AceForm4.0 Overview
Status and Learnings for Validation
Status
Project Overview

Horizon 2020 Coordination and Support Action (CSA) project Oct 2016 - Oct 2018

Objectives

- Establish a European Formulation Interest Group (EU-FIG)
- Identify common technical and industrial challenges for the European Formulated Products Industries
- Establish a common vision and roadmap
- Arrange knowledge exchange activities and facilitate new initiatives along the value chain

Key project outputs

- Influence the content of future EU calls
- EU-FIG community with >500 organizations
- > 10 new collaborative cross-sectorial initiatives

www.formulation-network.eu
Objective 1: Establish a European Formulation Interest Group

Objective 2: Identified Common Scientific and Industrial Challenges

Objective 3: Establish a Common Vision, Roadmap for 2025 and Associated Implementation Plan

Objective 4: Through Knowledge Exchange Activities Facilitate Creation of New Cross-Sector Value Chains Initiatives

Objective 5: Establish a Business Plan for Continuity

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Progress against Objectives
Phase 1 - learning

Objective 1
Establish a European Formulation Interest Group
- Newsletter (1 of 5)
- Web portal
- 100+ members (of 500)

Objective 2
Identified Common Scientific and Industrial Challenges
- 24 Interviews
- 106 surveys
- Report complete

Objective 3
Establish a Common Vision, Roadmap for 2025 and Associated Implementation Plan
- Reports (draft)
- Analysis of 5 SRAs

Objective 4
Through Knowledge Exchange Activities Facilitate Creation of New Cross-Sector Value Chains Initiatives
- 2 x Workshops (of 6)
- Draft value chain mapping structure

Objective 5
Establish a Business Plan for Continuity

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Progress against Objectives
Phase 2 - validation

Objective 1: Establish a European Formulation Interest Group
- Newsletter (2 of 5)
- 130+ members (of 500)

Objective 2: Identified Common Scientific and Industrial Challenges
- Through Knowledge Exchange Activities
- Facilitate Creation of New Cross-Sector Value Chains Initiatives
- 5 x Collab supports (of 10)
- 5 x Workshops (of 6)
- Value chain maps x 6

Objective 3: Establish a Common Vision, Roadmap for 2025 and Associated Implementation Plan
- Open / survey
- Interviews 20+
- Validation Events
- WP4 workshops
- 3 x webinars

Objective 4: Establish a Business Plan for Continuity
- Launch event
- Develop plan

Objective 5: Final validated Reports
- Completed (Green)
- Ongoing (Orange)

Priorities for engagement
Key targets for engagement to enable a balanced and robust output are:
- Agro Tech & Plant Protection sector
- Contract Research Orgs, Consultants, Manf. contractors, Equipment and instrumentation suppliers, Governmental bodies or agencies and non-governmental organisations
- Organisations in southern and east European countries.
- Champions of novel sustainability focussed business models (academics, SMEs, NGOs).

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Learnings for Validation
1. Context and Scope
   1.1 The Formulating Industries: What makes them unique
   1.2 The six target sectors
   1.3 Cross-sector trends / drivers
2. Common Vision for 2030
3. The EU Formulating Industries: Market Growth Opportunities (per sector)
4. Common Challenges and Opportunities/Recommendations and Actions
   4.1. Value Chain & Cycle Collaboration
      ▪ Systems-based Solutions for Complex Challenges
      ▪ Value Cycle Collaborations: Closing the loop
   4.2. Circular Economy – Unlocking Value through Systems-based Sustainable
      ▪ Circular Economy (CE) and Formulation: Understanding the relevance
      ▪ Circular Economy (CE) and Formulation: Modelling the impact
   4.3. Industry 4.0 – The toolkit for Future Formulation
      ▪ Industry 4.0 and Formulation: Understanding what it is and the Implications
      ▪ Industry 4.0 and Formulation: An enabler for Radical Product and Process Design
      ▪ Industry 4.0 Challenges: Knowing where to start?
5. Recommendations and Summary of Actions
6. Common Vision for 2030: Success Indicators
The Formulating Industries: What makes them unique?

Formulation: More than Mixing...

