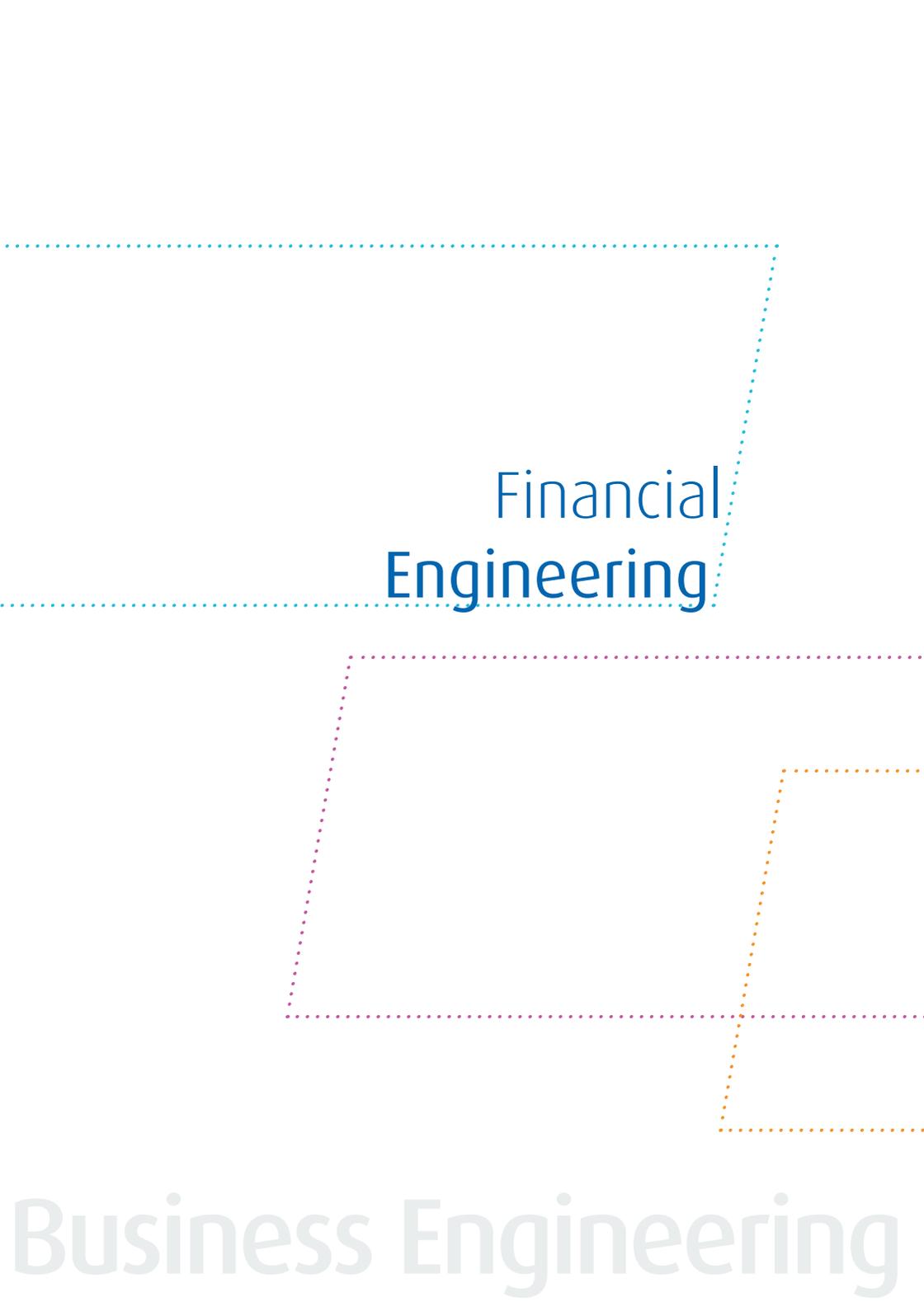


Financial Engineering



Master in Business Engineering

Business Engineering



Financial
Engineering

Business Engineering

Introduction

As an effect of the 2008 and 2011 crises, financial professions have come under fire and often though not always rightly so.

