



# CREST REVEALED

From Paper to Automation - Streamlining UK Securities Settlement

## Research Sponsored By



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## ACKNOWLEDGEMENTS

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We would also like to thank **Copenhagen Business School** for supporting Dr Cristiana Parisi as a principal researcher in the CREST Research team; **Anglia Ruskin University** for supporting Dr Hermann Rapp as a principal researcher in the CREST Research team; Leicester University for supporting Dr Marta Gasparin as an initial member of the research team; and **London Metropolitan University** for its support for this research project in hosting the research interviews.



And last but not least, this research would not have been possible without the support of the interviewees, who contributed invaluable insights and perspectives on the CREST project.

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## FOREWORD



*Thirty years ago, Britain's Big Bang brought sudden and massive change to the way the London stock markets work. Concepts that are now almost forgotten, like fixed commission charges and open-outcry trading - not to mention the stockbrokers and stockjobbers who ran the business - were replaced on the London Stock Exchange by electronic screen-based trading. Those changes helped consolidate London's position as the leading international financial centre, and Britain's financial services industry as one of the most highly-regarded on the globe.*

*The Chartered Institute for Securities & Investment (CISI) was, at the time of Big Bang still part of London Stock Exchange, sharing its two centuries of heritage. We are delighted to have contributed to the production of this history of a more recent market development - CREST, the paperless settlement system, which made its highly-successful debut 20 years ago. As you will read in these pages, the CISI played an important role, which continues to this day. My esteemed colleague Scott Dobbie CBE FCSI(Hon), whom I was honoured to succeed as Chairman of the Institute, chaired CRESTCo during the critical launch phase; it's equally highly-regarded first Chief Executive, Iain Saville CBE FCSI(Hon), is another former colleague on the CISI Board.*

*CREST's development has been one of many success stories that have cemented Britain's reputation for excellence in infrastructure projects, in financial services as with CREST, and in helping fund roads, railways, airports and much else across the globe, from Victorian days to our present global leadership in advising on and financing such transactions. Long may that success story continue. The CISI is delighted to play its part, equipping the next generation with the right knowledge, the right skills, the right behaviour - in short, true professionalism - to lead us into the future.*

**Sir Alan Yarrow, Chartered FCSI(Hon), Alderman of the City of London**

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It has been 20 years since CREST, the real-time securities settlement system for the UK and Ireland, went live in 1996, and 23 years since the CREST project was launched by the Bank of England. Since the time when CREST first became a glint in the eye of its creators, the system has proven, in its ongoing performance, to be one of the most important and successful systems to be introduced in the financial markets.

While CREST continues to work seamlessly in the background, it is somewhat ironic that many of today's practitioners, academics and students of the securities industry know so little about this important component of the European post-trade infrastructure.

Today, the ongoing changes in the industry and advances in financial technology force companies to focus on current challenges. There is no central archive, for public use, of documents and reports by contemporary witnesses who were directly involved in making history. With key actors retiring, and most material only kept in private archives, it is very difficult to access such information. B.I.S.S. Research (BISS) felt it was important to recognise the contribution that CREST made to the financial services industry and the economy, and to capture the views and opinions of the key players.

The economic value provided by CREST and the return on investment in it, is incalculable. In 2014, the annual number of transactions processed through Euroclear was approximately 190 million, with a value of 674.7 trillion euros. A substantial percentage of this was settled through the CREST system, which settles equity, fixed income (UK government bonds – "gilts"), and money market financial instruments. CREST's value proposition includes; privatisations and other flotations, corporate actions, and mergers and acquisitions CREST remains state of the art in global terms; its architecture has allowed it to be developed and its capacity upgraded over the decades.

- Why was it so successful in meeting the primary objectives of all projects and systems, being on time and budget?
- Why did CREST succeed when so many other major projects fail?
- How has a system, designed at a time when today's modern technology was still in its infancy, managed to stand the test of time and continued to underpin UK financial markets?
- What impact did its introduction have in a wider context?

These are some of the key themes that are being investigated by an international team of leading academics. Initial findings from the research were presented at the SWIFT Business Forum 2016 in London. In academia, the first conference papers were presented at the annual congress of the European Accounting Association (EAA) in Maastricht, in Copenhagen at the Ministry of Education, and at the 9th International Workshop on Design Theory, in Paris.

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When the CREST Research project was undertaken the aim was to link the academic research with industry insight and it was envisaged that BISS would produce a single report based on the academic research. However, the quality and uniqueness of the data already collected, and the data still to be added, has enabled so many research themes to be identified that it will provide a long term legacy, as a rich source for researchers. The first academic paper ‘*From paper-based to electronic securities post-trading: Financial automation and the case of CREST*’ will be published shortly. *Further information on the research can be found @ [bissresearch.com](http://bissresearch.com)*

This industry report is an analysis of the material gathered, which relates to the research currently being conducted. BISS aims to make the CREST research material available to other academic researchers, subject to strict control, to safeguard quality and ensure continuing value for both academia and Industry. This should enable the publication of more academic papers and related Industry reports, which will expand on themes, current thinking and analysis developed by researchers.

**CREST**

This report will concentrate on the time period between 1993 and 1996 when CREST was designed, built and launched and its ongoing impact.

The CREST system drew on the Bank of England’s experience with gilts and money market settlement; but added numerous innovations to servicing equity markets.

- Its provision of (near) real-time gross settlement of equities, against competitively provided bank balances was innovative.
- Whereas many equity CSDs were subsidiaries of the local stock exchange, CREST was at arm’s length from the LSE. Support for competition wherever feasible was a key CREST value, expressed not just in payments, but also in CREST’s support for trading on multiple trading venues, and its insistence on competition between (licensed) providers of secure electronic messaging.
- Its business model was not for profit, and its ownership and funding was in essence provided by a co-operative of users. Shares carried a fixed dividend.
- All functionality was open to all users of the system.

Some of these features have been adopted by other CSDs. The system that most closely resembles CREST is T2S, the Eurosystem’s recently launched central settlement engine for all types of securities against euro central bank money and (potentially) multiple currencies. It is independent of trading platforms, belonging to the central banks of the Eurozone; it is not for profit, like CREST; and it seeks to be accountable to its users as CREST did (and still does).



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Many people (including the CREST team) suggest that the key reason why CREST worked, and was on time and on budget, is that TAURUS failed. This underestimates other reasons for the success of the project. There was some causation, but it was a long way from being the key reason. It is more complex and this report attempts to analyse why.

