Studiolo

A proposal to the MIT Learning for Civic Action Challenge

Solution Overview

Name	***Studiolo*** – a global research collaboration platform
Organization	***Foundation for Information Society***, Hungary (Információs Társadalomért Alapítvány) https://infota.org/en/
One-line summary	Studiolo is an open platform for scholars, teachers, and students to do scientific research together and improve shared knowledge in a more efficient and transparent environment.
Elevator Pitch	2-minute introduction video on YouTube

What specific problem are you solving?

Specific problem (SP) 1: Science Education of K 12-18 age groups is in a deepening crisis everywhere in the World.

Basic banking education models (including its advanced *discovery-based form*) needs and creates learners, not active participants in scientific endeavors. And, where we find *research-based education practices*, the goal is only entertaining rediscovery of existing scientific knowledge. There are rare attempts to establish in schoolchildren the culture of producing new scientific data and knowledge. True scientific activity is most often a privilege of child prodigies and the talented few; however, to acquire scientific literacy though application should be open to all the estimated 900 million young minds throughout the World.

Our research has not shown almost any students within ad hoc Citizen Science project groups. ***Most volunteer citizen scientists do not have scientific literacy skills (SP2).*** Combining regular education with extreme citizen science projects will open new horizons for teachers. The main motivation of learning will be to obtain enough knowledge and skills to take part in research programs, both local and global. And, with teachers supporting the quality of the students' scientific work this project can generate hundreds of million 'lifelong researchers': professional amateurs, who can participate in any new and important scientific projects.

The production of prepared and experienced, scientifically literate students also answers one of the biggest challenges of contemporary science: ***the lack of enough human brains in problem solving scientific communities (SP3).*** As the number of professional scientists has decreased, the number of microtasks to be done have multiplied precipitously. (e.g. to tag and interpret the everyday, gargantuan data stream of scientific megamachines alone.)

Studiolo, as a new collaboration platform reflects these three specific problems together. Furthermore, from execution we can expect a solution for two additional specific problems, too.

Our unique knowledge asset, the accumulated ***universe of scientific documents, data, information, and texts is currently nothing more than a heterogenous, inefficient, ad hoc, redundant, unverifiable hyperspace (SP4)*** that is far from the early digital dreams about its mission to augment human intelligence, support brain work and build an open, universal library for the common good of mankind.

Studiolo can create an extraordinary solution, providing a channel to re-build the hyperspace alongside the original principles. Scientists should create knowledge to support the student's and teacher's work, and the results of the research projects will also flow into the same structure. Thus, the most important aspect of the existing results will be progressively transferred into this new, quality-controlled knowledge space. Hopefully, a growing number of publications will align with this knowledge organization model in time (except that managing, updating, correcting, and upgrading knowledge cards – 'trailblazing', in Vannevar Bush's vocabulary – can be also a target of Studiolo work). And finally, a notable contribution to offset ***the biggest trap of large AI-language models (SP5): changing the untrustworthy feedstock to the tendered input of responsible publishers.***

What is your solution?

Our life in the 21st century depends on "universal scientific literacy". Formal schools provide organized and verified materials, but cannot compete with online, self-paced learning services and organizations. Both present science as a product to learn and use. Cooperative and critical thinking— from validating information to the excitement of reaching new understanding is missing.

Studiolo invites participants to the heart of science: the research workshop, let them work together and solve real problems together, learning both state-of-the-art science and soft skills along the way.

Studiolo is an open scientific marketplace, guests can access public information. Participation requires individual registration. Configurative access control allows personal data/privacy protection according to applicable laws, especially for the very sensitive K12-18 age group.

The Studiolo environment defines the following roles:

- ***Scientist***: established academic professors, experts in their fields who initiate research projects.
- ***Teacher***: mediators between *Scientists* and *Students* who organize tasks, schedules, and activities, give feedback and in formal environments, evaluate the progress of the *Students*.
- ***Student***: participants who are interested in understanding the context and execute tasks within the given timeframe and guidelines.

The role of the same person may differ between projects, but within a project each member can have only one generally fixed role.

In the marketplace, *Scientists* or *Teachers* publish research projects by setting goals, giving background materials to study, and tasks to accomplish. As *Students*, people can join to read materials, pick tasks, and create responses. *Teachers* set up detailed task descriptions, dependencies, and time schedules; they check the responses and refine them with the *Students* or present them to the *Scientists*. The *Scientists* give final feedback to the collected materials, improve the project if needed, compile and manage the final product (generally a formal scientific publication).

Studiolo uses "knowledge cards" (as in NLS by Douglas Engelbart or Apple Hypercards) and "fact tables" (like protected Excel tables).

- A knowledge card is a limited, roughly one-page of formatted text about one topic. It can refer to other cards to refine commonly used terms or explain statements, contain link(s) to external sources, media, etc. ***The goal is to replace long, repetitive texts with an interlinked network of bite-sized blocks— a very efficient way to browse and understand a target context.*** Networks of knowledge cards contain project and external source descriptions, and the textual results of tasks. The feedback and discussions also use knowledge cards, thus making the cooperative thinking process transparent. The final publications also refer to these cards
- Fact tables start with a ***strict terminology and methodology description from the shared global scientific vocabulary— what those words objectively mean***, and instructions like what and how to measure, calculate, or evaluate. This gives context to the "columns" of the data tables that the *Students* should fill in. Studiolo stores the definitions and fact tables for later reference.