The financial function, indeed, remains as crucial as ever in our economies for irrigating them and managing efficient resources. Hence, it is essential for responsible and capable graduates to take the lead in future in order to keep past and present abuses in check. Through its Financial Engineering orientation, HEC Liège ambitions to train these future executives to become most competent and responsible and thus restore public confidence in financial technicians.

The Financial Engineering orientation, which by nature is highly quantitative, therefore, aims at training highly-skilled graduates in the modelization of financial instruments and markets while keeping a sharp eye for possible excesses and the "end-to-end" control of the financial transmission processes to the economy.

This orientation program is taught entirely in English.

Objectives

The program aims at providing students with the methods and techniques needed to take an active part to the creation, management and control of financial products and services with a high scientific and technical added value. An emphasis is placed on mastering the concepts and techniques and the opportunity to use them in an innovative environment.

This specialization is geared towards students drawn to leading financial professions and willing to strengthen their skills by additional training in the areas of mathematical finances or actuarial services. To date, it has no equivalent in the Master's programs. Students taking this direction make a deliberate choice for an international working environment.

Students choosing this orientation can expect to develop the following skills:

- Thorough knowledge of institutions, financial markets and assets, of the principles governing their functioning and/or use.
- A command of the concepts and issues as they specifically relate to asset and risk management;
- An ability to identify price formation and risk emergence mechanisms so as to control the conceptual and technical aspects of market and banking finance;
- A command of the technicality of financial operations through developing innovative-calculation and optimization procedures;
- Applying the tools and techniques developed throughout their studies, in quantitative and methodological aspects, and through individual or group projects and applications.

Job prospects

This specialization prepares students to work namely in the quantitative departments of financial institutions, in risk management, in the technical departments of insurance companies, in pension funds, or else in the structuring functions of trading rooms or for managers of investment funds, including hedge funds.

Graduates in this orientation will be eligible to the following employment sectors:

- **Asset management professions** (mutual funds/pension funds/hedge funds management etc.) with the idea of portfolio construction;
- **Modelling and complex risk management professions** (use of derivatives, cash, credit, operational) in the financial sector;
- **Investment banking professions** relating to preparing and operationalizing complex strategies regarding the origination, evaluation and exchange of financial securities, including the case of mergers and acquisitions.

Strengths

- **Proximity to the field**, including numerous collaborations with services concerned with portfolio construction, asset management, risk management and consultants specializing in the area of financial modelling;
- **The technical competence of multidisciplinary faculty** combining expertise in financial economics, econometrics, statistics and engineering sciences;
- **Access to a trading room** equipped with tools allowing live testing of modelling techniques and their market implications;
- **An international learning context** as far as both faculty and students are concerned and a large degree of openness;
- **Collaboration with partner enterprises** strongly involved in the Chairs (see p. 13) and proximity with the Gambit spin-off, which is active in developing state of the art systems for investor profiling, portfolio analysis and optimization.

Program

The specialization in Financial Engineering relies on compulsory courses in engineering (55 credits) following which students choose **6 specialized courses** (5 credits each) out of a range of 7 and skills **portfolio** workshops (5 credits). They do an **internship** (10 credits) and a **thesis** (20 credits), all of which spans a period of two years.

