on existing initiatives to link sets with semantic web solutions, such as the linkage of the STCN with sets of the Rijksmuseum using RDF representations. Relevant collections of the Koninklijke

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Bibliotheek and Rijksmuseum can be linked with the large datasets of the Netherlands Institute for Art History (RKD), such as RKD Artists and RKD Portraits, by providing them with similar RDF representations. Metadata of Nederlab and DBNL at the Meertens Institute can be linked with no extra costs to the *Golden Agents* infrastructure, because the conversion from their CMDI metadata standard into RDF is budgeted for in the CLARIAH infrastructure.

Ad 2) Digitize and disclose new (meta)data to correct the imbalance in historical information on the production and consumption of the creative industries

There is currently an imbalance in information available about the production of the creative industries and the consumptions of the goods created by these industries. Especially, digitizing the very rich probate inventories over the period 1580-1800 in the notarial acts of the Amsterdam City Archives will make research move beyond this obstacle. It would allow for the first time the analysis of a dataset with very rich information on the presence of silverware, books, atlases, paintings, clothes etc. in Dutch households in a systematic, comparative and quantitative way. Even before the computer set in, individual researchers and groups, such as Simon Hart and the working group led by Sjoerd Faber, launched modest attempts to harvest information from the notarial archives on certain topics. Their attempts were followed more recently by a collaboration between Dutch and American scholars who linked individual documents in this database of the notarial acts to information in the Montias database in the Frick Collection in New York, The Getty Research Center (for instance the Getty Provenance Index) in Los Angeles, and ECARTICO. However, since the notarial archives comprise approximately 15-20 million documents from the period 1578-1915, sitting on three kilometers of shelf without a central index, such attempts to single out the information of probate inventories of the Golden Age could only be very limited. Research that has been done so far is mainly based on protocols made by Simon Hart which cover less than 10% of the total. Many researchers limited their research to the years 1701-1710 because for those years the information of the notarial archives can be consulted using system cards. Digitizing and indexing the notarial acts of Amsterdam City Archives for the period of the long Dutch Golden Age would allow us to analyze the probate inventories of this most important period in a systematic way. Connections will be made with the available database of probate inventories of other smaller cities in the Meertens Institute for comparative analyses, such as of Doesburg, Maassluis and Weesp and datasets concerning the material culture of Leeuwarden.

The systematic digitization of the notarial acts in Amsterdam City Archives will be an impetus for a much stronger collaboration between Dutch individual scholars and institutions such as the RKD on the one hand and international institutions such as the Frick Collection and the Getty Research Center, that with its Project for the Study of Collecting and Provenance (PSCP) aligns its research collections with the work of scholars interested in the history of collecting, provenance, and exhibition around the world (see letter of support and further international context).

Ad 3) and 4) Develop a multi-agent platform based on web semantics and ontologies and analytical tools

The users of the Golden Agent research infrastructure will be able to perform their queries by the proposed platform of computer agents, but they also need to be able to visualize the results of their queries, and analyze digitized texts in search for conceptual shifts. To this end, the platform will be enhanced with text mining, network and geographical visualization and topic modeling tools developed by the CLARIAH and Nederlab infrastructure.

Research question(s)

The overarching question of this proposal is: **What are the dynamics of the creative outburst of the Dutch Golden Age?** In order to answer this question, we need to address the following methodological issues:

- 1) How can we develop ontologies that are relevant for exchange of structured information among databases on cultural products, including artefacts and images?
- 2) How can we develop a research infrastructure that reflects the qualitative methods and multi-perspective approaches characteristics of the humanities, i.e. a research infrastructure for digital hermeneutics?
- 3) How can such tools enable us to find out how producers and consumers of the creative industries of the Dutch Golden Age interact?

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4) Which conceptualization of styles, genres and fashions in material (books, prints, silverware etc.) and immaterial expressions (science, literature, theatre plays, etc.) of the creative industries can enable us to analyze how these elements are reflected in the consumption of cultural goods during the Dutch Golden Age?

5) What is the best conceptual architecture to study historical changes in concepts of key terms (innovation and design) of the creative industries?

Eight examples of projects related to the research program that would benefit from the infrastructure

The need for such a research infrastructure is further reflected by several current projects and submitted applications for research of the creative industries of the Dutch Golden Age. These are a few examples of Dutch projects (proposals), but there are several international projects as well (See further, under heading International Context) that could be enhanced fundamentally by the *Golden Agents* research infrastructure. Of course not all submitted applications will be granted, but together with past and current projects, they reflect the continuity of studies of the Dutch Golden Age and the need for a research infrastructure that allows for a more systematic and comprehensive study of the creative industries of Dutch Golden Age for several research groups and for many less visible individual scholars that often have been working for years with limited means and facilities and will continue to do so.

1. Mapping the book trade, publishers and printers

Book historian dr. Paul Dijstelberge (University Library Amsterdam) shares his data on the book and printing industry in open access with various public and private partners (Arkyves.org, GEOconTEXTing the international book trade and GLAM). It consists at the moment of more than 20.000 images of typographical material from Dutch printers and more than 50.000 from 15th and 16th century European printers (Dijstelberge, 2015 forthcoming). The next four years all Dutch printers from the 15-18th century will be added to the database. It is planned to link this database to the STCN and ECARTICO. This project would benefit from interactions with the research of Prof. Wijnand Mijnhardt (UU) and dr. Elmer Kolfin (UvA) respectively on the history of the Dutch book trade of the 18th Century in international context (Picard) and Printmaking in the Dutch Republic at the Dawn of the Enlightenment. The same applies to the project below of prof. Charles van den Heuvel and prof. Harald Hendrix (UU, KNIR) that compares the role of the art market and book market of Amsterdam with the cities of Florence, Rome and Venice. The proposed infrastructure would allow us to answer the following research questions of this project:

1. How did the Dutch publishing industry succeed in selling their products on an European scale?
2. How and why did Dutch printers and publishers companies change during the 17th century?
3. How did new printing techniques influence both the production and consumption of books?