*“Making good decisions in a time conscious manner, drives the project forward...”*

The CREST project team (led by Dr Iain Saville and with support from the industry, the Bank of England and a governance committee, soon to become the CRESTCo board) worked tirelessly together, to deliver the project to a tight timescale and budget. They decided that the initial target was to deliver in 2.5 to 3.5 years, at a cost of less than £35m. They – and the industry – regarded this as very challenging. CREST accepted the significant risk of failure as the price for energising the securities industry to take the project seriously and invest resources in helping the team to analyse, plan and decide, in very many rounds of formal and informal consultation. In the event, the industry rapidly accepted that failure was not an option, and co-operated fully and willingly.

Nevertheless, the team had huge challenges to master, and met resistance from several different quarters, in part because the design of CREST was very different from the existing system, being constructed with a tacit objective of consolidating other financial products into one system. This, alongside near real-time operation, pushed the industry (used to batch and customised processes) into making many changes in their systems and processing. After the effort and cost wasted on TAURUS this was a difficult ask, but they did and this has to be down to the confidence the industry had in the project team.

People had to be retrained and new systems designed by several hundred firms, all within a very short time span. To promote engagement, CREST provided information through many formal consultations, monthly newsletters, working parties, and regular meetings with trade bodies. CREST users, payment banks and registrars responded (after initial scepticism) with energy and enthusiasm. The result of this commitment to the change process was that CREST went live in less than 3 years after the formation of the CREST team; and the total cost borne by CRESTCo was £28m rather than £35m. This was as much a success for the UK finance industry, as it was for the CREST project team.

It is not a surprise that the research has shown CREST to be an explorer project, producing a system that has stood the test of time, one which is still performing admirably today. What is interesting is the wide impact that CREST had, on previously unconnected market sectors and processes.

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As it unfolded in 1993-94 the design became a radical departure from the existing central Stock Exchange market processing. It extended the central market to include settlement banks actively providing (secured) credit and payment services for CREST users, to reduce risk by ensuring an adequate standard of simultaneous delivery versus payment.

The design required reconciliation between registrars, the CREST system and all users. Hence it required not only connectivity between Issuers, the market and institutional investors via the registrars, but also with agents and retail investors via the brokers.

The design obliged share registrars to interact electronically with CREST to confirm within a maximum delay of 2 hours that ownership of securities had been legally transferred. (The risk that ownership could not be fully transferred was mitigated by other legal measures, but not fully eliminated until new law came into force, some years later. There was no incidence of loss in the interim period.)

CREST was also designed to reduce the risk and costs associated with handling share certificates and paper instruments of transfer. (Government was not prepared to legislate their abolition – as France had done.) CREST functionality provided much cheaper, more timely and safer processes for the holding and transfer of shares, and the team expected that use of non-electronic methods would quickly decline – but not disappear.

CREST offered the alternative of “sponsored membership” for investors who did not wish to become unknown to the companies in which they invested; they could remain on the register of owners, and avoid the risks implicit in being part of a pooled nominee. This innovation has not had much uptake, but its existence has stimulated better service provision by custodians.

**INNOVATION**

CREST was innovative both in a technical sense and through the introduction of new procedures.

**Technical Innovation**

- CREST enabled payment banks to monitor in quasi real-time the use of credit by CREST market user clients.
- CREST provided a facility by which a bank could offer a client both an unsecured credit limit and a secured limit driven by a bank-specified haircut on the securities held in the client’s own account. This enabled banks to manage and monitor market and credit risk, and improved settlement performance through efficient use of cash.
- CREST placed no restrictions on membership of CREST, except technical competence. This reduced barriers to competition.

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- Collateral for bank or stock loans was standardised as CREST enabled securities houses/market makers to fund their overnight equity positions by delivering a basket of varied securities of a specified type in exchange for cash borrowed from a cash rich entity such as an insurance company, the delivery to be reversed at the start of the following day.
- As well as near real-time settlement, CREST offered periodic optimisations (“circles”) designed to improve settlement efficiency and thus reduce the costs and risks of settlement failures.
- CREST provided functionality for processing corporate actions ranging from simple dividends to complex optional events.
- CREST led the European move to standardise messages and processes to enable clients of one CSD to access securities native to another CSD, to help development of the single securities market. It introduced CDIs (CREST Depository Interests) to increase the investment options available to CREST clients.

**Procedural innovation**

- In order to improve efficiency further, CREST pioneered a “settlement discipline” regime, based on league tables of performance, and introduced fines for failure to meet set performance standards. Some 18 years later, these will become mandatory across the EU.
- CREST insisted on improved asset and account reconciliation, which was often done monthly or even longer, becoming a daily function task for registrars; custodians and other CREST settlement members quickly adopted the same approach.

**Business Benefits**

- Streamlined processing and created near real-time management of settlement risks.
- CREST enabled reduction in the settlement cycle, which reduced operational and credit risk.
- CREST settlement of a greater volume of transactions, without increasing users’ overheads and risk.
- CREST improved management control of the settlement process.
- CREST improved the operational environment by eliminating manual and mundane practices.

**5 REASONS WHY CREST SUCCEEDED**

There are many reasons why CREST succeeded and is still working well after 20 years. This section outlines, in no particular order of preference, five.

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**Early good decision making:** The design being based on successful Bank of England systems (CGO for gilts and CMO for money markets), and in the selection of two network providers, SWIFT and BT, enabling choice and allowing users to negotiate the best deal.

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**Starting the work on creating the legal environment:** Travers Smith worked tirelessly with a dedicated CREST team member (Mark Kirby) from the beginning, to ensure the necessary changes in law were achieved on time, with the Treasury, UK ministers and Parliament, and the House of Lords, supporting the changes. Without its expertise, the system may well have been delayed, with subsequent costs for the industry.

**INDUSTRY TRAINING**

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**Communication to the industry:** The enormous efforts to keep ongoing dialogue with the industry (users) to ensure they fully understood the system, how to operate it and the benefits gained. The Securities and Investment Institute (now the CISI) had a massive role in the success of CREST, by training the people in the industry to be able to make the difficult transition from paper to an electronic world.

**WAS CREST A DISRUPTIVE TECHNOLOGY?**

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**Strong leadership and teamwork:** In Iain Saville and Pen Kent, [who was superseded by Scott Dobbie] the industry had the right men, at the right time, to lead the project. This was evident in the CREST project team selection and their performance. The focus on getting the job done and meeting deadlines and the discipline it instilled in the industry, created confidence and certainty that success would be achieved.

**WHY HAS CREST CONTINUED TO WORK SUCCESSFULLY FOR 20 YEARS?**

**Industry collaboration:** The effort by the industry, from Government down and all market sectors impacted, plus their suppliers, was extraordinary. It demonstrates that large infrastructure projects and systems, can be implemented, if there is a united will and focus to achieve the objective. The open, coherent and frequent communication by the CREST team was a necessary condition for creating united will.

