XLP Operating Manual

Version 1.0

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What is XLP?

XLP stands for “Extreme Learning Process,” a methodology that enables **communities of learners** to design and conduct collaborative learning activities. Our aim is to become a **crowdlearning** “operating system” that facilitates collective learning in this increasingly large macro ecosystem. Communities of learners are empowered to work together within and between teams, and incorporate both digital and offline (or “real world”) elements.

Communities of Learners

Communities come in all shapes and sizes. They may be:

- Large or small
- Physically together, near each other, or spread around the world
- Of similar ethnic, cultural, educational, professional, and religious backgrounds, or vastly different backgrounds
- Similar or different skill sets, skill levels, interests, and life experiences
- Relatively homogeneous, or highly diverse
- Stay together for many years, or come together to design and conduct a single learning activity

Crowd Learning

Whatever the form, XLP helps communities build collaborative learning activities that engage individuals and the community as a whole. Each community designs and operates its own learning ecosystem that serves the individual and collective aims of the creators and participants.

These micro-learning ecosystems come together to learn something specific, often for a specific duration. Multiple ecosystems can interact, and may later flow together to form macro-learning ecosystems, just as amoebas divide and recombine in different ways. As the macro-learning system becomes larger, it increasingly approximates the real world, and participating individuals, institutions, systems and societies can iterate upon increasingly optimal solutions.

Evaluation and Assessment

Using secure tools like the Blockchain, learner activity can be tracked at each level, assessing how individuals contribute to a micro-learning ecosystem, and how a micro-learning ecosystem contributes in turn to the macro- level. This allows individuals and teams to receive personalized feedback on their performance and iteratively improve over time.

This in turn applies to grading and certification, with both micro-credentials and full degrees stored on the Blockchain. Access rights can be granted to other universities or employers to show tamper-proof evidence of achievement.

Containers of Knowledge

When we think of managing knowledge, it helps to use metaphors. XLP's metaphor is *containers of knowledge*. We categorize knowledge into five layers, each of which represents a kind of digital asset, and these data assets can all be managed from within our online Remix platform.

Decentralization

By using computer-generated smart contracts stored on the Blockchain, XLP runs as a decentralized autonomous organization (DAO). This means that participant performance can be assessed algorithmically and stored securely on their lifelong digital learning profile.

Using Blockchain ensures XLP abides by the principles of Trustworthy Computing, giving participants, organizations, and employers faith in the quality of work.

Outcomes

For Students

Real World Decisions

XLP engages students by ~~allowing~~ them to make financial, legal, cultural and technical decisions, so they can achieve goals set by the student groups themselves.

Pragmatism

XLP is pragmatic. The XLP -method induces realistic human dynamics, utilizes modern technologies, encourages students to create social norms, and establishes executable regulations based on the design principles of the fast evolving Internet.

Realizing Potential

XLP drives students to realize their untapped potentials and emerging powers of collaboration through having them stretch the educational envelop by shifting focus from teaching (top-down) to learning (bottom up).

For Teachers

Evolutionary Process

XLP encourages an evolutionary process, which creates a digitally enabled learning context that delivers rich social-interactions and leaves no-one behind.

Curating and Evaluating

By placing students in control of learning, XLP redefines teachers' roles as curators of learning resources and as evaluators of students' learning-potentials.

Network Enabling

XLP provides network-enabled learning data management technology that enables stakeholders to record, analyze and identify learning trajectories to define new directions for progress.

Impact

Since June 2012, XLP-based orientation programs and semester-long courses have been conducted at:

- Tsinghua University, Beijing
- National Taiwan University of Science and Technology
- Singapore University of Technology and Design
- Taylor's University, Malaysia
- Eurasia University, Xi'an
- Tianjin Vocational College of Mechanics and Electricity

Courses have also been conducted at many leading high schools in China. Due to XLP's experimental success, China's Ministry of Education has invited the founder of XLP to serve on the Design Committee of National Curriculum Standards on Technology Education. The goal is to use XLP as a learning architecture and a learning activity design methodology for over 300 million registered students in the Chinese education system.

XLP is scalable and applicable to a broad range of students. A teacher from Tianjin Vocational College of Mechanics and Electricity stated his observation:

> "In the past, I can only judge students' quality by their test scores. However, after seeing the students with low test scores can sometimes be the most productive contributors in XLP-enabled learning process, I realized XLP presents many opportunities for students to demonstrate their natural talents."

Mr. Wang Hong Yu, the General Manager of China's Open Course Resource Center, stated how XLP might affect his business:

> "With shock and awe, I personally witnessed the transformative effect of a few XLP events on students. I realized that a radical transformation in education has already taken place here in China. The traditional textbook-oriented industry could no longer be lasting. We have to re-position ourselves in the future ecology of education."

Why XLP? Why Now?

Computing Power

The processing power of computers doubles about every 18 months, while data storage and bandwidth are rocketing and costs are falling. This influences every aspect of our lives, and the opportunities to learn in new and different ways are expanding exponentially.

Big Data

Every second, gigabytes of data are being collected, and no one – or even any organization – will ever be able to access or process all of this data. Micro-learning communities can come together to deal with subsets of this data and solve real world problems.

This big data makes what and how humans learn more important. As data collection and processing increasingly lets machines connect and aid human decisions, (hence creating value,) human ingenuity, creativity and intuition are becoming increasingly important. More and more, the only things that people *should* do are the things that only people *can* do – and this, of course, places a premium on humans' ability to learn.

Open Source

Open-source gives anyone the right to use, change, or share a given technology, thus dramatically reducing the cost of using, copying, modifying, and redistributing software (and indeed, hardware). This means anyone can be a creator and build upon the shoulders of giants.

Mobile Devices

Developments in mobile communications and the ubiquity of digital electronic devices mean that more people can connect to the Internet – and each other – anytime, anywhere. This means newer, richer opportunities to learn from and with others, no matter where they are.

Containers and Clouds

Big data needs big computing power – too much for any one institution. With cloud providers like AliCloud or Amazon Web Services, anyone can run virtual machines to perform big computing tasks, and with the power of container platforms (Docker, Kubernetes) they can scale and replicate with ease.

Globalization

The problems of today's world require diverse communities to offer new insights. These problems are too big for just one individual or institution, but affordable internet access is enabling people all over the world to collaborate in micro-learning communities to solve these problems. Learning and working together globally across boundaries of space and time – across *all* boundaries – is

mankind’s greatest hope for making progress, and XLP enables this crowd learning and collaborative effort to improve the state of the world.

XLP pushes for the emergence of the world as we believe it should be – egalitarian and equitable, a world in which everyone has a fair chance to have their voice heard, and a fair opportunity to contribute to the progress of the world and humanity.