2. Mechanisms of Language Creativity in the Dutch Golden Age

A team of researchers led by professors Els Stronks (UU) and Lia van Gemert (UvA) studies various forms of innovation in the Dutch 17th-century language and literature to shed more light on the mechanisms of language creativity as an understudied driving force behind the rise of the Golden Age. From what we know, language innovations were partly driven by influences from the Classics, the transition of Dutch to new social domains (religion, science, etc.), and the urge to develop a standard language. However, the effects of the enormous variation in language uses has never been charted. Dr. Feike Dietz and dr. Marjo van Koppen submitted a proposal for the NWO-Open Competition to study how individual authors experimented with language within and outside literary conventions to enhance the force and role of language in social-cultural dynamics and its impact on language innovations. In the context of CREATE, Van Gemert and Nijboer are currently working on related research into stylistic and topical changes in texts, to find out how fashions in style and topics were hyped and renewed. To study specific forms of new production of language that contributed to the creative dynamics of the period, a PhD-project by Willemijn Zwart will focus on young authors' contributions to the creative industry. In projects like these, literary researchers at large, profit from a RDF representation of the STCN developed during Stronks' KB/NIAS-fellowship (currently linked to other RDF representations of the Rijksmuseum, Rijksprentenkabinet, RKD and Royal Library for even wider use). Moreover, these STCN RDF schemes could be enriched by the information on the book

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and print industry by Dijkstra (UvA Library) that is not covered by the STCN yet, and linked with RDF representations that will be generated from his database.

The proposed infrastructure would allow us to answer the following research questions of this project:

1. What language innovations occurred in the Dutch literature; in which genres did these innovations originate and how and where did they spread?
2. What characterized the sites of innovation and the personalities of the innovators?

3. *Imaging Mankind. How the Golden Age creative industries created a market for visual knowledge about mankind.*

A team consisting of professor Inger Leemans (VU) and Eric Jorink (Leiden University/Huygens ING), dr. Frans Blom (UvA) and dr. Elmer Kolfin (UvA) investigates the development of the illustrated book as an innovative and highly successful product for the international market. In the Golden Age, the Dutch Republic succeeded in obtaining the position of *Magazin de l'univers*, distributing books all over Europe and beyond. This international textual community underwent a 'visual revolution' through the fast growing amount of printed visual material, e.g. maps, and illustrated books. Building on pilot projects that linked the STCN with the Rijksmuseum and other digital collections and lexicons (Invenit1 & 2; *Linking the STCN and Performing Big Data Queries in the Humanities*), this team will research this visual revolution and the changing role of illustrations as instruments for knowledge transfer. The research group benefits from the Golden Agents Research Infrastructure, in answering the following questions:

1. How were book illustrations used as instruments for the transfer of new knowledge and what changes can we detect during the early modern period?
2. How can we trace the rise of the illustrated book, and the innovative market strategies that publishers and artists developed, to combine arts and knowledge for new visual forms of knowledge transfer, that appealed to a large public?
3. Can we trace the development of a "visual image of mankind", through which the fast expanding knowledge of (non) European cultures was mapped?

4. *On Stage: Online Database of Theatre in the Dutch Golden Age*

In the context of CREATE (UvA) a team under the supervision of dr. Frans Blom develops an online database of theatre performances in the Dutch Golden Age with the aim to understand its "successful" role in the creative industry of that period by analyzing networks of actors and publishers, theatre programs, popularity of plays and the import and export thereof. In order to establish the role of theatre in the creative industries of the Dutch Golden Age in a comparative way, this project would benefit from linkage to the other databases in the Golden Agents research infrastructures and the provided network tools. It would enable to study interactions between material and immaterial expressions of creative industries. In terms of profit and amounts of spectators, the proposed infrastructure would allow us to answer the following research questions of this project:

1. Does the Amsterdam Golden Age and its increasingly wealthy population affect the break-even point for a theatre play to be annually programmed in the Schouwburg repertoire?
2. How does the repertoire program of the Amsterdam Schouwburg reflect a balance between financial profit on the one side and cultural prestige on the other?
3. What networks and agencies were responsible for organizing and carrying out the production of foreign drama in the Amsterdam Schouwburg, both for its import and export?

5. *Mapping Historical Networks of the Creative Industry: Connecting Creative Agency in Early Modern Amsterdam, Florence, Rome and Venice*

Prof. Charles van den Heuvel (Huygens ING) and prof. Harald Hendrix (UU/KNIR) submitted a proposal for the NWO Open Competition to investigate the history of the creative industry of Amsterdam, Florence, Rome and Venice in the Early Modern Period from intellectual, technological and artistic perspectives, by analyzing creative agency, focusing on knowledge agency and artistic agency. This research project builds upon a pilot project *Mapping Notes and Nodes in Networks: Exploring potential relationships in biographical data and cultural networks in the creative industry in Amsterdam and Rome in the Early Modern Period*. (Álvarez Francés & Heuvel 2014) funded as a KNAW Private Public Participation project in which parts of datasets ECARTICO, Hadrianus, Sculptors on the Move were linked with the software tool Nodegoat. The assembled metadata sets would be enormously enhanced by linking

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them as well to STCN, Arkyves, GLAM-map etc. Access to full contemporary texts of the arts and culture in the Golden Age would allow for further contextualization of the concept of creative agency.

The proposed infrastructure would allow us to answer the following research questions of this project:

1. How can the concept of creative agency be explored to understand the creative industry from multiple historical perspectives?
2. What kind of networks of actors and artefacts can be associated with the history of the creative industry? What were the roles played by these networks in cultural and artistic transmission processes?
3. How can analyses of the concept of creative agency and the operationalization hereof in visualizations of networks of actors and artefacts of intellectual and artistic agency provide new insights in existing literature of the history of science, cultural history and art history?

6. *Historical Transnational and National Nodes and Networks in the Netherlands (NaNoNeth)*

The NaNoNeth project of prof. Marjolein 't Hart (Huygens ING/VU) in collaboration with prof. Inger Leemans (VU) and prof. Karel Davids (VU) in which multilayered networks are created of intersections between the fields of history of politics, economy and culture, opens up the opportunity to link cultural agents to political patrons and to political "fashions" and "taste". Existing datasets at the Huygens ING supports this research: the Municipal Council of Amsterdam 1578-1795 (Elias); the 'Repertory van Holders of Political Office and Civil Servants'; the Resolutions of the States of Holland; the Resolutions of the States General; Biography Portal, and Correspondence of Huygens and others, which are linked in the Huygens ING Timbuctoo repository infrastructure. The linkage of these data sets to the Golden Agents Infrastructure (See also, Local Context and Design and implementation) allows us to address the following research questions:

1. How did the cultural industries contribute to the status of politicians?
2. When and how did authorities recognize the status of certain cultural industries?
3. Did politicians further the development of the cultural industries in a certain direction?