**COULD ANYTHING HAVE BEEN DONE BETTER?**

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The high quality of the flexible and forward-looking design of CREST was the major reason why it has stood the test of time and is still relevant to today. The fact that transaction volumes have grown since CREST implementation to levels that could never be predicted, and the system is still functioning, is a lasting testament to the correct decisions of the CREST project team and the industry as a whole, in investing in and pushing through, all the changes necessary to get the system live on time.

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Arguably there was a weakness in that the UK government did not set a date when all paper share certificates would be eliminated; but the new processes for sales and purchases worked extremely well even in the frenetic volumes following privatisations of major businesses.

**ABOUT BISS RESEARCH**

The CREST project was about people making good decisions in a time conscious manner, which drove the project forward to start at the early end of the target date range. There were problems all along the phased introduction to full live running, but all the problems were overcome one way or another. This says a lot about how the industry en masse, reacted to the challenge of the project and made it succeed.

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**THE BIRTH OF CREST**

Although the CREST project started in 1993, the drivers for settlement modernisation can be traced back to a number of historic developments. For example, in the early 1980s, government privatisation programs created a large increase in shareholder ownership and an increase in retail investors actively trading in the markets, fuelling an increase in transactions. This dramatic increase in trade volumes happened whilst the underlying operation was paper-based, and unsettled bargains built up in back offices leading literally to piles and piles of paper.

Government policies, such as deregulation of the securities markets, allowed large domestic and foreign banks to buy stock exchange member firms, which led to the financial “Big Bang” in October 1986, resulting in massive amounts of capital flowing into the City of London, fuelling a boom in investments, which resulted in an increasing number of transactions.

Paper based certificates in combination with dramatically expanding volume of transactions, led to the settlement crisis in London, which was aggravated by the Global Stock Markets crash in October 1987.

Although, the London Stock Exchange (LSE) had designed and implemented the Talisman settlement and accounting system, which partly eliminated paper from the settlement process by electronically matching transactions (or “bargains” as they were known at the time). Paper based procedures produced a bottleneck creating risks and costs. Long lines of trades remaining unsettled and snail-mail postal services did not allow a fast enough turnaround for buy and sell transactions. This resulted in people selling shares that had not been legally registered into their name, not once, but many times. Inevitably firms and people began to own illiquid assets and by the time of the crash in 87, paper losses were beginning to be reflected in bank accounts, which occasioned defaults. Consequently, settlement risk became an issue of concern. Thus it became clear that significant changes were required.

Subsequently, the Group of 30 (G30), established in 1978, came up with 15 recommendations for the financial markets, which included the reduction of the settlement cycle from once a fortnight to T+3 rolling settlement. The LSE’s response was the TAURUS project.

TAURUS was initiated as a project that looked similar to the creation of Talisman, but this time the users, firms and structure organisations impacted were quite different. Vested interests and weak management created unending development, as change requests mounted at an alarming rate, with costs and implementation timescales continually increasing.

The communication process for TAURUS was incoherent because there were more than 30 industry committees working on it, without strong central oversight and co-ordination by the LSE.

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No one, not even the members of SISCOT, (Securities Industry Steering Committee on TAURUS), had a good overview, in consequence no one dared to assess and challenge it, with the needed rigour, which led to uncritical thinking, and ultimately disaster struck. Confidence in TAURUS began to trickle away, and that trickle led to a torrent and eventually project abandonment. On 11<sup>th</sup> March 1993 the Board of the LSE suspended work on TAURUS, having informed the Bank of England a couple of days earlier.

**CALAMITY, CALAMITY, WHAT TO DO?**

The City of London was the leading financial market in the world, incorporating every major international banking firm, as well as leading firms from the insurance and foreign exchange markets. There were a large number of cross-border transactions and IPOs being conducted through SEAQ International - the London Stock Exchange's automatic quotation, dealing system and it was essential for the UK Government and the UK economy that London was able to continue to maintain its dominant position, both internationally and with regards to continental Europe.

Having been informed by the LSE of the cancellation of the TAURUS project, the Bank of England established a task force to propose a new solution for an electronic central settlement service. Pen Kent led the task force ably supported by a small team. After 16 weeks of research and consultation with several hundred financial organisations and market experts, the report was presented in June 1993. One month later, Iain Saville was appointed to lead the CREST project team.



"Why do you say we should go paperless?"

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## THE CREST PROJECT

### WHY DID IT SUCCEED?

One of the most obvious responses that people give as to why CREST succeeded, is that it was because it followed the TAURUS disaster. This has some weight, as it reflects the perceived urgency and the need for change, but is in no way, the overall answer. It belittles the many difficult barriers that had to be surmounted. The genius of the design simplicity, and the enormous effort and skill of the project team and the support from many important areas of industry.

### BUILDING CONFIDENCE

TAURUS cost the industry an estimated £400m, but in all likelihood it was much more. Fresh from this outlay firms were being asked to fund another project. So the first barrier was to gain market confidence that this time, investment would produce the

*“Scaling up for industry projects requires buy-in from the various actors at the beginning...”*

desired result. The CREST team gained confidence through an extensive consultancy phase that was as personal as it was correspondent. It had to continually win the right from the industry to build the system, and give

direction and leadership. Not all was plain sailing, as discussions and arguments with various industry sectors and individuals had to be won. This, over the time of the project became less, as the industry as whole accepted CREST and the project team.

### CORPORATE STRUCTURE

The corporate structure of the new company CRESTCo, encouraged users to become stakeholders, which created a momentum to succeed and meet targets, and in the early days helped to quickly establish CREST. The structure had four subscription bands, allowing small firms to have a stake alongside larger ones. Thus, investing in the new system, gave them a direct interest in its success.

This decision avoided one of TAURUS’s many problems, where vested interests protected the status quo, rather than achieved an effective outcome.

### COMMUNICATION

CREST was very different from TAURUS, the relationship between the CREST project team and the industry and ultimately the CREST users was a text book case of good relationship management, with communication flowing two ways and continuous action to move the project forward.

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Interaction with industry was streamlined by Pen Kent, Iain Saville and the CREST team. Project communications with the City were highly controlled, but industry user groups were in direct contact with the core team and dissemination of information was carefully coordinated through rigorous internal CREST processes.

*“The communication process for TAURUS was incoherent...”*

**PROJECT TEAM**

Unlike TAURUS, the initial CREST project team was small consisting of; Hugh Simpson, Paul Symons, David Wyatt, Caroline Lee, Mark Kirby, Peter Ross, Brian Goode, Ian Dowglass and Larry Webb, with a flat management structure working under Iain Saville and Pen Kent. They maintained absolute authority and control, creating trust in the markets.