YEAR 1

Compulsory courses in **Business Engineering** (45 credits)

+

Financial Engineering (15 credits)

- Financial Mathematics and Stochastic Calculus (5 credits)
- Financial Derivatives (5 credits)
- Investments and Portfolio Management (5 credits)

YEAR 2

Compulsory courses in **Business Engineering** (10 credits)

+

Financial Engineering (50 credits)

- Empirical Methods in Financial Markets - Theory and Applications (5 credits)
- Internship (10 credits)
- Master Thesis (20 credits)
- Skills portfolio (5 credits)

2 courses to be chosen among:

- Droit et fiscalité des institutions financières .
Advanced Corporate (5 credits)
- Finance and Modeling (5 credits)
- Ethics, Regulation & Compliance in Finance (5 credits)
- Financial Data Modeling and Analysis (5 credits)

The contents of the specialization are briefly described in the following pages. Full pedagogical mission statements are available on the ULg site (http://progcourses.ulg.ac.be/cocoon/programmes/G2UING01_C.html#3269589) and on the Lol@ platform used by HEC Liege (<http://lola.hec.ulg.ac.be/>).

First year: 3 compulsory courses

FINANCIAL MATHEMATICS AND STOCHASTIC CALCULUS

The bases of probability theory and stochastic processes are introduced. Then, two families of applications are presented:

- Continuous time stochastic finance (stochastic calculus, option pricing models, interest rate models);
- Risk theory in non-life insurance (compound Poisson process, collective risk process, ruin probability, tariffication principles).

The course objectives are to:

- Give the rigorous mathematical bases of stochastic processes and stochastic calculus;
- Apply these bases to some financial and actuarial models.

FINANCIAL DERIVATIVES

Over the last decades, firms have been increasingly challenged by financial price risks due to unpredictable movements in exchange rates, interest rates and commodity prices. Financial markets have responded to this increase in volatility by developing a continuously growing range of financial instruments, called derivatives, as well as strategies combining these with other traditional financial instruments. As a result, derivative markets have been rapidly increasing in volume for the last decades and derivatives are today recognized as very useful corporate finance and investment tools. Not only the officially exchange traded instruments are very popular as hedging or speculative devices, but also privately arranged or Over The Counter contracts attract a wide variety of customers. Any student in Financial Economics should at least have some basic knowledge of the possible uses, users, and pricing of the most important derivative instruments. In this course we aim to provide such knowledge. At the end of the course students should feel more comfortable about this complex financial environment.

At the end of this course students will be able to

- understand how financial derivative instruments (forward, futures and options) work as well as for what purpose they have been designed;
- design forward-, futures- and option-based arbitrage and hedging strategies;
- build rational forward-, futures- and option- price estimates (including among others Black and Scholes option price estimates);
- get a first introduction into swap markets, understand the role and functioning of swap instruments;
- get a first introduction into credit derivative markets and understand the role and functioning of CDS instruments;
- develop optimal investment strategies integrating financial derivative instruments.

INVESTMENTS AND PORTFOLIO MANAGEMENT

The course follows the whole investment process. Its logical follow-up is the course of Financial Risk Management (BAM, FE, E&F), Financial Risk Modeling (FE, E&F), Estate and Financial Planning (BAM), among others.

This course features in the framework of the CFA Institute University Recognition Program. It spans a significant portion of the CFA Program Candidate Body of Knowledge (CBOK), and explicitly prepares for the CFA certification.

Course structure:

- A - Efficient capital markets
- B - On the way to the CAPM
- C - Multifactor Models
- D - Passive and Active Strategies
- E - Bond Portfolio Management
- F - Alternative Investments
- G - Portfolio Performance
- H - Special topics based on guest lectures (specific material, attendance is compulsory)

Second year: 1 compulsory course and 2 courses to be chosen among 5

EMPIRICAL METHODS IN FINANCIAL MARKETS - THEORY AND APPLICATIONS

The financial world shows a deeper and deeper interest for quantitative forecasting methods. For the broker, having good approximations of future values of his equity portfolio is essential. A financial analyst should always anticipate as well as possible the behaviour of firms in which his clients are likely to invest. In this framework, this course develops different existing methods to treat those problems. Its content heavily depends on students' interests and their professional expectations. Among others, topics in the sequel can be involved.

- Forecasting of seasonal data
- Risk management
- Causality
- Autoregressive moving average models (ARMA models)
- Generalized autoregressive conditional heteroscedasticity models (GARCH models)
- Kalman filter
- ...