7. *Selling the Golden Age: capital, connoisseurship and collector's culture on the Dutch 18th-century art market*

A team of Dutch art historians from various institutions, including prof. Frans Grijzenhout (UvA), dr. Marten Jan Bok (UvA), dr. Everhard Korthals Altes (TU Delft), dr. Chris Stolwijk (RKD) and Dutch private auction houses submitted a proposal for the NWO-Open competition. The aim of the proposal is to understand the appreciation and reception of Dutch Golden Age by analyzing sales of the masterpieces of that period in public auction catalogues of the eighteenth century. They will digitize circa 1,000 auction catalogues in the Netherlands to study their vocabulary and rhetoric in comparison both to contemporary art biography and art criticism. To this end they link information of the RKD, the Getty Provenance Index databases in LA and Montias' database of inventories of the Dutch Golden Age of the Frick Art Reference Library in New York.

The proposed infrastructure would allow us to answer the following research questions of this project:

1. What is the role and impact of different actors ("vendue-meesters", auctioneers, art dealers, middle men, buyers in Amsterdam) in art auctions in various segments of the (inter-)national art market?
2. Is Van Miegroet&De Marchi's theory of growing transparency on the French market valid for the Dutch Republic as well?
3. Is there a relation in the vocabularies and rhetoric of auction catalogues and contemporary art criticism?

8. *Consumer silver in the Dutch Republic*

Researchers at Utrecht University under the supervision of prof. Maarten Prak, prof. Oscar Gelderblom and prof. Joost Jonker (UU/UvA) and at the University of Amsterdam under the supervision of dr. Harm Nijboer study the role of silver as a commodity, a product that was even more popular with Dutch households than paintings. Although silverware was still used for the purpose of hoarding, another reason must have been that silverware was offered in all price categories and a large variety of products, ranging from buttons and clips on family bibles to elaborate table pieces. Lots of silver pieces survive in public and private collections, and have already been described in catalogues and local studies of the silversmithing industry. We know a fair amount about the production of silverware by individual silversmiths. The challenge is to move to more refined stylistic descriptions of objects in a systematic and meaningful way. Comparison with other sources on the production and consumption of the creative industries in the

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Dutch Golden Age would be very useful.

The proposed infrastructure would allow us to answer the following research questions of this project:

1. What product innovations occurred in Dutch silverware; where did these innovations originate, how did they spread and what characterized the sites of innovation and the personalities of the innovators?
2. How broad and deep was the market for silverware in the Dutch Republic, and how did that market evolve over time?
3. Did the use of silverware as a hoard decline (or rise) over time; how did towns and countryside behave in this respect and what was the role of women as owners of silverware?

Potential use of research infrastructure beyond the study of the creative industries of the Dutch Golden Age

The proposed infrastructure also has potential for research well beyond the Dutch Golden Age. Some studies analyze multiple Golden Ages of cities in various countries in a comparative way to identify structural conditions explaining historical trends in cultural production (Hall, 1996; O'Brien et al., 2001; Hessler & Zimmerman, 2008). Others focus on the source of innovation themselves. The research team of Prof. David Stark at Columbia University in the field of sociology of innovation employs large datasets to study the social sources of creativity. Supported by a major grant from the National Science Foundation they develop network analytic methods to examine the historical structures whereby collaborations assemble, disassemble, and re-assemble between actors in various creative teams. It is just one of the many examples to demonstrate how our proposed infrastructure could be extended in other international research programs and research fields.

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Description and motivation of the investment

Motivation

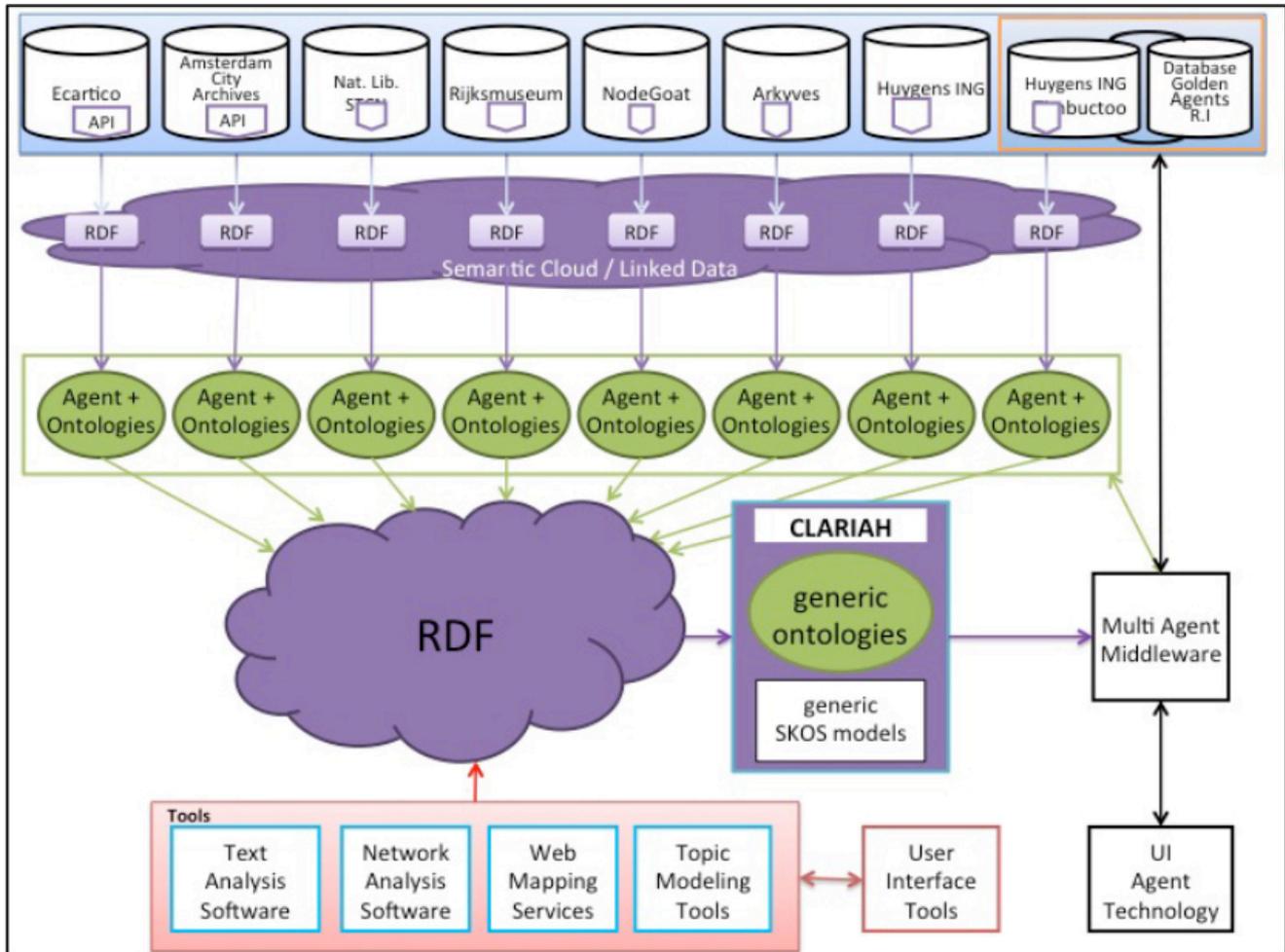
The research of the creative industries of the Dutch Golden Age lacks 1) an infrastructure that links existing and future information on facets of the cultural industries of the Dutch Golden Age for comparative and comprehensive research with emphasis on producers-consumers interactions; 2) good (access to) certain data to correct the imbalance in historical information on the production and consumption of the creative industries of the Dutch Golden Age; 3) an embedding in national (CLARIAH, Nederlab) and international research infrastructures to profit from standards, SKOS's and digital tools used and developed in these infrastructures, and the opportunities these infrastructures offer to study the creative industries of the Dutch Golden Age.