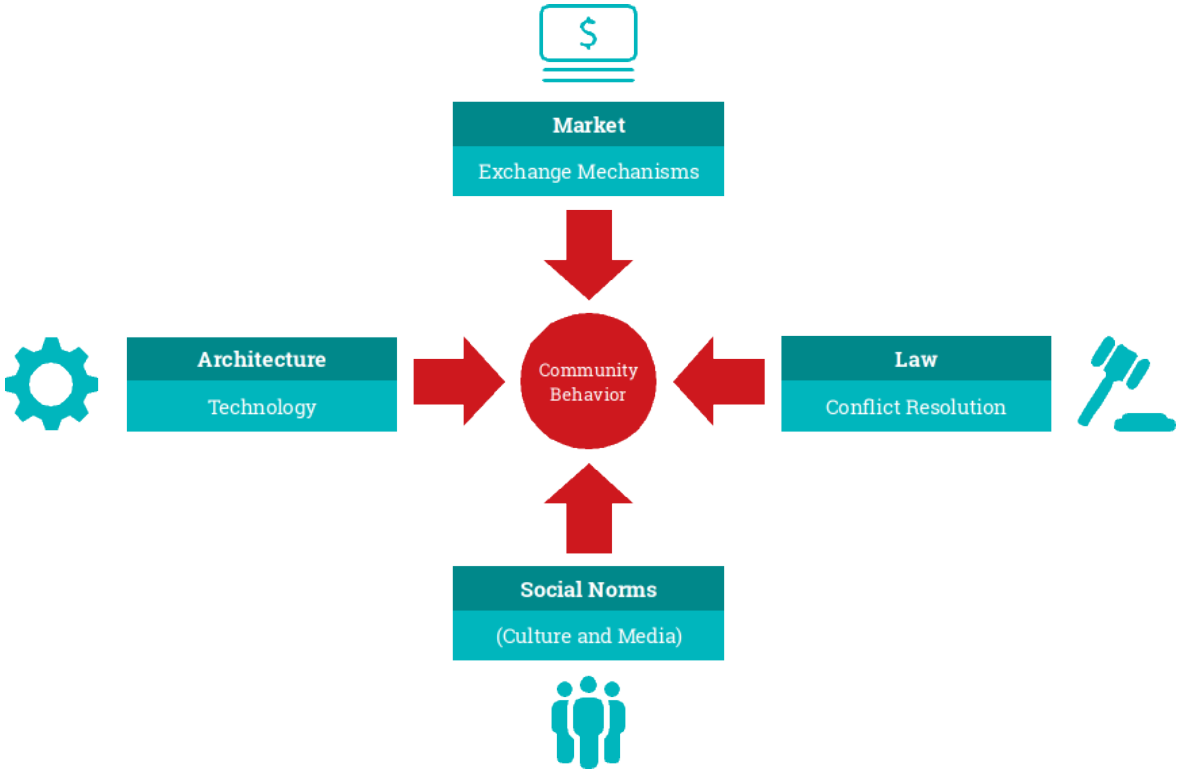
Summary

These enable and necessitate new modes of learning than those that have existed in the past. Learning is increasingly collaborative, personalized, self-directed, active, engaging, and global. XLP has enabled micro ecosystems of learners to form, disband, and learn collectively more easily and inexpensively as they ever have before. The ubiquitous interconnectedness of data, people, things, and processes, the opportunities for collaborative crowd learning – and new modes of crowd learning – will increase exponentially. These technology trends will enable learning to be measured in a way that it never has been before, and will redefine what the outcomes of learning should be. XLP capitalizes on these trends and enables new learning environments and opportunities. XLP is enabled by these trends – and at the same time is necessitated by them. What humans learn, and the way they learn, must and will be transformed. We envision XLP becoming the learning operating system of the Internet of Everything.

How XLP Works

Philosophy: Four Forces

Lawrence Lessig's *Code Version 2.0* states that a number of forces regulate the behavior of individuals in a society or community"[i]:



Law: The Rules a Community Recognizes

- Imposes constraints on the behavior of members by explicitly threatening punishment or sanctions that the community as an entity will enforce

Social Norms: How a Community Expects You to Behave

- Similar to the law in that they constrain behavior of community members
- Unlike the law, community members impose social norms on each other informally
- Whereas the law, and (prospective) punishment for breaking the law, is explicit, social norms are often understood by all, or most, community members without being explicitly stated or mandated

Market: How Much Do You Pay?

- Enables buyers and sellers of goods, services, information, labor, and capital to exchange these things
- Determines how the forces of the supply and demand determine respective prices of these things
- Regulates behavior of community members by establishing prices of goods, services, and other things exchanged by these members

Architecture: The Way the World Is

"The way the world is, or the ways specific aspects of it are."

- The way a product (not a service) has been designed and created, manufactured, or built
- Regulates community members by imposing physical or technical/technological constraints
- Special due to "agency" - does not require direct human intervention to operate (whereas other forces require police force, community members, merchants, etc), so it is "self-executing"

While each of these regulating forces is separate and distinct, all four influence each other as they regulate the behavior of community members.

Example: Smoking

In Code version 2.0, Lessig uses the regulation of smoking to illustrate the operation and interdependence of these four forces. If you want to smoke, Lessig asks, what constraints do you face?

Law

Federal, state, and local laws laws regulate:
- Minimum age and ID requirements
- Where you are permitted to smoke
- Tax on purchase of cigarettes (aiming to reduce smoking incidence)

Social Norms

Social norms can constrain behavior even more than laws:
- Smoking in the house of a non-smoking friend
- Smoking near children in restaurants

Market

- The higher the price of cigarettes, the less likely you are to smoke
- Higher insurance premiums for smokers

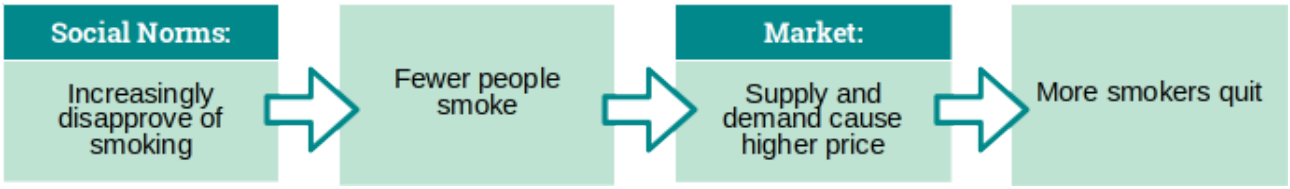
Architecture

The way cigarettes are designed and manufactured.:
- Filterless cigarettes are more dangerous, so more pressure to reduce smoking. Ultralights may tempt you to smoke more (thus costing more in terms of money and social norms)

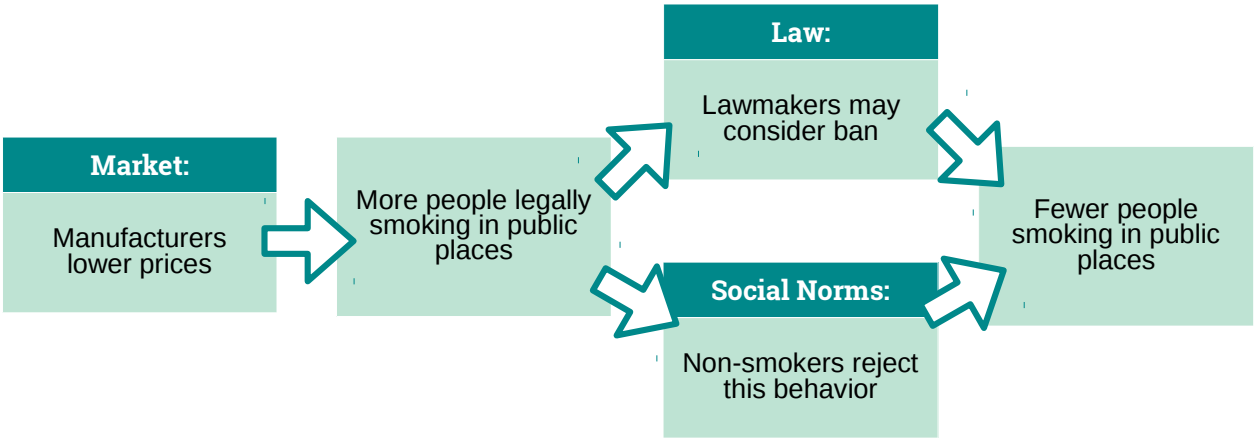
How do the Four Forces Interact?

The four mechanisms are interdependent; they interact, and influence each other as they regulate the behavior of individuals in the community. A change in one force may influence another.[ii]. Using the example of smoking:

Social norms → Market



Market → Law/Social norms



How do the Four Forces Relate to XLP?

Since XLP is a methodology for crowdlearning, or a crowdlearning operating system, these Four Forces also (by definition) regulate the behavior of individuals in each micro learning ecosystem, and ultimately increasingly large macro learning ecosystems.

Law	The law is constituted by XLP's digital recording infrastructure (legal evidence collection mechanism), which allows the filing of complaints, patent filing, and law enforcement.
Social Norms	One of the most important forces shaping social norms in XLP is the idea that all learning outcomes must be demonstrable. One of the most important end products is publishing the crowdlearning results online using a digital publishing system.

Market	XLP's transaction validation system records and validates transactions executed in the crowd learning environment.
Architecture	XLP's technology architecture is one of the most important forces that regulate the behavior of individuals in our crowdlearning environment. The architecture mechanism is the only one of the four mechanisms that, once created or enabled, does not require direct human intervention to operate. It functions alone and directly; that is, it is "self-executing." The architecture in XLP's crowdlearning environment is the Remix Platform, a combination of hardware and software. A later section in this manual will describe it in detail.

XLP and The Real World

A noteworthy feature of XLP is how each force within a specific micro or macro learning ecosystem interacts with the same force in the "real world." For example, much of XLP's **legal framework** and that of the real world: It is difficult to divorce the two, given that the real world's legal frameworks and mechanisms have evolved over centuries, and to greatly regulate the individuals in a community. Patents filed in the XLP crowdlearning environment might very well also be filed in the real world, for example.

Similarly, given that one of the most important end products of an XLP activity is publishing the crowdlearning results, it is natural that these results are published via a real world means like social media, other online media, or traditional media that is accepted by **social norms**.

In the **market**, a product or service might attract investment in the XLP environment – and might also attract real world investment. Intellectual property in XLP's environment might be bought and sold in the real world too.