DROIT ET FISCALITÉ DES INSTITUTIONS FINANCIÈRES (In French language)

1. Scope

This course aims to introduce students to the legislation and tax regimes of banks and insurance companies, with a view to approaching the legal problems which these institutions face on the one hand and the taxation on their products on the other. Analysis of these products will cover tax aspects of saving and investment products, but also certain hybrid products.

2. Contents

- a. Distinction debt vs. equity. Analysis of certain hybrid products issued by financial institutions.
- b. The banking world. (i) banking products for individuals. Interest, dividends, capital gain and group investments. (ii) Banking products for companies. (iii) Tax regime of investment funds.
- c. The world of insurance. Introduction. (i) Life insurance and income tax. (i) Life insurance and inheritance law. (iii) The success of Luxembourg life insurances linked to individual funds
- d. The end the banking secrecy and the automatic exchange of information. Money laundering.

By the end of the course, students should be able to:

- Demonstrate that they are familiar with concepts relating to the banking and insurance world, such as: money laundering; compliance; the automatic exchange of information (CRS).
- Describe the taxation regime of a savings or investment product (shares and investment bonds, mutual funds, pension plans, life insurance, insurance bonds etc.) or certain hybrid instruments (bonds convertible into shares).
- Identify the problem described in a case, find the legal rules or regulations which are applicable and justify their application;
- Help a third party choose a savings or investment product with full knowledge of the taxation regime.

ETHICS, REGULATION & COMPLIANCE IN FINANCE

The course provides a deep-dive into the main challenges surrounding three dimensions that have become core in the activities of financial institutions after the worldwide financial crisis of 2008:

- **Ethics:** how has the finance profession been reformed in order to promote an ethical behavior, enabling the financial circuits to play their role as an efficient and reliable channel to transfer resources, risks and maturities throughout the economy?
- **Regulation:** an unprecedented wave of rules has been adopted at the supranational as well as the national levels. What are the motives and impacts of the ECB, EU, and national-based legal and regulatory measures on the evolution of the financial community?
- **Compliance:** beyond the mechanical integration of rules and standards of conduct in the financial sector, how is the compliance with these constraints organized and enforced from an organizational perspective?

The course will focus on two types of financial organizations for which these notions are especially relevant, both from an institutional and an environmental (given the particular geopolitical positioning of the Liege region) point of views: banks and investment funds. The prospective structure of the course adopts this splitting approach. For each topic, the course will either be illustrated with relevant experience of finance professionals, or case studies meant to let students appropriate the body of knowledge underlying the key notions of the course.

This course features in the framework of the CFA Institute University Recognition Program. It spans a significant portion of the CFA Program Candidate Body of Knowledge (CBOK), and explicitly prepares for the CFA certification.

FINANCIAL DATA MODELING AND ANALYSIS

Organization and Contents

- A. MATLAB, Excel... for financial modeling
- B. Financial statement forecasting
 1. Review of theory and concepts
 2. Modeling examples
- C. Time Value of Money
- D. Bond models
 3. Modeling the term structure
 4. Duration
 5. Bond pricing
- E. Equity models
 6. Simulating stock prices
- F. Portfolio models
 7. Efficient portfolios
 8. Estimating betas (+Kalman filter)
 9. Black-Litterman
 10. Value-at-Risk
- G. Option-pricing models
 11. Binomial option pricing
 12. Black-Scholes model
 13. Option Greeks
 14. Portfolio insurance

FINANCIAL RISK MODELING

"Financial Risk Modeling" introduces students to a set of techniques for measuring risks in financial portfolios. The course is not about risk management but about risk measurement and modeling. Lectures are divided into two main parts. The first part focuses on measuring market risks. The second part presents a few real life, practical issues in financial risk management and demonstrates how stochastic processes can help model these.