**PROJECT CULTURE**

The project culture within the CREST team was instrumental in its overall success and established a good model for future generations to follow. The CREST team established a behaviour pattern where they were able to interact with different industry groups and market sectors.

The development strategy, structure and support model was established very early on and then modified throughout, being transmitted to the clients by the team, who built a collective responsibility with the industry. No them and us!

The innovation of solutions was dynamic, with regular white boarding sessions, written reporting and internal, as well as very frank external, discussions, where assumptions were assessed, challenged and criticism was encouraged.

It was by creating this dynamism that individuals felt an important part of the overall solution design.

*“Strong leadership can also be demonstrated by deciding to change the plan...”*





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In considering how CREST created and innovated, the five determinants of strategy, structure, support mechanisms, behaviour and communication (see diagram below) can be used to explain how CREST’s organisational culture led to innovation.

*A more detailed analysis of the practical application of these determinants will be published in a separate report in the CREST series.*

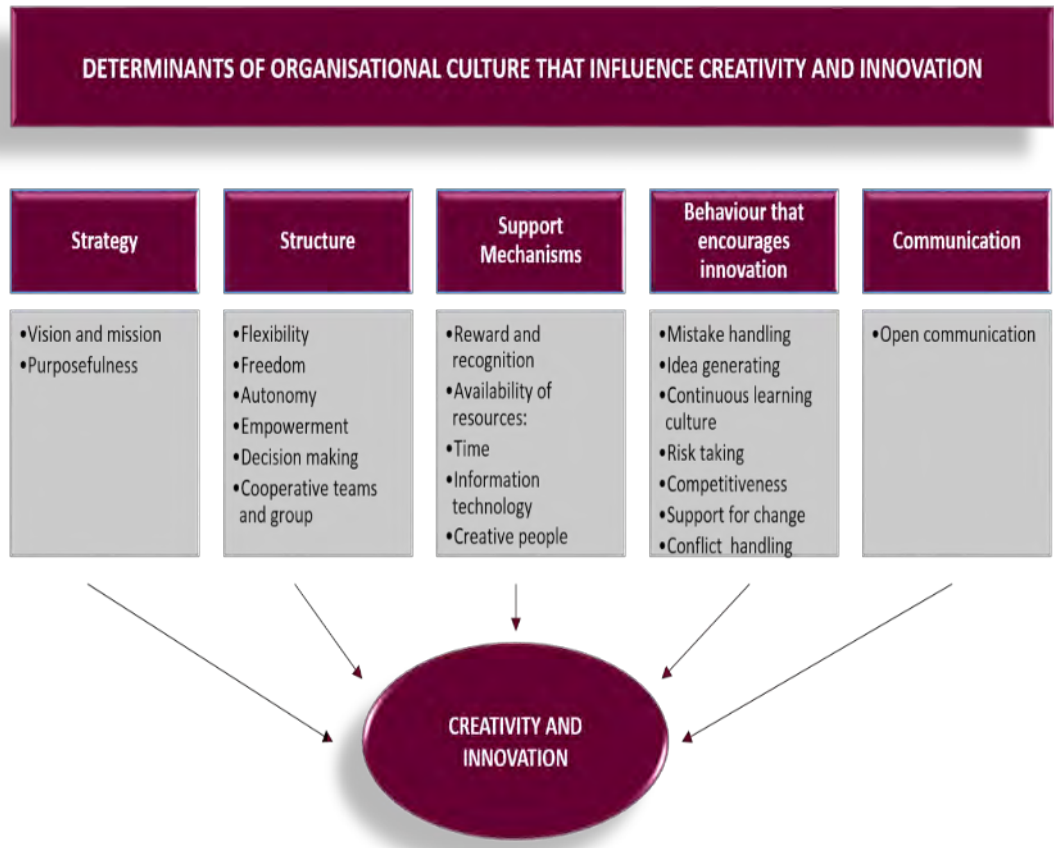


Figure 3: Influence of Organisational Culture on Creativity and Innovation  
 Source: Martins and Terblanche (2003, p.70)

**CREST DESIGN & INNOVATION**

The core proposal for CREST was laid out in the report of the Task Force on Securities Settlement to the governor of the Bank of England in June 1993. The report analysed the situation and set criteria suggesting the design of CREST. The report outlined the core capabilities, but did not present detailed specifications. These had to be developed by the CREST project team, with frequent testing at progressively greater levels of detail with the market, before finalising the design of each business area.

The Central Gilts Office System (CGO) and the Central Money Office(CMO), both designed and operated by the Bank of England, had a strong influence upon the initial design of CREST. Both systems were working successfully and this will have been in the minds of the creators.

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*“CREST created a massive learning curve for the industry...”*

CREST faced and overcame many challenges in providing functionality beyond that of the CGO and CMO to meet the requirements of the equity market. As a bonus, the clarity and simplicity of its design allowed CREST to be developed to support Gilts and other financial money market products.

There was a marked difference from TAURUS, where the complexity of the design and over ambition in its implementation were some key factors in its failure. CREST had as much ambition as TAURUS, but benefited from its easy to understand and focussed deliverables for initial launch.

**TESTING**

Phased and careful testing at many levels is crucial for successful implementation and ongoing live operation. Bugs and faults found during technical, and then internal user testing must be rectified in an internal test environment, without being exposed to the full glare of users (especially since if found in live operation) losses of money, confidence and risks can be substantial. Especially, loss in confidence of the new system. An essential process in internal projects and system upgrades, but in the introduction of new industry-wide systems upgrades, its importance is magnified many times over. CREST was launched without users incurring any major disruption and no losses. Its careful and thorough testing was key in achieving industry acceptance and success.

Testing can also heighten user understanding, reinforce training and assist with the introduction of new procedures. This was achieved in CREST through the cooperation of industry groups/firms and suppliers all working towards the sound of the drum that CREST, was by this stage, beating loudly.

Weekends and other various times were set aside to test the network connectivity and connectivity with CREST users (FS firms) and within their operations. Testing scripts were created for both industry sector and overall industry use, but also within users’ firms and their system suppliers. Arguably this was one of the best tested projects of the last century.

Coordinating and managing the results of the tests was centrally managed by CREST alone, with some oversight by its regulator, then the Securities and Investments Board (SIB), which became the FSA in 1997.

Industry preparedness was a key issue to be addressed, and CREST devoted significant resources to helping struggling firms. Ensuring that each CREST user was adequately prepared to use CREST was important, but not vital. Some firms found they could not cope and outsourced their back office to those who could.