We propose an investment to create

- **an innovative research infrastructure that combines semantic web solutions with multi-agent technologies to access and query large distributed datasets**
- **access to existing datasets and newly digitized sources, that inform us about severely understudied consumers' responses (as found in the notarial acts of the Amsterdam City Archives)**
- **embedding of the Golden Agent infrastructure in national and international research infrastructures that will give research into the creative industries of the Dutch Golden Age a visible, even leading role in the world**

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Global Design and implementation of the Golden Agents Research Infrastructure



Description

The starting point of this project is a set of (existing and newly built) databases each annotated with metadata using a domain specific ontology. The technical aim of this project is to provide tools and technologies that allow users to analyze and fetch data from this heterogeneous set of databases. These analyses will provide valuable and solid answers to the questions of the Humanities researchers involved in this application, but also elsewhere in the world. Given this technical aim, we need to agentify various heterogeneous databases allowing them to interact by exchanging and combining information between them. Important requirements for this application are that:

- 1) it works around the fact that the databases use different metadata and ontologies,
- 2) the databases can thus continue to be developed and maintained independently,
- 3) new databases may be added to the system, and that
- 4) the users can post queries for which the answers should be computed collectively by the set of databases (for no single database contains all the requested information).

The innovative approach followed in this project integrates various technologies from multi-agent systems and the Semantic Web to analyze, fetch, filter, merge and update information that is scattered over the various heterogeneous databases. This is done by developing computer agents that are able to 1) reason about, maintain, and fetch data from their associated databases that are described using specific ontologies (we call them agent private ontology), and 2) communicate and collaborate to analyze and answer user queries based on a shared ontology (we assume the shared ontology to be rich enough to express user queries). Interaction protocols and

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multi-agent services will be designed and developed to allow agents to 1) decompose user queries to sub-queries and distribute them among agents, and 2) filter and compose the agents' answers to a general answer for the user query.

In order to answer a user query, computer agents should be capable of aligning/mapping the shared ontology onto their private ontologies, i.e. each agent should be able to translate the shared ontology to the specific ontology used in its associated database and back. The idea is that a user (cross-database) query is communicated to the agents based on the shared ontology and that the agents answer parts of the query by translating the query part (described in the shared ontology) to a query that is described in their private ontology. In answering a query part, the agents can also subcontract queries to each other. In order to design and build such a multi-agent application, semantic web technologies have to be integrated at both individual agent and multi-agent levels.

Tasks

In order to realize this design and its implementation the following tasks need to be completed (See further, figure Management plan)

- 1) **converting existing (meta-) datasets** relevant for the history of the creative industries of the long Dutch Golden Age (1585-1800) to RDF format.
- 2) **digitizing, data curation, coding, adding metadata and making indexes** to RDF sets of the probate inventories of the Dutch Golden Age in the notarial archives of the Amsterdam City Archives and for other strategically chosen data sets and texts.
- 3) development of **domain specific standards, SKOS and ontologies** that are complementary to, but completely interoperable with the standards and ontologies of the CLARIAH infrastructure.
- 4) design and development of a **multi-agent platform** that enables the principled integration of these (meta-)datasets based on semantic web solutions and supported by these ontologies developed by domain experts.
- 5) design of **interfaces** to give researchers and other users **access to** this multi-agents platform and to existing **data mining, topic modeling and text-analytical tools of the CLARIAH and Nederlab platforms** to analyze, annotate and visualize metadata and textual and visual sources.
- 6) **co-development** by scientific programmers of the hosting organization of the Golden Agent research infrastructure **and training** in the use of the multi-agent programming language to guarantee its **sustainability**.

Ad 1) converting linking existing (meta-) datasets relevant for the history of the creative industries of the long Dutch Golden Age (1585-1800) to RDF format.

We build upon recent initiatives in which distributed datasets such as catalogues of the Rijksmuseum and Rijksprentenkabinet are linked to the STCN (Chris Dijkshoorn VU and Lizzy Jongma (Rijksmuseum) in project INVENIT) using RDF representations. We develop RDF schemes for those relevant databases which yet do not have such (meta-)data representations, to be exported by API's (and via a process of formalization using standards and developing domain specific ontologies) to be imported in the multi-agent platform for further modeling. Developers and data managers of databases who lack the expertise to develop such RDF schemes and API's themselves will be supported by developers under the supervision of prof. Frank van Harmelen and an advisor of the Knowledge Representation & Reasoning group of the Network Institute of the VU University Amsterdam that has much experience from several European and national projects with the development of semantic web solutions.

Ad 2) digitizing, data curation, coding, adding metadata and making indexes to RDF sets of the probate inventories of the Dutch Golden Age in the notarial archives of the Amsterdam City Archives and for other strategically chosen data sets and texts.