- Multicomponent and multiphase mixtures
- Complex interactions across multiple time and length scales
- Properties designed and balanced for different stages through the product life-cycle
- Designed to change physical form - complex stability challenge to manage when compared with more conventional materials

- Formulated product = 3 – 100 times higher than the value of ingredients
### 1.2 The EU Formulating Industries: The six target sectors

<table>
<thead>
<tr>
<th>Sector grouping</th>
<th>Subsector</th>
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<tbody>
<tr>
<td>1. Home, Industrial &amp; Personal Care</td>
<td>Personal care – cosmetics, cleaning, well-being, perfumes</td>
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<td>Home care – cleaning, laundry, hygiene</td>
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<td></td>
<td>Industrial and Institutional cleaning</td>
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<td>2. Pharma &amp; Health Care</td>
<td>Pharmaceuticals – small molecule, biologics</td>
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<td>Healthcare – hygiene, skincare, pain relief, nutrition</td>
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<td>Medical Devices, Diagnostics, Imaging</td>
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<td>3. Agro Technologies &amp; Plant Protection</td>
<td>Crop Protection</td>
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<td>Agrichemicals</td>
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<td>Seed treatments</td>
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<td>4. Coatings and Surfaces</td>
<td>Paints</td>
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<td>Inks and dyes</td>
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<td></td>
<td>Lubricants</td>
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<td>Adhesives</td>
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<td>5. Food &amp; Drink</td>
<td>Food – confectionary, processed foods, sauces, animal feed</td>
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<td>Drink – alcohol, soft drinks, coffee</td>
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<td>6. Advanced materials</td>
<td>Composites, polymers, ceramics</td>
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<td>Catalysts</td>
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<td>Paper and packaging industry</td>
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<td>Additive manufacturing</td>
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- AceForm analysis focusses across 6 main sectors; selected based on:
  - i) **Potential for economic and societal impact** (sector size, EU footprint, potential for growth)
  - ii) **Potential for cross sector collaborations and synergies** (ingredient/materials base; current capabilities; collaboration culture).

- This approach does not preclude engagement and applicability of AceForm outputs to other sectors.

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1.3 Cross-sector trends / drivers

• **New Product and Process Development**
  - Faster Product lifecycles and product obsolescence
  - Radical effects and high performance
  - Faster time-to-market
  - Customisable and personalised products

• **Manufacturing and Supply Chain Performance**
  - Operating and maintenance costs of plants
  - Rejuvenating legacy assets to maintain and/or improve competitiveness.
  - End-to-end productivity of supply chains
  - Responsiveness of supply chains
  - New revenue generating business models (e.g. shift to service)

• **Sustainability and the Circular Economy**
  - Resource efficiency and the reuse across the whole supply chains
  - Renewable and/or bio-degradable ingredients
  - Rising awareness of human impact on the environment (ocean, air and land)
  - Rise of internet-empowered consumer
Europe will lead the global path in the innovation and commercialisation of new sustainable formulated products that deliver radical effects and high-performance to downstream industries, end-users and consumers whilst optimising resource and energy efficiency and minimising adverse impacts on biodiversity and the environment.
AceForm highlights and prioritises public intervention on complex opportunities; intractable by current value chains

**Action 1: Make recommendations for CR&D calls themes; highlighting potential for formulation (Fund)**

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<tr>
<td>• Product differentiation through personalisation</td>
<td>• Personalised medicines</td>
<td>• Automated smart farm concept</td>
<td>• Real time performance monitoring (service model)</td>
<td>• Reformulation for low fat, low sugar; high nutrition</td>
<td>• Reformulation for Additive Manuf.</td>
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<td>• Products for ageing population</td>
<td>• Preventative care models</td>
<td>• Formulation for close-loop digital health model</td>
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<td>• Process scale-out to regions with lower cost base</td>
<td>• Energy storage materials</td>
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<td></td>
<td>• Managing increasing variability in regional ingredient supply</td>
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<td>• Materials for IoT</td>
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**Digitalisation and Technology**

| • E-commerce driving reformulation to support novel Direct-to-Consumer models | • Formulation for emerging therapies | • Water scarcity Resistance | • Various regs/legs for removal of harmful ingredients | • Reformulate to reduce CO2 impact | • Lightweighting | • Reformulate to reduce CO2 impact |
| • Formulation for close-loop digital health model | • Automated smart farm concept | • End of life / recycle / recover | • End of life / recycle for composites | • Zero waste (product) | • End-of-life / recycling for composites | • Zero plastic waste |

**Environment and circular economy**

| • Drive for sustainable products; enabling resource efficiency. | • Biofeedstocks | • Various regs/legs for removal of harmful ingredients | • End of life / recycle / recover | • Reformulate to reduce CO2 impact | • Lightweighting | • Reformulate to reduce CO2 impact |
| • Biofeedstocks | | | | • Zero waste (product) | • End-of-life / recycling for composites | • Zero plastic waste |

Note: Examples given above are illustrative of fuller analysis available in full draft report.
Value Chain & Cycle Collaboration – Systems-based Solutions for Complex Challenges

1. Finding new Partners – beyond ‘business as usual’ networks

Circular Economy – Unlocking Value through Systems-based Sustainable Solutions

3. Understanding the Relevance - for all formulated products
4. Enabling Disruptive Companies and Business Models
5. Modelling the Impact – Environmental, Societal, Commercial