Studiolo data can be accessed by research projects for validation, or by participants as an activity and achievement log, part of a scientific or industrial career.

Who does your solution serve, and in what ways will the solution impact their lives?

According to a rough but conservative extrapolation based on UNESCO data, there are approximately more than 900 million students in the 12-18 age cohort, supervised in an orderly and structured manner by some 45 million teachers.

Dealing with the new generations, proofed, and influenced by information culture, we must find the most important points and role in their society, locality and civilization problems. All our approaches and ideas about the development and management of their digital ecosystems, tools and literacies must be rest on the changing nature of their social life, integration and involvement level.

Studiolo serves the education system and practice to move from desk-orthodoxy towards the horizontal forms of communication and the world of cooperating and problem-solving communities of students. Each child should be taught to think at an early age via an apparatus also used in the scientific survey of problems. ***Education should build on the fact that children are self-confident and easy users of the world of information technology tools***, applications, and practically integrate skills and knowledge with their mother tongue.

The teacher should not be a lesson-introducing machine, but an animator. He/she should smartly combine the pupils' independent knowledge operations with the library, Internet resources and smartphones as a mobile laboratory with research-supporting applications joining at the critical points.

Studiolo will support the cooperation of researchers, teachers and students with assignments that are distinguished as a function of the time requirement, profundity, and scope of each task. *It transforms the existing intergenerational **learning** practice into intergenerational **collaborative research** practice.*

If research process appears in any form, it primarily and exclusively serves learning. It also improves the efficiency of learning by increasing the level of interest and motivation. ***This is the missing last mile in digital science pedagogy.***

From the perspective of scholars, involved in extreme citizen science projects, Studiolo prioritizes staffs of sufficient size, availability, and professional-methodological quality assurance of activities. Accountability, dedicated areas of responsibility, deadlines met and capable of being met, clear project scenarios, and professional management are also integral aspects. Another focus is the organized transfer of or instruction in the background minimally that is necessary to join a project. Additionally part, facilitation of tasks, continuous mediation among individual participants of the system. Finally, Studiolo has a flexible, many-sided online system management service, oriented to facilitating horizontal as well as vertical interactions.

Civil society has joined with companies and science policy as an agenda setter affecting the trends and possibilities of scientific research, opening new, participative channels of reflecting on civilization's problems. The social contribution of science is not merely the dissemination of its "blessing" anymore, but active participation in processes of gaining knowledge— by establishing personal relations and forming their own questions and demands.

*The Studiolo-based school of the future will also be a **civilization school**, the basic knowledge necessary for the survival of civilization will be introduced into the curricula urgently and in their full range.*

How are you and your team well-positioned to deliver this solution?

Laszlo Karvalics (Team Lead)

He has a 30+ years academic career focusing on the different ways of sharing knowledge over centuries, and the missed opportunities that a more efficient IT tooling would bring. For decades he has been improving the vision of Studiolo under different names and tooling and has written many articles and cooperated with research groups in this area.

In his current institution at iASK, Studiolo would be a central research topic, a proof-of-concept service to carefully decentralize and democratize education, raise the international and peaceful nature of scientific research against many current political, economic, and social tensions.

He already has 3 pilot research projects planned on paper and has negotiated with participants, waiting for the pilot implementation of the system. The success of these projects would both involve new ones from these pilot organizations and allow reaching out to other members of the scientific community already aware of and interested in Laszlo's initiative.

Lorand Kedves (Tech Lead)

As a developer, architect, and analyst, he focuses on understanding the propagation of knowledge in information systems and development teams, from planning, coding, process management to user manuals. Finding the current tools inadequate and global changes in IT industry alarming, he returned to the academic environment, conducted his PhD research on Dynamic Knowledge Representation, both its history and possible implementation in the current IT ecosystem. He found that efficient knowledge management was the original goal of information technology, and Studiolo perfectly represents this aim. It is an excellent way to use current emerging technologies, cloud and edge computing, AR/VR environments and equipment for immersive spatial knowledge representation and shared management in a virtual space. The close interaction with Laszlo and the Studiolo audience would ensure that the technical improvements would follow their needs and motivations, not just consumer popularity or profit opportunity.

Organizational partners

Foundation for Information Society - https://infota.org/en/

Foundation for Information Society (INFOTA) has been operating as a research institute and knowledge center since 1998. Its interest area has a wide range, including information society, social networks and multicultural issues, information management, knowledge management, eLearning, educational games, simulation and optimization of value production business processes, e-business and e-services, data and text mining, economic modeling, trend analysis, decision support, digitization and information retrieval, data protection and information freedom, IT safety and security, tourism and heritage protection. INFOTA is a registered adult training institution.

Women in Science - https://nokatud.hu/eng/

The Nature Award-winning Association of Hungarian Women in Science (NaTE) was established in 2008 by 10 female researchers with the aim of ensuring that the achievements of both sexes are equally recognized in the field of science and technology.