(a) Digitization of probate inventories in the notarial acts of Amsterdam City Archives

The crucial importance of the **probate inventories in the notarial acts of the Amsterdam City Archives** for the history (in particular the consumption and social stratification) of the creative industries of the Dutch Golden Age has been mentioned earlier in the research program. To retrieve relevant probate inventories and other deeds such as last wills from the notarial acts of Amsterdam City Archives requires a special approach. The notarial acts (archive 5075) consist of protocols of 731 notaries with minutes and some contemporary indexes from the period

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1578-1915. Considerable parts of the 3 km long archives, albeit not all documents, are relevant for the history of the Dutch Golden Age. In order to create a sample of the long Dutch Golden Age in principle all documents need to be analyzed. The Amsterdam City Archives recently started a project for a systematic digitization of the complete set of notarial acts. First, the acts are scanned (duration between 4 and 6 years (2015-2021)). This results in approximately 15.000.000 to 20.000.000 scans. Metadata will be created for the indexing of these acts and full transcriptions of the acts will be made in a crowd sourcing model based on their experiences with the successful *VeleHanden* project that was developed by the private company Picturae. The Amsterdam City Archives will contribute matching in kind of € 1.200.000 out of their larger scheme to create a representative sample of acts relevant to the history of the Dutch Golden Age. Moreover, the Amsterdam City Archives will assist in the conversion of metadata to RDF schemes and EAD/EAC standards and in the design of typologies of the notarial acts for the development of ontologies (see below ad 3). In order to create the sample we will take carefully selected probate inventories that will be transcribed and encoded (to be coded as TEI compliant XML documents). We will use semi-automatic procedures to convert these documents into data (Spaeth, 2008). Ontologies will be developed to transfer these data sets to RDF. These scans, metadata and indexes, different from the other data in the Amsterdam City Archives, will be completely open for use and reuse.

The probate inventories in the notarial acts are not the only inventories and documents to be digitized. In addition to this large, complex but most important digitization project we will **digitize, code and index strategically chosen inventories, sources and texts.**

(b) Scanning data and adding metadata of Archive of Bredius (RKD)

Adding metadata of the Archive of Bredius (RKD) to the Golden Age Research Infrastructure

The notes of Abraham Bredius (1855-1946) in the RKD in The Hague of archives concerning the provinces of Holland and Zeeland during the Dutch Republic contain not only metadata about the notarial acts with probate inventories kept by the City Archives of Amsterdam, but also of notarial acts and other archives in many other Dutch cities. Bredius' notes will be used to enhance the digitization of the Amsterdam acts as well as for comparative analyses. Source of comparison are for instance excerpts from the archives of the important city of Middelburg that were destroyed during WOII, and can now only be consulted using Bredius' notes. We will digitize approximately 16,250 texts with his notes on artist names, cities, artist professions, inventories of the years (1600-1810) and various findings in archives.

(c) Scanning and adding metadata of a relevant selection of edited sources and reference works

Furthermore, we have composed a list of source publications and reference works that contain relevant information about actors and artifacts related to cultural industries in the Dutch Golden Age. We will process the exemplary work on the Amsterdam book trade done by Kleerkooper and Van Stockum (1914-1916), Moes and Burger (1915) and Van Eeghen (1960-1978). For the visual arts we will process Bredius' famous *Künstler-Inventare* (1915-1922), Obreen (1877-1890), Rombouts & Lerijs (1864-1877), Muller (1880) and Miedema (1980). We will also process reference works on newspaper advertisements for cultural goods (e.g. Van der Krogt 1985, Dudok van Heel 1975 & 1977) and on patents and privileges that contain information on technical innovations and the legalization of intellectual property rights (Doorman 1940). The work that needs to be done to complete this task varies. Some of these sources (such as archival sources in the Biographical Reference Works of the Huygens Institute) only need to be indexed and converted for further processing.

Ad 3) development of domain specific standards, SKOS and ontologies that are complementary to, but completely interoperable with the standards and ontologies of the CLARIAH infrastructure.

The above mentioned metadata of the sources and texts need to be made machine readable and formatted to provide input to the multi-agent platform. To do so, the Golden Agents Research Infrastructure will re-use existing ontologies, registries and thesauri where and whenever possible:

- (a)** ontologies and SKOS standards of the CLARIAH infrastructure (for instance for personal and geographical names)

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(b) standards and ontologies developed within three CLARIAH-pilots: language studies, media studies and socio-economic history

(c) XML-TEI, EAD, AAT, specific RDF/SKOS schemes developed for the STCN, Rijksmuseum and the Rijksprentenkabinet.

When they do not yet exist, new ontologies are developed

(d) for specific domains within the creative industries.

Domain experts (historians, art-historians etc.) will assist a team led by prof. Arianna Betti to develop (i) a conceptual model which will serve as basis for the ontologies and (ii) translate specific domain expertise into scenarios to model the actions and communications of the computer agents on the multi-agent platform. The design of the ontologies is complex and requires multi-perspective and dynamic approaches in order to chart the shifts in meaning of specific terms and concepts such as innovation in various creative industries. The output of this task is input for the multi-agent platform.

Ad 4) the design and development of a multi-agent platform that enables the principled integration of these (meta-)datasets based on semantic web solutions and supported by ontologies developed by domain experts.

While the RDF sets will represent metadata and data relevant to the history of the creative industries of the Dutch Golden Age, artificial intelligence in the form of computer agents will enable users to find the answers to their queries expressed in this (meta)data. Computer agents will use the ontologies to process these queries but also to suggest alternatives. This way, the agents will gain knowledge from previous queries.

The proposed multi-agent platform is designed and developed by the Intelligent Systems Group led by dr. Mehdi Dastani (UU) in these stages:

(a) Design and development of individual agents. Each agent will be responsible for managing and maintaining a specific database, reasoning and answering possible queries, reasoning about a shared ontology (the ontology used among agents) and translating it to its own private ontology (the ontology used in its associated database), communicating with other agents.

(b) Design and development of a distributed middleware. The middleware allows individual agents (including their databases) to run on different platforms and to communicate with each other. It also allows various services to be implemented and composed to define complex services.

(c) Design and development of multi-agent interaction. In particular, the design and development of protocols that allow individual agents to interact with human users (including design and development of user interfaces) and to exchange information among agents. In addition, services should be designed and developed to allow new agents (responsible for new databases) to enter the system, to register their private services/datasets, to translate ontologies and possibly help agents to acquire general information (e.g., translate words, finding synonyms, finding specific information on the web), and to compose services.