In addition, XLP's **architecture** has its roots in the public commons of universities, and specifically physical campuses and other resources that enable the crowdlearning environment to emulate the the real world to a large degree. This is an important reason that XLP enables learning on a large and public scale.

Curriculum

Micro, Meso, Macro

The XLP curriculum has three tiers:

Macroscopic in Nature
Globally search and compile relevant information, and creatively tell a compelling story using trustworthy data sources and presentation techniques.

Mesoscopic in Sorting Order
Apply optimization technologies and understand the principles of optimal limits, so that students and teams can apply optimization to all their learning activities.

Microscopic in Contexts
Guide students to be acquainted with domain-specific vocabulary and rules, so that they can leverage existing body of knowledge in an organized manner.

Digital Publishing Workflow

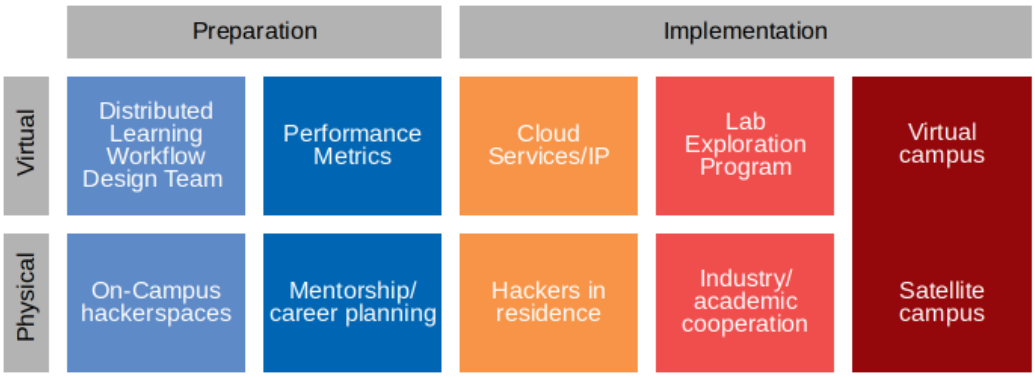
Here we'll look at the different **resources** and **steps** in the digital publishing workflow.

A learning environment encompasses **resources** in both the virtual world and the physical world: (each of these resources will have a description added)

Digital Learning Workflow

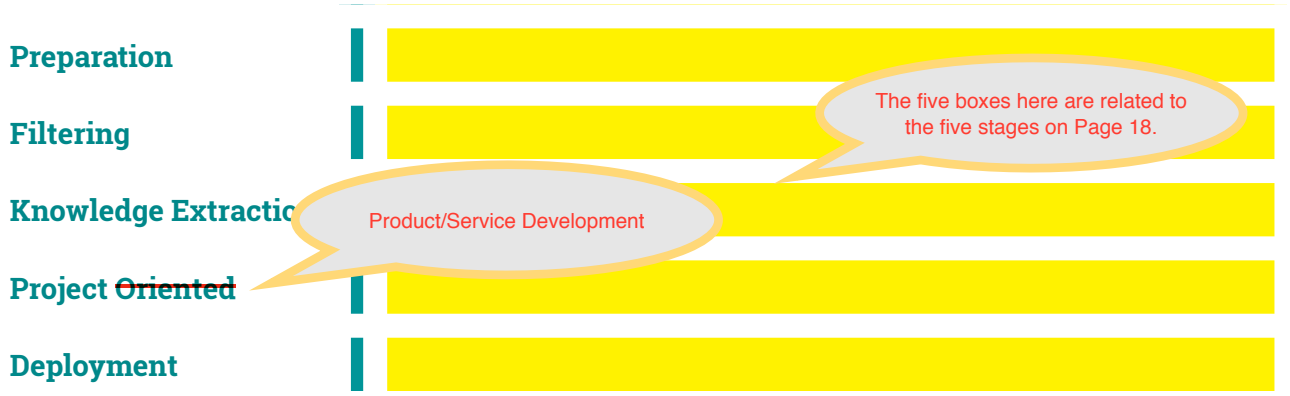
Physical	Virtual
On-Campus Hackerspaces Labs at the university with computing and rapid prototyping resources	Distributed Learning Workflow Design Team
Mentorship/Career Planning	Performance metrics
Hackers in Residence	Cloud services/IP
Industry/academic cooperation	Lab Exploration Program
Satellite campus	Virtual campus

These resources can be divided into two categories: namely, resources to prepare before the learning process and resources (which have been used and tested in the past) to implement during the learning process:



During the preparation phase, Mission Designers and Mission Executors work together to prepare tools to use during the implementation phase.

In total, there are five steps to the digital publishing workflow, which can be iterated (or looped) repeatedly by Mission Designers to refine the digital publishing workflow and improve the missions for the Mission Executors participating in XLP. The five steps use the resources we outlined above:

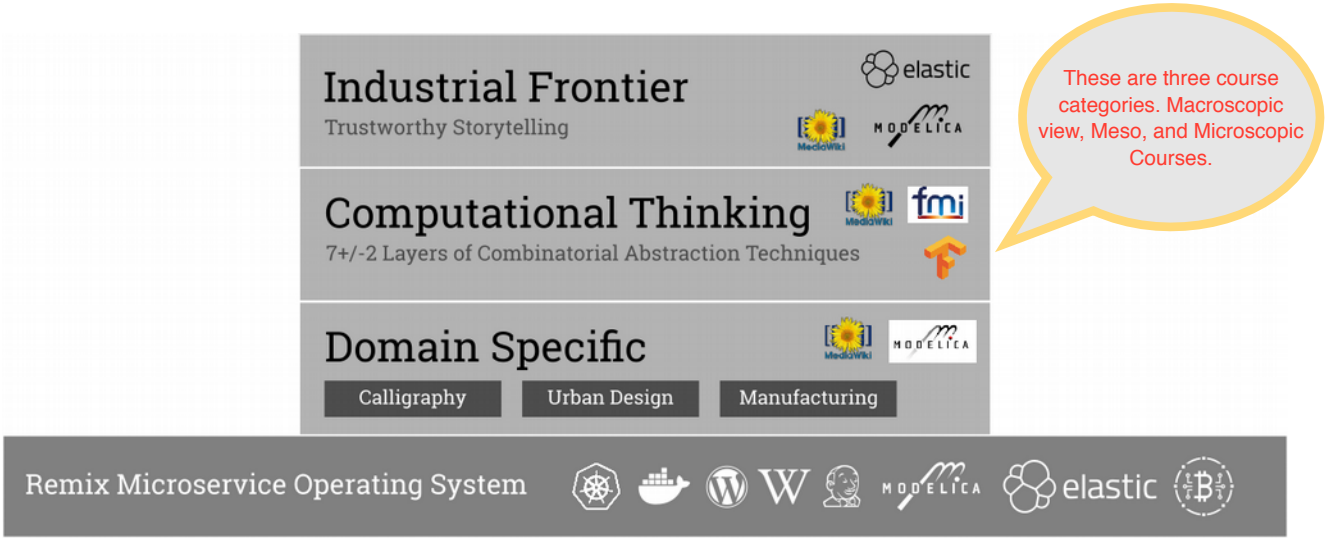


The Mission Designer and Mission Executor come together during the implementation phase, where the Executor iterates over their own loop in conjunction with the Designer. During the activity, the Executor iterates over 3 steps:

Each learning activity may have several inputs – human resources, capital, and mission statements, for example, and outputs like the experience of the Mission Designers and Mission Executors; the statistical data that comes out of the XLP event; and physical products or other inventions derived from the intellectual efforts of the event participants.

Digital Publishing Workflow Operating System

The three tiers are built on top of our Remix platform, which provides a foundation of industry-standard tools to help XLP students achieve the goals of their curriculum.



Participants

XLP assigns three roles to force interdisciplinary collaboration, which are regulated by the Four Forces:

Sponsor

School/department that provides resources for XLP program

Mission Designer

Design and test learning missions in accordance with the goals sponsors
Create tailored learning “games” to fit resources and requirements, and push the Mission Executors to learn.
hem to come up with challenging problems of “games” to solve and then solving these problems, and then by figuring out how to guide other people to execute the mission at a higher level of complexity or at a faster speed.