NaTE imagines a world where only true professional competence matters and acknowledgement is not gender specific. It has been working to support women and girls in their careers in science and technology, helped thousands of young people and adults so far.

What is your solution's stage of development?

Prototype: A venture or organization building and testing its product, service, or business model, but which is not yet serving anyone

What makes your solution a Prototype rather than a Concept.

Historic background

More efficient knowledge transfer and management was the initial goal of inventing information systems to solve challenges from local communities to the global level (As We May Think, Augmenting Human Intellect / Boosting Collective IQ, Can We Survive Technology, Amusing Ourselves to Death, ...).

We studied early implementations like the NLS (Douglas Engelbart), the Hypercards system (Apple) or the Plato (University of Illinois). Ted Nelson presented an arguably better approach to represent interconnected information (ZigZag database) and text (Xanadu media with transclusion) including a proper business model (transcopyright). Some of these references can be found here.

The conclusion of these attempts is that working systems like Studiolo existed for decades and disappeared. We learned from these lessons and attempt to address the identified root causes.

Laszlo Karvalics - Pilot projects and academic background

Laszlo as an academic professor, spent many years investigating the mechanisms of knowledge transfer. He focuses on the efficient cooperation of team members with all levels of experience, from the established scientific researcher to people who are only interested in giving some help. This approach is fundamentally different from the current methods, from formal classroom education to "learn by doing" scientific portals or even video lecture series of universities, where there is a clean producer / consumer separation. Studiolo focuses on cooperation while learning both verified state-of-the-art science and the meta skills of efficient collaboration. These are the missing from any general civic activities today— the misused information infrastructure is the source of fake news, idea bubbles and tribal behaviors.

Laszlo already prepared multiple research projects, negotiated with participants so the pilot knowledge content is ready.

Lorand Kedves – System development, industrial background

Studiolo is an open framework to support dynamic knowledge management, which can be:

- ***Structured*** – terminologies collected and provided by the Scientists that allows creating property sheets and fact tables to be filled in by Students by doing measurements, calculations, etc. Such knowledge allows automatic, reliable processing. The challenge here is that our current tooling, generally using independent configurations and programming languages, are not optimal for mutable meta structures.

- ***Textual*** – where participants can discuss their ideas, findings, give and process feedback. Textual knowledge is for human processing as automatisms are not scientifically reliable. The challenge here is to avoid overlapping statements, gradual obsolescence as we learn, language barriers and clean terminologies. We must continuously reorganize and translate our textual knowledge base while keeping their internal references and history transparent and intact.

Lorand as a developer and architect in industrial environment, initially addressed the problems with structured data management, the separation of technical and business logic in various data management systems. The summary of the results from 2011 can be found on GitHub; the response was the Dust Framework. As he returned to the university (MSc and 2 years of PhD research), he first extended the structured data management to a general dynamic knowledge repository, later this became the MiND model, summary from 2019 can be found on YouTube. The research focus moved from a Java programming framework to a general knowledge management environment, the name changed to ARK, then the current, Giskard.

During his PhD research he used the knowledge card concept from Douglas Engelbart and the Xanadu / transclusion model from Ted Nelson. He used Dust to create a knowledge card framework for mutable text management using the online Hungarian Civil Code of Law as a prototype (the project ended together with the PhD). In 2021, he used Giskard to process the 15 volumes of the Taekwondo Encyclopedia, transform the original PDF files of scanned book page images to uniquely identified knowledge cards, then using automatic translation he created the text in other languages while keeping the book structure and references (due to lack of resources, only 3 volumes processed).

Studiolo will be based on Giskard. At the time of writing this text, its current, Gen05 version is addressing the question of separating “terminology” (semantic network of knowledge items) from a set of tokens (words that humans need to use these networks for interaction). Knowledge card management will be migrated to this version from the earlier ones soon.

A summary of how information systems should be used in civic activities in general can be found here.

Why are you applying to Solve?

Fundamental motivations

The explanation of the Civic Action Challenge details many necessary “soft skills” like fact checking, critical thinking, cooperative communication, and utilizing the diversity of experience and backgrounds of the participants. It also emphasizes the importance of learning both in and out of classrooms.

When discussing the future of Studiolo, we naturally extended its target audience to any self-organizing communities solving problems of any kind in a global, open environment. The “project” could be any shared goal, “Scientists” become responsible experts, “Teachers” are organizers / administrators, in the same global task and resource marketplace. However, the exact operation and services of such a platform should be mature enough to avoid less favorable tendencies of natural human or business motivations. A global open platform that should support efficient civic activities, requires an incubation phase within a safe and objective environment, which is the current aim of Studiolo.

The MIT Solve community is a highly respected and globally known academic environment, the Learning for Civic Action Challenge requires the collected experience and shows a clear path for generic use of the Studiolo platform.