Ad 5) design of interfaces to give researchers and other users access to this multi-agents platform and to existing data mining, topic modeling and text-analytical tools of the CLARIAH and Nederlab platforms to analyze, annotate and visualize metadata and textual and visual sources

In addition to queries supported by computer agents, the users of the Golden Agents Research Infrastructure will be offered text mining, network and geographical visualization and topic modeling tools as developed by CLARIAH and Nederlab. General User Interfaces will be developed for access to both these tools and the multi-agent platform.

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Ad 6 co-development by scientific programmers of the hosting organization of the Golden Agent research infrastructure and training in the use of the a multi agent programming language to guarantee its sustainability.

The developers and programmers in the Intelligent Systems Group under the supervision of dr. Mehdi Dastani (UU) will involve scientific programmers of the Huygens ING where the research infrastructure will be hosted in the design and development of the multi-agent platform. Moreover, they will be trained in the use of a multi-agent programming language to enable the curation, update and reuse of the multi-agent platform for future researchers and other users.

National context of the facility

Scientific national context

The facility underpins one of the sectors of the Dutch top sectors policy: creative industries. It sheds light on the understudied historical perspectives of these industries, more in particular on the social dynamics that fostered the unprecedented explosion of creative activities at the time of the Dutch Golden Age. How did all actors involved (from producers to traders to consumers) contribute to this explosion? It will thus contribute to NWO's role to "support the knowledge base of the Dutch top sector creative industry." The combination of data relevant to the history of creative industries of the Dutch Golden Age, as preserved by large national cultural heritage institutions such as the Koninklijke Bibliotheek, the Rijksmuseum, the Netherlands Institute for Art History (RKD) and the Amsterdam City Archives, will be of importance and use to all scholars in the Netherlands interested in the history of the Dutch Golden Age, as well as for the great number of international scholars working on this subject.

The Golden Agents Research Infrastructure on the one hand could not exist without the CLARIAH infrastructure. On the other hand it is complementary to CLARIAH, for it covers the new and unexplored terrain of the creative industries.

Societal national context

There are three distinct ways in which the proposed facility will reach out to an audience outside academia. First of all, the modern creative industries are inspired by earlier examples. Museum collections will allow designers and other parties in the creative industries easy access to a wealth of material related to both very famous and not-so-famous predecessors in a variety of branches. Secondly, the infrastructure will connect various heritage institutions (museums, archives) in novel ways. Thirdly, there is a very substantial interest among the general public for artefacts from the Dutch Golden Age, as has been underlined in recent months by the Late Rembrandt exhibition, where about 200.000 visitors came from the Netherlands. The Rijksmuseum's website, which offers high-quality images of its collections, has added substantially to the museum's visibility and reputation.

Accessibility

All metadata and data will be made available in open access.

Relation to other research groups/centres

Existing

The consortium of the research program is located in Amsterdam, The Hague and Utrecht.

Amsterdam (VU, UvA).

At the University of Amsterdam the Amsterdam Centre for the Study of the Golden Age (ACSGA) coordinates the interdisciplinary program Dutch Golden Age of the Institute of Culture and History of the Amsterdam School for Culture and History (ASCH). The program focuses on the art, culture and history in the "long" Dutch Golden Age and explores connections between artefacts. It brings together professors and their staffs from Dutch history (prof. Geert Janssen), literature (prof. Lia van Gemert), art (prof. Frans Grijzenhout), business history (prof. Joost Jonker), the history of Amsterdam in global context and Dutch elite culture (prof. Kees Zandvliet) and finally digital

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methods in historical disciplines (prof. Charles van den Heuvel). Within the Centre, dr. Harm Nijboer and dr. Marten Jan Bok developed the database ECARTICO for the visual arts. It was expanded in the NWO program *Economic and Artistic Competition in the Amsterdam Art Market c. 1630-1690* and in the KNAW project *The Cultural Industry of Amsterdam*. This Centre has strong connections with cultural heritage institutions such as the Rijksmuseum, Amsterdam Museum, the Amsterdam City Archive and the Special Collections of the University Library of Amsterdam. Furthermore, it is directly linked to two of three priority areas within the Faculty of Humanities: *Cultural Transformations and Globalisation* (CTG) and *Cultural Heritage and Identities* (CHI). The centre participates in the research program of CHI in the project *Creative Amsterdam: an E-Humanities perspective* (CREATE), that investigates the Dutch capital's creative industries from 1600 to the present. CREATE and the Institute of Logic, Language and Computation (ILLC, with prof. Rens Bod and prof. Arianna Betti) work closely together and joined forces within the Centre for Digital Humanities, a collaboration between de University of Amsterdam, the VU University Amsterdam and Royal Netherlands Academy of Arts and Sciences. Together they provided funding for Public Private Participation projects. After a first successful experiment, the UvA and VU will offer the *Digital Humanities Minor* for students of both universities again in 2015-2016. The Network Institute of the VU worked closely together with Huygens ING in the *Dutch Ships&Sailors* and *BiographyNet* projects in which the data was correlated via semantic web technology. This collaboration continues in the development of shared CLARIAH services for the structured data hub.

The Hague (Huygens Institute for the History of the Netherlands)

The project leader of the proposed infrastructure, next to his function of head of research of history of science and scholarship at Huygens ING, holds the chair Digital Methods in Historical Disciplines at the UvA. He participates in the research of Amsterdam Centre for the Study of the Golden Age, in the program CREATE, in the Centre for Digital Humanities and in the UvA/VU minor. His research group History of Science and Scholarship is involved in the program Making the Knowledge Society of the Huygens ING and closely cooperates with the Descartes Centre of Utrecht University among other things in editing the most prominent periodical in the history of science of the world: *ISIS*. Researchers in intellectual and cultural history of the Early Modern Period of Utrecht University, Huygens ING, VU University Amsterdam, University of Twente and the University of Antwerp participate in the research project The Global Knowledge Society of the Descartes Centre with the Max Planck Institute for History of Science in Berlin.