MD’s are generally divided into four or five groups that reflect the four forces that were discussed above:

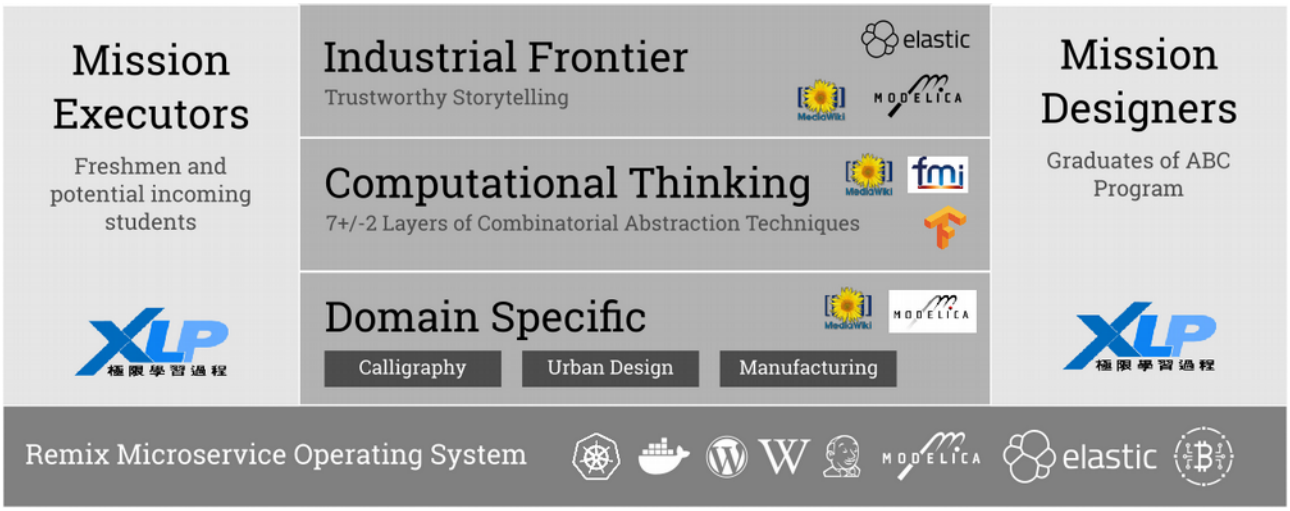
- A law court and perhaps a patent office to regulate the l**egal interactions** between ME’s
- A media department to reflect the **social norms** of the ME’s

through social media, other digital media, and traditional media
- **Market** regulators to regulate the operation of the market
- T**echnology support** to enable ME's to execute missions using the technology architecture required to do so

Mission Executor

Mission Executors are the student participants who play the "games" designed by Mission Designers, and later becomes Mission Designers themselves. While playing the games, they learn to execute the mission at a higher level of complexity or speed, and learn how to guide others to perform the mission.

The MD's and ME's learn individually and collectively. The community of sponsors, MD's, and ME's is a microcosm of a larger context – for example, a university, a society, or a nation.



XLP forces every learning team to be a focused goal-oriented microscopic society in a digital publishing / learning workflow environment. Each learning program is divided into four stages:

Learning Activities

Digital Identity

Every entity in an XLP micro or macro learning ecosystem has a verifiable digital identity, the basic building block of the digital world. Entities include individuals and organizations, as well as physical resources and technical services. Digital identities (like email addresses or OpenID) enable the tracking of every entity's contribution to the crowdlearning process, and allows participants to sign **Smart Contracts**.

Constitutional Framework

Constitution Reading Session: Before an XLP activity, each prospective participant participates in a constitution reading session to learn the framework of the activity. The constitution details the

responsibilities of each participant in the XLP activity, in addition to services provided by the sponsor of the activity. Participants digitally sign a Smart Contract (stored on the Blockchain) stating that they understand the details of the constitution and their responsibilities, and an agreement stating that they agree to abide by the constitutional framework during the XLP activity.

Constitution Revision Process: Given that a constitutional agreement is a framework for public collaboration, it should be a dynamic document and explicitly detail a procedure to refine it to fit the evolving context, and be tracked via a version control mechanism.

Digital Publishing Workflow

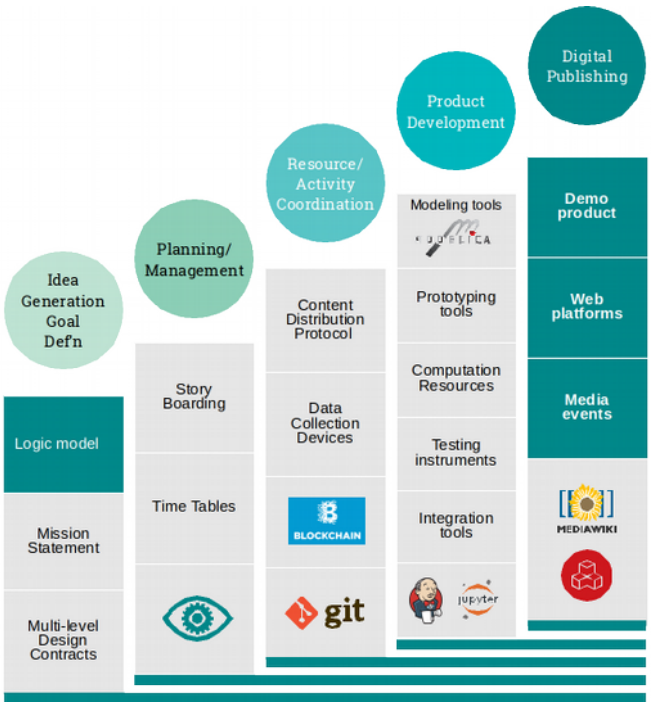
After receiving their digital identity and reading the constitution, participants take part in the digital publishing, or digital deployment, workflow. This becomes each participating entity's experience for the XLP activity in which they participate for the rest of their life. In this experience, participants use their digital identity to contribute to developing, acquiring, using, sharing, and publishing digital and physical assets. In today's digital society, this digital publishing workflow is an ongoing process for each entity that participates in XLP.

Design Contract

As part of the workflow, students work together to create a one-page design contract, taking into account activity context, inputs, activities, and outcomes. This helps participants check if they are consciously aware of their own actions:

Quality and Quantity through Digital Tools

Students assure quality by working together via **Remix**, XLP's online collaborative learning platform. This suite of tools enables collaboration, content distribution, data collection, and data modeling:



Stages of a Learning Activity

1. Orientation Program

Usually involves **digital identity**, **constitution reading session**, agreement reading/signing and quick overview teaching students how to use **digital publishing** tools in general. Participants also gain experience dealing with many other people on the fly, encountering the courtroom, participating in market transactions, participating in media – i.e. learning how the four forces interact with XLP activities.

2. Lab/Knowledge Exploration

"Taster" classes allow students to visit many laboratories and researchers in a big campus (e.g. Tsinghua University's laboratory exploration program that makes available more than 100 laboratories and gets students on campus to see each other's research results) This gives a broader context of available technology and research results.

3. Professional/ Career/Strategy

Students write a personal career plan document and a group industry analysis report using the digital publishing workflow mentioned previously. They use this to collect information and present what they really want to do over time for themselves individually and for the group

	to propose possible products.
4. System Design/ Development	Uses the previous three classes as an information source to identify talented individuals and highly functioning teams so that they can pick a team of candidates to build a product. This course might take at least three months, sometimes 1-2 years. The product would then go into their graduate thesis or enter the real marketplace.
5. Public Events/ Presentations	The fifth stage is constantly offering **public events to present learning results** to the public through major media and in public forums (like hackathons and international competitions) so that we can broadcast learning results outside the university or hackerspace.