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<p><b>EXECUTIVE SUMMARY</b></p>	<p>CREST did have some post live problems, but these were successfully managed by CRESTCo and we could find no evidence during the research that any material losses were incurred. At one point the proposed live dates for extra securities to enter CREST were delayed; but the migration finished on time.</p>
<p><b>THE BIRTH OF CREST</b></p>	
<p><b>THE CREST PROJECT</b></p>	
<p><b>NETWORK COMPETITION</b></p>	<p>That fact that CREST succeeded as it did, is a testament to the quality of the test plans and the industry as a whole, and their willingness to work collectively towards a shared objective.</p>
<p><b>INDUSTRY TRAINING</b></p>	<p>Although testing can't be flagged as a primary reason for CREST's success in completing migration, and subsequently in many other major deliveries of functionality, there is no doubt it was a very significant factor in establishing CREST and creating confidence across the industry in the new system and the new company CRESTCo.</p>
<p><b>LEGAL</b></p>	
<p><b>WAS CREST A DISRUPTIVE TECHNOLOGY?</b></p>	<p><b>IMPLEMENTATION</b></p> <p>Streamlining and improving efficiency and reducing risk were the core aims of CREST implementation. Moving from a certificated paper based environment to an electronic dematerialised environment, a significant benefit, but reducing the settlement cycle would help to reduce credit and operational risk. CREST was designed to handle a shortening settlement cycle, and in fact from the start of live operation, T+0 was available, and increasingly used for collateral-based transactions.</p>
<p><b>IMPACT</b></p>	
<p><b>WHY HAS CREST CONTINUED TO WORK SUCCESSFULLY FOR 20 YEARS?</b></p>	<p>Prior to the introduction of CREST, the settlement cycle was originally a two-week account cycle. In preparation for the implementation of CREST, this was changed to ten day rolling settlement (T+10) in July 1994. A year later it was reduced to five days (T+5) and in 2001 to T+3. Nowadays, it is T+2, which was introduced in October 2014. This meant that the industry had to change their systems to accommodate rolling settlement. Implementation of CREST on an industry wide-scale was achieved through strong CREST leadership, detailed planning and cooperation of registrars/financial intermediaries and suppliers.</p>
<p><b>COULD ANYTHING HAVE BEEN DONE BETTER?</b></p>	
<p><b>WHAT LESSONS SHOULD BE LEARNED?</b></p>	<p>Whilst reduction of the settlement cycle was achieved reasonably quickly, reduction in the use of paper certificates and transfer forms took much longer. During migration, CREST organised the admission of specified issuers entering CREST at regular intervals.</p>
<p><b>RESEARCH METHODOLOGY</b></p>	
<p><b>RESEARCH SPONSORS</b></p>	<p>Many user firms created shareholder accounts in CREST to hold client assets as well as proprietary assets: either as a pooled nominee account, a pool with designation of the shareholder, or as a CREST "sponsored account". This provided control in the industry rather than a mass dematerialisation all in one go.</p>
<p><b>THE RESEARCH TEAM</b></p>	
<p><b>ABOUT BISS RESEARCH</b></p>	<p>Unfortunately, some might say, the government insisted that it was the legal right of shareholders to retain paper certificates if they wanted to, so whilst there was a vast reduction in paper share certificates, share certificates are still held by some shareholders today.</p>

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CREST decided to create competition regarding network suppliers, with the objective of providing choice for CREST users in order to reduce costs. An open licensing process was created, and the result was that two suppliers; SWIFT, owned by the banks, which operated a private network and Syntegra (BT) a commercial network, passed the stringent tests of security and performance.

It's likely that most firms in the Stock Broker/Investment Manager sector of the market had never considered network costs in their operation before CREST. Talisman costs might be the nearest and there is evidence in some quarters that connectivity charges to CREST, were actually less than for Talisman.

**SWIFT**

At the time of the CREST development, countries around the world were very protective of their settlement systems. Euroclear and Clearstream using SWIFT, operated a connectivity network between separate jurisdictions. [Today, Target 2 Securities (T2S) is the Eurozone provider to CSDs of seamless cross border settlements, and also has competing network providers.]

Long before the introduction of CREST, the SWIFT network provided a way of sending payment messages, authorising movement of funds. In the late eighties SWIFT opened up its network for securities messages. Messages were sent in ISO7775, which had been developed for payments. The result was chaos, with industry initiatives set up to resolve the problem. Notably US and European ISITC worked to specify an industry solution, which emerged as ISO15022 in the early 2000s.

In the absence of acceptable standards, CREST specified its own proprietary DEX messages, which are still being used today. SWIFT had to adapt to this extra set of standards, as well as meeting standards related to security, resilience and performance. (Unfortunately, development to unify DEX messages with ISO15022 was never undertaken.) So at the time that CREST was being created SWIFT would not have necessarily been an obvious choice. However, SWIFT's network had established levels of resilience and customer support that made the network very secure and reliable.

The CREST project presented SWIFT with the opportunity to extend their capabilities into the securities post-trade markets and gain new customers. The decision by CREST not to enforce its own monopoly connectivity was virtually unique in Europe; SWIFT had a rare chance to become a key component of a national settlement system.

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**BT (SYNTEGRA) NETWORK**

Syntegra (part of BT) was the bidding supplier at the time CREST was being created, but for the purposes of this report we will refer to them as BT.

BT had to make a decision whether to bid for a licence or not, and based their eventual decision on the likelihood that CREST would succeed. BT viewed the CREST project as a national imperative that the UK government would make sure succeeded. As such it offered BT a significant opportunity to penetrate further into financial markets and gain prestige. Achieving increased market share within the UK financial markets was a BT objective, and in terms of the number of firms that signed up to BT, they succeeded beyond initial expectations.

*“BT played an active role in CREST succeeding in its objectives, by introducing high quality technology and a secure environment ...”*

As one of the world’s largest commercial network suppliers and developer of modern technology solutions for financial markets, BT’s bid to be a CREST network supplier was clearly logical based on the fact that the vast majority of financial services firms that would become CREST users would have BT as a supplier in their offices.

Like SWIFT, BT had to make sure its network met the high standards set by CREST, covering security, resilience, performance and technical support to users and CREST. BT created a bespoke team to make sure they could support CREST and its users every minute of the day, with specific policies and controls all concentrated on maintaining the highest standards possible.

CREST astutely utilised the knowledge and power of BT to good effect and concentrated on managing and building the solution, whilst maintaining an ongoing dialogue with the network provider. This was a clever ploy by CREST although exacting on managing the relationship, as in effect CREST was accrediting their network suppliers. BT decided to compete on all levels to win CREST based business customers.

BT played an instrumental role in CREST succeeding in its objectives, by introducing high quality technology and a secure environment, which for many of its users was the first time they had gained such benefits.