Beyond a limited pilot project

After launching the Studiolo platform and completing the first research projects, we have goals far beyond the reach of a small team. The MIT Solve cooperation could open opportunities like:

- ***Contacting and organizing author groups on various scientific fields to create and maintain the root knowledge cards.*** We assume that in a global open platform this would “emerge” over time, but a proper management would give this process a very important boost. This work includes selection and transformation of core materials (books, articles, lectures) into knowledge cards. The goal is opposite to some current activities like digitizing books for sale or LLM training in closed, for-profit environments, or creating many overlapping publications.
- ***Create globally accepted curriculum for fundamental scientific fields*** that can be shared in the same open platform with anyone, after a careful translation to local languages.
- ***Organize groups to create their own curriculum about their local knowledge.*** Such groups could include indigenous minor languages, mythologies and natural environments. That would add an efficient infrastructure and mobilize local talent and communities of many SDG programs.

Financial support

- The team is committed to creating the proof-of-concept implementation of the Studiolo platform and launch the planned pilot projects. However, the speed and quality of this as a side project is a challenge and could even lead to failure even if the concepts and tools are otherwise sufficient.

- The above listed goals need proper budget. We would offer compensation for the efforts of the participants, especially those who would connect their communities to the platform by translating global or authoring local knowledge.
- Extending the prototype to a global system has its technical costs, porting between various platforms, involving popular technologies like AR/VR or NLP, building a proper global cloud infrastructure for reliable operation, or providing (even low-cost) equipment like eBook readers or tablets to those who can't afford them.

In which of the following areas do you most need partners or support?

- Financial (e.g. accounting practices, pitching to investors)
- Human Capital (e.g. sourcing talent, board development)
- Product / Service Distribution (e.g. delivery, logistics, expanding client base)
- Technology (e.g. software or hardware, web development/design)

More About Your Solution

What makes your solution innovative?

Studiolo platform

- ***Breaks the common producer / consumer separation*** of current scientific environments (from closed classrooms to open lecture series and "repeat what is presented" self-paced learning sites), focuses on true cooperative scientific research.
- ***Focuses on knowledge creation instead of presentation***, teaches organized thinking by creating and managing the network of knowledge cards, instead of writing long texts and creating fancy slides.
- The network of interconnected knowledge cards that also support proper versioning allows browsing the thinking process over time. This ***allows external viewers understand the evolution of the ideas and their relationships*** at any later time, "virtually joining" the team and reuse the experience.
- Adding question, refinement request, counter argument, knowledge cards allow conducting a ***constructive debate shared in the same ecosystem as part of the research project***, learning the rules, avoiding all too common fallacies.
- As part of the research project, Scientists create knowledge cards that summarize external, existing sources (books, lectures, etc.) that allows ***curated, focused inclusion of existing sources in a globally shared knowledge body*** – instead of putting them behind a paywall or training vendor-locked LLMs and chatbots.
- Allows ***collecting and practicing fundamental patterns of knowledge-based collaboration necessary for any efficient and transparent civic activity*** (e.g. source validation and fact checking; preparing, and following task schedules; writing focused and well-organized texts; conducting constructive debates)

Technology (Giskard)

- The core system is a transparent, self-containing semantic network that uses the same tools and interfaces for any knowledge. This is an ultimate low/no code environment that shortens the learning curve and allows unlimited reach to any part of the system.
- The infrastructure is responsible for an open, global storage of any knowledge provided by "authors"; track changes and keep the references locked to the seen version; allows a transparent but strict access control for sensitive data protection. It can also be extended with transcopyright / microtransaction support if authors want monetization. The core network is published under the Apache2 license to ensure open and free access.
- The solution is language and platform independent, and minimally dependent on current tools; previous implementations showed adequate performance on relative low hardware equipment. This allows access from legacy (more affordable) devices.

What are your impact goals for the next year and the next five years, and how will you achieve them?

Next year's primary goal is to launch and execute the Studiolo platform with the pilot projects and create the first scientific publications.

- The participants collect experience of working together in this virtual environment. Scientists produce knowledge cards about their fundamental knowledge and sources, their project initiatives, and publications based on the collected knowledge. Teachers used the platform to plan an interactive cooperation, used this environment to give feedback and assist Students with their work, evaluated their progress. Students participated in real research projects, learned from the best sources, and conducted constructive debates.
- Participants provide feedback and requests to improve the services of the platform, thus by the end of the pilot projects, the ecosystem will be tested and ready for other research projects – or even general use.
- Guests can browse public materials of the projects, learn about the topics in general or follow the research process following the timeline to share the actual experience.
- Depending on the material and human resources, Giskard/Studiolo can be opened to other institutions and groups to design and conduct their own projects, reusing already existing knowledge and sharing their own. The initial self-organizing author groups may appear around specific topics or scientific areas.
- Higher-level organizations may express interest in using Studiolo, e.g. research groups to share their knowledge on their area as authors, or UNESCO to create global curriculum for core areas like mathematics or physics.

In five years, the underlying infrastructure (Giskard) and services are settled, extended to the most popular devices, languages, platforms. Global access to the stored knowledge is available through established service providers.