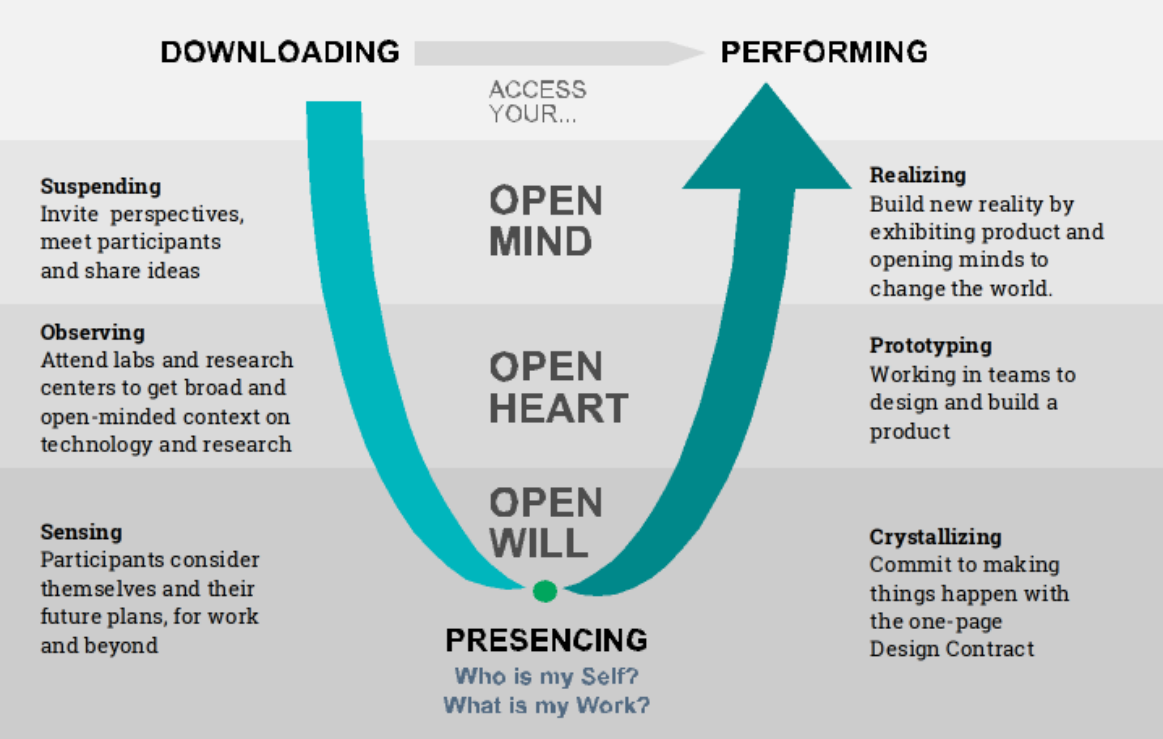
The above articulates how XLP works in a university environment, but there's also a sixth stage:

6. Material Creation	We realize that XLP can also be used as a **mechanism for teachers to use the same 4 forces to create syllabi and even detailed teaching material in an intensive workshop.** Therefore we also apply the same technique to generate and compile interesting learning material across multiple campuses, as a "training the trainer" curriculum, and enable students, and professional instructors of any discipline to participate in the creation of static or interactive learning material.

XLP and Theory U

Theory U is a change management method Otto Scharmer, who has worked with Tsinghua and Xu Lili (Theory U's China Coordinator) to refine XLP. The principles of Theory U are suggested to help political leaders, civil servants, and managers break through past unproductive patterns of behavior that prevent them from empathizing with their clients' perspectives and often lock them into ineffective patterns of decision making.

Several of XLP's steps correlate with Theory U:



By following these principles, we can achieve several beneficial outcomes:

Early Success	Provides resources and knowledge that enables students to kickoff their learning journey with excitement.
Fail Early, Fail Safe	Insures student learning assignments are challenging enough, so students can observe their short-comings and correct their course of actions in the early stage of the "game".
Convergence	Guide students to re-combine their team structures to create a synergistic product/service with other teams.
Demonstration	Every learning program should end with a ceremonial event that allows students to summarize their learning experience and present it to other people who might be future participants of XLP.

Learning Outcomes

Proposal or Report Form	Discusses the conclusion of a certain research study, or the conclusion of certain industry analysis (“research study,” “business proposal,” or “industry analysis report”)
Budget	Including both a planning schedule (i.e., a resource and human resource budget and timetable) in addition to a financial budget
Short Movie	Usually a compilation of interesting video footage of the activity, annotated with words and non-proprietary music
Prototype Product	A book, pamphlet, brochure, or even physical product
Team	One of the most important aspects and products of any XLP event is the friendship developed between students. Ideally the students can create a social network, or WeChat group so they can always tap into these human resources to do something more interesting in the future.
Refined XLP Manual	As everyone is using a similar mechanism to learn from each other, in theory we will be able to use the operational data as a statistical reference point to suggest how we might improve XLP as a general learning process – so that everything we do in this methodology can be used as case studies or as data to improve the practice in future. Obviously the most direct contributions will be sections or refinements or revisions to the XLP operating manual that you are reading now.

XLP Technical Analysis

XLP activities are executed in a highly technical context, which takes into account the Four Forces discussed previously. These forces require:

Legal Mechanisms	A dispute resolution process and patent filing process
Market Mechanisms	Facilitating exchange of goods, services, information, and capital, and establishing prices for these through supply/demand dynamics
Technical Architecture	Sophisticated technology infrastructure that allows transdisciplinary learning across space and time
Social Norms	Agreed upon standards for what constitutes acceptable behavior – covered in orientation and general university practices

Participants need access to technology that enables the four forces to regulate behavior, and, just as importantly, must learn its use before the XLP activity.

Through their digital identity, participants must be trained to (among other things):

- File patents
- File complaints and sue other entities
- Defend their legal rights
- Buy and sell intellectual property and financial and other commodities
- Publish the products of their learning and their learning outcomes via social (or other) media

The Four Forces are all present to an extent in traditional modes of learning, but their respective and collective functions in crowdlearning is relatively minimal, and not systematic. A major reason is the lack of a common digital infrastructure to track market transactions, patent applications, and refutation processes; nor has social media been systematically used to identify and measure cultural norms in a classroom and how they relate to a specific learning scenario.

Therefore, the an XLP activity context is highly technical, and requires big data and other sophisticated technologies and principles to collect, store, process, and analyze data.

From a technical perspective, XLP is:

- A crowdlearning distributed operating system that collects, stores, processes, and analyzes data and generates condensed and refined content with machine and human help.
- A learning ecology that combines organic entities with digital equipment and processes. XLP leverages open source technologies, distributed version control systems, and cryptocurrencies to track learners' individual and collective contributions to the collaborative, collective learning process and learning outcomes.

Computer cycles for collecting, storing, processing, and analyzing data are clearly different from human cycles. Thus enabling many people to simultaneously revise content, for example, requires sophisticated engineering management practices and workflow management techniques, which we generally don't find in traditional educational settings. However, this technology is becoming increasingly mature and is being leveraged by XLP to become a distributed crowdlearning operating system that provides a learning context – both for individuals and for the crowd – that is very different from that of a traditional educational setting.

Byzantine Fault Tolerance

A potential barrier with big data generated simultaneously across a distributed network is the Byzantine Generals Problem[iii]:

> Reliable computer systems must handle malfunctioning components that give conflicting information to different parts of the system. This situation can be expressed abstractly in terms of a group of generals of the Byzantine army camped with their troops around an enemy city. Communicating only by messenger, the generals must agree upon a common battle plan. However, one or more of them may be traitors who will try to confuse the others. The problem is to find an

> algorithm to ensure that the loyal generals will reach agreement. It is shown that, using only oral messages, this problem is solvable if and only if more than two-thirds of the generals are loyal; so a single traitor can confound two loyal generals. With unforgeable written messages, the problem is solvable for any number of generals and possible traitors.

In an XLP activity, the equivalent would be the XLP operating system failing to process a massive amount of data concurrently – for example, if many participants contributed and processed information at the same time. One solution to this is unforgeable written messages[iv] – signed using digital signatures, for example.

In the XLP operating system, the equivalent is a distributed repository (like Git) allowing all participants to transparently observe all content contributed by other participants. This increases everyone's confidence in the trustworthiness of their fellow participants, therefore increasing the likelihood that participants will contribute and share information content, and that this content will be compiled into a consistent result.

The XLP operating system uses existing computing science techniques that improve the ability to process the concurrent publishing of massive amounts of distributed intellectual content. Bitcoin also ensures Byzantine fault tolerance – in other words, solves the Byzantine Generals Problem – by incorporating a distributed database that lets any participant view the entire history of transaction records. This enables the processing and compiling of massive amounts of intellectual resources on an Internet scale. Open source version control software, like Git, Concurrent Versions System (CVS), and Apache Subversion (SVN), also enables sharing of human-contributed content – be it source code, novels, textual content, movies, or photographs – and enables the processing and compiling of data on a massive scale.