BT built upon relationships with existing customers by extending their services into back office operations. This was an important starting point to the use of electronic messages and the digitisation that we see today.

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## INDUSTRY TRAINING

One of the less lauded reasons why CREST succeeded, was due to the timely creation and provision by the CISI, of the industrial strength training and examination programme, which had to succeed in order that users would be able to operate CREST settlement. The training had to be designed to meet user requirements, whilst the system was being created. This was achieved and carried out successfully.

The changes in post-trade operations that resulted in the introduction of CREST created a massive learning curve for the industry, which had to be mastered before implementation. If CREST was to be a success.

CREST introduced different terminology, processes and concepts to post-trade operations, which had to be understood by many people with a long history of working in a Talisman environment. How to ‘teach old dogs new tricks’ had to be overcome!

As well as CREST training, new internal systems were being introduced by firms to connect to CREST and this required supplementary in-house training.

To enable a virtual army of back office settlement people to be sufficiently trained to operate the CREST system across the whole industry, the CREST project team worked with the Securities Institute, formed in 1982, now known as the Chartered Institute for Securities and Investment (C.I.S.I.).

### THE C.I.S.I.

*“It is testament to the effectiveness of management at the CISI that this massive industry training programme was accomplished in time for CREST’s live running.”*

The C.I.S.I. created the CREST syllabus and exams, with a lot of help from the CREST team, and the assistance of its member firms, and managed the training and certification of individuals. In addition to providing their own training courses, the CISI engaged with external training companies to deliver the training in order to meet the demand flooding into their offices.

Today, the CISI continues to lead the way in training new entrants in the financial services industry and has expanded its reach globally. It also partners with Schools, Colleges and Universities to offer qualifications and career education for young people who want to learn about the industry.

Through its networking events, professional forums and interest groups, it provides continuous professional development to enable experienced industry professionals to remain updated on all the latest business, regulatory and technological changes in the Industry.

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CREST required the introduction of new laws and amendment to existing laws. It was vitally important that the design of CREST was able to, not only supply operational efficiency, but that it was legally robust.

*“The early selection of Travers Smith was instrumental in CREST being able to meet the regulatory targets set by the government in time for implementation in 1996.”*

The importance of combining technology, design, and operational objectives with legal necessity, is not always appreciated and Travers Smith fulfilled a vitally important role in achieving this, which should be recognised as a fundamental component in CREST’s success and in the history of the City.

Travers Smith worked closely with the CREST team in negotiations with the various vested interests within the markets. These vested interests had played a big part in the failure of TAURUS, but with CREST, hard work in negotiation and persuasion paid off. This could only have succeeded with strong leadership and a strong relationship between the legal and project teams.

Travers Smith were unique in that they were involved in both TAURUS and CREST. This resulted in knowledge gained through the TAURUS project of the legal issues involved by moving from a materialised to a dematerialised environment. This expertise would have provided a distinct advantage for the CREST project and was surely a factor in their selection by Iain Saville. (This demonstrates that important lessons can be learned from challenging circumstances.)

Travers Smith was able to offer CREST a broad range of complementary legal expertise, both domestic and international, including knowledge on securities, payments and operation with CCPs, which would have produced significant benefits throughout all phases of project delivery.

Liaison with many industry groups throughout the industry was vitally important in building an understanding of the legal issues that CREST was raising and then being able to solve them in an equitable way. Lively exchanges of view built knowledge exchange that mushroomed beyond the meeting room and deepened understanding throughout the industry of legal matters that were previously little known.

Contracts with CRESTCo had to be drawn up across all parties impacted by CREST: users, payment banks, registrars and network providers in particular. It was a huge undertaking that ran in parallel, whilst the system was being built.

This was yet another example of the core delivery team, which fully included Travers Smith, building trust through relationships with intelligence, hard work and skill.



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<b>EXECUTIVE SUMMARY</b>	Significant changes in law were required to secure users of CREST: in particular the Settlement Finality Regulations and the Financial Markets Insolvency Regulations.
<b>THE BIRTH OF CREST</b>	At a later stage, getting direct access to central bank money to support the safety of CREST settlement was a crucial improvement, a major step that Travers Smith helped CRESTCo to obtain from the Bank of England.
<b>THE CREST PROJECT</b>	
<b>NETWORK COMPETITION</b>	It cannot be underestimated the amount of effort required to bring different market sectors in line and negotiate the swings and roundabouts benefits. There were organisations who were poles apart, with different agendas and objectives that had to be won over to enable CREST to succeed. This behind the scenes effort laid the groundwork for CREST and along the way gathered support through the negotiation and legal design process. A further example of the CREST design working in tandem with legal advice was the creation of the escrow account to enable acceptances in corporate actions.
<b>INDUSTRY TRAINING</b>	
<b>LEGAL</b>	
<b>WAS CREST A DISRUPTIVE TECHNOLOGY?</b>	CREST gave much attention from the beginning to legal protection of the buyer's immediate and absolute right to shares from the outset, through equitable title. Further, new law was made to ensure that legal rather than equitable title was achieved at the moment of settlement. Accordingly, although the movement of legal entitlement in CREST was established, it was not activated in 1996, but some years later. It was the legal positioning of this possibility that eventually allowed this to happen seamlessly, moving it from the Registrars to CREST.
<b>IMPACT</b>	
<b>WHY HAS CREST CONTINUED TO WORK SUCCESSFULLY FOR 20 YEARS?</b>	The UK government played a major role in promoting secondary legislation related to the Companies Act through both houses of Parliament.
<b>COULD ANYTHING HAVE BEEN DONE BETTER?</b>	The Treasury and the CREST team had a solid understanding, which was a crucial element in improving legal certainty, and was a commendable example of government working closely with industry, with strong legal support.
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## WAS CREST A DISRUPTIVE TECHNOLOGY?

Whether a technology is disruptive or not can be assessed by looking at the time period in which change was achieved, and at the degree of the resulting performance improvement. A disruptive effect happens if the time period is rather short and the performance increases dramatically.

Although the CREST software experienced some teething problems once volumes had increased after its launch, by the end of 1996, the most significant of outstanding issues were rectified. Overall, CREST achieved the transition process in a remarkably short time.

In November 1996, CREST was being used by about 1000 investing institutions, brokers and banks settling over 10,000 transactions per day in 571 securities, accounting for around 25% of the total market volume of transactions at the time.

In July 2001, CRESTCo announced that the number of transactions had increased to around 300.000 transactions a day with a value of around £200bn. This means that in a time period of five years the performance was increased thirtyfold. Such a performance improvement would not have been possible by traditional paper-based techniques and the existing Talisman system.