- Every individual on Earth can connect to a shared repository of knowledge and actively participate in organized activities within this platform. They can contribute their time and efforts, and their offers or past activities can be discovered by others working on related projects.
- Studiolo becomes an accepted standard to conduct scientific research and share knowledge. The relation to the for-profit publisher industry is questionable and should be managed by organizations like the EU or UN.
- The global repository of core scientific knowledge improves, and efforts are underway to develop a curriculum suitable for elementary and high school levels. This curriculum can be implemented by any educational institution worldwide, including those in less developed regions, as it has minimal hardware requirements.
- Giskard becomes a trusted general knowledge management and collaborative organization platform. Its core services are free and can be run on local hardware. Public infrastructure costs can be negotiated with providers, who may support "pro bono" projects as part of their corporate social responsibility activities. Due to its adaptable nature and low resource requirements, Giskard can also be utilized in limited environments such as disaster management scenarios.

- The platform's transparent structure enables algorithmic processing, allowing for the identification of similarities to offer solutions, optimization of resource management, understanding of trends, and detection of anomalies. All these functionalities are presented in a self-explanatory manner.

Which of the UN Sustainable Development Goals does your solution address?

- 4. Quality Education
- 10. Reduced Inequalities
- 16. Peace, Justice, and Strong Institutions
- 17. Partnerships for the Goals

How are you measuring your progress toward your impact goals?

- ***Feedback from participants*** – Initially, we anticipate encountering various technical and usage issues, as well as receiving improvement ideas and suggestions. However, as the pilot projects progress, we expect the frequency of such issues to decrease. To address common queries, we will develop knowledge cards that explain the Studiolo platform and provide comprehensive answers. Additionally, members in the roles of Teachers and Students may evolve into advanced users who can assist in responding to questions.
- ***Self-organizing body of knowledge*** – Within Studiolo, author teams spontaneously form and organize themselves around diverse scientific areas and technical tasks. The growth and transparent organization of the knowledge body within the platform serve as vital indicators of the effectiveness of our services.
- ***Visitor sessions*** (count and length) – As the visibility of Studiolo projects increases, scientific publications will reference them, prompting participants to share their activities. We anticipate the emergence of external guests who will explore projects within Studiolo and share links to invite a wider audience to engage with the platform.
- ***Cooperation requests*** (count and feedback) – Independent organizations, including notable "pro bono" projects, express interest in incorporating Studiolo within their own environments. They seek to test the platform's capabilities and provide feedback on its suitability for their specific needs.

What is your theory of change?

For humanity to ensure its survival, it must embark on an evolutionary adaptation process that builds upon the advancements of previous cultural evolutions, but at significantly higher levels of knowledge and complexity.

The root cause of challenges encountered in previous transitions lies within the underlying human culture, which perpetuates a social dynamic that has become increasingly maladaptive when confronted with global limits. ***The interplay between the transition of science and education control relations significantly influences the trajectory of the sustainability transition, and vice versa.*** Positive changes on either front can initiate a beneficial cycle of cumulative causation, which also manifests in the fundamental hierarchical control relationships prevalent in contemporary societies. ***We propose that by leveraging these interconnected aspects, informed by the inherent humanism of ancient traditions, we can unlock promising solutions to humankind's evolutionary challenges in the 21st century.***

Scientific literacy encompasses more than simply teaching and learning sciences in public education; it encompasses a complex set of knowledge, methods, approaches, attitudes, and skills. Increasing the number of scientifically literate citizens aids in overcoming the control crisis faced by contemporary Science, necessitating a true Copernican shift to attract new minds into problem-solving research endeavors. Between the ages of 12 and 18, individuals have the capacity to think and work like scientists – although not everyone will become a scientist, everyone can learn to engage with scientific issues as part of research communities even beyond their school years.

The new control revolution of science can only emerge through the human infrastructure, as a *revolution of human relations*, calling for social innovation rather than purely technological advances. In addition to the customary institutional and cognitive aspects of the cultural transition towards sustainable development, it should also address the *emotional and volitional dimensions* that encompass intentionality, relationships, and spirituality.

A single actor should not possess plenipotentiary authority in setting directives (as symbolized by the allegory of an *instruction policy*); instead, authority should be distributed among many stakeholders. *The new control structure will be partially composed of a* ***multi-stakeholder world*** *and partially a world of* ***self-governance***. It will largely function as ***a self-organizing system, although conscious actions and social innovations realized on a political level will heavily influence its organization.***

Our vision and goal are to integrate small communities into a hierarchy-free network that allows for central coordination when necessary, without infringing upon the autonomy of the communities or their individual members. ***The objective of the new control structure is to nurture creative and autonomous community members who have developed the ability to engage constructively with others through cooperative knowledge production, fostered within educational institutions.*** Moreover, this outcome should extend beyond the most talented individuals and be accessible to all who graduate from the education system.

Describe the core technology that powers your solution.

Abstract thinking and automation have played significant roles in the development of human problem-solving abilities.

In the past, as mankind tackled complex tasks, a common approach was to ***create analog models before engaging in the actual activity.*** Initially, these models took the form of small-scale static replicas of monuments, paintings, or buildings. Subsequently, engineers conducted dynamic experiments on ships or airplanes to gain insights and improve designs. Advancements in technology led to the utilization of different physical phenomena, such as electric analog computers, to calculate ballistic trajectories and simulate complex systems.