Remix: The XLP Operating System

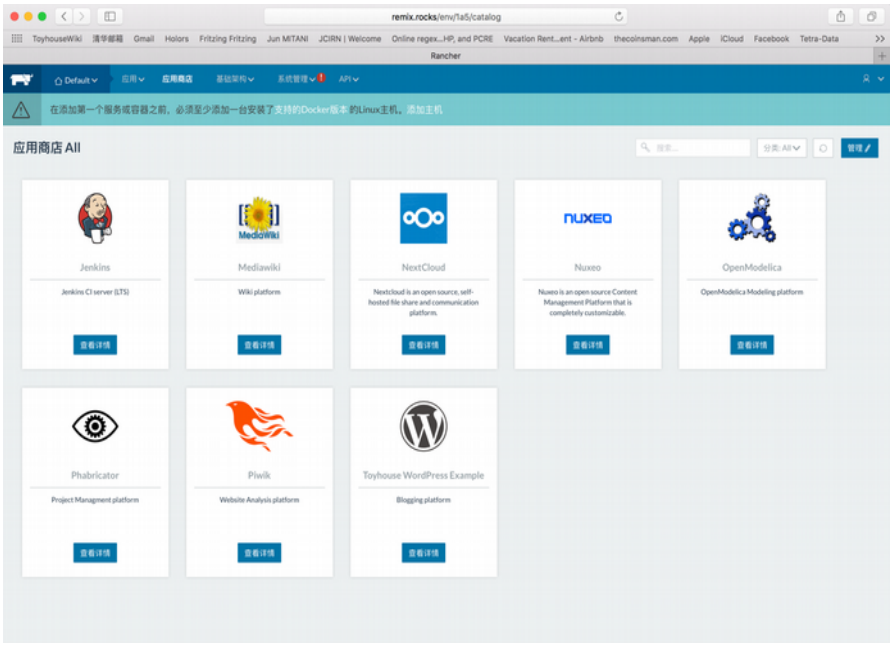
Think of the world you live in: Imagine the classroom of the future:

In a world that becomes increasingly digital, it is essential to teach the skills required to navigate through the digital environment as early as possible. A gap is opening between those who are technologically mature and others that are yet to be comfortable with handling software. The ones who are on the wrong side of this gap will eventually suffer the detrimental implications to their careers and lives. Such individuals will not be able to take part in collaborative work, thereby limiting their ability to increase their knowledge. Already, individuals and institutions lack the tools to create new digital assets or work with the existing digital information, both of which decrease their overall potential. Clearly, students need a solution to escape this situation. Imagine a classroom of the future that is modeled after the reality outside the classroom. If the reality outside the classroom is one pervaded by digital tools, so should the classroom. Remix makes sure this happens. Students will no longer study for exams but prepare for the challenges that await them in the future. It helps them work and self-manage teams with tools like Phabricator and Git, while allowing teachers to track student progress and individual contributions (captured using a digital data processing system) towards their respective projects using GitLab.

Trustworthy computing technologies such as Blockchain technology are integrated into Remix. These ensure immutability while ensuring credit is given where credit is due.

Remix Tools

The Remix platform offers a large array of powerful tools, manageable by anyone and scalable to any size.



These tools will be an important asset for any modern educational institution for which it can fully develop the intellectual potential of its students and staff. The platform democratizes services that were previously limited to such an extent, that only established companies were able to utilize their full potential. These services are now combined into a single platform allowing any individual or institution to start their digital transformation. Without the need for continuous online connectivity, the platform can be brought to the farthest corners of the globe, where a new generation of individuals can start fulfilling their computational needs. In short, Remix can bring the tools used by established software companies into any classroom or home enabling anyone to take part in the future of the digital world.

Together, students can create new data using tools like Jupyter and OpenModelica or analyze and optimize existing information using Elasticsearch and TensorFlow. Ultimately, every individual can create or take part in a Digital Publishing Workflow – a cycle going from Data Input to Data Management to Data Publishing, all from their own laptop in one single application. This is Remix.

Data Input

OpenModelica
Simulate complex systems

Jupyter Notebook
Python coding

Kiwix
Wikipedia data

NextCloud
File storage

Nuxeo
Digital assets

Data Input

Logstash
Extract, transform

Elasticsearch
Search and optimize

Kibana
Visualize

TensorFlow
Machine learning

Data Management

MediaWiki
Wiki publishing

WordPress
Blog publishing

Hyperledger
Transparency, immutability

Infrastructure

Docker
Containerization

Kubernetes
Orchestration

Jenkins
Continuous integration/ deployment

DC/OS
Container operating system

Phabricator and Gitlab are for Coordination Management. They belong to the category of Groupware.
Piwik is for usage tracking, for analyzing web traffic, therefore, more relevant to infrastrctures.

Misc

GitLab
Code repositories

OpenID
User authentication

Phabricator
Collaboration

Matomo
Analytics

Could we put these in a better category?

Data Input

Data Input describes the different ways through which data may enter the Remix platform. In the Digital Publishing Workflow, Data Input lies between Data Publishing and Data Management, as previously published data can act as input for Data Management.

Generally, data may enter the system from three source types or combinations of them.
Data Creation Remix comes with micro services from which new data can be created. For instance, **OpenModelica** enables users to create simulations of complex systems. The data produced by these simulations can then be saved for later use. Another service, **Jupyter**, allows for coding, solving equations, and showing their visualizations that can then be shared in real time among different users. Again, all the data created can be saved for later use.

Online data

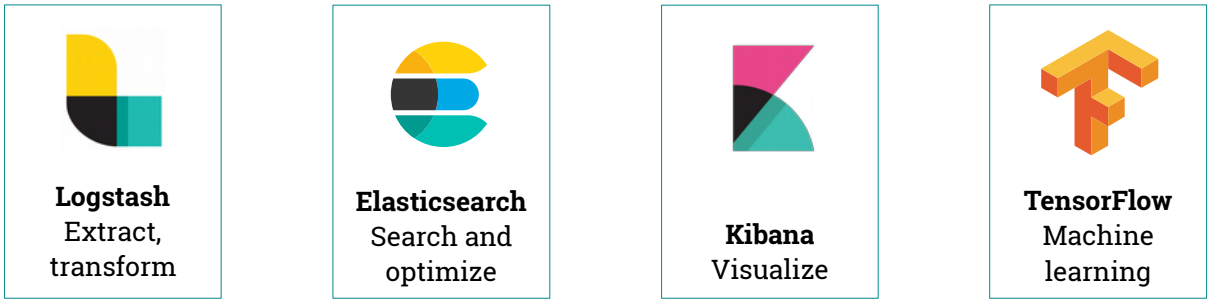
Remix also allows users to source data from the internet such as databases, wikis, or pictures. Again, different microservices are available and integrated for this purpose. Data may be used directly from the internet or downloaded first (for instance, to be brought to regions where internet access is spare or internet is slow). **Kiwix**, for instance, offers the entire Wikipedia, WikiVoyage, TED talks, and more for free to download on their website. This data may also be used as input for Data Creation,subsequently representing a combination of data.

Private Data

Finally, Remix enables users to use their own private data as input for Data Management and Publishing.

For this purpose, the platform comes with micro services such as **Nuxeo**, which is a digital asset library already used by institutions, companies, and individuals to manage their digital assets and **NextCloud** for file storage in the cloud. Hence, they can tap into their existing data and use it as input for other micro services to create new data, again representing a combination. Generally, such private data may belong to an individual, an institution, or a company who can scale up their data storage as required without having to scale the other microservices thanks to the underlying system architecture.

Data Management



The data management part of Remix utilizes four different tools to perform a number of user related tasks. In the Digital Publishing Workflow, Data Management lies between Data Input and Data Publishing. The purpose of data management is to load the given information from the different data inputs, then optimize it so that it becomes searchable and produces the best results, which in turn can be visually presented to the user. This is possible through the use of the ELK stack from Elastic, consisting of Logstash, Elasticsearch, and Kibana, in combination with the machine learning capabilities of TensorFlow. These tools are combined to allow users to perform queries on wide array of data that in-turn, can be optimized based on an infinite number of characteristics. The following section will describe each tool and how they are an integral part of the of the Remix framework.

Logstash: Data extraction, transformation, and loading

Remix consists of a large number of data sources that each produce a large quantity of data, in many different formats. It is therefore necessary to have a tool that can extract, transform and load the input data into the next step of the process. This is where **Logstash** is used. Logstash is an open source server-side data processing pipeline based on the extract, transform, load (ETL) process.

Each step has varying degrees of complexity, that will be explained in the following sections:

The first job carried out by Logstash is the extraction of data from the different defined sources. Extraction is conceptually the simplest task of the whole process but also the most important. Theoretically, data from multiple source systems will be collected and piped into the system for it later to be transformed and eventually loaded into the system. Practically however, extraction can easily become the most complex part of the process. The process needs to take data from the different sources, each with their own data organization format and ensure that the extraction happens correctly so that the data remains uncorrupted. This is where validation is used. The extraction process uses validation to confirm whether the data that was extracted has the correct values, in terms of what was expected. It works by setting up a certain set of rules and patterns from which all data can be validated. The provided data must pass the Transform Load validation steps to ensure that the subsequent steps only receive proper manageable data. If the validation step fails, then the data is either fully rejected or passed back to the source system for further analysis to identify improper records, if they exist.