Part I: Modeling market risk (M. Lambert)

As initially emphasized by Markowitz, the two relevant characteristics of an asset portfolio are its expected return and the dispersion of possible returns around the expected return, i.e. the standard deviation of returns. Presuming risk aversion, rational investors will choose to hold efficient portfolios, i.e. those that maximize the expected return for a given degree of risk or, alternatively, minimize risk for a given level of expected return.

Modules 1 and 2 on "How to model market risk" reviews Modern Portfolio Theory by emphasizing the limits of a Markowitz analysis. We first focus on the challenge in estimating the input parameters (Module 1) and the need for higher-moment measures (i.e. beyond the mean-variance) (Module 2).

Module 3 on "How to achieve risk diversification" challenges the hypothesis of the value-weighted portfolio as a proxy for the efficient portfolios. It introduces students to fundamental indexing and smart beta strategies.

Part II: Stochastic processes and financial risk modeling (F. Boniver)

In this part, we present a few real life issues in financial risk management and show how stochastic processes can help model those. The focus is on the link between mathematical ingredients and business needs, rather than on theory or applications only.

As a starting point, we observe that the quantitative studies involving stochastic processes that are carried out nowadays in financial institutions relate to (at least) one of the two paradigms made up by the "real-world" and the "risk-neutral" measures. We thus focus on three practical sample cases (making up course modules) that enable us to discuss relevant features of stochastic processes in a financial setting:

- Valuation of assets according to a risk-neutral probability
- Strategic Asset Allocation simulations under the real-world probability
- The mixed case: direct (internal model) measure of market risk under the Solvency II regulations

The first case lets us present two fundamental theorems of asset pricing involving the equivalent martingale measure, and illustrate it on the very classical but informative pricing of a European call option in both discrete and continuous time, in the models of Cox, Ross, and Rubinstein, and of Black, Scholes, and Merton. The second case links with the first part of the course by showing how stochastic processes can support an optimization quest for the risk/return combination. The third one introduces students to a state of the art application of financial risk modeling combining both paradigms: the estimation of a high-order quantile (Value-at-Risk) of some value-in-the-future distribution.

Keywords: asset pricing, call option, derivatives, martingale, equivalent martingale measure, strategic asset allocation, Monte Carlo simulations, Value-at-Risk (VaR), Solvency II, (insurance company) solvency.

ADVANCED COPORATE FINANCE AND MODELING

The course provides students with a comprehensive understanding of the key capabilities CFOs need to acquire in order to create a successful finance function: How to perform diagnostics on company's operating performance? How to lever on the key value drivers and improve its performance ? How to design value creating investment, financing or distribution strategies? How to generate external growth inside the company and structure a buyout (due diligence, buyout process and debt-quasi equity financing)?

The course also introduces students to equity research and fundamental analysis (sector, industry and company) with all its applications in portfolio management and company acquisitions (private deals).

Especially, the course provides students with

- modeling tools and advanced techniques for capital budgeting and firm and equity valuation;
- tools to conduct a fundamental analysis (due diligence) about one company;
- an opportunity to develop a thorough understanding of how financing as well as the firm's dividend policy could affect the market value of the firm and distort investment decisions;
- tools to design sound corporate strategies at each point of the firm financing cycle (leveraged recapitalization, leveraged buyout, management buyout);
- financing tools (senior versus junior debt, bullet debt, mezzanine financing, debt push down mechanism, paid-in-kind and cash interests, club deals and syndication);

The course is structured as follows:

Introduction: Financial analysis (ratio analysis, vertical and horizontal common-size statements) and review of firm valuation techniques and capital budgeting

Part I: Fundamental equity analysis and equity research: sector, industry, company due diligences, private equity and leveraged buyout. Alternatives to the Free Cash Flow to the Firm approach (Free cash flow to the Equity) and Residual Income Approach (with applications for impairment tests).

Part II: Advanced techniques in Valuation and Capital Budgeting (NPV and sensitivity analysis, Monte Carlo simulation, decision trees, real options, ...).