Concurrently, ***scientists embarked on constructing an objective and reliable model for the thinking process***, approaching the challenge from different angles. Linguists like Noam Chomsky explored the complexity of language and identified distinct classes based on predictability and ambiguity. Mathematicians like Kurt Gödel and Alan Turing examined and formalized the thinking process itself. Engineers like Claude Shannon and Vannevar Bush devised physical equipment capable of executing mathematical operations.

John von Neumann played a pivotal role by integrating these diverse efforts. He invented the Neumann Architecture, which comprised the essential components of Memory (MEM), Arithmetic and Logical Unit (ALU), Central Processing Unit (CPU), and Input/Output (IO). Von Neumann demonstrated that the collaboration of these core elements was analogous to the Universal Turing Machine, a theoretical device capable of performing any computation. Moreover, he designed ENIAC, a functioning physical realization of his architecture. This marked the birth of "software," as it ***eliminated the need to modify a physical machine to alter a model or its behavior.*** *Software engineers* now describe algorithms through sequences of MEM, ALU, CPU, and IO operations, ranging from operating systems to chatbots. Meanwhile, *physical engineers* continually improve the hardware that executes these algorithms.

The advent of abstract thinking and the ability to manipulate software independently from hardware have greatly expanded the scope and flexibility of problem-solving approaches. This ongoing collaboration between software and physical engineering continues to drive innovation in various fields.

Computers, not thinking machines!

The emergence of computers executing any algorithm by simply changing their "program," gave rise to a new field: knowledge engineering. This also raised important questions about the relationship between human beings and computers.

The early pioneers in this field had clear ideas about the nature of this cooperation. They likened it to the ***collaboration*** between humans and physical machines, ranging from excavators to airplanes. They emphasized that the focus of IT infrastructure should be on "transferrable" knowledge, as articulated by JCR Licklider. This refers to ***objective knowledge applicable in scientific and engineering contexts,*** distinct from knowledge requiring human interpretation and involving subjective feelings and impressions.

These pioneers also ***issued warnings about the potential risks associated with the exponential growth in machine performance*** initially projected by Douglas Engelbart. They cautioned against the sole focus on executing obsolete activities at a faster pace, as highlighted by Joseph Weizenbaum, instead of investing in the creation of new models. They stressed that such an approach might have catastrophic consequences, as John von Neumann pointed out, and could create an illusion of intelligence, as emphasized by Alan Turing.

Unfortunately, these ideas were often disregarded or misunderstood, as they ran counter to business motivations and prevailing common sense. As a result, ***the field of general information technology witnessed a rapid advancement in hardware performance but experienced a decline in the abstract quality of information systems***, as noted by experts like Alan Kay or Bob Martin.

The significance of these early insights should not be overlooked, as they shed light on the potential pitfalls and challenges that can arise when technology outpaces our ability to utilize it effectively. ***By heeding these warnings and striving for a balanced approach, we can harness the power of computers while ensuring that their development aligns with our broader goals and aspirations.***

The technology in a nutshell: MiND + Dust + Giskard

Returning to the original challenge posed by Alan Turing—whether machines can think—we must establish a constructive and precise definition for the terms "think" and "machine." In the pursuit of this definition, we should consider if there exists a formal, mutable representation of "any knowledge" as a logical progression following the representation of any algorithm. Is it possible to create a "runtime" capable of storing such knowledge and executing algorithms, which are essentially a specific type of knowledge?

The MiND model serves as the von Neumann Architecture of knowledge, and its acronym encompasses several fundamental terminology modules:

- ***Model***: This module stores knowledge using terms such as *Value, KnowledgeItem, Unit, Author, Reference*, and more. It serves to capture the state of a system.
- ***Idea***: This module deals with meta-information, including *Type, Member, Tag, CollectionType*, and others. It facilitates the definition of domain-specific languages (DSLs) to express concepts and ideas.
- ***Narrative***: This module comprises *rule sets that validate* the state represented by a model. It also encompasses *processes that transition* a system between valid states. In essence, it can be compared to the source code of a system.
- ***Dialog***: This module represents the *interaction among "agents" that execute algorithms* described by the narrative or invoke native functions. It captures the essence of a running system.

Dust serves as the runtime that executes any system defined within the MiND terms. It provides the essential technical terminology and a pure Java reference implementation for services such as *Module, Application, Brain*, and more. This runtime can be likened to ENIAC, as it allows for the creation of implementations in other programming languages or the generation of source code in those languages.

Giskard is the embodiment of the "thinking machine" as defined within this framework. It utilizes the MiND model running on Dust nodes and enables human interaction. Giskard can be utilized to gather knowledge across various domains, starting with primary forms, DSLs, and the models built upon them, but extending to encompass texts and any other form of digital media. It represents a global, unified entity—a potential realization of the envisioned "library of the future" (Licklider), MEMEX (Vannevar Bush), or the "global brain" (H. G. Wells and others).