The data that is extracted then moves on to the data transformation stage. The purpose of this stage is to prepare all submitted data for loading into the end target. This is done by applying a series of rules or functions to ensure that all business and technical needs are met. Logstash does this by applying up to 40 different filters to all submitted data. When filtering is completed, the information is transformed into a common format for easier, accelerated analysis. At the same time, Logstash identifies named fields to build structure from previously unstructured data. In the end of the transformation process, all data in the system will be structured and in a common format that is easily accepted by subsequent processes.

The last part of the ETL process is the load phase. The load phase takes the submitted and transformed data and loads it into the end target. There are certain requirements defined by the system that must be upheld. This pertains to the frequency of updating extracted data and which existing information should be overwritten at any given point. Logstash allows the system to load onto a number of systems, Remix does however only require that Elasticsearch receives the data.

Elasticsearch: Search and optimize

Search and optimize are two key attributes of any data management system. It allows a system to filter away all the unwanted data and prioritize the results based on a number of given attributes. Search and optimize are not functions that are limited to basic keyword searches, but can instead be used for a wide variety of possibilities. Everything from choosing the correct strategy in a game of chess to simulating the trajectory of a moving vehicle. In all these cases, the function utilizes the available information from the different data sources in combination with machine learning intelligence to give the desired outcome To achieve this Remix uses **Elasticsearch** and **TensorFlow**. Elasticsearch is a distributed, RESTful search and analytics engine that stores data in a searchable manner. All the data that is passed through Logstash eventually ends up in Elasticsearch. Here it is structured and analyzed to allow users to search based on their chosen parameters. The given parameters are in turn used to filter away all the unwanted results. What remains is a list of results that in one way or another are linked to the original search criteria. This list is, in turn, handed to TensorFlow.

TensorFlow is a mathematical library using deep neural networks in order to analyze data. The system takes in the data that was selected by Elasticsearch and prioritizes/orders it according to the pre-determined criteria. This gives the user a selected number of results that should be suited exactly to their defined needs.

When it comes to searching and optimizing, Remix’s key difference compared to other services is that results are purely based on the user. If a user specifies a certain interest or academic field that they are studying, then the optimization will be created with that parameter as a focus point. Thus, opening up focused research where all advertising-based rankings or unwanted results have been removed.

Kibana: Data visualization

In certain scenarios, the outcome of the data management process doesn't come in the form of links or lines text. In these cases, it is often required that the data goes through some sort of visualization in order to turn it into something that is manageable.

This is the job carried out by **Kibana**, the last tool of the data management process. Kibana is a data visualization plugin that works together with Elasticsearch to provide visualization capabilities on top of the content that has been indexed. It takes all the data that the user has asked for and gives a visualization if it is applicable. Kibana can therefore also be seen as being part of the data creation aspect of Remix.

Data Publishing

The final aspect of any standard research project concerns the publishing of results and conclusions.

For this reason, the final part of the Remix framework is data publishing. The purpose of this step is to ensure distribution of new data to a wide audience while guaranteeing rightful credit and ownership of published research and findings. To do this, the platform uses two main tools, **MediaWiki** and **Hyperledger**, in combination with the machine learning capabilities of TensorFlow. MediaWiki is a digital publishing tool created by the Wikimedia Foundation. It allows information to be published in a structured and navigation friendly way. Remix uses MediaWiki to allow institutions or individuals to create closed or open wiki spaces in which all their information and research can be published. Each publisher then creates a distinct name for each new published article or piece of information. All the information on the given wiki space is then individually connected using the deep neural network capabilities of TensorFlow, as mentioned in the previous chapter. TensorFlow analyses each piece of information and carefully links it together with other related information. This, in the end, produces a wiki space which is full of research articles and other information, in combination with existing Wikipedia data, that is fully connected. Furthermore, connections and recommendations of articles can be made based on user preferences. In other words, if a user is studying biology and is doing research on the flight patterns of butterflies, then Remix will start creating more links and finding more research articles on that topic specifically. In that scenario, it might connect the flight patterns of butterflies to the evolution of airplane wing structures.[v]

Ultimately, a person can, through Remix, have access to a deeply interconnected network of research, published articles, and existing data from the internet.

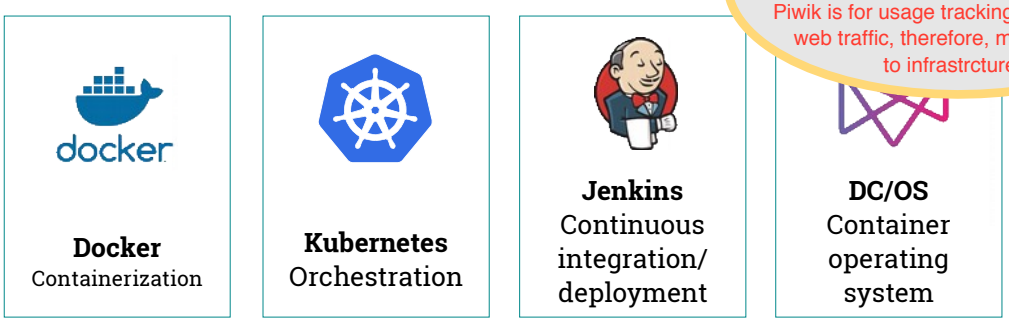
To ensure that all information in the system is untampered with and that publishers are rightfully credited, Remix uses trustworthy computing technologies such as Hyperledger. Hyperledger is an open source collaborative blockchain technology that ensures transparency and immutability of all information that is created or submitted in the system. This, in turn, also insures that any information for which there may be a rightful owner, is credited as such. These tools open up for a whole new dimension of the digital publishing process that will allow institutions and individuals to contribute their knowledge to a greater audience.

Collaboration and Assessment

Phab, OpenID, GitLab, Piwik – are these in the right category? If not, where should they go? Is there anything missing?

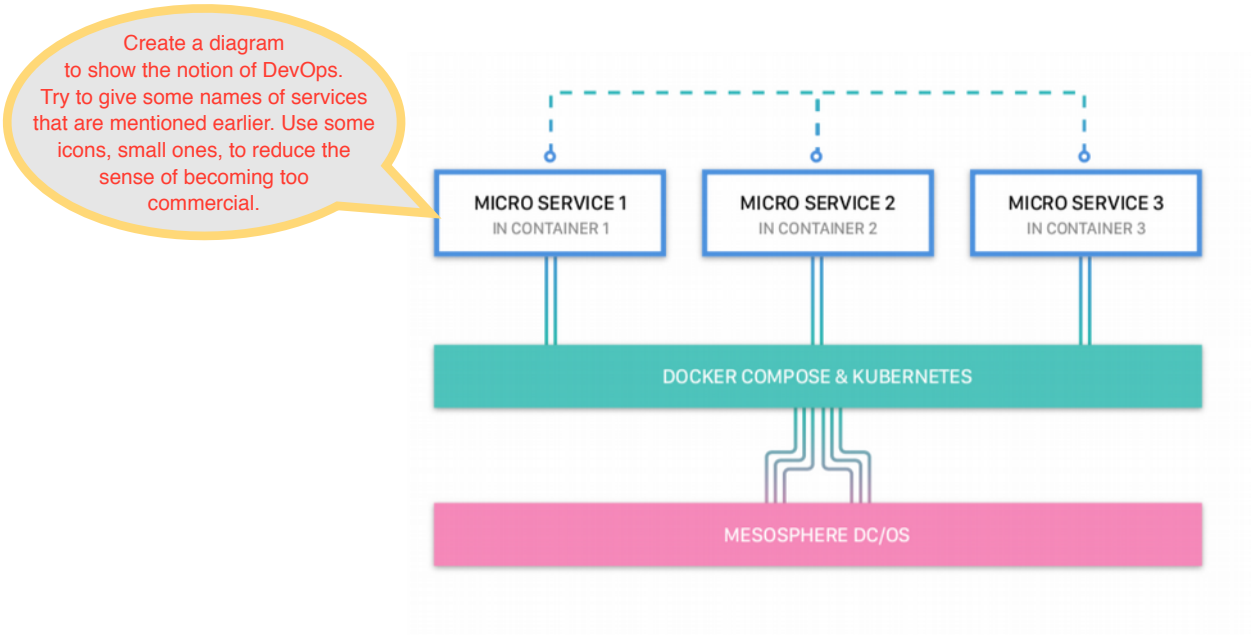
Phabricator and Gitlab are for Coordination Management. They belong to the category of Groupware.
Piwik is for usage tracking, for analyzing web traffic, therefore, more relevant to infrastrctures.