Utrecht (Faculty of Information Sciences, UCEMS, Descartes Centre)

The department of Information Sciences and the department of Humanities of Utrecht University work closely together in developing this Golden Age Research Infrastructure. Prof. Remco Veltkamp and dr. Mehdi Dastani are well known for their multi-agent system theories and applications, in particular specification and programming languages for multi-agent systems and logics to reason about multi-agent specifications and programs. Dr. Dastani collaborated with a group of humanities scholars of Utrecht University and prof. Charles van den Heuvel in an experiment in which the expertise of curators of special collections of cultural heritage institutions was used to develop computer agents that recombined maps with contextual documents that were separated in the past due to 19th century archival practices (Heuvel 2009; Heuvel, Spruit, Breure & Voorbij 2010). The early modern specialists in the Faculty of Humanities are united in the Utrecht Centre for Early Modern Studies (UCEMS) as well as in the Digital Humanities Lab: at the cross section of these two the idea for the Golden Age Research Infrastructure was developed. Professors Maarten Prak, Oscar Gelderblom and Wijnand Mijnhardt are internationally renowned socio-economic and cultural historians of the Netherlands in the seventeenth and eighteenth centuries and have published about its painting, jewellery and book trade respectively. Prof. Els Stronks has coordinated and collaborated in various digitization projects on early modern Dutch literature.

Planned cooperation for KNAW institutes

The Huygens ING participates in Nederlab (NWO- Large Investment Subsidy), in close collaboration with the Meertens Institute where this infrastructure is developed. In 2016 the Huygens ING will move to Amsterdam and cluster with two other large research institutes of the Royal Netherlands Academy of Arts and Sciences, the Meertens Institute, and the International Institute for Social History, and will actively make use of the facilities of

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the Netherlands Institute for Advanced Studies of the KNAW that will be moved to the Dutch capital as well. Although these institutes will keep their own independence and research programs, an additional research program has been developed for a "KNAW Humanities Group" in which the research institutes cooperate. The Royal Netherlands Academy of Arts and Sciences has allocated additional funding of 7 million euro to enhance this cooperation with a focus on e-humanities research and the development of a digital infrastructure for these research institutes. The cooperation of more KNAW institutes opens up further possibilities for collaboration with the consortium.

International context

The American organization *Historians of Netherlandish Arts* alone includes around 700 individuals and 30 institutions and businesses that for the greater part join this organization to study the Dutch Golden Age. The Rijksmuseum is one of the most visited museums in the world (2,2 million visitors in 2013 when it reopened, and numbers are rising), especially for its 2000 paintings of the Dutch Golden Age. Silverware, architecture and ceramics of the Dutch Golden Age attract similar levels of attention. The creative industry of the Dutch Golden Age is thus an international brand in its own right, and this in itself positions the proposed project in international spotlights. Moreover, the participation of world known institutes such as the RKD (Netherlands Institute for Art History, the world's leading center for the study of Dutch art), the Getty Research Center, and the Frick Collection in the proposed facility guarantees international exposure of our project. This collaboration also implies a commitment to the international development of to provide Open Access to research facilities and data. The Getty Research Center recently released its Getty Artists Names (ULAN) catalogue in linked open data: this policy enables the linking of this center's collections to the Golden Agents Research Infrastructure for we intend to use the open standards developed by this center (such as the Artist and Architecture Thesaurus (ATT) if they present a good alternative for RDF representations). It is our shared goal to provide open access to databases on the production and consumption of the creative industries of the Dutch Golden Age on a global level. With the help of artificial intelligence, users from all over the world will find precise answers to their queries.

Local context

Profile of the Huygens Institute

The proposed infrastructure will be hosted at the Huygens Institute for the History of the Netherlands. This institute of the Royal Netherlands Academy of Arts and Sciences is one of the largest humanities institutes of the Netherlands. It combines research of history and culture with development of innovative tools to disclose inaccessible texts and sources and to enable users to analyze them. A group of about 70 researchers in three departments: history, history of science and literary studies works closely together with a team of about 15 IT developers and project managers. Furthermore, it has a department of Digital Data Management that guarantees a professional handling and sustainable access to digital data and tools. Furthermore, the Huygens ING is an official CLARIN B Centre, which is a member of the European CLARIN ERIC. Huygens ING hosts the headquarters of the largest professional union of historians in the Netherlands: The Royal Netherlands Historical Society (KNHG). The history department would especially benefit of the Golden Agent research infrastructure (See further, Eight examples of projects, 6 NaNoNETH)

Huygens and CLARIAH

The Huygens ING is the main applicant of the Common Lab Research Infrastructure for the Arts and the Humanities (CLARIAH) that received a grant of 12 million euro from the National Roadmap for Large-Scale Research Facilities to develop a sustainable digital infrastructure for the arts and humanities. The Huygens Institute has a leading role in the work packages 1) Technical implementation of the infrastructure and 2) Interoperability which guarantees a sustainable embedding of the proposed infrastructure that will make use of the tools and standards developed in the context of the Common Lab as much as possible and where new, more domain specific ontologies and standards will be developed/will be made compliant with the CLARIAH infrastructure.

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Additional relevant expertise

Apart from the expertise from the Huygens ING with the development of innovative tools for editing historical and literary texts, the institute successfully experimented with various data mining and topic modeling methods for (semi-automatic) analyses of complex multilingual datasets with much spelling variation, for instance in the development and implementation of the internationally praised *ePistolarium* tool in the context of the NWO funded project: *Circulation of Knowledge and Learned Practices of the Dutch Republic*. The combination of the content of letters of 20.000 Dutch scholars or scientists in this database with texts on Dutch art theory would enable comparative analyses of the innovative role of scientists and of knowledge as commodity with innovations in art production in the global market of the Golden Age. The Huygens ING does have experience with the integration and providing access to documentation of the most famous painter of the Dutch Golden Age, Rembrandt. Together with the Radboud University funded by CLARIN-NL they built the *RemBench - a Digital Workbench for Rembrandt Research*. It enables one to search and browse for works of art, artists, primary sources and library sources related to Rembrandt, using faceted search and fuzzy key word search. Rembench combines the content of four different databases behind one search interface:

- RkDartists and RkDimages, two databases maintained by the Netherlands Institute of Art History (RKD)
- RemDoc, a collection of original documents related to Rembrandt van Rijn from the period between 1475 to circa 1750
- RUQuest, a library system that provides access to full text articles, as well as the complete collection of (e-)books and journals from the Radboud University Library Catalogue

Huygens and Open Access

Huygens ING provides open access to all research data unless third parties have granted only limited access to the data concerned under certain conditions. The data acquired in the context of this proposal will be open access with no further limitations for re-use by third parties. Research data that is stored in Huygens ING own repository is made accessible primarily through Huygens ING own websites. They are made accessible via virtual research environments tailored to research use. Furthermore, the research data from Huygens ING's own repository is periodically deposited with DANS.