The relation to Studiolo and general knowledge handling

Returning to the roots: When ***computing machinery was first invented***, it was characterized by its high cost, limited capabilities, and slow performance. Its primary objective was ***to alleviate the administrative burdens faced by highly skilled knowledge workers in addressing global challenges***. JCR Licklider's analysis included an estimation of the character count required to represent the entirety of "transferrable human knowledge," and he predicted that by around 2000, we would have the necessary infrastructure to enable its global shared management. Douglas Engelbart's A-B-C model further elucidated how global organizations could and should control the exponentially increasing human potential for improvement.

Among the various insights offered by these visionaries, they also cautioned against the potential negative consequences if we were to lose control over the predicted exponential growth in computing power. Unfortunately, that is precisely what we observe today: ***rather than focusing on the wise organization, utilization, and enhancement of our intellectual heritage, our attention is often directed towards "content creation," with evaluations based on popularity and entertainment value***. We tend to overlook costs such as the ecological footprint of technologies like cryptocurrencies or massive server farms used for storing personal videos or supporting global corporate entities. We generate vast amounts of repetitive texts with minimal substantive information content, both on social media platforms and within scientific arenas, while valuable knowledge is often safeguarded behind paywalls or proprietary publishing systems.

Studiolo, with its clearly defined knowledge card management environment, redirects our attention back to "transferrable" knowledge and emphasizes that this transfer must be a collective endeavor. It necessitates our acquisition of proper terminologies, employing them in concise and focused statements. We must construct a network of interconnected knowledge cards, subjecting them to controlled, transparent, and objective debates to foster improvement. Furthermore, we should actively share these cards with others, enabling their reuse, testing, and critique.

By embracing Studiolo's approach, we can ***restore the emphasis on valuable knowledge exchange, collaboration, and critical thinking***. It allows us to overcome the barriers imposed by profit-driven publishing models and harness the power of collective intelligence for the betterment of society as a whole. ***A global Studiolo platform powered by Giskard is "As We May Think" in the 21st century***, having implemented the vision of the founding father, Vannevar Bush.

Which of the following categories best describes your solution?

A new technology

How do you know that this technology works?

The current reference implementation of the technology (Giskard Gen05) is a zero-dependency modular Java application based on previous Giskard and Dust implementations, all available on GitHub in various repositories under MondoAurora

Later development may add dependencies to time tested external services via wrapper modules like JDBC connector for accessing databases, the Jetty servlet container to act as a web server, MVEL expression/script/template engine to enable custom business logic integration via embedded scripts and templates, etc. All these modules were present in previous implementations.

Publicly available materials

- A summary of fundamental problems with IT tooling from ~2011.
- Short videos explaining Dust from 2019 (the MDPC model evolved to MiND), including live demonstration of the Montru knowledge editor.
- Recorded one-week coding session creating a complete database connector module to Dust, read the complete meta-structure of the connected database, load records as entities into Montru. The motivation of moving towards Giskard is to further decrease the dependency on actual coding.
- EUvsVirus Hackathon proposal, explaining how MiND / Dust could help creating adaptive yet reliable information systems.

Previous industrial / government usages

Please note that as they were closed source projects, public references cannot be provided.

- The core idea of flexible metainformation management comes from DataScope, an AI / data mining system that among others, won Comdex 1999 Fall in Las Vegas.
- Configurative user interfaces and export to various formats, modular flexible database object management etc. were introduced in IACS, the EU agricultural fund distribution system of Hungary (2002-2006).
- MVEL-based configurable business logic and report/email/etc. templates; configurable data import from various data sources with adaptive metadata management; Jetty-based web portal first used at Continental Automotive, Brake systems software quality monitoring (2012-2014).
- Configurative metadata management with source code generation in multiple programming languages (Java, C#, C++) in an R&D project with Pázmány Péter Catholic University (2019-2020).

Please select the technologies currently used in your solution:

- Big Data
- Crowd Sourced Service / Social Networks
- Software and Mobile Applications

The Team

How long have you been working on your solution?

Laszlo Karvalics: ~20 years (academic research, articles, cooperation); Lorand Kedves: ~15 years (industrial applications, scientific research).

What is your approach to incorporating diversity, equity, and inclusivity into your work?

Diversity within the core team (Laszlo and Lorand) is not applicable during the pilot implementation and launch. Being aware of this weakness, we already ***joined forces with the Association of Hungarian Women in Science*** (NaTE). They both plan to use Studiolo in their STEM education programs for girls of the target age group and provide their expert feedback on how the platform could improve in this direction.

Studiolo projects are open, participants publish their cards and data, discuss over their content in a transparent environment where improper behavior can be identified and discussed. As all communication is stored indefinitely and personal presence holds long-term value for each member, we assume adequate self-moderation over time. The matured Studiolo community may find it important to set up an ethical authority to lay out the fundamental communication rules and handle such issues.

In the developed regions it is easy to forget about basic infrastructural, economic, or cultural barriers that can exclude the majority of a region. Various challenges can impede seamless access to Studiolo, including network reliability and bandwidth limitations, device performance constraints, power consumption concerns, language barriers (particularly weak English proficiency), and economic constraints affecting affordability. However, ***we have devised strategies to mitigate these issues***.