Architecture



The interconnectedness of services in Remix is made possible using the **Docker** platform. Docker uses container technologies to allow micro services and other digital assets can be run in easily-replicable sandboxes and not interfere with each other. Unlike virtual machines, containers do not require a guest operating system which makes them more lightweight, allowing for more or bigger applications running on a server or single computer.

With Docker container technologies, we can re-define all digital assets into three main categories: content data, software data, and configuration data. These categories can be tagged using a hash code (similar to Git or Blockchain labels), and can be trading by swapping out “tokens” or hash IDs of the asset. This allows participants to easily install different software services and start using the asset almost instantly. The end result is that participants and instructors can better manage learning activities, and use one consistent namespace to organize all their assets.



Hence, a multitude of containers can easily be combined in a single application. This can be done through Docker Compose. While Docker focuses on individual containers, Docker Compose engenders scripting the installation of multiple containers that work together to create a bigger application. Microservices in Remix talk to each other to modify and move data from its creation, to its management, and publishing. At the same time, since the micro services are still housed in their respective containers, any service may be added or removed at any time without damaging other containers.

Remix also enables deployment, monitoring, and scaling microservices with **Kubernetes**, a tool specifically designed for this task. Microservices can then be scaled individually and independently from each other (thanks to their containerization), specific to the needs of the user.

Finally, the Mesosphere DC/OS acts as the foundation of the system and adds a layer of abstraction between Kubernetes and Docker and the underlying OS used by the user such as Linux. This operating system for datacenters works specifically well with micro services and among other things, takes care of resource allocation and makes the system fault-tolerant. In Summary, Remix is an application that is lightweight, modular, and easy to install, use, and scale, enabling everyone to make use of the powerful micro services included. The platform achieves this using a three-part structure with the micro services being the highest layer of abstraction followed by the combination of Kubernetes and Docker and completed by the Mesosphere DC/OS.

Glossary

Blockchain: Digital ledger in which transactions made in bitcoin or another cryptocurrency are recorded chronologically and publicly

Campus, Physical: The physical elements of a campus, e.g. people, buildings, land, equipment

Campus, Virtual: Non-tangible aspects of a campus, e.g. distributed learning workflow design team, cloud services and intellectual property, etc

CCC: See *Cognitive Construction C*

An improved and interactive version of Logic Model.

Cognitive Construction Chart:

Container: Operating-system-level virtualization, also known as containerization, refers to an operating system feature in which the kernel allows the existence of multiple isolated user-space instances

Containerized Digital Asset: Content data, software data, or configuration data stored in a Docker (or other) container

DC/OS: Open-source operating system and distributed system

Design Contract: One page document to ensure participants are cognizant of their own actions. Covers context, inputs, activities, and outcomes.

Digital Publishing Workflow: Cycle going from Data Input to Data Management to Data Publishing

Distributed Autonomous Organization: Organization that is run through rules encoded as computer programs called smart contracts

Docker: Computer program that performs operating-system-level virtualization also known as containerization

Elasticsearch: search engine that provides a distributed, multitenant-capable full-text search engine with a web interface

Fab Lab: small-scale workshop offering (personal) digital fabrication, typically equipped with an array of flexible computer-controlled tools that cover several different length scales and various materials, with the aim to make "almost anything". Similar to *hackerspace*

Four Forces: Lawrence Lessig's four forces that constrain our actions: the law, social norms, the market, and architecture.

Free Software: See *open source*

Git: Version control system for tracking [illegible]uter files and coordinating [illegible]g multiple people

GitHub: The most popular web-based Git repository manager.

GitLab: Open-source, user-hostable web-based Git repository manager

GNU/Linux: Family of free and open-source software operating systems built around the Linux kernel. Typically packaged in a form known as a Linux distribution for both desktop and server use.

Hackerspace: A place in which people with an interest in computing or technology can gather to work on projects while sharing ideas, equipment, and knowledge. Similar to *Fab Lab*

Hyperledger: Umbrella project of open source blockchains and related tools to support the collaborative development of blockchain-based distributed ledgers.

Jenkins: Automation server that helps to automate the non-human part of the software development process, with continuous integration and facilitating technical aspects of continuous delivery.

Jupyter Notebook: open-source web application that allows you to create and share documents that contain live code, equations, visualizations and narrative text. Uses include: data cleaning and transformation, numerical simulation, statistical modeling, data visualization, machine learning, and much more.

Kiwix: Open-source offline wiki browser

Kubernetes: Open-source container-orchestration system for automating deployment, scaling and management of containerized applications

Ledger: Used in blockchain. A database held and updated independently by each participant (or node) in a large network

Linux: See *GNU/L*

A one page, seven item summary of a project's Context, Goal, Effects, Output, Process,

Logic Model

Macroscopic

Makerspace: A pl… hich people with shared interests, espe… technology, can ga… while sharing ideas, … knowledge. Similar to *hack…* but often more focus on education

A category of courses in XLP that lead students to investigate the contextual information of a system. Namely the historical development trajectory of Technologies, People, and Relevant Institutional Changes.

Matomo: A web analytics application

Mediawiki: Open-sourc… Wikipedia

A category of courses in XLP that focuses on the combinatorial nature of macroscopic opportunities, and microscopic technical resources. This course category is often called System Design in Computational Thinking.

Mesoscopic

Mesosphere: Mesosphere DC/OS is an enterprise grade datacenter-scale … system, providing a single … containers

A category of courses in XLP that focuses on the technical details of a particular domain. Say quantum physics, biology, or civil construction. Some subject content that relates to highly specific fields.

Microscopic

Microservice: Software development technique that structures an application as a collection of loosely coupled services. In a microservices architecture, services are fine-grained and the protocols are lightweight

Open Source: Software for which the original source code is made freely available and may be redistributed and modified.

Phabricator: Suite of web-based software development collaboration tools, including the Differential code review tool, the Diffusion repository browser, the Herald change monitoring tool, the Maniphest bug tracker and the Phriction wiki.

Piwik: A web analytics application (now renamed *Matomo*)

…L P's online platform of tools for …nts

Smart Contract: A computer protocol intended to digitally facilitate, verify, or enforce the negotiation or performance of a contract. Smart …acts allow the performance of credible …thout third parties.

…gn/Development: Software …nt process that relies on the repetition of a very short development cycle

Trustworthy Computing: Broad term that …ies and proposals for …curity problems through …ents and associated …ications.

U Theory: Change management method …adership as process of inner …novation developed by

…nd's most popular open-source content management system based on PHP and MySQL

XLP: Extreme Learning Process, a methodology that enables communities of learners to design and conduct collaborative learning activities

Appendices

CCC Logic Model

Using the CCC logic model ensures that every task or project starts with explicitly-analyzed test cases, originating from Test Driven Design. Each step of the model feeds into the next step, generally with a one-to-one relationship. Similar to writing a computer program, the logic model has two stages of checking/analysis:

- **Static Analysis:** A way to read the model itself, and see if the content in all boxes is consistent and relevant.
- **Dynamic Analysis:** A way to use the “measurable effects” to confirm output matches expected outcomes, and if task performance fits the goal.

1. Context

What’s your current situation or context?
Includes spatial and temporal description (where will you do the activity, and when?)

2. Goal

W do?
I r example “conquer Rome,” or “land a man on t

These text has alignment problems.

3. Measurable Effects

H rmine success?
(i) Set of conditional statements. Output will be measured against these to confirm it has achieved desired goal

4. Output

What will you deliver?
(ii) Concrete objects like micro-movies, logic model documents, industry analysis reports, financial statements, etc

5. Process/Activity

What do you need to do to succeed?
(iii) Set of partially ordered activities, outlining what happens during the project and how to accomplish the project goal

6. Input

What resources do you need?
(iv) Resources required to initiate the activities, including budget, human skills, head counts, etc

7. External Factors

What could go wrong?
(v) Any factors that could prevent the team from achieving their goal

Each of the boxes above will have precise linguistic properties that can be examined by human or machine (via Natural Language Processing), to know if the information in the box fits the specified requirements. In this way, participants can be assessed and certified automatically, using Blockchain-witnessed process data collected using the Remix platform.

i *Murray, Andrew D. (January 1, 2011). "Internet regulation". In David Levi-Faur. Handbook on the Politics of Regulation. Edward Elgar Publishing. pp. 272–274. ISBN 978-0-85793-611-0.*

ii Lessig

iiiLeslie Lamport, Robert Shostak, and Marshall Pease, The Byzantine Generals Problem, 1982

iv Ibid

v (see: The Structural Origins of the Modern Airplane. P Jakab) or the formation of insect flight behaviour (see: Pheromones and Flight Behaviour, T. C. Baker).