Industry 4.0 – The toolkit for Future Formulation

6. Understanding what it is and the implications
7. An enabler for Radical Product and Process Design
8. Universal Industrial Challenges - Integration, Data Sharing and Digital skills gap
9. Formulation Specific Technical Challenges
10. Knowing where to start? – Digital Formulation Capability Benchmarking and Roadmapping
Value Chain Collaborations
Systems-based solutions for complex challenges

• A key recommendation from AceForm is to prioritise and enable collaborations that extend reach along and across value chains

• The big 21st century challenges/opportunities demand better sharing of:
  • Technical expertise, data and insights
    • Much of which extends beyond formulation
      • E.g. chemical production, devices, packaging, env. remediation, process eng.
  • Specification/Customer understanding
    • including extend reach beyond tradition routes consumers / consumer groups
  • Constraints
    • e.g. cost base, supply base, regulations (sometimes conflicting across sectors)

• Action 2: Improve Formulation outreach (Inform, Connect)
  • Grow EU stakeholder value chain maps; reaching beyond ‘business as usual’ partner networks
  • Develop resources to do better job of selling value of formulation.
4.1 Value Cycle Collaborations
Closing the loop

- A further recommendation is to prioritise and enable collaborations that extend to **value cycle** thinking.

Note: sustainability isn’t always the primary driver for value cycle collaboration e.g. other drivers - security of supply, quality.

- **Action 3:** Promote prioritisation of CR&D calls where extended value chain / cycle collaboration can be demonstrated (Fund)

- **Action 4:** Promote access to, and coordination of central resources for modelling value chains/cycles (Connect, Access)
Looking beyond the current “take, make and dispose” extractive industrial model, the circular economy is restorative and regenerative by design. Relying on system-wide innovation, it aims to redefine products and services to design waste out, while minimising negative impacts as well as energy consumption. Underpinned by a transition to renewable energy sources, the circular model builds economic, natural and social capital.
Circular Economy (CE) and Formulation Understanding the relevance

- CE is a significant opportunity for economic and societal impact across Formulating Industries
- General awareness across Formulating Industries is good; but issues around understanding
  - Generally not enough big picture thinking – typically tackling sustainability from operational silos.
  - Consumables – unclear that CE can be applied, assumed not as product ‘in-use’ life-span is short
  - Difference between formulations that have potential to be:
    - intrinsically circular (e.g. motor lubricant); or a CE enabler (e.g. packaging ink that enables recycling)

**Action 5: Improve awareness of formulation related CE case studies (Inform)**
**Action 6: Promote and explore innovative ways to stimulate investment in disruptive CE businesses (Fund)**

25. Are you familiar with the term "Circular Economy" within your organization?

27. Does your organisation have a defined strategy for addressing one or several aspects related to Circular Economy?
Circular Economy (CE) and Formulation
Modelling the impact

• Formulating Industries, particularly SMEs, are limited in their ability to exploit CE opportunities as there is poor access to (or at least awareness of) relevant collaborative tools for modelling impact.
  • Environmental impact – Full Life-Cycle Analysis; Quantitative; Complex systems
  • Societal impact – see donut economics thinking (schematic below)
  • Modelling value chains/cycle – to secure role and IP in future disruptive value chain/cycle
  • Modelling Business models – e.g. shift to service model; how to re-configure business

Action 7: De-risk shift to CE by improving access to relevant collaborative tools to model impact (Access)
Industry 4.0 is the integration of various digitalisation technologies (existing and emerging) to enable advanced capabilities to **connect, model** and **automate** design, manufacturing and supply chains systems. => delivering products, processes and services faster, more efficiently and more flexibly.
Industry 4.0 and Formulation
Understanding what it is and the Implications

- AceForm consultation highlights a generally poor understanding of Industry 4.0 across Formulating Industries.
- Elements are being applied in silos; so missing the bigger picture opportunities.
- **Action 8 – Improve awareness of resources and networks that promote the value of Industry 4.0 (Inform, Connect)**

### 31. Are you familiar with the term "Industry 4.0" within your organization?

- Yes: 39%
- No: 20%
- Do not know: 41%
- No Answer: 10%
Industry 4.0 and Formulation
An enabler for Radical Product and Process Design

- **Industry 4.0 can unlock a more collaborative, dynamic approach to product and process design**
  - Breaking barriers between lab, factory and field
  - Enabling new Value Chains/Cycles and Circular Economy collaborative opportunities

- i4.0 enables step-change learning from data (modelled, experimental, in-use)
  - across many locations, companies, environments and points in time
- i4.0 enables flexibility to adapt design and production protocols to evolving technical and market learnings.
- Return on investment in radical toolkit is high
  - as products require re-formulation on regular cycles and are highly variable.
- **Action 9 – Influence CR&D calls to prioritise deployment of i4.0 technologies for radical Product and Process Design (Fund)**
- **Action 10 - Influence wider Industry4.0/digitalisation calls; maximising relevance to formulating industries (Fund)**