- Throughout the implementation process, we prioritize compatibility with existing legacy platforms. Additionally, whenever feasible, we aim to enable offline operation capabilities, thereby reducing the barriers to connecting to Studiolo.
- To address language-related challenges, we use the knowledge card system for textual information and a language-independent semantic network management approach for structured data. This enables comprehensive translation and multi-language presentation of the same knowledge. Consequently, individuals can access curated professional translations in their native languages, fostering a deeper understanding, or they can utilize the Studiolo environment to learn and explore other languages.
- We plan to allocate a dedicated budget to support small communities. This includes facilitating professional translation services and empowering these communities to preserve their local knowledge, language, and cultural heritage. By providing these resources, we strive to ensure that diverse communities can actively engage with Studiolo while maintaining their unique identities and contributions.

Your Business Model & Funding

What is your business model?

Studiolo functions as an open knowledge management platform, adopting a service and business model akin to centralized project management tools such as JIRA.

During the pilot projects and their execution, the core services and foundational infrastructure will be established on the chosen platform(s). These resources will be freely accessible for experimentation in local environments. It's important to note that this free access is accompanied by community support and does not come with any warranties. For users requiring additional assistance, higher-tier options are available that offer paid support and consultancy services.

Individual access models

- The central public portal of Studiolo serves as the host for the pilot projects, providing limited guest access to public information and the ability to explore the knowledge networks.
- To utilize features such as searching the knowledge network or finding members based on custom criteria, users will need to create a login. To enhance convenience and streamline access, we plan to support general authenticators like Google, Apple, Microsoft, etc. Furthermore, access to certain functionalities will be governed by quotas, with larger quotas allocated to users in higher-paying tiers.
- Individuals have the option to join as members of different organizations. Membership within these organizations grants extended quotas and write access to the knowledge network, which is overseen by the organization's administrators. This hierarchical structure ensures effective management and control over the shared knowledge within Studiolo.

Organization access

- Organizations can pay for services, number of members, size of knowledge networks, access to advanced features of the system, publications, on the public Studiolo ecosystem.
- Nonprofit / pro bono organizations can get access for free, to overcome economic gaps between different regions.
- For profit organizations may support non-profits, selected projects, offer infrastructure (cloud providers) or donate Studiolo as part of their CSR activity.

Intellectual Property

The true value within Studiolo lies not solely in the platform itself, but rather in the knowledge that is created and the collaborative efforts of the participating organizations. As mentioned earlier, the core functionality is released under the Apache 2 license, and we anticipate that general university projects will adopt a similar open access model. However, there may be instances where certain knowledge is intended to remain private or shared for a fee.

If a demand arises for monetizing specific content, we plan to implement the Transcopyright model at the level of knowledge items. This means that if I utilize and share transcopyrighted material, my audience would be required to individually purchase access to the referenced items. This approach aligns with the concept of microtransactions, wherein users pay for access to specific pieces of content. The author of the material would have the ability to activate monetization and set a fee or royalty for its usage.

By employing this model, we can strike a balance between open access and the potential need for monetization, ensuring that creators are appropriately compensated for their valuable contributions within Studiolo.

Do you primarily provide products or services directly to individuals, to other organizations, or to the government?

Organizations (B2B)

What is your plan for becoming financially sustainable?

The Studiolo platform, powered by the underlying Giskard infrastructure, relies on core services that are essential for the successful execution of the planned pilot projects. To achieve this, a small developer team will be involved, potentially funded by grants or through volunteer contributions. However, allocating a proper budget would expedite the development and maintenance activities, enabling support for a wider range of platforms such as portable devices and eBook readers. Initial projects and independent local deployments of Studiolo can utilize existing local infrastructure without incurring additional costs.

The core Giskard development team will remain small, with the possibility of community support following the principles of Linux development or receiving financial donations and grants. We anticipate that necessary enhancements, such as introducing new services, integrating external components, or expanding to new platforms, can be addressed by incorporating new modules and negotiating the required budget with the respective requestor.

As Studiolo aims to go global, there are associated expenses involved in transitioning the global knowledge base to the cloud, likely with the support of major cloud providers. Initial analysis suggests that the knowledge stored in Giskard is highly compact, requiring only a fraction of the storage and communication bandwidth compared to established IT services like streaming, cryptocurrencies, or social networks. We presume that the infrastructure costs for the core knowledge segment, which is available to everyone under the Apache 2 license, could be covered by major IT companies as part of their corporate social responsibility (CSR) initiatives or through donations from global organizations such as the UN or World Bank. Private or for-profit projects built on the platform would be responsible for funding their own infrastructure and paying for the usage of Studiolo/Giskard services for their private activities.

Additionally, we anticipate that the focus will soon shift from platform development and maintenance to knowledge curation. These will be independent projects with their own budgets and financial management, not under the direct control of Studiolo. However, as the assumed costs are relatively low, it is likely that these projects will contribute to keeping the platform alive. Some examples of such projects include:

- Core materials and services to improve the quality of service: creating user manuals; identifying and sharing best practices; organizing meta-authorities to maintain ethical rules, etc.
- Authority teams for fundamental scientific fields, who transform existing scientific material to knowledge card network, manage the global core curricula for children.
- Local teams who ensure the coherent translation of the global core knowledge to every language. They also process their language, cultural etc. heritage and store it in the knowledge cloud.