Part III: Corporate decisions and firm value (capital structure and inefficiency costs, dividend policy and stock repurchases, corporate governance - agency theory and compensation package)

Conclusions drawn on the firm financing cycle (LBO, MBO, LR, ...)

Internship/Master Thesis

In order to fulfil the requirements of their training at HEC Management School of the University of Liège, all students of a 120-credits master program are to perform an internship in a company and to write a master thesis in the second year of their studies.

As concerns the practice-based thesis, the internship and the master thesis are strongly interrelated and defined within the scope of the student's chosen specialization.

As concerns the research thesis, the internship and the master thesis are defined within the scope of the student's chosen specialization but not necessarily interrelated.

Students choose one of the following two options:



10-week Internship

Students do an internship in a company lasting over the first 10 weeks of the academic year (from mid-September to end-November).

The internship can be done within a private (either commercial, financial or industrial) or public enterprise, a semi public institution or an international organization. The internship is based in Belgium or abroad and is generally not remunerated.

Students choosing this internship option are bound to do a Research-Paper as an ESP (end-of-study project). Those choosing the internship as integrated within the Project-Paper are to refer to the last option detailed hereunder.

For more details: go to the «10-week internship» menu available on LOL@.

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Research-thesis

Students are expected to deliver a master thesis treating an original research problem to be defined within the scope of their chosen specialization. The master thesis presents rigorous scientific analysis and constitutes a contribution to the field of research. It demonstrates the theoretical knowledge that students acquired during their master studies and their ability to apply this knowledge critically in order to build and propose some original, creative and viable solutions to a complex management problem.

For more details: go to the «Research-Thesis» menu available on LOL@

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Practice-based thesis

Students writing a practice-based thesis analyze a complex management problem arising in a private or public organization located in Belgium or abroad. The studied problem must be original and related to their chosen specialization. The practice-based thesis makes use of rigorous scientific analysis in order to demonstrate the theoretical knowledge acquired by students during their training as well as their critical thinking and problem solving skills.

Students begin the practice-based thesis by working one day a week in the company during the first semester and deepen their analysis within the framework of a 10-week internship in the second semester of the second and final year of their studies.

For more details: go to the «Practice-based Thesis» menu available on LOL@.

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Associated Chairs

The faculty coordinating this orientation have considerable influence through three chairs enabling them to avail themselves of resources and close collaboration with their sponsors:

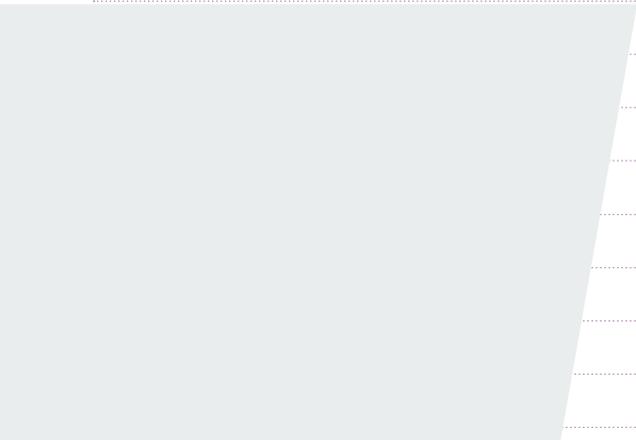


The Ethias Chair in Risk Management is managed by Laurent Bodson, Affiliate Professor of Finance. The Ethias Chair seeks to develop research and teaching methods in the field of financial risk management. In particular, several applied research projects and workshops have been organized in order to develop reporting of the management of the assets of an insurance company.



The Deloitte Chair in Financial Management and Corporate Valuation is held by Marie Lambert, PhD University of Luxembourg and University of Liège. This collaboration, which is over 10 years old, pools the expertise of Deloitte Belgique, Deloitte Luxembourg and HEC Liege with the view to make significant advances in the field of asset and private management, to better understand management processes and to influence the control processes of financial performance.

Notes



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Contact & information

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