The fact that CREST enabled the processing of much higher numbers of electronic transactions was disruptive for settling trades, predominantly those struck on the London and Irish Stock Exchanges in UK and Irish securities. It is therefore fair to say that CREST was a truly disruptive technology.



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## IMPACT

CREST had a huge range of diverse impacts that changed not only processes and systems, but also some people’s lives. Some are obvious, whilst some are not. The obvious ones are market actors; banks, brokers and investors. Less obviously, software suppliers and even postal workers. *A more detailed analysis of the areas impacted by the introduction of CREST will be outlined in a further report in the CREST Research series.* However, a summary table is given below that briefly outlines these impacts.

Political	<ul style="list-style-type: none"> <li>• CREST enabled the UK to cement and retain its international dominant position as the leading financial centre in the European time zone. The economic value of CREST to the UK was incalculable.</li> </ul>
Economic	<ul style="list-style-type: none"> <li>• Efficiencies - Improved management of the financial position of participants.</li> <li>• Cost efficiencies.</li> <li>• Increased capacity and transaction volumes.</li> </ul>
Social	<ul style="list-style-type: none"> <li>• Provided necessary data and operational efficiencies that enabled good accounting practices, also brought accounting into the transaction process flow.</li> <li>• Creation of the oversight structure, benefiting the users, their bank and investors/clients.</li> <li>• Positive impact on London as a leading financial centre.</li> <li>• Improved working environment, especially for the back office employees.</li> <li>• New skill sets</li> </ul>
Technological	<ul style="list-style-type: none"> <li>• Post trade transformation, automating back office processes.</li> <li>• Direct –increased efficiency, reduced cost, increased security and reduced risk.</li> <li>• Indirect – when combined with other technologies, i.e. SWIFT, Syntegra, database technologies, increased the impact.</li> <li>• Driver for the new generations of software vendors and new technologies development based on CREST design.</li> <li>• Enabled new software houses to enter the market.</li> </ul>
Legal	<ul style="list-style-type: none"> <li>• Legal framework.</li> <li>• Corporate governance.</li> <li>• Regulations and standards.</li> </ul>
Environmental	<ul style="list-style-type: none"> <li>• Dematerialisation - massive reduction of paper.</li> </ul>
Industry	<ul style="list-style-type: none"> <li>• Industry impact manifested in all of the above and was immediate, due to the number of firms involved.</li> <li>• Increased capacity, increased efficiency, reduced settlement cycle, reduced settlement risk, operational risk, credit risk, reputational risk, increased safety in the settlement cycle risk.</li> </ul>

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**WHY HAS CREST CONTINUED TO WORK SUCCESSFULLY FOR 20 YEARS?**

Settlement of financial transactions is a complex and difficult field, with historically based relationships that have evolved over many years. New technologies introduced over decades, new laws and regulations have all helped to create the markets we have today. Typically, nothing was designed by the UK market with market efficiency in mind, rather it has been reactive. However, CREST provided a unique opportunity to innovate and create a new market model.

Clearly CREST was designed for purpose in 1993, but it’s a remarkable feat that it has been able to meet all the settlement needs over the intervening years, and carries on doing so today.

*“Its design has enabled CREST to cope with; increasing transaction volumes and reducing settlement cycles, with T+0 within its technical capability.”*

It was multi-currency from the outset, therefore the introduction of a new currency, such as the euro, held no problems.

CREST is extremely competitive in terms of speed and low cost, being accepted as a value for money system.

The corporate structure of CRESTCo was a key factor in its longevity, as it helped to ensure the ongoing use of the CREST system, by its stakeholders. CREST users have continued to support the system, resulting in total integration to provide the DNA, within modern systems, which have replaced some of the original systems, designed to provide CREST connectivity and settlement functionality. To the extent that CREST has become part of the industry furniture, where it sits almost unquestioned by its users because it is reliable, it works and gives them what they want.

The test of a good design and system can be found in its longevity and relevance over time. In CREST we can find an example of a solution, which has achieved such benchmarks.

It is highly unlikely that there will be a scenario where CREST will be replaced, like Talisman was two decades ago. Most likely CREST will continue to be upgraded technically and modernised by its current owners. Today, CREST operates under the umbrella of Euroclear as an important and high performing component of the European post-trade infrastructure.

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## COULD ANYTHING HAVE BEEN DONE BETTER?

CREST was designed to become the single settlement system for the UK and Irish securities market. The achievement of this objective is an outstanding success. But the London Stock Exchange was characterised by a broader set of interests, such as international cross border trading. Thus settlement of these trades were of still greater importance to the City of London financial markets, its actors and the UK in a wider context. Integration with other European post trading infrastructure providers could have been beneficial.

CREST's response was to seek to interoperate with other European CSDs, while leading work for standard protocols and messaging that would permit those CSDs to make one IT investment, reusable with multiple interoperating CSDs. This work (under the auspices of the European CSD Association, of which Iain Saville was chair) had widespread support from CSDs and smaller users, but large users of multiple markets argued for cross-border mergers of CSDs, ideally culminating in a single (user owned) European CSD. As a result, interoperability did not succeed. It has however been adopted by CCPs, with great success.

Euroclear acquired several domestic CSDs, including CREST in 2002. Euroclear had the ambition of moving all its domestic CSD businesses on to a single platform, but had to relinquish that idea, partly because harmonising markets sufficiently, proved very hard to accomplish.

In the event, the Eurosystem of Central Banks delivered (2015) T2S, a single settlement platform for all Eurozone countries, and encouraged the necessary harmonisation by national authorities and markets.

The UK Government could have set a date when all shares would be held electronically, removing the option for paper certificates to have legal value, or be proof of entitlement. This would have enabled significant cost savings for custodians and sub-custodians.

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When discussing CREST, the unique historic context has to be taken into account. However, there are a range of features regarding the project management of CREST which can be the basis for lessons learned.

CREST was implemented under intense pressure within the CREST project team, but also (after a sanity check of the CREST team's skills and logic) by industry actors, eager to void a TAURUS like disaster. The UK Government and the Bank of England needed to ensure that the UK remained in its global position as one of the three leading financial markets along with New York and Tokyo, and the dominant player in the European time zone. The stakes were very high and the pressure to succeed was enormous.

Wrong decisions would have been expensive, not only in monetary terms, but also in reputation and confidence, in delivering a workable solution. While the historic context of CREST and the project is unique, there are lessons that might be learned for today's projects no matter what the scale.