Knowledge exchange and transfer

Creative Industries: Impact for international research, Public-Private Participation Projects and SME's

The thematic NWO program: *Creative Industry* reflects the Dutch government's top sector policy. Our research supports its aim in two ways: on a national and on an international level.

Impact on national level: topsector policy and the creative industry research infrastructure

The creative industries have been identified by the Dutch government as one of nine key sectors for the Dutch economy. The report *Creative Industrie. Clusterstrategie Kennis & Innovatie* (2011, p. 3) outlining the sector's strategy, claims that Amsterdam is important for the creative industry "from an international historical perspective." It is correct that Amsterdam played this role during the seventeenth and eighteenth centuries, the period covered by this project; much less so in the nineteenth century. Historical comparative studies have so far been difficult to write because the data were so complex (exceptions are Hall 1996; O'Brien e.o. 2001). This project will first of all give the modern creative industries a much more solid history. This is important for three reasons. Firstly, embedding cultural heritage in modern environments is a key objective of the Creative Industry Topsector. The proposal is supported by several heritage institutions, who offer large datasets and their expertise for this project. Secondly, the project will permit scholars to develop a much better understanding of the conditions under which creativity can blossom. The Golden Age is used as a laboratory to study, historically, best practices and their effects. Thirdly, the Golden Age cultural heritage is a repository of ideas and examples for modern designers. This proposal will permit practitioners from the creative industries easy access to a huge store of images and background information about artists.

Researchers involved in this project have collaborated – and will continue to do so – with private small and medium enterprises (SME's) in Public-Private-Participation (PPP) projects financed through the multiple calls by the Royal Netherlands Academy of Arts and Sciences and the two universities of Amsterdam. For instance, The Huygens

Institute together with the two universities in Amsterdam collaborated with Lab 1100 (private company) to create and visualize multilayered networks of the creative industries of Amsterdam and Rome in the Early Modern Period with the software Nodegoat. In the project Digital Canal Ring, the ECARTICO data were plotted on a digital map of Amsterdam by Webmapper (private company). In the current CAAN project, supported by a NWO Kiem grant, the ECARTICO data is linked to those of the Amsterdam Museum by Islands of Meaning, a company specialized in developing innovative tools for e-humanities, to develop a demonstrator-tool to visualize and explore the generated artefact-actor-networks. Dr. Paul Dijstelberge develops and shares his rich collections of the Dutch book and printing industry in open access in Arkyves with private companies such as Brill Publishers and Mnemosyne that are linked with large international digital classifications, such as ICONCLASS. These examples demonstrate the interest of the private sector in the development of the sort of tools that we expect to deliver in this project.

Impact on International Research

The second contribution to the Dutch government's top sector policy is the development of our multi-agent technology, which will have an impact on international research. Not only will this multi-agent platform be built upon newly developed ontologies for the creative industries, but it will also be re-usable and extendable, just as the metadata, data and ontologies produced by our project are freely available for other creative industries researchers to use. Given the fact that we have chosen for linked open data these, (meta-)data and ontologies will not only be interoperable with the context of the CLARIAH infrastructure, but as well with the Semantic Web as a whole and therefore have a global reach. Within the context of the Semantic Web there is a need in particular for good ontologies in specific knowledge domains of the arts and cultural heritage (Gradman, 2014). The development of ontologies that take "concept drift" into account will give an extra dimension to the Semantic Web and will be re-used in other contexts. Semantic web solutions are logical in the context of national and international initiatives that already started to link databases with information on the creative industries. Current national initiatives to link the STCN of the Koninklijke Bibliotheek to Rijksmuseum and Rijksprentenkabinet, to link ECARTICO to the Amsterdam Museum and Netherlands Institute for Art History (RKD), to link the Arkyves data base to GLAMmap, will be enormously reinforced and enhanced by the semantic web solutions. The same implies to the international project in which information of Dutch probate inventories were linked to the Montias database in the Frick Art Reference Library in New York and the Getty Institute in Los Angeles (See, letters of support). The Dutch government's top sector policy provides a good context for a further exploitation of the research infrastructure concerning the history of the creative industries and stimulates further extension of current cooperation between the applicants, other scholars and private SME's.

Impact on Public-Private Participation Projects: Training and engagement of genealogists and amateur historians in crowdsourcing and public history

The datasets with information on the production and consumption of creative goods produced on the proposed project could easily be extended to databases with information on legal history, family history, social history of the Dutch Republic of United Provinces (1588-1795) where "burghers" in power could become the central force in the new, globalizing world. The most frequent visitors of the archives in the Netherlands by large are genealogists, followed by local historians. The digital access to the notarial acts is a goldmine for these amateur historians interested in all aspects of societal dynamics. More concretely, we plan to engage these historians in a crowdsourcing project (many of them already did contribute to previous projects such as the "Gekaapte brieven" (Prize Papers).

The Amsterdam City Archives took the initiative for the development of the crowdsourcing environment *Velehanden.nl* by the private company Picturae in which in two projects approximately 25,000 records are created per week. The notarial acts of the Dutch Golden Age, especially those of the 17th century, are more difficult to read. For that reason, the Amsterdam City Archives participate in another project: "Ja, ik wil" (Yes, I will) of Utrecht University in which historical banns with announcements of weddings are indexed and transcribed at a deeper level with volunteers that are trained in palaeography. The Amsterdam City Archives will use a combination of paid professionals and volunteers and collaborates with the research group "Publieksgeschiedenis" (Public History) of the University of Amsterdam to set up a test bench to experiment with indexing and transcription of the notarial acts to prepare for further digitization processes. Working on the notarial acts will thus not only engage many volunteers in

public and family history, but will also keep the knowledge of the Early Modern Dutch language and palaeographical skills alive.

Impact on Tourism

The research infrastructure will reveal a much wider and more profound picture of the creative industries of the Dutch Golden Age and provide the information on objects and collections preserved in cultural heritage institutions that are a major attraction for the tourist industry. In 2011 a quarter of the total value produced in the Dutch industry came from heritage institutions. The Rijksmuseum alone has 2.5 million visitors each year and is one of Amsterdam's most important attractions, as is the Mauritshuis museum in The Hague for that city. The dimensions of the impact of this project on tourism are impossible to quantify at this point, but it will add substantially to the web-presence of the arts and culture of the Dutch Golden Age and thus inevitably fuel an interest in this topic, which in turn is bound to stimulate visits to the Netherlands.

Budget