- e.g. Resource Efficient Formulations for the Smart Farm
- e.g. Digital Preventative Healthcare
- e.g. Tailored Engine Oil; mobility as a Service

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Industry 4.0 Challenges

**Universal Industrial Challenges**

- **Data—sharing** - A step-change is required for greater access and sharing of data currently segmented across a risk adverse supply chain.
- **Integration** - Many digital systems, many functional business needs, many legacy capital assets
- **Digital skills** – Retraining for tools of the future

**Formulation Specific Technical Challenges**

- **Digital Twins** - Are not easily created for formulations; performance/failure mechanisms are not well understood (rooted in subtle nano/micro phenomena; often product specific) and so i4.0 may create more data and levers, but without any underpinning insights as to how/when to use them.
  - Formulations are inherently unstable. ‘Good’ is only a point in time. As such, stability / performance / quality assessments over can be unreliable over short periods of time.
  - Standards for describing formulations or structuring data don’t exist. This limits the ability to apply novel data approaches and codify knowledge.
- **Target properties** - Are generally difficult to reduce to a discrete measure/physical attribute; as such it will continue to be difficult to make a meaningful quality measurement.

**Action 11** – Raise awareness and build on projects already seeking to resolve these issues (Inform, Connect)
Knowing where to start?
Digital Formulation Capability Benchmarking & Roadmapping

- By benchmarking and roadmapping respective digital formulation capability journeys
- Companies can better i) identify a practical first small step ii) identify collaborations & ii) map long-term value
- In turn, public bodies can better inform investment in greater-good public infrastructure
- AceForm proposes that capability journeys should be mapped over 5, 10 and 15 years

Against Four themes
1. **Quantification** – all aspects of the formulation life-cycle should be reduced to numbers or numerical models.
2. **Connection** – data should be generated through all stages of the formulation life-cycle and captured centrally. Associated integrated control capabilities should also be in place.
3. **Embed multiscale modelling** – truly predictive design capability will only be realised by bridging material/structure-property relationship models across time/length-scales and across the formulation life-cycle.
4. **Embed intelligence** – systems should be developed to codify ‘expert’ human intelligence so as to automate routine decision making and artificial intelligence to enable better resolution (advanced empiricism) of intractable design problems.

Across six stage of Formulation life-cycle
1. **Ingredients**
2. **Mixture** (often viewed at the formulation)
3. **Process** – including recovery/recycle
4. **Delivery** - Storage/transportation/device e.g. pack, lorry, shelf, injection, spray
5. **Application** e.g. wetting, delivery, heat transfer
6. **Subject** e.g. skin, leaf, engine

**Action 12** – Develop and deploy toolkit to roadmap and benchmark digital formulation capability (Connect, Access).
**Action 13** – Influence CR&D calls to value impact of co-development of advanced underpinning formulation capability (Fund)
**Action 14** – Analyse capability roadmaps to identify infrastructure gaps to be supported through public investment (Fund, Access)
## Recommendations

### Summary of Actions

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<td>De-risk shift to Circular Economy by improving access to relevant collaborative tools to model impact</td>
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Success Indicators

- Formulation is valued as a key contributor to **EU economic growth, job creation, sustainability and well-being**.
- Formulating Industries has a **step-change in extending reach and partnering across value chains and value cycles**.
- Formulating industries embraces, adapts and identifies new ways to **create value through the Circular Economy**.
- Formulating industries lead in exploiting **Industry 4.0 to enable Radical Formulated Product and Process Design**
- All formulating companies have a roadmap and active action plan to **advance underpinning digital formulation capabilities**
- Public and private **uplift in R&D and innovation investment**; driven by evidence of value creation.
- **SMEs with high growth potential** have **enhanced access to advanced capabilities** via open-access facilities.
- **Cross sector and value chain collaborations** function with minimal friction and are common place for leading innovative companies.

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*Europe will lead the global path in the innovation and commercialisation of new sustainable formulated products that deliver radical effects and high-performance to downstream industries, end-users and consumers whilst optimising resource and energy efficiency and minimising adverse impacts on biodiversity and the environment.*

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The EU Formulation Interest Group
Validating and actioning AceForm outputs

Your benefits:

- Possibility to influence future call topics in the area
- Get access to a network of important players in the formulation area
- Connect to experts across industrial sectors
- Become aware of opportunities in connection to research initiatives along the value chain
- Get exclusive access to deliverables, presentations, partner search engine and further information in the restricted members area
- Gain understanding on the implications of the potential of Circular Economy and Industry 4.0 trends for formulated products
- Receive information on coming events

Register and connect here: formulation-network.eu/members