- Managing complexity requires getting top management commitment and this must be demonstrated to project managers and the users on a public platform. Scaling up for industry projects requires buy-in from the various actors at the beginning. It must be managed throughout to ensure confidence remains high, so the result is never in serious doubt. Marketing the benefits and retaining focus on deliverables will help keep buy in secure.
- The project team must keep responding to the needs of the users. This assistance keeps the relationship with various actors within the project strong and helps to overcome problems when they arise. The users must not be kept in the dark, to be constructively part of problem solving, make them feel an important part of delivering the solution.
- CREST was created in a crisis, but does a crisis help, or make things even more difficult? It can do both! It's important that like the CREST project team, there is focus on a successful outcome.
- Strong decisive leadership is fundamental in progressing along at a good pace and in meeting the milestones of a project. However, strong leadership can also be demonstrated by deciding to change the plan if a wrong turn has been taken. Whilst listening and responding to requests of actors can be a sign of strong leadership, it can also indicate weakness, if every wish is granted causing time and focus to be lost. Ultimately, as with TAURUS, this tends to cause project failure. So it is important to get the balance right.

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- Creating a project and solution in a crisis requires getting many more decisions right than wrong while under time pressure, but also skills in recognising and recovering quickly from wrong decisions. In turn, this requires flexibility and the self-confidence to admit mistakes early on.

The CREST project was not perfect, but it was good at developing and propagating design ideas to engage the users, and making workable compromises.

There is evidence that most of those involved – users and the core team – positively enjoyed the ride, however stressful it was at times, because of the friendly tone of the interaction between supplier and clients. This may well be a critical success factor when delivering a complex project.

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Interviews were conducted in person and via telephone, between June and September 2015, with people who were intimately involved or impacted by the CREST project. It was intended that the scope of the interviewees would be as broad as possible, covering different market sectors and suppliers, as well as government and legal advisors. The objective was to get a big picture view and then delve deeper into specifics, by follow up conversations.

On site interviews were hosted by London Metropolitan University. All the interviews were recorded and transcribed, printed out and entered into an analytical programme to aid the researchers.

Furthermore, business news articles were collected, covering a decade of CREST's development and operations, dating back to the initiation of the project in 1993 up to 2002, when CRESTCo was acquired by Euroclear to become Euroclear UK and Ireland (EUI), and the following year 2003, while the settlement system adjusted to changes in leadership, culture, structure, etc.

Scientific databases were screened and 57 relevant articles from reliable sources like the Financial Times were identified. These documents helped to contextualise the development of the settlement system and add another dimension to the findings.

Additionally, the researchers were given access to various internal and external documents of the CREST project, including the original report by the Task Force (the "Golden Book") from June 1993

BISS held regular online meetings to discuss the themes identified and at which 3 & 4\*academic conferences, and journals these should be targeted. The researchers met at writing retreats in Cambridge and London. On these occasions, the researchers also presented their ongoing work to key actors of the CREST project. Alongside peer review, this process became an essential part of the research methodology allowing the researchers to get additional feedback, providing further guidance and insights.

During the course of the research a number of academic themes were identified and the relevant literature and prior research reviewed. Initial presentations at conferences provided very positive feedback proving the relevance of the contribution, based on a rich data set, and the attractiveness of the case study.

An important contribution of the CREST research to academia is that it created a novel way and method of how academics and renowned industry expert practitioners can collaborate to the benefit of both parties.



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Euroclear UK & Ireland’s investment funds service uses the CREST system for the settlement, reconciliation, transfer and corporate action events processing of mutual funds held in the UK and Ireland.

Euroclear is the financial industry’s trusted provider of post-trade services providing settlement, safekeeping and servicing of domestic and cross-border securities, from bonds and equities to investment funds. We connect financial market participants across the globe and ensure securities transactions are processed safely and efficiently. As an open and resilient infrastructure, we help clients cut through complexity, lower costs and mitigate risks.

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**DR HERMANN RAPP**

Hermann is an academic researcher and technologist with a research interest in banking technology, financial markets operations and project management leading the CREST Research. He has over 10 years of industry experience in software, project management and banking.

Since 2010 he worked as a Senior Lecturer at Anglia Ruskin University in Cambridge and Chelmsford, and previously for other UK and European universities. He has presented his research at major European and UK conferences and is a fellow of the Higher Education Academy (HEA), and a member of the European Operations Management Association (EurOMA), and the British Accounting and Finance Association (BAFA). He is the editor of a forthcoming book to be published by Springer, about new technologies in the financial industry. His current research projects focus on information systems research, data standards for financial markets, business intelligence and analytics.



**DR CRISTIANA PARISI**

Cristiana Parisi completed her MA in Accounting at the University of Florence, Italy, with first-in-class honours in September 2004. She received her Ph.D. degree in Accounting from the University of Florence in April 2008. Her Ph.D. project was conducted in collaboration with the Centre for Corporate Social Responsibility at Copenhagen Business School) and was focused on the performance management of sustainability within a leading pharmaceutical company based in Copenhagen (DK). Currently, Cristiana holds an Assistant Professor position in Management Accounting at the Operations Management Department of the Copenhagen Business School (CBS) after being a Postdoctoral Fellow in Management Accounting at the University of Southern Denmark from October 2008 to June 2011. Cristiana also completed the three-year training program required to become a licensed public accountant. The training provided her with relevant work experience in the fields of Management and Financial Accounting.

Cristiana Parisi's research interests lie in the area of management accounting and mainly focus on the conditions and consequences of the implementation of management control technologies within organisations. Her research interests are interdisciplinary, and they are both qualitative and quantitative in nature. Cristiana's work explores the pervasive and enabling characteristics of performance management practices and spans the areas of sustainability accounting, auditing, and accountability. She performs single- and multiple-case qualitative analysis as well as structural equation modelling applications.

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**ALFIA BRIDGEMAN, RESEARCH ASSISTANT**

Alfia is the research assistant for the CREST research team. She has participated since the very early stages of the research project, and took part in data collection, data analysis and literature review. She supports the research team by applying her knowledge of analytical programmes and management skills, and has become an invaluable asset to the team.

Alfia is about to graduate and receive an MBA degree from Anglia Ruskin University having written a dissertation on the impact of venture capital on Fintech start-ups. In the last years she has started a family and founded a successful design business with her husband. In 2006, Alfia earned a Business Management BSc with honours at CASS Business School and at the Kazan Federal University with outstanding results. Based on her studies in management sciences, Alfia is now focusing on her research interests in financial technologies (Fintech).

B.I.S.S. Research would like to extend its thanks to Dr Marta Gasparin from Leicester University, for her assistance in the initial stages of the project. Unfortunately, Marta had to leave the research team at an early stage due to other commitments.

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If you were involved with, or impacted by, the introduction of CREST and would like to contribute to the research.

Please contact Dr Hermann Rapp to discuss.

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